An Investigation into the Effects of the Use of Financial and Operational Hedges on Australian Corporate Foreign Currency Risk Exposure

Thesis submitted by

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STATEMENT ON SOURCES

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I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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ABSTRACT

The purpose of this thesis is to investigate the effects of the use of financial and operational hedging on foreign exchange rate exposure among Australian multinational corporations. Since the flotation of the Australian dollar at the end of 1983, Australian firms have become increasingly exposed to foreign exchange rate risk. To eliminate this risk, Australian firms have undertaken substantial corporate hedging programs, which are both financial and operational in nature. It is notable that there has been an increase in financial hedging techniques such as derivatives and foreign-currency denominated debt, and operational hedging such as diversifying and spreading subsidiaries across foreign countries. Despite the substantial involvement in corporate hedging strategies, there is a paucity of Australian research studies examining the relationship between the use of financial and operational hedging by firms and their levels of foreign exchange rate exposure.

A two-stage market model was used to investigate the main research problem using a sample of 62 Australian multinational corporations. The first-stage model - Jorion's (1991) model – was adopted, to test the first hypothesis of whether there exists a relationship between stock returns and changes in exchange rates, by estimating the exposure coefficients to foreign currency risk during the period from January 2000 to December 2004. Next, the second-stage model utilised cross-sectional regression models to examine the effects of the use of financial hedging, separately and/or in combination with, operational hedging on foreign exchange risk exposure. This second-stage model was estimated for the 2004 financial year data to test seven hypotheses. These seven hypotheses were related to whether the use of financial separately, or in combination with, operational hedging effectively reduced exposure. Therefore, eight main research hypotheses were tested in the study.

Findings of the study were that there is only weak evidence to support the hypothesis that stock returns were sensitive to changes in value of the Australian dollar. It was found that the use of foreign currency derivatives was significantly related to exposure reduction. The use of foreign debt was also found to be significantly related to exposure reduction, indicating that foreign debt is used for hedging purposes. Furthermore, the combined use of these two financial hedging strategies was found to be significantly associated with the exposure reduction. By the same token, these two financial hedging strategies were found to be substitutive to each other in reducing exposure. Operational hedging proxies were also significantly associated with the exposure reduction. This latter finding indicates that, for the purposes of hedging, firms diversify and disperse foreign operations and subsidiaries across countries and geographical regions. In addition, the combined use of financial and operational hedging was found to be negatively associated with exposure. Finally, the use of financial hedging was found to complement operational hedging in reducing exposure.

The models used in this study could be applied to further research into the relationship between the use of financial and operational hedging and exposure. This could be achieved by using different time spans, different markets (countries) data, and larger samples, together with other measures. As Australian firms are greatly exposed to foreign exchange rate risk and consequently are heavily involved with financial and operational hedging activities, the results of this study could be beneficial to corporate managers, individual and corporate investors, researchers, derivatives designers and regulators.

JEL classification: F23; F31; F37; G30; G32

***Keywords*:** foreign exchange risk exposure; multinational firms; International Finance; financial Risk management; operational hedging; financial hedging; financial derivatives.

PUBLICATIONS FORM THE RESEARCH

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TABLES OF CURRENCY SYMBOLS AND ABBREVIATIONS

CURRENCY SYMBOLS

The following currency symbols are used frequently in this dissertation:

AUD	Australian Dollar
CAD	Canadian Dollar
CHF	Swiss Franc
CPAM	Capital Asset Pricing Model
EUR	European Union Euro
FJD	Fijian Dollar
GBP	United Kingdom Pound
DM	Douche Mark
HKD	Hong Kong Dollar
IDR	Indonesian Rupiah
INR	Indian Rupee
JPY	Japanese Yen
KRW	Korean Won
KWD	Kuwait Dinar
MXP	Mexican Peso
MYR	Malaysian Ringitt
NOK	Norwegian Krone
NZD	New Zealand Dollar
PHP	Philippine Peso
SAR	Saudi Arabian Riyal
SBD	Solomon Island Dollar
SEK	Swedish Krone
SGD	Singapore Dollar
SUR	Russian Rouble
THB	Thai Baht
USD	United States Dollar
ZAR	South African Rand

ABBREVIATIONS

The following abbreviations are used frequently in this dissertation:

3SLS	Three-Stage Least Squares
AASB	Australian Accounting Standards Board
ABS	Australian Bureau Of Statistics
ADF	Augmented Dickey-Fuller Test
AGSM	Australian Graduate School of Management
AIET	Australian International Equity Trust
AOI	All Ordinary Index
APT	Arbitrage Pricing Theory
AR	Autoregressive Order Scheme
ARCH	Autoregressive Conditional Heteroskedastic
ARMA	Autoregressive Moving Average
ASX	Australian Securities Exchange
BIS	Bank For International Settlements
BLO	The percentage of shares held by block-holders
BLUE	Best Linear Unbiased Estimators
CAPEX	The percentage of capital experditures to total assets
CLRM	Classical Linear Regression Model
CMT	Capital Market Theory
CPAM	Capital Asset Pricing Model
CR	Current ratio
DER	Derivatives to Total Assets Ratio
DF	Dickey-Fuller Test
DIR	The percentage of shares held by directors
DW	Durbin-Watson Test
EBIT	Earnings Before Interest And Taxes
EMH	Efficient Market Hypothesis
EMS	European Monetary System
Eq(s)	Equation(s)
EWI	Equally-Weighted Index
FASB	Financial Accounting Standards Board
FCD	Foreign Currency Derivatives
FDD	Foreign Currency Denominated Debt
FDI	Foreign Direct Investment
FS	Foreign Sales Ratio
FX	Foreign Exchange
GARCH	Generalized Autoregressive Conditional Heteroskedastic
GDP	Gross Domestic Products
GLS	Generalized Least Squares
GMM	Generalized Method Of Moment
HERF1	Herfindahl Index 1 (country level)
HERF2	Herfindahl Index 2 (geographical region level)
IAS	International Accounting Standards
IMF	International Monetary Funds

INS	The percentage of shares held by institutions
IPC	International Parity Conditions
IRR	Internal Rate of Return
LEV	Leverage ratio
LM	Lagrange Multiplier
MERM	Multilateral Exchange Rate Model
MLE	Maximum Likelihood Estimation
M-M	Modigliani and Miller Theorem
MNCs	Multinational Corporations
MSCI	Morgan Stanley Capital International
NAB	National Australia Bank
NAFTA	North American Free Trade Agreement
NPV	Net Present Value
NRC	The natural logrthim of the number of subsidiaries per country.
NRF	The natural logrthim of the number of subsidiaries per geographical region.
NSGM	The number of business segments
NZ	New Zealand
OLS	Ordinary Least Squares
OTC	Over-the-Counter
p.a.	Per Annum
PER	Price-to-Earnings
POT	Pecking Order Theory
PPP	Purchasing Power Parity
RBA	Reserve Bank of Australia
RD	Research And Developments
RIP	Real Interest Rate
ROA	Return on Assets
SASB	Statements of Accounting Standards Board
SDR	Special Drawing Right
SFE	Sydney Futures Exchange
Size	Firm Size
SIZE	The Size of the firm
SUR	Seemingly Unrelated Method
TWI	Trade Weighted Index
TWIVER	Trade-Weighted Index Value Excess Return
U.K.	United Kingdom
U.S.	United States
UEH	Unbiased Efficiency Hypothesis
UIP	Uncovered Interest Parity
VaR	Value-at-Risk
VWR	Value-Weighted Index
WLS	Weighted Least Square

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CHAPTER ONE

INTRODUCTION TO THE THESIS

1.0 STRUCTURE OF CHAPTER ONE

Chapter one presents the foundations of the research study. It comprises an introduction to, and justification for, the research study. The statement of the research question, and the research hypotheses to be tested, are stated. Data selection procedure and sources, and methodologies are discussed. Findings and empirical results of the study are also briefly summarised. Delimitations of scope and key assumptions are also outlined. This Chapter also includes a plan for the remainder of the study.

1.1 INTRODUCTION

The collapse of the fixed foreign exchange rate regime in the early 1970s, and the increasing globalisation of business in the last three decades, have resulted in many firms finding themselves increasingly exposed to exchange-rate volatility.[1] An unexpected change in exchange rates is considered to be a major source of risk (uncertainty), which potentially affects both individual investors through their portfolios, and the values of firms with domestic and international investments, through their competitive positions. Foreign exchange risk exposure refers to the degree to which the value of a firm is potentially affected by unexpected exchange

[1] The Australian dollar was floated in December 1983 (RBA, 2003).

rate changes. Since this exposure can affect the firm's current and future cash flows, there is a vital need for specifically designed strategies to manage it. The process whereby a firm seeks to protect itself from unanticipated changes in exchange rates is known as hedging. The underlying aim of hedging is to establish an offsetting currency position for the firm, so that, whatever is lost or gained on the original foreign currency exposure will be, as much as possible, offset by a corresponding gain or loss on the currency. The increased use of corporate hedging strategies has triggered considerable interest among financial markets researchers over the last three decades.[2]

To manage the risk generated by foreign exchange rate volatility, firms have adopted both financial and operational hedging strategies. Financial hedging refers to both derivative financial instruments ('derivatives') and foreign-currency denominated debt. Derivatives financial instruments (forwards, futures, swaps and options) have proved to be the most popular financial hedging technique with a healthy growth in use over the last three decades. In addition, there has been a growing trend in the use of foreign-currency denominated debt (foreign debt hereinafter).[3] For example, corporations issue foreign debt to hedge foreign currency cash flows with offsetting interest payments. This requires a firm to have net debt in the currencies in which it has positive exposure or net debt in currencies which are highly correlated with the exposed currency. Therefore, it is not surprising that many empirical studies have

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[2] Modigliani and Miller (1958), Myers (1977), Myers and Smith (1982), Stulz (1984), Smith and Stulz (1985), Shapiro and Titman (1985), DeMarzo and Duffie (1995), Bessembinder (1991), Nance et al. (1993), Froot et al. (1993), Tufano (1996), Berkman and Bradbury (1996), Geczy et al. (1997), Howton and Perfect (1998), Haushalter (2000), Allayannis and Ofek (2001), Di Iorio and Faff (2002, 2003a), Nguyen and Faff (2003b, 2006), Hagelin (2003), El-Masry (2006a), and Al-Shboul (2007), among others).

[3] The previous literature considered foreign debt as a natural hedging strategy which should be undertaken under a swaps derivatives umbrella (see e.g., Nguyen & Faff, 2003b). However, the present study considers foreign debt as a separate and an independent financial hedging strategy.

found support and have argued that the both financial hedging techniques are effective in reducing foreign exchange rate exposure (e.g., Kedia & Mozumdar, 1999, 2003; Keloharju & Niskanen, 2001; Berkman, Bradbury, Hancock, & Innes, 2002; Elliott, Huffman, & Makar, 2003; Chiang & Lin, 2005; Nguyen & Faff, 2003b, 2006). However, it is necessary to indicate that firms may engage in using these hedging startegies for speculation pusrposes (Allayannis & Ofek, 2001, Hegalin, 2003).

While it is true that these financial hedging techniques have sufficient ability to hedge the firm's short-term (transaction) exposure, they are not effective in reducing long-term (operating or economic) exposure (Chowdhry & Howe, 1999; Hommel, 2003; Wong, 2003, 2005). To hedge operating exposure, firms have started implementing operational hedging strategies to reduce long-term foreign exchange rate exposure. An operational hedging strategy is the process whereby firms diversify and disperse their foreign operations across foreign countries and geographical regions, not only to reduce costs, but also to eliminate foreign exchange rate exposure (see Allen & Pantzalis, 1996; Doukas et al., 1999; Carter et al., 2001, 2003; Kim et al., 2005; Gleason et al., 2005; Al-Shboul, 2007). This strategy results from that such corporations have followed the Foreign Direct Investment (FDI) scenario to create value by extending and expanding their operations abroad, thus establishing an effective hedging strategy for long-term exposure. These long-term operating policy adjustments are costly and difficult to reverse. It follows that they are most effective when the firm possesses a network of multiple operating units, which span many businesses and geographic areas. In sum, the increasing popularity of FDI together with the volatility of exchange rates and the integration of the Australian economy into the global markets require considerable attention among researchers and market participants in investigating the impact of operational hedging on foreign exchange rate exposure.

Although Australian firms are exposed to both the short-term and long-term exposures and have actively been engaged in using both financial and operational hedges, there is a lack of Australian academic literature investigating the impact of the use of financial and operational hedging on foreign exchange rate exposure reduction. For example, the Australian studies which investigated foreign exchange risk hedging programs, have concentrated only on investigating the effects of the use of financial hedging on foreign exchange rate exposure (e.g., Nguyen & Faff, 2003, 2004, 2006; Al-Shboul & Alison, 2007a) without investigating the effect of operational hedging on exposure. Therefore, the present study also contributes to the literature by investigating the impact of the combined use of financial (currency derivatives and foreign debt) and operational hedging on the exposure to foreign currency risk.

This research study is a comprehensive investigation into the effects of the use of financial and operational hedges on foreign exchange rate risk exposure of Australian-based multinational corporations.

1.2 JUSTIFICATION FOR THE STUDY

The general rationale for implementing this study is to provide a comprehensive conceptual framework concerning foreign exchange risk management to the various

Australian market participants, including managers, investors, researchers, and regulators. This is undertaken specifically by modelling the impact of the use of financial and operational hedging on corporate foreign exchange rate exposure. Although it is known that Australian firms use these hedging strategies, the lack of research studies investigating this topic encouraged the author to select Australia as a suitable environment for proceeding with the current study.

The market for foreign exchange is the most heavily traded of all the global financial markets. Trading in this market is undertaken by organizations, and individuals, in support of management of assets and liabilities in different currencies, to facilitate the international trade of goods and services and also to profit from movements in exchange rates. The daily average turnover in this market is significant with trading taking place at any time of the day across several time zones. In April 2004, the Bank for International Settlements (henceforth: BIS) conducted a triennial survey of foreign exchange markets and estimated that the global average daily foreign exchange turnover was around USD1.9 trillion, up 56% from the 2001 figure (BIS, 2005). Since the floating of the Australian dollar in late 1983, the Australian foreign exchange market has grown considerably and is now a highly liquid and globally integrated market. In 2004, the Australian market was the seventh largest in the world, with daily spot trading in all currencies growing from USD4 billion daily in 1985 to over USD81 billion in April 2004. The Australian dollar was the world's sixth most heavily traded currency (RBA, 2005a). This dramatic increase in the size of the Australian foreign exchange market over the past two decades provides another justification for conducting this study.

Another reason for conducting this study is that the Australian dollar has become more volatile since its flotation in late 1983. This volatility may be due to the increase in the size of the Australian foreign exchange market, as the increase number of foreign exchange transactions may generate market uncertainty, which may finally impact the stock returns of Australian multinational corporations. For example, Boulton, Dungey, and Parkin (1990) and Edison, Cashin, and Liang (2003) reported that there was an increase in the volatility of the Australian dollar over the flotation period compared with the pre-flotation period. Therefore, the volatility of Australian dollar in recent years has further increased the importance of foreign current hedging, and a need for a study on their implications, have motivated the author to undertake this study.

A further justification for conducting this study relates to the high transparency of the Australian capital markets and the existence of a financial infrastructure, which is among the most developed in the world. Many types of sophisticated financial instruments are traded in the Australian capital markets on a basis competitive with that for the same types of products and services traded in other international financial markets. In recent years, it has been recognised that Australian firms are heavily engaged with different types of hedging strategies, both operational and financial designed to protect their assets and liabilities denominated in foreign currencies. To this end, considerable amount of financial derivatives are used. In April 2004, a Bank for International Settlements (henceforth: BIS) survey estimated the average daily global turnover in the Over-the-counter (henceforth: OTC) derivatives markets to be USD1.2 trillion, a rise of 112%, at current exchange rates, compared to the April 2001 figure (BIS, 2005a). In 2004, a survey by the RBA reported that the total daily derivatives turnover in Australia averaged USD18 billion, an increase of 47% on the amount reported in its 2001 survey with currency options accounting for more that 70% of the increase (Becker, Debelle, & Fabbro, 2005; RBA, 2005a). The heavy involvement with these instruments by Australian firms in recent years strengthens the justification for conducting this study.

In recent years, Australian firms have increased their use of foreign-currency denominated debt (natural hedging). For example, the 2004 survey conducted by the RBA reported that the aggregate foreign currency debt of Australian entities amounted to AUD252 billion in 2005, compared to a total of AUD165 billion in March 2001 (Becker et al., 2005; RBA, 2005). In addition, Nguyen and Faff (2006) observed that for Australian firms, approximately 55% of their total debt, on average, is denominated in foreign currencies, during the period 1999 to 2000. Firms may borrow in foreign currencies both to diversify their sources of funds and to hedge their foreign exchange rate risk. This use of foreign-currency denominated debt by Australian firms is of interest to financial market participants and provides another justification for, the author to undertake this research study.

Australian corporations have been heavily involved with the establishment of foreign subsidiaries and the relocation of their production overseas. For example, the Australian Bureau of Statistics (ABS) reports that the level of Australian investment abroad reached AUD658.5 billion at 31 December 2004, compared with AUD506.2 billion at year end 2001, an increase of AUD152.3 billion (i.e., approximately 23%) (ABS, 2005, p. 95). In particular, Australian direct foreign investment (FDI) accounted for around AUD262.1 billion at end year 2004, compared to around

AUD214.7 billion at year end 2001, increasing by AUD47.4 billion (i.e., approximately 18%) (ABS, 2005, p. 95). While there may be several reasons for this increased FDI (see e.g., Dunning, 1998; Hezai & Pauly, 2003), little research attention has been paid to investigating the relationship between the operational flexibility resulting from this geographical diversification and the potential for the management of foreign currency exposure. Therefore, this provides further justification for conducting this Australian study.

Another reason for conducting this study is that the Australian businesses and foreign exchange rate environment are somewhat unique and different from businesses and foreign currencies exposure effects of the other developed economies such as U.S. and European Economies. This is because the Australian economy presents unique varaibles and challenges that may explain the causes and effects of the relationships between hedging strategies used to reduce foreign currency exposure by Australian firms. These varaibles would explain these relationships in a better way rather than corporations in other countries. For example, size of the market, the types of owenership structure and southern himospher economies and commodity-based economy are the varaibles that could make this study a unique research to be conducted.

To conclude, although other justifications might possibly be drawn, the reasons indicated above are considered sufficient rationales for the implementation of the current study.

1.3 STATEMENT OF THE RESEARCH PROBLEM AND HYPOTHESES

The primary research problem addressed in this study is stated as follows.

Is the use of financial and operational hedging effective in reducing corporate foreign currency risk exposure?

The research is restricted to:

1. the foreign currency risk exposure of Australian multinational corporations for the period from January, 2000 to December, 2004;
2. the recent developments in foreign exchange rate risk management for Australian multinational corporations;

There are several reasons for confining the study to this period, and to this market. These are as follows.

- This sample time period is selected: (1) to avoid, as much as possible, any overlap with the sample time periods selected in previous research studies; (2) to produce up-to-date results for a recent sample period, (3) to study a period in which the Australian dollar (AUD) is volatile (e.g., Boulton et al., 1990; Edison et al., 2003).

- Reliable, historic, share price data are available for all corporations listed on the ASX[4];
- The published corporate annual reports provide a convenient source of information regarding the use of currency derivatives and the amount of foreign debt for each firm;
- The vast majority of the Australian listed firms have foreign operations and/or foreign subsidiaries;

From the basic research problem, and a review of the relevant published theoretical and empirical research, eight main research hypotheses are developed. Most of them are interlinked, and are stated as follows, to test whether:

1. there exists a relationship between exchange rate changes and stock returns;
2. the use of foreign currency derivatives reduces foreign exchange rate exposure;
3. the use of foreign debt reduces foreign exchange rate exposure;
4. the combined use of currency derivatives and foreign debt reduces foreign exchange rate exposure;
5. the use of foreign currency derivatives is a complement to foreign debt in reducing foreign currency rate exposure;
6. the use of operational hedging reduces foreign exchange rate exposure;
7. the combined use of financial and operational hedges reduces foreign exchange rate exposure;

[4] Some difficulties were encountered with (1) the Australian Graduate School of Management (AGSM) share price database (these difficulties are discussed in Chapters 4 and 5), and (2) the corporate annual reports, as not all of them disclosed foreign sales, foreign debts or currency derivatives in Australian dollar terms.

8. the use of financial hedges is a complement to the use of operational hedges in reducing foreign exchange rate exposure;

1.4 CONTRIBUTIONS OF THE STUDY

The main aim of this study is to investigate the effects of the use of financial and operational hedging on the foreign currency exposure of Australian multinational corporations. Since the flotation of the Australian dollar, in late 1983, Australian firms have been substantially exposed to the variability of exchange rates through their future cash flows and their competitive positions (economic exposure, transaction exposure, and accounting exposure). To manage the risk generated by a volatile exchange rate, firms have been adopting both financial and operational hedging strategies.

Financial hedging refers to both derivative financial instruments and foreign-currency denominated debt. Derivative financial instruments (forwards, futures, swaps and options) have been the most popular financial hedging technique which being in a healthy growth over the last three decades. Another financial hedging technique is the use of foreign-currency denominated debt (foreign debt hereinafter). Corporations issue foreign debt to hedge foreign currency cash flows with offsetting interest payments. This requires a firm to have net debt in the currencies in which it has positive exposure or net debt in currencies which are highly correlated with the exposed currency. Therefore, many empirical studies have been supportive and argued that both financial hedging techniques are effective in reducing foreign exchange rate exposure (Allayannis & Ofek, 2001; Kedia & Mozumdar, 1999, 2003;

Berkman, Bradbury, Hancock, & Innes, 2002; Elliott, Huffman, & Makar, 2003; Chiang & Lin, 2005; Nguyen & Faff, 2003, 2006; Al-Shboul & Alison, 2007).

While it is true that financial hedging techniques have sufficient ability to hedge the firm's short-term (transaction) exposure, they are not effective in reducing exposure long-term (operating or economic) exposure (Chowdhry & Howe, 1999; Hommel, 2003; Wong, 2005). Therefore, firms have started implementing operational hedging strategies to reduce foreign exchange rate exposure. An operational hedging strategy is the process whereby firms diversify and disperse their foreign operations across foreign countries and geographical regions to eliminate exchange rate exposure. This process results from following the Foreign Direct Investment (FDI) scenario to create value by extending and expanding their operations abroad and to establish an effective hedging strategy for the long-term exposure. Despite these long-term operating policy adjustments being costly and difficult to reverse, they are most effective when the firm possesses a network of multiple operating units, which span many businesses and geographic areas.

Although Australian firms have engaged in this comprehensive hedging exercise of combining both financial and operational hedges, the Australian academic literature has not paid serious attention to investigating the effect of this combination on foreign exchange rate exposure reduction. For example, the Australian studies, which investigated foreign exchange risk hedging programs, have concentrated only on investigating the effects of the use of currency derivatives on foreign exchange rate exposure (Nguyen & Faff, 2003, 2006; Al-Shboul & Alison, 2007) and/or the effects of the use of foreign debt on exposure (Nguyen & Faff, 2006). These studies reported that these foreign currency derivatives and foreign debt have been an effective hedging strategy for the short-term (transaction) exposure. This investigation has become an area of interest to both researchers and investors because Australian multinational firms are being subjected to short-terms and long-term exposures. Therefore, the present study also seeks to investigate the effect of the use of financial hedging strategies (derivatives and foreign debt) and operational hedging in reducing the exposure. This is because prior Australian studies have investigated only the relationship of the use of financial hedges without paying a research attention to investigate the effect of operational hedging on foreign exchange rate exposure.

To clarify this main contribution, this section provides a brief summary of the eight contributions of the study to the relevant literature. These contributions are specifically related to the research methodologies and empirical findings attributed in the literature to investigate the topics discussed in this study. The contributions are as follows:

1) Foreign exchange rate exposure coefficients

The first contribution of the study relates to the estimation of foreign exchange rate exposure coefficients. Following Adler and Dumas (1984), Jorion (1990) derives his augmented market model to examine the relationship between changes in an exchange-rate and stock returns. This augmented model measures the exposure to foreign exchange risk as the sensitivity of stock returns to changes in the exchange rate after controlling for movements in the stock market. Jorion (1990) indicates that the estimated foreign exchange rate exposure coefficients differ systematically across multinational firms and finds empirical evidence, although "weak", that the firms' stock returns are related to exchange-rate changes.

Exploring the possibility that measurement errors may have been responsible for the weak evidence reported by Jorion (1990), several subsequent empirical studies re-examine this relationship by introducing some modifications and adjustments to the augmented model.[5] Some of these studies report similar findings to Jorion (1990), while others report "stronger" evidence of the sensitivity of firm's stock returns to changes in exchange rates.[6] To apply these modifications to the augmented model, a few Australian studies (Loudon, 1993b; Nguyen & Faff, 2002) used Jorion's (1991) model instead of using Jorion (1990) to examine the relationship between changes in exchange-rate and stock returns. This was because Jorion's (1991) model could be more efficient in providing empirical results as it takes into account the concerns of managers and all market participants about the risk premium as the effects of foreign exchange rate changes cannot be isolated from the effects of interest rates and inflation rates.[7]

These Australian studies investigated this relationship using industry level data (with exception of Benson and Faff (2003) who used a sample of Australian International Equity Trusts). They reported mixed evidence to support the relationship, and

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[5] Within the relevant literature these empirical studies can be grouped into three main phases (see, Chapter 3).

[6] In the light of this inconclusive evidence, Jorion (1991) developed a two-factor arbitrage pricing model to test for the existence of a currency risk premium in equity returns, using 20 U.S. industry portfolios. Jorion's results led him to conclude that stock returns were insensitive to changes in foreign exchange rate indices.

[7] This concern results from the fact that the premium earned by investors, i.e. the extra return obtained from the difference between the risk-free return and the risky return on ordinary shares, might be exposed to foreign exchange-rate risk. This premium compensates investors for taking on the relatively higher risk of the equity market (Ross, Westerfield, and Jaffe, 2002, p. 232). This is why the present study takes the asset pricing model approach to build its model.

overall, they failed to provide significant evidence of a relative sensitivity. In light of these mixed results, and to the lack of Australian published studies, to date, especially in investigating this relationship at firm level, the current study contributes to the literature. This is effected by examining the relationship between foreign exchange rate changes and stock returns using Jorion's (1991) model for a sample of Australian multinational corporations (at the firm level), during an updated data period, from January 2000 to December 2004.

2) The effect of the use of currency derivatives on foreign exchange rate exposure

The second contribution of the study relates to the provision of incremental empirical research results on the relationship between firms' use of foreign currency derivatives and their foreign currency exposures. The mixed and ambiguous evidence provided by previous research studies has stimulated the author's interest in this research question. A primary assumption made by researchers is that the level of this exposure is determined simultaneously by a firm's foreign operations (proxied, for example, by the ratio of its foreign sales to total sales[8]) and its use of foreign currency derivatives. Extending the work of Allayannis and Ofek (2001),[9] Nguyen and Faff (2003b) investigated the effect of the use of derivatives by a sample of Australian firms, using the Generalised Method of Moments (GMM) to estimate their model. Both studies found that the use of currency derivatives was significantly related to foreign currency exposure reduction. However, contradicting results were

[8] The inclusion of the foreign sales to total sales ratio as a proxy for foreign operations was first suggested by Jorion (1990), who argued that a positive foreign currency exposure was created by this proxy.

[9] Allayannis and Ofek (2001) suggested that the positive exposure created by a firm's foreign operations could be offset (hedged) by the use of derivatives. They used the Weighted Least Square (WLS) method to estimate their model.

reported regarding the relationship between the foreign sales ratio and exposure, with Allayannis and Ofek (2001) reporting a significantly positive relationship between the foreign sales ratio and exposure, and Nguyen and Faff (2003b) failing to report such a relationship.

Firstly, the present study contributes to the literature by re-examining the basic relationship between the use of foreign currency derivatives and the absolute value of the exposure coefficients for Australian multinational firms. This is affected by applying the procedure of Allayannis and Ofek (2001), that is, by regressing the absolute values of the exposure coefficients against the use of foreign currency derivatives and the degree of foreign operations. Secondly, the study extends Allayannis and Ofek (2001) and Nguyen and Faffs (2003a) by including variables which are proxies for a firm's ownership structure[10]. The inclusion of these variables follows from Fok, Carroll, and Chiou (1997), who suggested that a firm's corporate ownership structure may have an effect on its propensity to hedge.

3) The effect of the use of foreign debt on foreign exchange rate exposure

It has been suggested that firms might issue foreign currency denominated debt (FDD) as a hedge against the foreign exchange rate risk generated by their foreign operations (for example, (Kedia & Mozumdar, 1999; Allayannis & Ofek, 2001). Issuing foreign debt may enable the firm to match the currencies of its cash inflows and cash outflows, thus mitigating the effects of fluctuations in exchange-rates. Since foreign operations can vary from basic exporting or importing, to more sophisticated

[10] The proxy variables are, namely, the percentage of the shares held by the directors, block-holders, and institutions.

business activities, this policy may require considerable organizational efforts (Kedia & Mozumdar, 2001). Also, the use of foreign currency debt is determined by assets and income type, consistent with agency costs, taxation costs and financial hedging theories (Allayannis, Ihrig, & Weston, 2002).

Some recent studies have investigated the impact of foreign debt on the foreign exchange rate exposure of multinational U.S. corporations, (e.g., Elliott, Huffman, & Makar, 2003; Chaing & Lin, 2005). Overall, these studies report contradictory results[11]. To the author's knowledge, no study to date has examined this topic using Australian data, and this gap in the literature, plus the contradictory results reported in existing empirical studies, has prompted this section of the current study.

The present study contributes to the literature by examining the impact of the use of foreign debt on the foreign currency exposure of Australian multinational corporations. Firstly, the model follows the assumption that the level of foreign exchange rate exposure is determined, simultaneously, by the firm's foreign operations (foreign sales ratio to total sales) and the extent of its foreign currency denominated debt (FDD). The study develops a model which regresses the absolute value of firms' foreign currency exposure coefficients against their use of FDD and their degree of foreign operations. Secondly, the present study includes in the above model, variables to control for the firm's incentive to issue foreign debt. These control variables are, specifically: firm size, leverage ratio, and the current ratio.

[11] One reason for the contradictory results might be differences in the measurement of the foreign debt variable, across the relevant models used.

4) The effect of the combined use of currency derivatives and foreign debt on foreign exchange rate exposure

Multinational corporations employ a variety of financial techniques to reduce or hedge their exposure to changing exchange rates (Bodnar, Hayt, & Marston, 1998; Marshall, 2000). These techniques include foreign-currency denominated debt and foreign currency derivatives. Several research studies have investigated the direct relationship between the combined use of those two financial hedging strategies and currency exposure (Elliott et al., 2003; Chaing & Lin, 2005; Nguyen & Faff, 2006).

While it is true that these studies have implemented the same basic methodology (a cross-sectional regression model), the mixed results are perhaps due to the differing measurement bases, especially for the explanatory and control variables. In light of this, the present study contributes to the literature by re-examining the impact of the combined use of currency derivatives and foreign debt on the foreign exchange rate exposure *of Australian multinational corporations.* The present study is made up of two cross-sectional regression models to test the hypothesis of whether this combined use effectively reduces exposure. The first model regresses the separate proxies for the use of currency derivatives and foreign debt, against foreign exchange rate exposure, with respect to control variables included to testing for the effects of the firm's incentives to hedge. The second model examines the same relationship using an interaction variable, representing the two financial hedging proxies.

5) Foreign currency derivatives complement to, or substitute for, foreign debt

A study by Geczy, Minton, and Schrand (1997) provides indirect evidence that foreign debt and currency derivatives may act as substitutes for each other, in hedging corporate currency exposure. Several other studies (Elliott et al., 2003; Bartram, Brown, & Fehle, 2004; Judge, 2004; Chaing & Lin, 2005) have provided mixed evidence of whether those two hedging strategies act as substitutes for, or as complements to, each other. Rather than being solely a result of differences between the relevant control variables used, the mixed evidence may also be caused by differences in the models used. Some of the studies use a Logit regression model (dependent variable is a dummy variable) (Judge, 2004; Chaing & Lin, 2005), while others use a Probit regression model (dependent variable is a continuous variable) (Elliott et al., 2003; Judge, 2004; Nguyen & Faff, 2006). To the knowledge of the author, there is a lack of Australian research studies examining this hypothesis, and the current study addresses this deficiency. The study controls for firms' incentives to hedge currency risk and their degrees of foreign involvement, by introducing the following control variables: foreign sales ratio, firm size, leverage ratio, current ratio, and research and development expenditure. Further, continuous variables as proxies for both foreign currency derivatives and foreign debt are employed.

6) The effect of the use of operational hedging on foreign exchange rate exposure

While a large amount of empirical research focuses on financial hedging strategies, much less attention has been paid to operational hedging strategy and its direct impact on foreign currency exposure reduction. Some researchers argue that operational hedging, through the diversification of foreign operations, is advantageous for multinational firms in terms of reducing the volatility of cash flows (e.g., Carter, Pantzalis, & Simkins, 2001; Shapiro, 2002). Firms which have operational activities placed in countries whose currencies are not perfectly correlated, benefit from offsetting unanticipated changes in foreign currency exchange-rates. Several studies have attempted to investigate the impact of the use of operational hedges on currency exposure reduction, for different samples of U.S. firms (Simkins & Laux, 1997; Allayannis et al., 2001; Hassan, Francis, & Pantzalis, 2001; Pantzalis, Simkins, & Laux, 2001; Carter et al., 2001, 2003; Kim, Mathur, & Nam, 2005; Gleason, Kim, & Mathur, 2005). These studies included a proxy for financial hedging in their cross-sectional regression models as the authors believed that it was not possible for the firm to implement a costly operational hedging strategy in isolation from a financial hedging strategy. These studies found mixed evidence of the relationship between the use of operational hedging and foreign currency exposure. For example, Pantzalis et al. (2001) found that a firm's geographical dispersion of foreign subsidiaries across countries was associated with exposure reduction, while dispersion across geographical regions was associated with an increased exposure.

The current study contributes to the body of empirical research by investigating the impact of the use of operational hedges on foreign exchange rate exposure reduction, for Australian multinational firms. To the author's knowledge, to date, there is a lack of Australia studies, investigating this relationship. A cross-sectional regression model is used to test the relationship, with the inclusion of several firm-specific control variables: the number of business segments, research and development expenditure, and capital expenditures. A specific contribution, which makes the present study's model different from all of the studies indicated above, is the inclusion of an additional factor (a proxy for foreign debt variable).

7) The effect of the combined use of financial and operational hedging on foreign exchange rate exposure

As indicated above, financial and operational hedges are the two fundamental strategies with which firms can manage their exposures to currency risk generated by unanticipated foreign exchange rate volatility. However, firms are normally subject to two types of foreign exchange risk: (1) transaction exposure and (2) operating (economic) exposure (Flood & Lessard, 1986). Transaction exposure is short-term in nature and can be hedged by using financial derivatives. However, operating exposure is long-term in nature and affects a firm's competitive position. Thus, if a firm's contractual foreign currency cash-flows (generating transaction exposure) are not perfectly correlated with its expected future operating cash flows (operating exposure), financial hedging is likely to be ineffective (Logue, 1995; Chowdhry & Howe, 1999; Hommel, 2003; Wong, 2003, 2005).

Since the separate use of these two hedging strategies are therefore not necessarily effective in reducing a firm's total exposure to currency risk, researchers have investigated the effect of the combined use of financial and operational hedging in this regard (Simkins & Laux, 1997; Allayannis et al., 2001; Pantzalis et al., 2001; Carter et al., 2001, 2003; Wong, 2005; Kim et al., 2005; Gleason et al., 2005). These studies find that the combined use of those two hedging strategies is more effective in reducing the exposure to currency risk, because it addresses the firm's overall exposure in both the short-term and the long-term. The existing studies, which have all considered U.S. firms, using U.S. data, have excluded a proxy for foreign currency denominated debt in their models, as the firms that they investigated were considered highly likely to have this in the form of a 'natural' hedge.

To the knowledge of the current author, no Australian study to date has investigated the impact of the combined use of operational and financial hedging on foreign currency exposure. The present study firstly, contributes to the literature by examining the impact of the combined use of financial hedging (currency derivatives and foreign debts) and operational hedging on this exposure, with respect to certain control variables: foreign sales ratio, firm size, capital expenditure ratio, research and development expenditure and the number of business segments.

8) Financial hedges complement to, or substitute for, operational hedging

A theoretical model constructed by Lim and Wang (2001, 2007) argues that financial hedging and operational hedging act more as complements to, rather than substitutes for, each other in reducing exposure to foreign currency risk. The model argues that financial hedging can be used to reduce the common component of profit variability, while operational hedging (geographic diversification) can reduce firm-specific risk exposures. Almost all of the relevant published research studies have used a cross-sectional regression model to empirically investigate this topic (Allayannis et al., 2001; Pantzalis et al., 2001; Carter et al., 2003; Gleason et al., 2005). These studies find evidence that operational hedging can be considered complementary to financial hedging in reducing the exposure. However, this evidence is different across studies with both weak and strong operational hedging variables' coefficients being reported.

All of these studies include only the use of foreign currency derivatives (dependent variable) as a proxy for financial hedging strategy and ignore the use of foreign currency denominated debt. The present study corrects this omission by including in the model two proxies for financial hedging: foreign currency derivatives and foreign currency denominated debt. In this manner, the current study, firstly, contributes to the literature by investigating simultaneously the relationship between the use of financial hedges and operational hedges in reducing exposure to foreign currency risk. Since there is an absence of published Australian research studies in this field, the second contribution of the current study is that it can be considered the first study to have paid serious attention to investigating this topic using Australian multination firms and Australian market and corporate data.

1.5 DATA AND METHODOLOGY

This section contains a preliminary overview of the data and research methodologies used in the study. A comprehensive discussion of the data and the methods is presented in Chapter 4.

1.5.1 Data

Initially, the 500 largest-sized (market capitalization) Australian listed firms were sourced from the Australian Stock Exchange (ASX) database. From those firms, a sample of 62 multinational firms, which used financial and operational hedges to reduce their foreign currency exposure in the 2004 fiscal year, was compiled. In constructing this sample the following six specific selection criteria were used:

1) Firms with headquarters located outside Australia are excluded;

2) Financial firms and financial services firms are excluded;
3) Firms with no foreign subsidiaries outside Australia are excluded;
4) Firms with less than 10% of total sales as foreign sales are excluded;
5) Firms which do not use both foreign currency derivatives and foreign currency denominated debt are excluded;
6) Firms with data unavailability are excluded;

As noted above, after the application of this selection procedure, the final sample of firms forming the subject of this study consisted of 62 Australian multinational corporations.

Another important feature to be mentioned in this section relates to the data collection. Several public sources of data were used to collect the data relating to each corporation. The data for the variables used in the first-stage model - a two-factor asset pricing model used to estimate the foreign exchange rate exposure coefficients - was extracted from the following three different public sources. First, the Australian Stock Exchange (ASX) database was employed to obtain the 500 largest-sized Australian listed firms. Second, the Australian Graduate School of Management (AGSM) database was used to source the monthly share prices and their Price Relatives for each firm, and the monthly observations of the share market index (All Ordinaries Index - AOI) with their Price Relatives. Third, the Reserve Bank of Australia (RBA) Bulletins and databases were used to collect the proxies for the exchange risk factor, the risk-free rate of interest factor and the monthly observations of the foreign exchange-rate index (trade-weighted index - TWI) of the Australian dollar against foreign currencies. The observations of the risk-free rate of interest are proxied by the monthly equivalent of the annual three-year Commonwealth Government bonds rates. All of these time series data were collected for the period from January 2000 to December 2004.

The data (financial accounting yearly figures) relating to the variables used in the second-stage model - cross-sectional regression models – were extracted from the Annual Reports of each corporation. These annual reports are obtained from the Connect4 database[12], which contains historical financial reports of 500 of the largest firms listed on the ASX. All annual reports of each corporation were reviewed manually for the 2004 financial year.

1.5.2 Methodology

Both the research methods and the models designed to test the hypotheses stated previously are comprehensively discussed in Chapter 4. A brief overview only of the methodology used in the study is presented below.

In this study, a two-stage market model has been used. In the first stage, a two-factor capital asset pricing model (Jorion, 1991) is used to estimate the relevant foreign exchange rate exposure coefficients for the sample of 62 Australian multinational firms during the period from January 2000 and December 2004. This first-stage model regresses the monthly excess returns on each firm's ordinary shares against both the monthly excess returns on the share market index and the monthly excess returns on an exchange rate index of the Australian dollar, orthogonalised to market

[12] Connect4 has been used as the prime and/or confirming database for several published empirical research studies. For example, see Holland and Ramsay (2003), Nguyen and Faff (2002, 2006), Al-Shboul and Alison (2007, 2008) and Al-Shboul (2007).

return. This model is used to test the first hypothesis, stated in Section 1.3. For each firm, the estimated foreign exchange rate exposure coefficient measures the sensitivity of its stock returns to changes in foreign exchange rates (i.e. its *exposure* to foreign exchange-rate risk).[13] The parameters of this model are estimated using the Ordinary Least Square (OLS).

The second stage of the two-stage market model uses a cross-sectional regression model procedure to test the other seven hypotheses (from the 2nd hypothesis to the 8th hypothesis), stated in Section 1.3. The second-stage model is designed to examine the effect of the use of financial and operational hedging on the foreign exchange rate exposures of a sample of 62 Australian multinational corporations, for the 2004 financial year. The dependent variable is the absolute value of the exposure coefficients estimated using the first-stage model. The explanatory variables represent the various financial and operational hedges used by the sample firms and various control variables as proxies for the firm's incentives to hedge. This model is estimated using the Weighted Least Squares and the Ordinary Least Squares.

1.6 FINDINGS AND EMPIRICAL RESULTS

This section contains a brief summary of the findings and the empirical results to the study (extensively explained in Chapter 5).

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[13] This exposure can be either positive or negative (see Chapter 3, section 3.3). For this reason, the absolute values of the exposure coefficients are used in the second-stage model.

The main finding of the present study is that there is evidence that the use of financial and operational hedges is effective in reducing exposure. Specifically, the findings of each research hypothesis are stated below as follows:

The first finding of this study relates to the estimation of foreign exchange risk exposure. The study found that there is a significant relationship between foreign exchange rate and stock returns of Australian multinational corporations. This significant relationship reflects how sensitive a firm's stock returns to changes in the value of the Australian dollar. Only 5 out of 62 corporations had significant foreign exchange rate exposure coefficients. This means that 8.06% of the sample firms showed a significant relationship between changes in exchange rate and stock returns (weak evidence). 1 out of 5 significant exposure coefficients had a negative sign, indicating that appreciation (depreciation) in the Australian currency would reduce (increase) the Australian firms' stock returns. However, 4 out of 5 significant exposure coefficients had a significant positive sign, signalling that appreciation (depreciation) of the Australian dollar would increase (decrease) the stock returns of such firm. Therefore, these positive and negative sign coefficients conform to the view that the stock returns are positively and negatively sensitive to changes in exchange rates. This weak relationship may result from the fact that Australian multinational corporations consistently hedge their foreign exchange rate exposures.

The second main hypothesis relates to whether the use of foreign currency derivatives effectively reduces the firm's foreign exchange rate exposure. The present study found strong evidence that the use of foreign currency derivatives is negatively associated with foreign exchange rate exposure. However, no evidence was found of the positive relationship between foreign sales ratio, as one of the determinants of the exposure, and the exposure. This indicates that foreign sales increase the exposure, which can be hedged by using foreign currency derivatives.

When the firm's hedging incentives variables (firm size, leverage ratio, and current ratio) and the firm's ownership structure variables (the percentages of shares held by directors, block-holders, and institutions) were included in the model, the present study found that the use of currency derivatives remains strongly significantly associated with the exposure reduction. However, no significant evidence was found of the negative relationship between foreign sales and the exposure. This indicates that there no significant effect of the firms foreign revenues generated abroad and the firm's exposure reduction. In case of the hedging incentives variables, it was found that no significant evidence of the negative relationship between the exposure and both firm size and current ratio. However, strong evidence was found to support that leverage ratio is negatively related to the exposure. In terms of the ownership structure variables, mixed evidence was reported. The present study found evidence that the percentages of shares held by block-holders and institutions increase the exposure. This indicates that block-holders and institutional groups of shareholders do hedge their own portfolios and they have less concern about their firm's risk exposure in which they own shares. No significant evidence was reported of the negative relationship between the percentage of shares owned by directors and the exposure. This means that Australian directors, who are concerned about the risk associated with their own assets, are expected to adopt hedging programs to reduce currency risk exposures. It is very clear that Australian firms' ownership structure has an effect on the implementation of hedging techniques of these firms. Therefore, the present study achieved a moderate success in identifying empirical evidence of the relationship between the use of foreign currency derivatives and the exposure to exchange-rate risk.

The third hypothesis relates to whether the use of foreign-currency denominated debt effectively reduces foreign currency exposure. When exposure coefficients were regressed on both proxies for the use foreign debt and foreign operations (foreign sales ratio) with respect to firm size, the present study found strong evidence that the use of foreign debt is associated with the exposure reduction. This confirms that Australian multinational firms issue foreign debt denominated by foreign currencies to hedge the foreign exchange rate exposure. However, no significant evidence was found to the negative relationship between foreign sales ratio and the exposure. This indicates that firms with higher foreign sales of total sales are more likely to have higher exposure. In addition, strong evidence was found to the positive relationship between firm size and the exposure. This means that large firms are more likely to encounter higher foreign currency exposure. However, when the model was controlled for the effect of hedging incentives variables (leverage ratio and the current ratio), the present study found that the use of foreign debt remains significantly related to the exposure reduction. This supports the argument that foreign debt is used as a hedging strategy for firm exposure. In addition, strong evidence was found between foreign sales ratio, as a proxy for foreign operations, and the exposure reduction. This indicates that firm's with higher revenues generated abroad and higher exports are more likely to have lower foreign currency exposure. However, mixed evidence was found to the positive relationship between leverage and current ratios. The current study has achieved a moderate success in identifying empirical evidence of the relationship between the use of foreign debt by Australian multinational corporations and exposure to currency risk.

The fourth hypothesis relates to whether the combined use of currency derivatives and foreign debt effectively reduces the exposure. The present study found evidence that the combined use of those two hedging strategies is effective in reducing exposure. This confirms that the combined use of currency derivatives and foreign debt is associated with exposure reduction. In addition, it was found that there is strong evidence of the positive relationship between firm size and the exposure, signalling the larger firms are more likely to have less foreign currency exposure. However, no significant evidence is reported to support the negative relationship between the exposure and leverage, current ratio, and foreign sales ratio. When the interaction variable of financial hedges proxies was used, the present study reported that there is strong significant relationship between this interaction variable and the exposure reduction. This indicates that the interaction between the use of currency derivatives and foreign debt is associated with reducing exposure. The negative relationship between the exposure and leverage, current ratio, and foreign sales ratio remains insignificant. Overall, Australian multinational corporations combine using foreign currency derivatives and foreign debt to effectively reduce (hedge) exposure.

The fifth hypothesis that the use of foreign currency derivatives acts a complement to the use of foreign debt in reducing exposure was tested. These two hedging strategies are tested simultaneously of whether they are complementary to each other in reducing the exposure. The present study found strong evidence that the use of foreign currency derivatives is a substitute hedging strategy for the use of foreign debt in reducing exposure and visa versa. In turn, when the model was controlled for the effect of some variables such as firm size, the ratio of foreign sales, leverage ratio, current ratio, and research and developments, the use of foreign currency derivatives remained negatively significantly related to the use of foreign debt. When the proxy of foreign debt was used, as dependent variable in the model, the present study found that foreign debt is negatively significantly related to foreign currency derivatives, signalling that these hedging strategies are subsitiute for each other. Overall, Australian multinational corporations simultaneously use either foreign currency derivatives or foreign debt to reduce foreign exposure rate exposure.

The sixth hypothesis relates to whether the use of operational hedges effectively reduces the exposure. The present study found strong evidence that operational hedging activities are negatively associated with the exposure reduction. This measns that diversifying and dispersing of the firm's foreign operations across countries and regions are effective hedging strategies of foreign currency exposure. This confirms our hypothesis of the use of operational hedges is an effective hedging strategy to reducing exposure to foreign currency risk. Therefore, these comprehensive hedging strategies are used by Australian multinational firms to reduce the exposure. Although the model was controlled for the effects of several variables (foreign sales, firm size, number of business segments, research and developments, capital expenditures), the present study found strong evidence that Australian multinational corporations diversify and disperse their foreign operations across countries and regions to effectively hedge foreign currency exposure.

The seventh hypothesis concerning whether the combined use of financial and operational hedging effectively reduces exposure. It was found that both financial and operational hedging strategies were negatively significantly related to exposure. This indicates that the combined use of financial and operational hedges is associated with exposure reduction. Although the model was controlled for the effect of some growth investment opportunity varaibles (firm size, research and developments, capital expenditures), the present study found the Australian multinational corporations use financial hedging (derivatives and foreign debt) and diversify and disperse their foreign ssubsidairies across grographical regions for the puspose of hedging foreign exchange rate exposure.

The eighth hypothesis relates to whether the use of financial hedging acts as complementary to operational hedging in reducing the foreign exchange rate exposure. The present study found significant evidence that those two hedging strategies are complementary in reducing the exposure. The use of foreign currency derivatives was complementary to operational hedging in reducing exposure. In addition, the use of foreign debt was complementary to the use of operational hedging. Therefore, it is very clear that Australian multinational corporations use both financial hedging proxies (foreign debt and foreign currency derivatives) as alternatives to operational hedging in reducing exposure.

1.7 OUTLINE OF THE THESIS

This section describes the topics addressed in the following chapters of this research study:

Chapter 2 provides a basic overview of the issues involved in foreign exchange risk and its management, which underlie the concepts and research works for the subsequent chapters. Firstly, the chapter defines foreign exchange risk and exposure, and explains the relationship between them. Secondly, it discusses how foreign exchange risk exposure can be measured and provides explanations of the relationship between this exposure and firm value. Thirdly, the chapter discusses how the three different types of exchange rate exposure (economic, transaction, and translation exposure) can be identified and measured. Fourthly, it describes how those types of exposure can be managed (hedged). Additionally, the chapter explains the conditions under which corporate risk management can be considered as irrelevant, in the sense that it does not add value to the firm. The question of why firms hedge is also addressed. Finally, the relationships between foreign exchange risk and interest and commodity price risks are discussed.

Chapter 3 consists of a comprehensive review of the published theoretical and empirical research relating to the discipline of managing foreign exchange rate exposure. The chapter is structured in a specific format, which develops the central question, of whether the use of financial and operational hedges has an effect on the foreign exchange rate exposure. From a research methodologies perspective, five main literature research themes are reviewed: the effect of exchange rate changes on firm value, the effect of the use of financial hedging on exposure, the effect of operational hedging on exposure, the effect of the combined use of currency derivatives and operational hedging on exposure and currency derivatives in relation to operational hedging (substitute or complement). The final section in this chapter is made up of conclusions and a summary of the respective contributions to the research literature.

Chapter 4 describes, comprehensively, the sources of data used in the study and the sample selection procedure. This chapter also discusses the research methodologies and methods used to test the developed hypotheses. The two-stage market model is discussed. The first stage model (times series model) is related to the testing of the first hypothesis, which refers to the relationship between a firm's stock returns and changes in the exchange rate, with respect to market returns. The excess return generating process for all the variables used in this model is comprehensively explained. In addition, the estimation procedure of this model is discussed. The second stage of the market model, which uses a cross-sectional regression model to test the remaining seven hypotheses, is also extensively discussed. The independent variables used in this cross sectional regression are identified and defined. This chapter also describes the estimation process for all the hypotheses. A final section draws the conclusions of the chapter.

Chapter 5 presents the data analysis and the results of the study. The empirical results and the research findings are reported and discussed in a pattern consistent with the methods described in the previous chapter. The results of the data analysis for the first model are reported and briefly compared with the empirical findings reported by previous studies. The empirical results for the second stage model are reported and analysed in both univariate and multivariate terms. The univariate analysis consists of descriptive statistics for the variables used in the model and the correlation coefficients between those variables are identified in a Pearson correlation matrix.

The multivariate analysis relates to the parameters of the explanatory variables used in the estimation models. Finally, a conclusion is drawn in the last section of the chapter.

Chapter 6 summarises the findings and the research hypotheses of the study. The contributions of the study to the research literature are also reported. The contributions to the body of knowledge are also explored. In addition, this chapter addresses the limitations of the study. The implications of the results for beneficiaries such as financial decision-making, managers, investors, corporate regulators and derivatives designer are discussed. The chapter concludes the implication of this study for future research directions which might be undertaken in light of the findings of this thesis.

1.8 DELIMITATIONS OF SCOPE AND KEY ASSUMPTIONS OF THE THESIS

The results of this study are subject to several features of the data and methods used which may indicate that caution should be observed in generalising the conclusions of the study to other scenarios. These features are as follows:

1. The specific sources of data;
2. The sample time periods studied;
3. The restriction of the study to the experience of Australian firms;
4. The nature of the foreign exchange risk hedging implicit in the specific strategies studied;
5. The assumptions implied in the methodologies.

1.9 CONCLUSION

The main purpose of this chapter is to provide a summary of the primary features of the research study, including the research problems and hypotheses, and the justifications for the study. A brief overview of the data selection procedure and sources, methodologies, and delimitations of scope and key assumptions is also presented. The current study contributes to the body of knowledge in the general area of managing foreign exchange rate risk among Australian multinational corporations, since it focuses on the corporate experience of financial and operational hedging strategies during a recent period of exchange rate volatility.

The chapter also includes a plan for the remainder of thesis. The next chapter presents an account of the various types of foreign exchange rate exposure, which can be managed by certain hedging strategies, followed by an overview of the theories of exchange rate risk management.

CHAPTER TWO

AN OVERVIEW OF FOREIGN EXCHANGE RISK MANAGEMENT

2.0 STRUCTURE OF CHAPTER TWO

This chapter provides an overview of the fundamentals of foreign exchange risk management. After the introductory section, the definitions of a foreign exchange rate and its associated risk are presented in Section 2.2. The relationship between this risk, and exposure to it, is also explained. The types of foreign exchange rate exposure, and how they can be measured, are explained in Sections 2.3 and 2.4, while the management of these types of exposure is explained in Section 2.5. Finally, the reasons why firms undertake the hedging of foreign exchange rate exposure and the conclusion of this Chapter are discussed in Sections 2.6 and 2.7, respectively.

2.1 INTRODUCTION

The main purpose of this chapter is to provide an overview of foreign exchange risk management. Since the flotation of exchange rates, globally, in the early 1970s, the practice of management of foreign exchange rate risk has been considered one the most important financial issues for business entities. This is partially due to the fact that foreign exchange rates have become increasingly volatile (Boulton et al., 1990; Edison et al., 2003).[14] The increase in volatility causes a large variability in output growth and inflation, which have been of particular concern in terms of the stability

[14] Managing exchange rate risk has become more an important issue not only because exchange rates have become more volatile, but also because businesses have become more globalised. This is why the word "partially" is used in the text.

of the market. Foreign currency risk is one of the most important factors, which potentially impact a firm's value through affecting its cash-flows.[15] It can be formally defined as the potential for foreign exchange rates to change in an unexpected manner, such that the value of the firm is affected (Adler & Dumas, 1984). The volatility of exchange rates can affect the value of assets and liabilities of firms, active either internationally or domestically (Bartov, Bodnar, & Kaul, 1996).

The ultimate goal of hedging foreign exchange risk is to reduce its impact on the firm. Multinational firms have recently started using various hedging programs, both financial and operational in nature, to manage their exposures to foreign exchange rate risk (see Section 1.2 of Chapter 1). In the Australian context, since the flotation of the Australian dollar in late 1983, it has been recognised that Australian firms are heavily engaged in using different types of hedging strategies to manage their exchange rate risks (Becker et al., 2005; RBA, 2005, 2005a; ABS, 2005 Nguyen & Faff, 2006; Al-Shboul & Alison, 2007a).

2.2 FOREIGN EXCHANGE RISK AND EXPOSURE

2.2.1 Foreign Exchange Rate

An exchange rate can be defined as the price of one country's currency in terms of another country's currency. It is well-known that the flotation of exchange rates

[15] There are three basic components of financial price risk: exchange rate risk, interest rate risk, and commodity price risk. Interest rate risk is the potential for unexpected volatility in interest rates. Commodity price risk means simply the potential for unexpected future movements in commodity prices, which can, over time, affect the value of the shareholders' wealth, while exchange rate risk potentially affects the value of the firm as a result of unexpected changes in exchange rates (Anthony, 2003).

increased the volatility and unexpected exchange rate movements.[16] These unexpected changes in foreign exchange rates have generated risk which potentially affects the market value of firms exposed to it. Thus, exchange rate changes have been extensively investigated over the last three decades, and have become one of the most important sources of uncertainty affecting the economy, in general, and firm value, in particular.

2.2.2 Foreign Exchange Rate Risk and Exposure

As noted above, foreign exchange-rate risk can be defined as the potential for foreign exchange rates to change in an unexpected manner, such that the value of the firm is affected (Adler & Dumas, 1984). However, foreign exchange-rate risk not only potentially affects the value of multinational firms (Heckerman, 1972; Ethier, 1973; Aliber & Stickney, 1975), but also the value of the assets and liabilities of firms trading in the domestic market (Hodder, 1982; Bartov et al., 1996). For example, ‘domestic’ firms may out-source their production to foreign countries. This means that they acquire costs in foreign currency (wages, taxes, material… etc.) and are, therefore, directly exposed to foreign exchange rate risk.

The term risk is different from the term “exposure”. Exposure refers to the sensitivity of the value of the item at risk. Since the source of foreign exchange rate risk is the unanticipated variability in the relevant exchange rate, exposure to foreign currency risk is defined as the sensitivity of the domestic currency value of items, which are

[16] For example, Trevor and Donald (1986) studied both interest rate and exchange rate volatility before and after the floating of the Australian dollar in December 1983. They provided evidence supporting the hypothesis that the exchange rate is relatively more volatile than the interest rate especially with the move to a floating exchange rate regime.

denominated in foreign currency, (e.g., assets, liabilities, and cash flows), to unpredicted changes in the exchange rate (Adler & Dumas, 1984). The present study, hereafter, will use the term “foreign exchange rate exposure” and “foreign exchange rate risk exposure” interchangeably.

Exposure to currency risk is divided into three specific types, in relation to its effects on assets and liabilities. These are long exposure, short exposure, and combined exposure (see Moosa, 2004, p. 369). A long exposure to foreign exchange risk refers to the situation, where the firm’s assets are the subject of the exposure. The domestic currency value of assets denominated in a foreign currency (‘foreign assets’) increases when the foreign currency appreciates against the domestic currency, and decreases if the foreign currency depreciates. Therefore, this type of exposure is measured by the potential for the domestic currency value of foreign assets to change as the relevant exchange rate changes. A short foreign currency exposure occurs when liabilities are the subject of the exposure. In other words, it can be identified by a negative relationship between the changes in the exchange rate and the domestic currency value of liabilities denominated in the foreign currencies. Therefore, this type of exposure is measured by the potential for the domestic currency value of foreign liabilities to change, as a result of exchange rate movements.

The combined effect on the values of assets and liabilities of a change in exchange rates is known as combined exposure. To explain this exposure, two cases are illustrated. The first case is where assets and liabilities are equally sensitive to changes in exchange rate. In this case, an appreciation of the foreign currency produces a gain in the value of the assets and a loss in the value of the liabilities. If the total value of the foreign currency assets equals the total foreign currency value of the liabilities, the gain/loss on the assets/liabilities will be equal. The second case is where the assets are more sensitive than liabilities to changes in exchange rate. In this case, the gain on the assets, produced by an appreciation of the foreign currency, would be greater than the loss in the liabilities. However, the opposite situation would occur if the liabilities were more sensitive to foreign exchange movements than the assets. Therefore, firms can benefit from combined exposure by netting their gain or loss in assets and liabilities generated by changes in exchange rates. Clearly, if firms deliberately undertake a hedging strategy such that whatever is lost on the assets exposure is exactly offset by a corresponding gain on the liabilities, the combined exposure to foreign exchange rate risk will be zero.

2.2.3 The Relationship Between Foreign Exchange Rate Risk and Exposure

The main issue discussed in this section is how a firm's foreign exchange-rate risk is related to its exposure. This relationship is presented as the relationship between the percentage change in the exchange rate of a given domestic currency and the percentage change in the (domestic currency) market value of the net assets of the a firm. Foreign currency exposure can be measured by the sensitivity of the firm's domestic stock returns and the changes in the relevant exchange rates. It is assumed in this study, unless otherwise indicated, that the exchange rate is given as foreign currency units per one unit of domestic currency.[17] Note that, if the exposure has a positive value, this indicates that there is a positive relationship between changes in

[17] An exchange rate presented in this way is referred to as an 'indirect' quote, from the perspective of the domestic firm.

the exchange rate and changes in domestic currency value of foreign currency denominated net assets and vice versa.

In relation to this general definition of exposure, Adler and Dumas (1984) link it with hedging by assuming that exposure can be quantified by a partial regression coefficient. This partial regression is mathematically expressed by,

$$K_i = \beta_1 S_i \quad \textbf{(2.1)}$$

Where K_i is the percentage change in the domestic currency value of the relevant net assets of a domestic firm situated in country *i*, and S_i is the percentage change in the exchange rate of country *i*'s currency (expressed as foreign currency units per one unit of domestic currency). Therefore, the firm's currency exposure is measured by the regression coefficient, β_1. Adler and Dumas (1984) define exposure as the current expectations, across *i* currencies, of the partial sensitivity of *K* to *S*, the effects of the other variables held constant. This quite general definition is insufficient however, because hedging minimizes the foreign exchange variance (risk), but cannot eliminate the risk totally, leaving a residual randomness that is independent of the exchange rate.

Where the residual randomness of a hedged position is independent of S_i, Adler and Dumas (1984) specify the regression to measure the exposure, assuming that it is normally distributed with a constant variance and a mean of zero. This regression model is expressed as follows:

$$K_i = \alpha_i + \beta_1 S_i + \varepsilon_i \qquad \textbf{(2.2)}$$

Where α_i, is the intercept term, the exposure is measured by the coefficient, β_1, and ε_i is the residual. Again, this residual is assumed to have a normal distribution with a constant variance and a mean of zero. Note that, $E(\varepsilon_i) = 0 = cov(\varepsilon_i, S_i)$ and E is an expectation, denoted by $E(X) = \bar{X}$.

When the variance of the both sides of the equation (2.2) is undertaken, the linear regression is expressed as follows:

$$\sigma^2(K_i) = \beta_1^2 \sigma^2(S_i) + \sigma^2(\varepsilon_i) \qquad \textbf{(2.3)}$$

The intercept term equals to zero as the variance of a constant term, α_i, is zero. This equation tells that the variance of the percentage changes in the domestic currency value of assets and liabilities is related to the variance of the percentage changes in the exchange rate by factor that reflects exposure, β_i^2.

2.3 THE TYPES OF FOREIGN EXCHANGE RATE EXPOSURE

Three different types of foreign exchange risk exposure are identified in the literature (Jacque, 1981). These are transaction, operating (economic) and translation exposure.

2.3.1 Transaction Exposure

Transaction exposure is the sensitivity of the domestic currency values of a firm's contractual cash flows, denominated in foreign currencies, to unanticipated exchange rate changes. In other words, transaction exposure results from contracting in foreign currencies at fixed prices, in a world where exchange rates are changing randomly. It is noted that this exposure arises from foreign currency assets and liabilities which are already recorded in the firm's financial statements.

2.3.2 Economic Exposure

Economic exposure, more commonly expressed as 'operating', refers to the impact of unanticipated exchange-rate movements on a firm's expected future cash flows (Eiteman, Stonehill, & Moffett, 2004). This kind of exposure arises because currency fluctuations can alter a firm's future revenues and costs (e.g., its operating cash flows) and, therefore, its present value. Expected future cash flow can be divided into cash flows resulting from contractual obligations and cash flows resulting from anticipated future transactions. In light of this, transaction exposure resulting from contractual obligations denominated in foreign currencies can be regarded as a part, or subset, of economic exposure.

As indicated previously, transaction exposure arises from contractual obligations, where the foreign currency amounts, to be paid or received, are known in advance. With economic exposure these future amounts are uncertain, non-contractual cash flows, based on estimates. In addition, through its effect on the value of future operations, the impact of economic exposure on a firm's value is likely to be much larger than that of transaction exposure. Economic exposure arises when a multinational firm incurs costs denominated in one currency and generates sales denominated in another. In this case, exchange rate changes can affect the competitive position of the firm. For example, if the currency of the country where the firm is producing goods or services appreciates against the currency of the country where the firm is selling these items, the profit generated may decrease. Of course, in addition to unanticipated exchange rate changes, various other factors may affect the future cash flow of the firm. These factors might be, for example, external in nature, such as a political crisis in a country, which would affect the level of sales.

Eun and Resnick (2004) indicate that economic exposure can be broken down into 'asset' exposure and 'operating' exposure. *Asset exposure* refers to the sensitivity of the future home currency values of the firm's assets and liabilities to random changes in exchange rates. *Operating exposure* measures the extent to which the present value of the firm is affected by any change in the future operating cash flows of the firm, caused by unexpected changes in exchange rates. The authors suggest that, because of the difficulty of measuring the exposure arising from operating cash flows, it is important that the firm properly manages it.

As a consequence, managing a firm's economic exposure requires a long-term plan, viewing the firm as an ongoing concern with operations whose costs, prices, and competitiveness could be affected by unanticipated exchange rate changes.

2.3.3 Translation Exposure

Because home country governments, investors and entire financial communities are interested in home currency values for performance measurement, and taxation purposes, multinational corporations with foreign subsidiaries must translate the foreign currency balance sheets and income statements into the corporation's home currency prior to consolidation with the parent's financial statements. Changes in exchange rates between consecutive consolidation dates will alter the domestic currency value (e.g., U.S. dollars) of foreign currency (e.g., Japanese Yen) denominated assets and liabilities, revenues, and expenses. This usually results in foreign exchange 'gains' or 'losses' in the financial statements. This potential for a firm's consolidated financial statements to be affected by changes in exchange rates, is known as translation exposure or *accounting* exposure (Eiteman et al., 2004, p. 269). It must be stressed that these foreign currency gains or losses are 'paper' or accounting in nature, and, unlike transaction or economic exposure, are not based on cash flows.

2.4 MEASURING FOREIGN EXCHANGE RATE EXPOSURE

A number of techniques have been used to measure foreign exchange risk exposure. The choice of technique used depends on the type of exposure as it may affect firm value differently. The following sections discuss these techniques in relation to each type of exposure.

2.4.1 Measuring Transaction Exposure

As stated in Section 2.3.1, a firm will be subject to transaction exposure when it faces contractual cash flows, which are fixed in foreign currencies. Generally, two techniques can be used to measure this exposure. The first technique is where the firm initially identifies the currency(ies) in which the transactions will be settled and then measures the volatility of each relevant exchange rate, based on historical data. The second technique for measuring transaction exposure is based on the correlation between the movements of two currencies against the home currency. Consider, for example, a British company with outstanding transactional amounts denominated in both U.S. dollars and euros. Based on historical data, let us assume that there is a negative correlation between the US dollar and the Euro. That is, when the U.S. dollar appreciates in value against the pound, it may be anticipated that the Euro will depreciate against the pound. Negative correlations are interesting for the firm since an increase in the value of one currency is offset by a decrease in the value of the other currency. Therefore, there is a reduced need to hedge transactions denominated in those two currencies. This approach has to be practiced with caution, as past correlations are not necessarily accurate estimates of future correlations.

2.4.2 Measuring Economic Exposure

The lack of clear guidelines for measuring economic exposure is a major obstacle to implementing its assessment. While Dufey (1972) and Ahkam (1995) drew attention to this need, financial literature has not adequately addressed the practical issue of how to measure corporate economic exposure. In the past, research interest in economic exposure concentrated on the estimated effect of exchange rate changes on accounting profits (e.g., Dumas, 1978). Each line of a firm's income statement and balance sheet was separated and the effect of an increase or decrease of exchange rates on each item was analysed. This was due to a recognition that foreign exchange rate exposure arose from the practical need to consolidate the financial statements of foreign operations i.e. translation exposure. The possibility of acquiring accounting gains or losses on receivables and payables denominated in foreign currencies (transaction exposure) was also recognised. However, firms are simultaneously exposed to multiple uncertain environment contingences and the dimensions of economic exposure are difficult to estimate using a model designed to measure accounting exposure.

Although the accounting concepts of translation and transaction exposures have been codified in accounting standards[18], no such standard exists for economic exposure. One point of confusion in the existing discussions has focussed on the choice of the dependent variable used to model this type of exposure. An accounting earnings sensitivity approach has been a poor performer in presenting a measure of economic exposure, and two main alternative approaches have been developed: the cash flow approach and the capital market approach (Miller, 1998).

The cash flow approach measures the sensitivity of firm value, proxied by the firm's discounted future cash flows, to changes in exchange rates (Shapiro, 1975, 1977, 1984; Cornell, 1980; Wihlborg, 1980; Lewent & Kearney, 1990; Martin & Meuer, 2005). However, many difficulties arise in terms of using this approach to measure economic exposure, including the choices of an appropriate discount rate and time horizon for a firm's operations[19]. As a result, researchers have developed an alternative, capital market approach to measure economic exposure.

[18] In the United States, the relevant Financial Accounting Standards Board statements have been FAS Nos. 8, 52, and 130. In Australia, the Australian Accounting Standards Board has issued AASB Nos. 1012, and 120 statements.

[19] For example, new strategic investments often involve several years of negative cash flows before entering into a period of positive cash flows. These negative cash flows may result from intensive investment in research and development, plant and equipment, and marketing, and limited initial sales. The deficiencies of cash flows or net income as dependent variables in estimating economic exposure have resulted in this approach being questioned in recent empirical studies (e.g. Ahkam, 1995; Moens, 1995).

If capital markets are assumed to have the capability of ascertaining the underlying value of a firm's competitive positions, the market value of the firm's equity can be used as the dependent variable in a regression on exchange rate changes (Adler & Dumas, 1984; Jorion, 1990). Economic exchange rate exposure could thus be measured as the relevant slope coefficient. A number of research studies have followed the Adler and Dumas's (1984) approach, which uses stock market returns as a proxy for firm value (Jorion, 1990, 1991; Loudon, 1993a, 1993b; Bodnar & Gentry, 1993; Bartov & Bodnar, 1994; He & Ng, 1998; Di Iorio & Faff, 2001a, 2002; El-Masry, 2006).[20]

2.4.3 Measuring Translation Exposure

Since translation exposure and its management are not of specific interest to the present study, this section provides only a brief outline of this exposure and its measurement. As noted in Section 2.3.3, this exposure occurs where a firm has foreign subsidiaries and needs to translate their balance sheets and earnings statements into its parent currency for consolidation purposes. Translation gains and losses will normally arise if the exchange rate has changed between two successive consolidation dates. The gains and losses are historical in nature and do not have cash flow implications. If, prior to the consolidation date, a firm wishes to estimate its translation exposure, it would normally estimate the future expected earnings of each foreign subsidiary and then apply a sensitivity analysis to evaluate the potential effect of fluctuations of exchange rates. On consolidation itself, the computation of

[20] The present study implements this approach (see Chapters 3 and 4).

the historic translation differences are regulated by the accounting standards promulgated by the various national authorities. These standards address issues such as the translation method to be used, the accounting balances to which these translation methods are to apply and the ultimate disposition of the translation differences in the group accounts[21]. As they have evolved, these accounting standards have generated much controversy, particularly among the executives of multinational corporations. The extensive regulation naturally affects the way in which a firm might seek to measure its accounting exposure at any time prior to consolidation.

Although these accounting adjustments have provided accounting methods to measure and record the effects of exchange rate changes on the translated financial statements of foreign affiliates, with the aim of providing meaningful information to the users of these statements, the economic effects of the accounting adjustments remain somewhat ambiguous.

2.5 MANAGING FOREIGN EXCHANGE RATE EXPOSURE

The main features of currency risk management are (1) to measure the potential exposure to exchange rate movements, and (2) to determine how the exposure should be hedged. If a firm decides to hedge part or all of its currency exposure, then it will adopt one or more of the appropriate hedging techniques.

[21] The current accounting standard in force in Australia is AASB No. 121 "The *Effect of Changes in Foreign Exchange Rates*", which replaced AASB No. 1012 "*Foreign Currency Translation*".

To manage foreign exchange rate risk (uncertainty)[22], firms have developed comprehensive financial and operational hedging exercises. These hedging activities address both short-term and long-term exposures. Financial hedging is divided into two techniques. These two techniques are the use of both derivative financial instruments and foreign-currency denominated debt. Operational hedging is the process whereby firms diversify sales and production, re-locate production facilities abroad or fund themselves in foreign currencies.

The topic of managing (hedging) foreign exchange risk has recently become an important element of corporate risk management (Rawls & Smithson, 1990; Marshall, 2000). Rawls and Smithson (1990), in their survey, showed that U.S. financial executives rank risk management as one of their most important objectives. Moreover, Marshall (2000), in his sample firms of large American, British, and Asian firms, found that foreign exchange risk management was one of the most important financial activities of these firms. Therefore, managing foreign exchange risk merits further attention and effort from both researchers and practitioners.

Recall that hedging exposure in a particular currency means establishing an offsetting position such that whatever is lost or gained on the original currency exposure is offset by a corresponding gain or loss on the currency hedge. Regardless of what happens to the future exchange rate, therefore, hedging locks in a dollar (home currency) value for the currency exposure. In this way, hedging can protect a firm from unexpected currency movements. If the main objective of hedging is to

[22] Although risk is traditionally different from uncertainty, the current study will ignore this distinction and use those two concepts interchangeably. For further information see Moosa (2004, p. 359).

maximize shareholder value, then hedging makes sense only when it is expected to lead to an increase in the value of the firm.

2.5.1 Managing Transaction Exposure

The objective of transaction exposure management is to conserve the home currency value of foreign currency transactions. Dufey and Srininvasulu (1986) claimed that transactions are costly in an imperfect capital market situation, and a firm should manage its foreign currency risk, especially if its default risk is affected. Shaprio and Titman (1985) observed that firms with higher total risk, assuming other things constant, are more likely to experience financial distress, which can disrupt the real operations of the business by adversely affecting risk-averse customers, employees, suppliers and other corporate stakeholders. Smith and Stulz (1985) argued that hedging foreign exchange risk creates value by diminishing the variance of firm value and reducing the expected costs of financial distress. Hence, it is important to manage transaction exposure as it becomes a reality.

Managing transaction exposure is a widespread practice. Rawls and Simthson (1990) reported, in a 1989 Business International corporation survey of 137 subscribers, that 79 per cent of the firms managed transaction exposure.[23] In an efficient capital market situation, stock returns should immediately reflect the short-run effects of exchange rate changes, and the widespread practice of hedging short-term foreign currency inflows and outflows can, therefore, sever this link. Thus, no significant short-term exchange rate effect on stock returns is expected.

[23] Batten, Miller, and Wan (1993) also found that around 61% of Australian firms manage transaction exposure, while Dolde (1993) reported that 85% of his sample firms manage transaction exposure using derivatives financial instruments.

Many techniques can be used to hedge transaction exposure. They can be divided into two specific categories: (1) Internal hedging and (2) External hedging.

2.5.1.1 Internal Hedging

To eliminate transaction exposure, firms give high priority to internal hedging as it is relatively less costly, and, hence, a number of possible internal hedging techniques have been used over time. These techniques include:

1) Leading and Lagging

Leading and lagging foreign currency receipts and payments is the other technique that can be used to hedge against currency risk. Leading signifies to paying or collecting early, whereas lagging refers to paying or collecting after the due date. If a firm using this strategy will lead the soft (i.e., domestic) currency receivable and lag hard currency payable, to avoid the loss from depreciation of the soft currency and benefit from the appreciation of the hard currency. Alternatively, the firm may attempt the opposite strategy of leading the hard currency payables and lagging the soft currency receivables. This strategy will reduce the transaction exposure that the firm faces.

2) Cross-hedging

This hedging technique is used when there is no possibility to hedge foreign exchange rate exposure using derivatives financial instruments as those instruments are not available, for example. In this case, the hedger looks for a specific foreign currency, whose exchange rate is highly correlated with that of the currency to be hedged and then take a forward, futures, or an option position on this foreign currency. It is important to indicate that the condition of strong correlation between the underlying exchange rates is so essential for the effectiveness of cross hedging.

Another approach of the currency exposure cross hedging does not involve the forward market. In this case, a long or short position on foreign currency can be hedged by taking a spot short (long) position on another currency. For example, if there are three currencies (AUD, GBP, and EURO) and the exchange rates between AUD to GBP and AUD to EURO are highly correlated, then a firm with a domestic currency AUD can hedge payables in GBP by buying EURO currency. For example, if GBP appreciates against AUD, then EURO will also depreciate. This indicates that the loss incurred on the short position in GBP will be offset by the profit on the long position in EURO. Therefore, the Australian firm can hedge its short position in the GBP currency by buying the Euro spot.

3) Currency diversification

Currency diversification means that a firm holds similar amounts of many different foreign currencies, whose exchange rates are not perfectly correlated. It thereby limits risk exposure of the firm’s local currencies. For example, if foreign currencies appreciate or depreciate against the Australian dollar, the Australian firm will not be harmed as if a large number of currencies are involved, which indicates that the exchange rates of these foreign currencies against AUD are not highly correlated.

This is due to some of these currencies will appreciate only slightly, while others may even depreciate. In this debate, Levy and Marshall (1978) examined some of the implications of the exchange rate fluctuations for investment demand, for money balances, both foreign and domestic. They found that foreign currency comprises a significant proportion of the efficient portfolio of U.S. investors. This result strongly suggests that the currency portfolio diversification should not be ignored in theoretical and empirical analysis of the demand for money, the level of exchange rates, and the efficiency of alternative monetary polices.

To conclude, the above discussion argues that diversifying the firm's portfolios of foreign currencies is more likely to act as a hedge and to participate in lower volatility in cash flows, and finally enhance firm value. Thus, a firm's hedging activity should be negatively related to its level of unrelated diversification.

4) Netting Exposure

Netting exposure probably one of the most internal hedging methods used. The idea is to reduce the number of transactions that a firm needs to make in order to cover an exposure. It requires the firm to organise its cash management. This means the company have to collect foreign currency cash flows between subsidiaries and group them together so as an inflow offset an outflow in the same currency. In this particular context, there are two types of netting exposure: bilateral and multilateral netting. The bilateral netting is generally related to one firm, which has, for example, two foreign currency exposures with two of its subsidiaries. Therefore, the parent firm attempts to netting (exchange) the cash flows exposure those two subsidiaries directly with reducing the number of transactions.

This technique is repeated for each currency to which the firm is exposed. The multilateral netting is more complex as it occurs with netting the cash flow payments of many foreign subsidiaries, but follows the same rationale. Rather than having all the transaction of the payments between subsidiaries taking place, only the netted amounts are exchanged through a netting centre. Netting is an appropriate and easy to implement techniques to hedge transaction exposure. Therefore, netting exposure means when a firm has both receivables and payables in a given foreign currency, it should consider hedging only its net exposure to particular currencies.

5) Price Adjustment and Choice of the invoice currency

These are techniques that are useful for firms engaged with international trade such as exporting production outputs and importing productions inputs. Price Adjustment is a technique involves changing prices to obtain the favourable effect of exchange-rate variability. First, when the local currency of a foreign subsidiary is depreciated, the subsidiary can increase the price, to cancel the effect of the depreciation. This technique can be used in countries where devaluation is high and where derivatives markets are inefficient. The disadvantage of this technique is the difficult implementation of this method, which needs to be signalled. Prices cannot be raised without any consideration about competitors, because if the price highly increases, customers can choose an equivalent and cheaper product from competitors.

Logically, a firm can increase the export price, but there are many forces can prevent this to happen.

Since the firm encounters not only local but international competitors, price variation process then becomes more complex. Second, firms may choose the currency of invoice, therefore. This technique may not be easily used especially when the price of the foreign currency is fixed by a contract. In addition, the increase in the price of the foreign currency may reduce the demand, and hence, the revenues. This process will be more successful if foreign demand is inelastic. The price may be set completely in domestic currency items. In this case, the domestic currency price is fixed but the foreign currency price changes with the exchange rate, rising as exchange rate decreases. If the firm acts as exporter, this method eliminates foreign exchange rate exposure. This means that risk is passed on entirely to the foreign importer.

6) Currency collar

This hedging technique relies on placing a lower value for the domestic currency receivables (from exporter perspective) at the expense of setting lower value. Therefore, it involves a trade-off between potential loss and potential gain. A currency collar (also called range forward) contains a certain range for the exchange rate extending between a lower limit and an upper limit. This process can be drawn in the following possibilities:

1. If the exchange rate falls below the lower limit, the rate used to convert receivables into the domestic currency is the lower limit itself and this is how the lower value is obtained.
2. If the exchange rate falls within the range, the conversion rate is the current exchange rate, which means that the domestic currency value of the receivables rises with the exchange rate within the range.
3. If the exchange rate rises above the upper limit, the rate used to convert receivables into the domestic currency is the upper limit itself and this is how the maximum value is obtained.

To sum up, although all the possible hedging techniques are discussed, it is recognized that there are many other hedging techniques, which could be used to eliminate foreign exchange risk exposure, have not explained in this study.

7) Foreign Currency Denominated Debt

However, the use of foreign currency denominated debt[24], as an internal hedging technique, is of strong interest to the present study, and this strategy is discussed in the following paragraphs.

In an attempt to protect themselves against the effect of unanticipated movements in foreign exchange rates on both their earnings (or cash flows) and their balance sheets, firms have issued foreign-currency denominated debt ("foreign debt" for short). The payments to service this foreign debt are cash outflows, and act as a

[24] Myers (1984), in his Pecking Order Theory, states that if firms intend to raise funds externally they will give priority to issuing debt rather than equity.

'natural' hedge against revenues received in the relevant foreign currencies. Of course, the issue of foreign debt itself increases the currency exposure of the firm. If it is not expected to be possible to repay the principal from foreign currency cash inflows, the firm could hedge this exposure by making an investment in an interest bearing asset in the foreign currency as soon as the obligation is known. The eventual principal repayment would be made by liquidating the investment. However, foreign debt laon may act as a hedge only if there is an underlying asset demoninated in foreign currency. Otherwise foreign currency debt may be a source of foreign exchange rate exposure.

In addition to protecting their earnings from exchange rate movements, firms with extensive foreign investments can use foreign debt to reduce translation exposure. For example, if the foreign subsidiary borrows, the net equity investment in the subsidiary will be reduced, while if the parent firm borrows in the foreign currency and converts the borrowed amount into local currency, it will have a gain (or loss) to offset against any loss (or gain) on translating the net equity investment of the foreign subsidiary. The foreign currency debt protects shareholders' funds from the effect of currency movements on the net assets of the group. For example, if an Australian parent company has a potential translation loss on the consolidation of the net assets of a U.S. subsidiary company, it could affect a loan denominated in U.S. dollars. The U.S. dollar net assets of the foreign subsidiary would be matched with the USD liability in the parent company's books, thus eliminating the necessity for translation on consolidation[25].

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[25] This technique for managing translation exposure is referred to as a 'balance sheet hedge'.

2.5.1.2 External Hedging

When internal hedging techniques are not, in themselves, sufficient to successfully manage exchange rate risk, firms can hedge their exposure using external techniques. External hedging is more expensive and more complicated than internal hedging. It involves using derivative financial instruments ('off balance sheet' items) such as forwards, futures, options, or swaps. Many research studies have shown that the use of derivative financial instruments is an important strategy to manage corporate foreign exchange rate exposure (Rawls & Simthson, 1990; Batten et al., 1993; Nguyen & Faff, 2002, 2003a). Rawls and Simthson (1990) indicated that almost all firms use forward contracts and numerous other firms use swaps and options. Batten et al. (1993) found similar results, with the most frequently used instruments being forwards, options, and currency swaps. Further, Nguyen and Faff (2003a) showed that 74.2% of Australian firms use derivatives.

2.5.2 Managing Economic Exposure

The main objective of managing economic exchange exposure is to stabilise future cash flows in the face of potential volatility in future exchange rates. Based on the effect of changes in the exchange-rate on the competitive position of the firm, it is important for the firm to manage its exchange exposure in the context of its long-term strategic planning[26]. However, Froot et al. (1993) state that, in general, there is no specific management framework in place, thus quantifying and managing

[26] Miller (1998) concluded that there are two specific rationales for hedging economic exposure: (1) many firms' stakeholders simply cannot fully diversify their firm-specific portfolios and (2) from a shareholders interest perspective, markets for strategic hedges may not be efficient.

economic exposure appear difficult. Marshall (2000) found that derivative financial instruments (short-term exposure hedging strategies) do not have the full power to manage economic exposure. Also, Pringle and Connolly (1993) indicated that a series of short-term hedging strategies, which are more likely to effectively manage transaction exposure, may not have the ability to manage economic exposure. This is because they do not significantly mitigate the cash flow effects caused by changes in the real foreign exchange-rate over time.

There is evidence that diversifying and spreading a firm's foreign investments are likely to reduce economic exposure. Since the geographical diversification of assets and cash flows provide some degree of protection against currency fluctuations, multinational firms with operations spread across many countries are likely to have less economic exposure to currency risk, whereas firms with more highly concentrated operations are likely to be more exposed (e.g., Pantzalis et al., 2001). Logue (1995) suggested that foreign investment diversification could provide a natural on-balance sheet operational hedge against economic exposure when purchasing power parity and uncovered interest parity fail to hold. Additionally, geographical dispersion of businesses might also reduce a firm's exposure to the economic cycle and so protect it from fluctuating demand.

To the extent that exchange-rate changes bring about relative price changes in a firm's inputs and/or outputs its competitive position will be altered. As a result, in addition to using off-balance-sheet instruments, management may wish to adjust the firm's production processes, its marketing mix and/or its financing mix, to accommodate the new set of relative prices. By making the necessary marketing and production revisions, for example, by re-locating production facilities abroad, or by raising finance in the relevant foreign currencies, firms can counteract the effects of unexpected currency appreciation or depreciation. Therefore, economic exposure can best be managed through operational hedges, which attempt to match foreign currency inflows and outflows, so that the amount of exposed cash flows is reduced.

It should be noted, however, that, since economic exposure affects a firm's international marketing, production and financing activities, the implementation of an operational hedging strategy could, in the short-run, be costly, be difficult to apply, and is unlikely to be effective immediately. Additionally, firm size may be a critical factor in the decision to implement an operational hedging strategy, since smaller firms may not have the necessary resources. To this extent, operational hedges could be undertaken by only those larger firms, which have the financial capability, managerial resources, active international organizational structure and international business experience (Agarwal & Ramaswami, 1992).

To implement optimal hedging strategies relating to marketing, production, and financing, academics and practitioners have suggested that it is more beneficial for a firm to apply a combination of financial and operational hedges to reduce its their total exposure. It is within this context that numerous theoretical studies argue that operational hedges are more effective in managing long-term foreign currency exposure, whereas financial hedges are more effective in managing short-run exposure (Chowdhry & Howe, 1999; Hommel, 2003; Wong, 2003, 2005). This is a result of financial markets providing only short-term tactical hedging strategies, while long-term, strategic hedges must be based on internal corporate operating strategies (Shapiro & Rutenberg, 1976; Aggarwal & Soenen, 1998). Relevant empirical research studies find evidence that integration of both financial and operational hedging strategies can effectively reduce total exposure for foreign exchange rate risk (Allayannis et al., 2001; Carter et al., 2001, 2003; Gleason et al., 2005; Kim et al., 2005; Al-Shboul, 2007).

To sum up, although the implementation of the combined use of operational and financial hedges is found to be successful in reducing economic exposure, implementing appropriate hedging strategies is a complex and expensive exercise, since this type of the exposure impacts the competitive position of the firm.

2.5.3 Managing Translation Exposure

As noted above, the management of translation exposure is not a subject of the present study, and only a brief discussion of the topic is presented in this section. Because of its potential to affect the reported earnings per share, and the reported amount of shareholders' funds, in the consolidated accounting statements, translation exposure may affect the value of the group in the stock market. Multinational firms have therefore indicated that they seek to manage translation exposure (Rodriguez, 1981). Several research studies have addressed the issue of the impact of translation exposure on firm value (e.g. Hagelin, 2003; Hagelin & Pramborg, 2004; Al-Shboul & Alison, 2007, 2008).

Several methods can be employed to manage translation exposure, including adjusting fund flows and netting of exposures across various currencies. Firms may also acquire forward and futures contracts to manage translation exposure. The goal here is to position the company in such a way that any translation difference which might arise as a result of a movement in exchange rates will be offset by profits or losses in the forward and futures markets. Of course, the success of such a strategy depends on the accurate forecasting of future exchange rate movements. Another popular technique for managing translation exposure is the balance sheet hedge. The principal drawback of using balance sheet hedges and forward and futures market to manage translation exposure is the potential for the group to incur an actual cash flow exposure, where not existed before.

2.6 WHY FIRMS UNDERTAKE THE HEDGING OF FOREIGN EXCHANGE RISK

Since the underlying theme of the present study is the hedging of corporate foreign exchange rate risk, for completeness, it is considered appropriate at this juncture to briefly discuss the reasons why multinational firms perceive a need to engage in this activity, per se.

Before considering the specific stated reasons for hedging, it is useful to consider two contentions that corporate hedging is a pointless activity. The first contention is based on the belief that hedging is not in the interests of a firm's shareholders, since they (the shareholders) can undertake personally, and relatively cheaply, any hedging they consider appropriate. The fact that some corporate hedging programs are costly to instigate and administer, lends some force to this argument. A counter argument, however, is that shareholders do not have the corporate knowledge, or the resources, to mount their own hedging programs. The shareholders may be in a position to diversify their portfolios internationally, but only the firm's management has the knowledge and ability to implement, for example, programs to manage operating exposure to foreign exchange rate risk.

Secondly, there is the question as to whether there are any situations in which corporate foreign exchange rate risk would not be considered to exist, thus obviating the necessity to manage it. One such situation would be where corporate treasurers possessed the ability to forecast, precisely, the future direction of exchange rate changes. Comprehensive details of foreign exchange forecasting techniques, including the theoretical[27] and practical resources at the disposal of the forecasters themselves, can be found in most international finance textbooks. For example, Eiteman et al. (2004, p. 164) refer to currency forecasting as a 'daunting' task. They conclude that the fundamental economic principles apply in the long term, i.e. there is a fundamental equilibrium path for any currency's value. However, they also point out that a variety of random events causes currency values to deviate from this fundamental path. Numerous empirical studies have been carried out into the accuracy of currency forecasting models.[28] While some models perform better than others over the various periods studied, the balance of evidence would indicate that the accurate forecasting of exchange rates, particularly in the shorter-term, is an elusive task and foreign exchange rate risk is, therefore, a reality of business life. Risk reduction is generally advanced as the basic reason why a firm endeavours to

[27] The core theories are the so-called international parity conditions which link together foreign exchange rates, price levels and interest rates. These are: purchasing power parity, the Fisher effect, the International Fisher effect, interest rate parity and the forward rate as an unbiased predictor of the future spot rate.

[28] For example, Boothe and Glassman (1987) and Altavilla and Grauwe (2006) suggest that combining different forecasting techniques generally produces more accurate forecasts than can be attained from a single model. Other research studies report a poor forecasting record for certain models, indicating that these are no more accurate than forecasts from simple time-series models, such as the random walk model (Meese & Rogoff, 1983).

hedge its exposure to currency price changes (Brown, 2001). This insurance argument in favour of hedging is predicated on shareholder aversion and management sensitivity to this aversion. Therefore, hedging foreign exchange risk is seen as a value safeguarding exercise.

Another basic argument for hedging is that it can be used to improve or maintain a firm's competitiveness. Firms do not exist in isolation and compete not only with other domestic firms in their sector, but also with foreign firms which produce similar goods for sale in the global marketplace. Therefore, by undertaking hedging strategies, a firm can manage foreign exchange rate exposure that has been created in its competitors' currencies. It is argued that reducing the risk of its future cash flows by hedging will improve the ability of the firm to plan its investment projects and operating strategies. That is, maintaining and reducing the volatility of cash flows by hedging is likely to increase firm value.

The final set of arguments for the desirability of hedging foreign exchange rate risk relate to the real world violations of the perfect market conditions assumed by Modigliani and Miller (1958). In a world of perfect markets with no taxes, no costs of financial distress, and no agency costs, it can be argued that hedging will have no effect on firm value. However, several authors have argued that the existence of these costs, and of capital market imperfections, make hedging strategies a necessary part of a firm's business activities (e.g., Myers, 1977; Mayers & Smith, 1982; Stulz, 1984; Smith & Stulz, 1985; DeMarzo & Duffie, 1995). These theoretical studies have implied that the benefits of hedging to shareholders and managers are likely to differ across firms in several ways, depending on various firm-level financial and operating characteristics. These studies have concluded that hedging is likely to be relevant to firm value and have provided five main theoretical rationales in support of this conclusion. These rationales are: the minimisation of tax liabilities; the reduction of the expected costs of financial distress; the reduction of agency costs; the reduction of the costs of managerial risk aversion; and the enhancement of financing and investment opportunities.

Several studies have operationalised the various theoretical predictions into testable empirical implications (e.g., Nance, Smith, & Smithson, 1993; Froot, Scharfstein, & Stein, 1993; Tufano, 1996; Berkman & Bradbury, 1996; Geczy et al., 1997; Howton & Perfect, 1998; Haushalter, 2000; Graham & Rogers 2000; Di Iorio & Faff, 2002; Hagelin & Pramborg, 2004). The studies have reported that hedging is a value-enhancing activity for a firm, mainly through the alleviation of the costs stated above.

2.7 CONCLUSION

This Chapter has discussed the issues concerning the fundamentals of managing foreign exchange risk exposure, specifically, the core topic of the relationship between the use of financial and operational hedges and the exposure. Both the abandonment of the fixed foreign exchange-rate regime in the early 1970s and the increasing globalisation of business have resulted in many firms finding themselves increasingly exposed to exchange-rate volatility. A foreign exchange rate is simply, the price of one country's currency in terms of another currency and is one of the most important prices in the economy. A change in exchange-rate is considered a major source of uncertainty, which potentially affects individual investors, through their portfolios, and firms with domestic and international investments through their competitive positions. Foreign exchange risk exposure refers to the degree to which the value of a firm is affected by exchange-rate changes. This exposure is divided into three types: economic, transaction, and translation.

After quantifying the foreign currency exposures, two specific hedging strategies are used by firms to manage the associated risk: financial and operational hedges. Financial hedges, such as derivative financial instruments (forwards, futures, options, and swaps, etc.), are designed to hedge short-term exposure (transactions), and the use of foreign currency denominated debt to manage exposure is also a financial hedging strategy. The empirical evidence as to the efficacy of financial hedges in managing exchange rate risk is mixed and this has prompted researchers to investigate this important topic.

The other currency hedging strategy is operational hedging. The advent of integrated global financial markets has facilitated the process whereby firms seek to create value by extending and expanding their foreign operations across geographical regions (foreign direct investment or FDI). These foreign operations vary from simple import/export activities to complicated strategic business directions, which require significant combined corporate effort such as integrated global sourcing, production location, and establishing foreign subsidiaries. While globalisation generates significant investment opportunities, multinational firms encounter a range of identifiable risks of which exchange-rate uncertainty represents one of the most important elements. Operational hedging can be described as re-locating, or diversifying production abroad, or investing in foreign markets, to manage exchange-rate risk and protect a firm's competitive position.

The other issue discussed in this Chapter is why firms hedge? The rationale for corporate hedging is the risks and costs reductions which it will, hopefully, generate. While this Chapter has concentrated on discussing the fundamental issues of foreign currency risk in relation to how the relevant exposures can be measured and hedged, the next Chapter (Three) will comprehensively review the literature related to this research study.

CHAPTER THREE

REVIEW OF LITERATURE

3.0 STRUCTURE OF CHAPTER THREE

Chapter 3 comprises a critical review of the literature associated with the relationship between corporate use of financial and operational hedging and foreign exchange rate exposure. From a research methodology perspective, a five-topic thematic review has been used to analyse the literature. The structure of the chapter as a whole is illustrated in Figure 3.1. The last section contains a conclusion and summary of current contributions to the literature.

3.1 INTRODUCTION

This chapter provides a critical analysis of the literature relating to the relationship of the use of financial and operational hedging on foreign exchange rate exposure. The five themes, referred to in the previous section, into which the literature has been categorised, are as follows:

1. The relationship between changes in the exchange rate and the value of the firm.
2. The effect of financial hedging on foreign exchange rate risk exposure. Four further sub-themes are derived:

a) The effect of the use of currency derivatives on foreign exchange rate exposure.

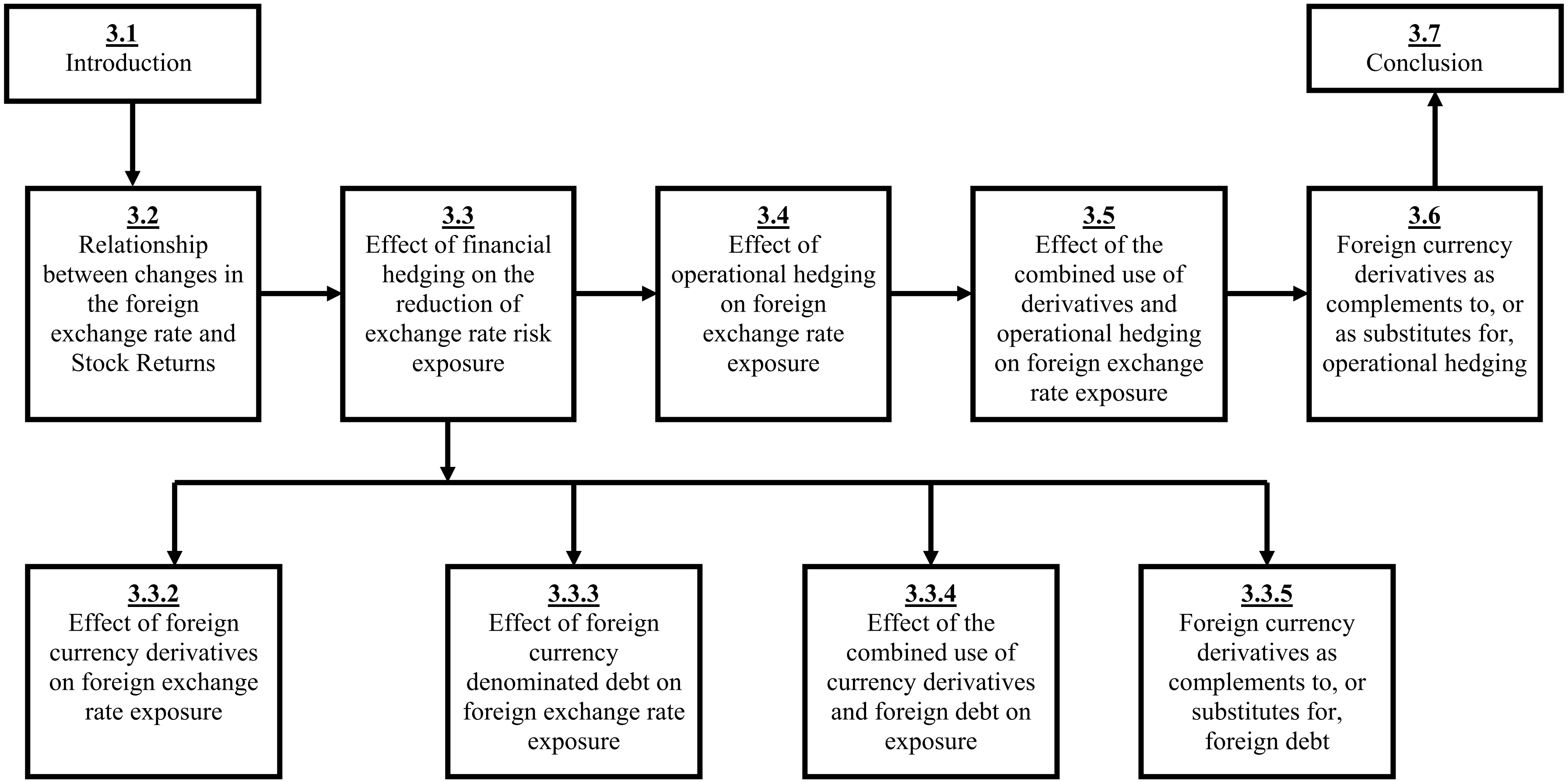
b) The effect of the use of foreign debt on foreign exchange rate exposure.

c) The effect of the combined use of currency derivatives and foreign debt on foreign exchange rate exposure.

d) Foreign currency derivatives as complements to, or substitutes for, foreign debt, in the reduction of foreign exchange rate exposure.

3. The effect of the use of operational hedging on exchange risk exposure.
4. The effect of the combined use of derivatives and operational hedging on foreign exchange rate exposure.
5. Foreign currency derivatives as substitutes for, or complements to, operational hedging, in the reduction of foreign exchange rate exposure.

Figure 3.1: Contents of Chapter 3



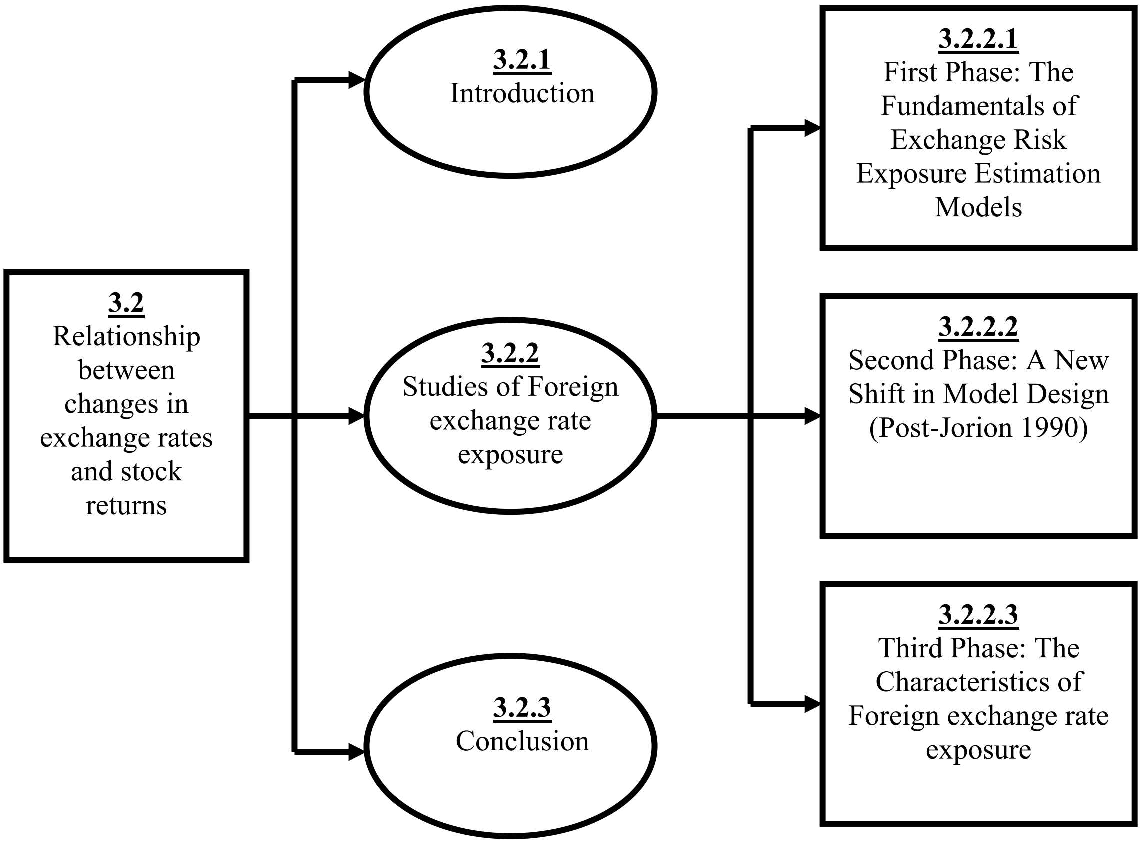
3.2 THE EFFECT OF EXCHANGE RATE CHANGES ON FIRM VALUE

3.2.1 Introduction

As indicated in previous chapters, exchange rate changes are considered a major source of risk, which potentially impacts a firm's expected cash-flows, and, ultimately, its competitive position. A number of theoretical studies attempt to model the relationship between firm value and changes in exchange rates (Shapiro 1975; Dumas, 1978; Hodder 1982; Cornell & Shapiro, 1983; Hekman, 1985; Flood & Lessard, 1986; Booth & Rotenberg, 1990; Bodnar, Dumas, & Marston, 2002, among others). These theories concentrate on using various techniques to examine this relationship. These techniques are specifically used to measure firm value such as the nature of a firm's business activities, a firm's structure of importing and exporting, foreign operations involvement, the currency denomination of a firm's competitive structure, and the competitiveness of its export and import markets. These theoretical models reported mixed and ambigious results in relation to the effect of changes in exchange rate and firm value.

However, a new theoretical model using a capital market approach was developed by Adler and Dumas (1984) who argued that stock returns (firm value) are affected by exchange rate changes. To develop Adler and Dumas's (1984) approach, a new model was developed by Jorion (1990). Jorion added the market risk factor to Adler and Dumas's (1984) model to measure the sensitivity between stock returns and changes in exchange rate. Jorion (1990) reported weak evidence that a firm's stock returns are sensitive to exchange rate changes. A number of empirical studies implemented Jorion's (1990) model to estimate foreign exchange risk exposure, using data for

<u>Figure 3.2:</u> The Relationship between Changes in Exchange Rates and Stock Returns



different types of firms, such as multinational firms, exporters, or manufacturing industries (e.g., Bodnar & Gentry, 1993; Loudon, 1993a, 1993b; Amihud, 1994). Again, these early studies found only weak evidence of a relationship between stock returns and changes in exchange rates. However, several recent studies, which implement some modifications to Jorion (1990), have found stronger evidence of stock return sensitivity to changes in exchange rates (e.g., Allayannis, 1997; Bodnar et al., 1998; Glaum et al., 2000; Di Iorio & Faff, 2001; El-Masry, 2006, among others). Therefore, it appears that there is a conflict between the various theoretical and empirical studies, on this issue.

This remainder of this section reviews the theoretical literature on foreign exchange rate exposure, and the empirical studies on its estimation. It also discusses the different methodologies used in estimating exchange rate exposure and their potential impacts on the estimation of the exposure. The section is illustrated in Figure 3.2.

3.2.2 Studies of Foreign Exchange Rate Exposure

As a result of increased volatility in foreign exchange rate movements, the volatility of both current and future cash flows of multinational and domestic firms has also risen (Bartov, Bodnar, & Kaul, 1996). The volatility of cash flows not only increases the frequency which firms will require to access capital markets, and bear the attendant costs, but also lowers the level of their investment, leading to a reduction in firm value (Shapiro & Titman, 1985; Lessard, 1991; Froot et al., 1993; Minton & Schrand, 1999). This has resulted in rising concern among managers, regulators, and other market participants, and, therefore, many theoretical studies have attempted to model the relationship between changes in exchange rates and firm value (see the Introduction section).

The theoretical approach which relates to the discussion of the current study is that of Adler and Dumas (1984). This approach models the effects of changes in exchange rates on shareholder value. As noted in the introduction to this section, it was in relation to this approach that Jorion (1990) developed his model, in which he added the market risk factor to Adler and Dumas's (1984) model, to measure the sensitivity between stock returns and changes in exchange rates. Following Jorion (1990), many empirical research studies have attempted to estimate foreign exchange rate exposure coefficients. However, they have failed to support this theoretical prediction by providing only limited evidence of the relationship between foreign exchange rate changes and stock returns. Therefore, to efficiently review the literature related to this relationship, these studies have been divided into three phases as follows:

1. The estimation models up to, and including, Jorion's (1990) augmented model (the fundamentals of exchange risk exposure estimation models);
2. The research studies post-Jorion (1990), which shifted the emphasis to the issues relating to the specification of the variables included in the fundamental estimation model;
3. The characteristics of exchange risk exposure and the recent developments in modelling this exposure;

3.2.2.1 The First Phase: The Fundamentals of Exchange Risk Exposure Estimation Models

The seminal work of Adler and Dumas (1984) defines foreign currency risk exposure as the magnitude of the sensitivity of the real market value of the firm, measured by its stock market returns, to random fluctuations in the foreign exchange rate over specific time periods. If this relationship is linear, the exposure can be estimated by the slope coefficient resulting from a regression of stock returns on the changes in the exchange rate.

In the early stages of this research, two market models were employed to investigate the relationship between exchange rate changes and stock returns: (1) the simple market model, and (2) the augmented market model.

The simple market model (Adler & Dumas, 1984) is specified as follows:

$$R_{it} = \beta_{0i} + \gamma_{1i} R_{FXt} + \varepsilon_{it} \quad \textbf{(3.1)}$$

Where R_{it} denotes the total stock return of firm i in period t, R_{FXt} is the exchange rate change in period t, γ_{1i} is the sensitivity of firm i's stock returns to unexpected changes in exchange rates, i.e. its exposure to foreign currency risk, β_{0i} is the intercept term, ε_{it} designates the error term (residual). An appreciation of the value of the home currency in terms of foreign currencies may result in a decline in foreign demand for the goods and services of local exporters. In contrast, domestic importing firms may gain from this appreciation of the domestic currency, as their imports become cheaper in terms of the home currency. Therefore, when the exchange rate is measured in terms of domestic currency units per 1 unit of the foreign currency, the regression coefficient, γ_{1i}, should be positive for exporters and negative for importers. Similarly, the liabilities of domestic firms, which are denominated in the foreign currency, will fall in value on an appreciation of the home currency and γ_{1i} should be negative. On the other hand, the assets of domestic firms, which are denominated in the foreign currency, will lose value, and γ_{1i} should be negative.

The foreign exchange rate exposure, γ_{1i}, in this simple market model, expresses the overall effect of exchange rate risk on the value of the firm, if market efficiency is assumed. This is because it incorporates all future cash flow implications of foreign currency movements (Martin & Mauer, 2005; Muller & Verschoor, 2006a). In contrast to the capital market approach, the cash flow approach focuses on the impact of foreign exchange rate changes on current cash flows (e.g., Walsh, 1994; Matrin & Mauer, 2003). Since the cash flow approach seeks to capture cash flow patterns, which result from exchange rate changes, it may decompose these exposure patterns into short-term and long-term components. Therefore, it has the ability to differentiate between transaction and economic exposure[29]. This decomposition is useful for understanding the nature of the existing exposures and evaluating the effectiveness of hedging programs. However, the cash flow approach has the disadvantage of being incomplete as it does not specifically include anticipations about future cash flows, and consequently, does not measure the total and future impact of currency fluctuations on firm value.

[29] Also, unless the exposure is measured in terms of cash flows, currency exposure may be difficult to determine, due to hedging influences (Chow, Lee, & Solt, 1997b).

While it is true that Adler and Dumas's (1984) model was the first to identify foreign currency exposure using a capital market approach, their model has some weaknesses. These weaknesses may lead to an exaggerated estimation of exchange rate risk exposure. The model estimates a firm's exchange rate exposure as part of a firm's stock return variance correlated with exchange rate movements. As such, it is often referred to as the 'total' exposure of a firm (Martin & Mauer, 2005). However, other macroeconomic variables[30] may covary with exchange rate movements and stock returns, then, failure to include them in the estimation model may result in exaggerating the estimation of the proportion of variance (risk) in stock returns resulting from foreign exchange rate movements.

As a result of the above weaknesses, Jorion (1990) derived a second market model (the 'augmented' model) to estimate the foreign exchange rate exposure coefficient. This approach measured the foreign exchange rate exposure as a 'residual' exposure after controlling for movements in the market as a whole. Jorion's model is specified in the following form:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + \gamma_{2i} R_{FXt} + \varepsilon_{it} \tag{3.2}$$

Where R_{it} refers to the total stock returns of firm i in period t, R_{Mt} is the overall stock market return in period t, β_{1i} measures firm i's stock returns sensitivity to the overall market return, R_{FXt} is the rate of change in the exchange rate orthogonal to the market return in period t, γ_{2i} is the sensitivity of firm i's stock returns to unexpected changes

[30] These macroeconomics varaibles are: industraial production growth, changes in expected inflation, unexpected infation, the risk premium in low grade bonds, the terms premium on long term govenmenet bonds (Chen, roll, & Ross, 1986; Jorion, 1990).

in exchange rates and ε_{it} is the error term. Thus, γ_{2i} denotes firm *i*'s exposure to the exchange rate changes, independently of the effect these currency movements have on the overall market. Jorion (1990) examined his model empirically using a sample of 287 U.S. multinational firms for the period 1971 to 1987. His study found that only 5.2% of the sample study exhibited significant exposure, indicating that this relationship varies systematically across multinational firms.

Many empirical studies have subsequently applied Jorion's (1990) augmented market model and have reported mixed evidence of the relationship between exchange rate changes and stock returns. One group of studies, using the exact form of the augmented model, with varying world market data, samples of firms and periods, reported a weak relationship between firms' stock returns and changes in the exchange rate, thus supporting Jorion's (1990) results. The other group of studies attempted to avoid perceived measurement errors in Jorion's model, by using modifications to the augmented model. After applying these modifications, they found stronger evidence than the researchers in the first group did.

These two groups of studies are discussed below:

a) Using the exact version of Jorion's (1990) augmented model

Early studies applied the exact version of Jorion's (1990) model, but with different time periods and using data from different countries. For example, Loudon (1993a), using a sample of 141 Australian firms' monthly stock returns from January 1984 to December 1989, found that the returns of only 9 firms, i.e., 6.4 % of the sample firms, were sensitive to changes in a trade-weighted index value of the Australian dollar. Similarly, Khoo (1994) using a sample of 98 Australian mining firms for the period from January 1980 to March 1987, found only weak evidence that their stock market returns were sensitive to exchange rate movements. The proportion of stock returns explained by exchange rate changes was also very small. A study by Amihud (1994) used the 32 largest U.S. exporting firms for the period 1982 to 1988, reported no evidence of a significant contemporaneous exchange rate exposure. Similar results were reported by Choi and Prasad (1995) and Miller and Reuer (1998). Finally, a study by Bartov et al. (1996) examined this relationship for a sample of U.S. multinational firms over two periods: January 1966 to December 1970 (five years of fixed exchange rates) and January 1973 to December 1977. These periods encompassed the 1973 transition to floating exchange rates. The authors found a significant increase in stock return volatility following the increase in exchange rate changes (around and after 1973) for the multinational firms, compared with the control firms.[31] However, their evidence supported Jorion's (1990) finding of only weak evidence for the relationship between stock returns and exchange rate changes.

Finally, a sample of 171 Japanese multinational firms was examined by He and Ng (1998). The authors found that about 25% of the firms in their sample exhibited significant positive exposure for the period January 1979 to December 1993. The extent to which a firm was exposed to exchange rate fluctuations was determined by the magnitude of its export ratio as well as by variables which were proxies for the firm's hedging policies. For example, highly levered firms, or firms with low liquidity, had more incentive to hedge and, thus, had smaller exchange rate exposures,

[31] Bartov et al. (1996) generated a sample of oil firms to control for the possible impact of oil price exposure and created a size-matched sample of non-multinational firms to control for possible confounding factors related to firm size.

while smaller Japanese multinational firms tended to have lower exposure to exchange rate risk. Overall, all of the studies, reviewed above, found weak evidence of foreign exchange rate exposure.

b) Using modified versions of Jorion's (1990) augmented model

Recent studies have implemented Jorion's (1990) model using different versions of exchange rates (multilateral or bilateral), market risk factors, sample firms, periods, horizons, and also extending the model by including extra independent variables. For example, Di Iorio and Faff (2000) examined currency exposure using both the daily and monthly stock returns of 24 Australian industry portfolios and a bilateral AUD/USD exchange rate, for the period January 1988 to December 1996. When applying daily and monthly data, the researchers found that 8% and 22% of their industries, respectively, exhibited a significant relationship between stock returns and exchange rate changes. Although these results showed mixed signals in terms of daily and monthly data, they provided stronger evidence of foreign exchange rate exposure compared to previous studies.

Di Iorio and Faff (2001a) extended their 2000 study using the same sample of companies but introducing intervals of 1, 2, 5, 20, and 50 days, and two bilateral exchange rates (AUD/JPY and AUD/USD). When the AUD/JPY was used, the study reported that increasing the time horizons from 1 day to 50 days was associated with an increase in significant foreign exchange rate exposure coefficients. The study found that 10 out of 24 industries (i.e., 41.6%) exhibited significant coefficients when 50 day horizons were used, while 6 out of 24 industries (i.e., 25%) were significant when 20-

day horizons were employed. In addition, fewer industries showed significant coefficients when using shorter horizons. Implementing the AUD/USD exchange rate for the same return intervals yielded approximately similar results.

Following Campa and Goldberg (1995, 1999), to characterise the industry structure of final goods and services, Allayannis and Ihrig (2001) used a sample of 18 U.S. manufacturing industry groups[32] for the period from 1979 to 1995, to examine currency exposure. Their study found evidence that the stock market returns of 4 out of the 18 groups, i.e. approximately 22%, of the U.S. manufacturing industries sampled, were significantly sensitive to exchange rate changes. On average, a 1% appreciation of the U.S. dollar decreased the returns of the average industry by 0.13%. The researchers also found a significant relationship between foreign exchange sensitivity and an industry's markup, with exchange rate movements having larger effects on an industry's returns during low markup periods.[33]

In a study using the monthly stock returns of 910 large U.S. firms, covering the 20-year period, January 1977 to December 1996, Bodnar and Wong (2003) found that both the return measurement horizon and the exposure model specification had an effect on estimates of foreign exchange rate exposure. In terms of the different time horizons, the authors reported that, while the precision of the estimates of exchange rate exposure increased with the time horizon, the impact of time horizon on the exposure was less significant than the impact of the independent 'market' variable used in the model to control for correlations between the exchange rate and broad

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[32] This sample captured approximately half of the total annual trade of U.S. manufacturing industries.

[33] An industry markup signifies the effects of industry competitive structure, export share and imported input share on foreign exchange rate exposure. As an industry's markup falls (rises), its exchange rate exposure decreases (increases).

macroeconomic factors. Since the exposure of the market variable is a combination of those macroeconomic factors and the average impact of the exchange rate on the cash flows of all firms in the market (as constructed), if different constructed market variables have different correlations with the exchange rate, this will affect the resulting exposure coefficients for individual firms (Bodnar & Wong 2003, p. 41). The authors demonstrated that, because of the significant size effect in firm exposure[34], differently constructed market portfolios had different exposures to exchange rates, resulting in the choice of the market variable included in the augmented Jorion model having a significant effect on foreign exchange rate exposure at the individual firm level. This size effect remained even after controlling for the involvement of individual firms in international operations. Bodnar and Wong (2003) suggested that the return on the CRSP cap-based decile portfolios be used as the market control variable in the Jorion model, as it resulted in a substantial reduction in (but not elimination of) the size effect.

Focusing on firms listed in an emerging market, Kiymaz (2003) used a sample of 109 Turkish firms exposed to currency fluctuations between January 1991 and December 1998. During March and April 1994, the Turkish Lira experienced a depreciation against foreign currencies (Turkish currency crisis). For the whole sample period, it was found that 67 out of 109 firms (i.e., approximately 61%) showed significant foreign exchange rate exposure coefficients. A comparison between the before and after crisis periods showed that the number of significant foreign exchange rate exposure cases were considerably lower before the crisis. The study also showed that

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[34] Bodnar and Wong (2003) documented a significant inverse relationship between (U.S.) firm size and exchange rate exposure, with larger, more internationally oriented firms, tending to have more negative exposures and smaller firms tending to have more positive exposures, to changes in the value of the U.S. dollar.

the degrees of foreign involvement (export and import) had significant impact on the level of exposure. Overall, the results showed stronger evidence of significant sensitivity of stock returns to foreign exchange rate changes than in most other contemporaneous studies.

Finally, relatively strong evidence of significant exchange rate exposure was reported by Dominguez and Tesar (2006). Using both trade weighted and bilateral exchange rates the authors investigated the exposures in a sample of eight (non-US) industrialised and developing countries for the period from 1980 to 1999 (country specific). Their study found a significant exposure between excess returns and changes in foreign exchange rates at both the individual firm and industry levels. With respect to the firm-level, more than 20% of the firms from five of the eight countries were significantly exposed to weekly exchange rate changes. The exposure at the industry level was generally higher with over 40% of industries significantly exposed in Germany, Japan, Netherlands, and the U.K. On testing individual sub periods the authors could find no evidence that exchange rate exposure was declining, or becoming less significant over time.

Overall, the studies reviewed in this section employing modified versions of Jorion's (1990) augmented market model have reported mixed evidence (weak and/or stronger evidence) of foreign exchange rate sensitivity.

3.2.2.2 The Second Phase: A New Shift in Model Design (Post-Jorion 1990)

a) Using excess returns

In relation to the mixed evidence provided by previous studies, the first criticism of Jorion's (1990) model is that it does not take into account the influence of interest rates, which affect risk premiums as an issue of concerns for financial managers. As a result, Jorion upgraded his 1990 model by generating a new model (1991) to estimate the exposure to foreign currency risk. This 1991 model adopted a two-factor asset pricing approach as follows:

$$R_{it}^{'} = \beta_{0i} + \beta_{1i} R_{Mt}^{'} + \gamma_{2i} R_{FXt}^{'} + \varepsilon_{it} \qquad \textbf{(3.3)}$$

Where R'_{it} refers to the excess returns of firm i's common stock in period t, R'_{Mt} is the excess return of share market index in period t, β_{1i} measures firm i's return sensitivity to the overall market risk, R'_{FXt} is the excess returns of foreign exchange rate index orthogonalized to the market return in period t, γ_{2i} denotes firm i's exposure to the exchange rate changes, independent of the effect these currency movements have on the overall market, ε_{it} is the error term. Jorion tested this model on a sample of value-weighted industry portfolios, using the same sample period used in his 1990 study and found evidence of significant cross-sectional differences among the exposure coefficients, γ_{2i}.[35]

In a study designed to investigate the pricing of foreign exchange risk in the stock market, Loudon (1993b) firstly applied Jorion's (1991) model to identify foreign exchange rate exposure, and found only 7 out of 23 Australian industry portfolios (i.e., 32% of his sample) exhibited significant exposure for the 12-year period January 1980 to December 1991. This number reduced to 4 (i.e., 17% of the sample) during the

[35] However, using arbitrage pricing theory methodology, Jorion (1991) found no empirical evidence that this foreign exchange risk was priced by the stock market.

period when the Australian dollar was floating (1984 to 1991). Evidence of the estimated exposure indicated that resources firms and industrial firms respond differently to fluctuations in the Australian dollar, which was consistent with Jorion (1990).

Using Jorion's (1991) model with monthly stock prices, Benson and Faff (2003) examined the exchange rate exposures, with special consideration of the 1997 Asian crisis, of a sample of Australian unlisted International Equity Trusts (AIET) for the period, from October 1989 to September 1999. Using the excess SDR (Special Drawing Rights) return, orthogonalised to the AOI (All Ordinaries Index), as a benchmark of foreign exchange rate changes, they found that only 8% of the sample trusts had significant exchange exposure. Using bilateral exchange rates instead of SDRs, the number of cases with significant foreign exchange rate exposure was larger (e.g., 47% for USD, 34% for JPY, 47% for GBP, and 19% for DM).

Bodnar and Gentry (1993) examined industry level exchange rate exposures for firms in Canada, Japan, and the U.S.A. However, unlike Jorion (1991), they used a two-factor capital asset pricing model without orthogonolising the rate of changes in exchange rate on market return. For Canada and the U.S.A, their model was estimated using the Seemingly Unrelated Regressions (SUR)[36] method, over a ten-year period from January 1979 to December 1988, while, in the case of Japan, the model was estimated by the Ordinary Least Squares (OLS) for each industry, over the period

[36] The SUR method is different from the OLS method in that the former method is considered an extension of the linear regression model, which allows correlated errors between various equations using the same set of data. Although the estimated parameters of independent linear regression models satisfy OLS assumptions, and provide BLUE estimators, this is does not necessarily mean that these estimated errors are not auto-correlated. Therefore, SUR is a method to test jointly the estimated errors of independent linear regressions against serial correlation, using the same set of data, even if each regression satisfies OLS assumptions.

September 1983 to December 1988. In all three countries, the authors found that less than half of the industries had exposures which were statistically significant. For the USA, 11 out of 39 industries showed significant exchange rate exposures (28 per cent); for Canada, four out of 19 industries exhibited significant exposures (21 per cent); for Japan, seven out of 20 industries had significant exposures (35 per cent). Overall, some industries in all three countries displayed significantly stronger exposures than others.

To conclude, the above studies, which used an excess returns approach with Jorion's augmented model, have provided stronger evidence of the relationship between stock returns and changes in exchange rates. However, the results remain mixed.

b) Using different versions of the exchange rate risk factor

Many of the studies using Jorion's (1990) augmented model, reviewed in Section (3.2.2.1, a), failed to report a robust relationship between changes in exchange rates and stock market returns, relative to their measurement errors. The measurement errors can be ascribed to two related issues. The first is associated with the complexity of choosing an appropriate foreign exchange risk factor, R_{FXt}. In this regard, it was believed that the failure to provide evidence of significant foreign exchange rate exposure resulted from two main issues: (1) the selection of the exchange rate index, and (2) the use of a real or a nominal exchange rate factor.

To avoid the multicollinearity problems which would result from using separate (positively correlated) bilateral exchange rates, exchange rate indices serve as parsimonious representations of these bilateral exchange rates (Chow et al., 1997a). Several studies used a Trade-weighted Index of exchange rate (TWI) as it was believed to be representative of all the exchange rate fluctuations affecting the sample firms' values. To date, a number of studies have investigated the relationship between changes in exchange rates and firm value using different versions of trade weighted indices (Jorion, 1990, 1991; Bodnar & Gentry, 1993; Bartov & Bodnar, 1994; Chow, Lee, & Solt, 1997a, 1997b; Di Iorio & Faff, 2001b, 2002). However, these studies have reported mixed evidence relating to the significance of foreign exchange rate exposures.

To eliminate these mixed results, studies have started using a single foreign exchange proxy, either a single bilateral exchange rate, or a weighted index of foreign currencies, to estimate exposure (e.g., Miller & Reuer, 1998a). This single proxy may underestimate economic exposure by omitting variables needed to capture the divergent movements in currency values. Miller and Reuer (1998a) conducted a factor analysis which revealed that single proxies did not satisfactorily capture the variability in foreign exchange rate movements. To transform these potential divergent movements and to solve the underestimation problem, Miller and Reuer (1998a) suggested that the most relevant proxy for the exchange risk factor was to include multiple single currencies in the model. They tested their model for a sample of U.S. manufacturing firms using monthly data for the 6-year period, from 1987 to 1992. Their study found that 13 to 17 percent of their sample firms exhibited foreign exchange rate exposure, a substantially higher proportion than reported in previous studies.

Additionally, the use of trade-weighted baskets of currencies as proxies for the exchange rate factor may cause lack of power in providing significant exposure coefficients where a firm is exposed to only a few currencies within the basket. That is, the trade-weights do not correspond with individual firms' or industries' trade patterns, and tests which restrict the measurement of exposure to a single exchange rate, such as a TWI, would be downward biased (Doidge, Griffin, & Williamson, 2000; Dominguez & Tesar, 2001). Using multiple exchange rates in their measurement of exposure, Dominguez and Tesar (2001) were able to demonstrate that the use of trade-weighted indices leads to an underestimation of the impact of exchange rate shocks on stock returns using a sample of Japanese firms. It was found that 24% of the sample exhibited no exposure to a trade-weighted exchange rate but significant exposure to one of the included bilateral rates.

Further support for the argument that the choice of the exchange rate factor should reflect firms' specific strategic positions was provided by Muller and Verschoor (2004). Confining the exchange rate factor in their exposure measurement model to six region-specific trade-weighted indices, the researchers demonstrated that the failure of earlier studies to document a significant currency exposure may have been partly ascribed to an indistinct specification of the exchange risk factor. Finally, Fraser and Pantzalis (2004) showed that when additional currencies were incorporated in an index, more firms with significant exposures were detected. This applied both to firms operating domestically, and to those with operations abroad.

In contrast to using an index proxy, other studies have used actual bilateral exchange rates to measure currency exposure (Booth & Rotenberg, 1990; Di Iorio & Faff, 2001a, 2001b; Dominguez & Tesar, 2001; Williamson, 2001; Entorf & Jamin, 2004). Generally, this method was implemented when the researchers estimated that, due to the dominance of one country as a trading partner, one currency primarily affects the value of the firms included in their samples.

Finally, a few studies have generated a special form of the exchange rate factor in their studies. For example, Martin and Mauer (2005), using a sample of 104 of the largest U.S. banks, constructed a special form of foreign exchange risk factor orthogonal to the interest rate differential and relative economic activity levels.[37] The orthogonal exchange rate factor was generated in the following equation, as the residual, or the unexplained portion, of the exchange rate which was not captured by macro-economic variables.

$$R_{FXt} = \alpha_{0i} + \alpha_{1i} IN_{it} + \alpha_{2i} GDP_{it} + \upsilon_{it} \qquad \textbf{(3.4)}$$

Where R_{Fxt} is the value of the U.S. dollar in terms of country *i*'s currency at time *t*, IN_{it} is the difference in long-term interest rates of country *i* and the U.S. at time *t*, GDP_{it} is the ratio of the real economic activity level in country *i* to the U.S. at time *t*, v_{it} is the residual exchange rate factor for country *i* currency at time *t*. Martin and Mauer (2005) used both capital market and cash flow approaches to estimate the currency exposure of their sample firms. Their results (for the study period, from 1989 to 1998) showed weak evidence of exposure using the capital market methods, while using the cash flow models provided no significant evidence of sensitivity to movements in the constructed exchange rate factor.

[37] Using an orthogonal exchange rate factor is common in empirical studies (see for example, Choi, Elyasiani, & Kopecky, 1992).

The second issue relates to whether nominal or real exchange rate risk factors should be used in the measurement of currency exposure. While economic theory might intuitively suggest employing real stock market returns and real exchange rates (Bodnar & Gentry, 1993), most empirical studies have used only nominal returns. Three main reasons appear to explain this practice. Firstly, in the context of thrift, it has to be stressed that if exchange rate movements were measured in real terms, the need for consistency would dictate that all variables in the regression equation would also have to be measured in real terms. Secondly, as financial markets do not observe inflation rates instantaneously, it would be highly likely that investors would primarily incorporate the impact of the more readily observable nominal exchange rates in stock prices (Bodnar & Gentry, 1993). Thirdly, the low variability of inflation differentials relative to exchange rate movements, on a monthly basis, implied that nominal movements actually dominate real exchange rate movements. As a consequence, the use of real versus nominal exchange rates has a negligible effect on exposure estimates (Bodnar & Gentry, 1993; Amihud, 1994; Choi & Prasad, 1995; Chamberlain, Howe, & Popper, 1997; Griffin & Stulz, 2001).

In conclusion, all the above studies, using different forms of the exchange rate factor in Jorion's augmented model, have failed to provide any clear evidence of the relationship between changes in exchange rate and stock returns.

c) Using different versions of market risk factor

From Jorion's (1990) perspective, exchange rate risk exposure was estimated as a residual between the total exposure of the firm and the exposure of the stock market (see Eq. 3.2). As noted in the previous section 3.2.2.1, the inclusion of a stock market return factor controlled to a large extent for correlated macroeconomic events. In other words, it was assumed that all firms listed on a national stock market were similarly affected by a change in the value of the currency of that country, and that the market risk factor reflected the country's overall market return. Using the examples of three different share market indices (equally-weighted, trade-weighted and firm size-matched market portfolios), Bodnar and Wong (2003) argued that the definition of the stock market risk factor is important when estimating foreign exchange rate exposure. They indicated that, because large firms are over-represented in these indices, the use of a trade-weighted stock market index to compute market returns may induce a positive bias in estimating exposure coefficients.[38]

A number of studies used different versions of share market indices in their models to explore whether this resulted in more significant exposure coefficients than did the single market index used in previous studies. For example, Glaum, Brunner, and Holger (2000) argued that, because it included a single proxy for the market risk factor, Jorion's estimation process failed to document, consistently, significant residual foreign exchange rate exposure, although, in reality, shareholder value was affected by changes in exchange rates.[39] Using data for the period, from January 1974 to December 1997, Glaum et al. (2000) applied the model of Adler and Simon (1986), i.e. Equation 3.1, to estimate foreign exchange rate exposure for a sample of German corporations. They found that the corporations were significantly exposed to changes in the value of DM/US-dollar. However, their results were unstable over time.

[38] This problem was confirmed by Pantzalis et al. (2001) and Starks and Wei (2003).

[39] Glaum et al. (2000) argued that the currency exposure coefficient estimated in the model of Jorion (1990) failed to reflect the full effect of exchange rate changes on a firm's returns, as specified by Adler and Dumas (1984). Instead, it measures firm-specific exchange rate sensitivity in excess of the exchange rate reaction of the market as a whole (Glaum et al., 2000, p. 3).

While the inclusion of a market risk factor alleviates the omitted variables problem, the specification of the market risk factor has, potentially, direct implications for the sign, magnitude and significance of the estimated exposure coefficients (Priestley & Qdegaard, 2007). Following Jorion's (1991) model, Priestley and Qdegaard (2007) used a new methodological approach to examine foreign exchange rate exposure using the market return (share market index) and macroeconomic variables (the term spread, the default spread, changes in industrial production and changes in the consumer price index). They attempted to prove that including only the return from a share market index is likely to provide inaccurate estimates of industry specific exposure. Their study was based on the depreciation and appreciation of U.S. dollar for 28 U.S industries, for three regime periods (1979 – 1985; 1985 – 1990; 1991 - 1998). After orthogonalising the market returns to the changes of exchange rate for the three periods, it was found that the model resulted in more significant foreign exchange rate exposures.

These arguments prompted the development of the multi-factor models with business condition variables, reviewed in the next section.

d) Using multi-factor model with business condition variables

In order to eliminate the failure of reporting significant evidence of foreign exchange rate exposure reported by Jorion (1990) and others, a group of studies designed alternative models, by including various factors representing business conditions such as macroeconomic factors, as proxies for the market risk factor (Choi et al., 1997a, 1997b; Chow & Chen, 1998). For example, Chow et al. (1997a), following Fama and French (1989), included in their model certain business condition variables, which had been found to explain expected stock returns. Their model was expressed as follows.

$$R_{i,t,t+T} = \gamma_{0i} + \gamma_{1i} R_{FXt,t+T} + \gamma_{2i} Dyld_{t-12,t} + \gamma_{3i} Dprm_t + \gamma_{4i} Tprm_t + \varepsilon_{i,t,t+T} \qquad \textbf{(3.5)}$$

Where $R_{i,t,t+T}$ is the continuous excess return on the stock of firm *i* for period *t* to *t* +T (T = 1, 2, …, 60), $R_{FXt,t+T}$ is the continuous rate of changes in a real exchange rate index for period *t* to *t* + T, $Dyld_{t-12,t}$ is the dividend yield in period *t*, $Dprm_t$ is a default premium, $Tprm_t$ is a term premium, as alternatives to the market return for period *t*. Using the returns on four U.S. diversified equity portfolios and a sample of 213 multinational firms from March 1977 to December 1991, Chow et al. (1997a) regressed stock returns on corresponding exchange rate changes and the other independent variables in Equation 3.5, for horizons varying from 1 month to 60 months. The researchers found that long-horizon stock returns were better suited for detecting long-term exchange-rate effects on firm value than short-term stock returns. Currency exposure coefficients only became significant at horizons of 12 months or more. Their additional finding was that small firms were negatively exposed to foreign exchange rate changes, while large firms tended to be positively exposed.

Chew et al. (1997b) used return horizons from 1-month to 48-month to estimate the exchange rate risk exposure of a sample of U.S. stocks and bonds for the period, from March 1977 to December 1989. The additional feature of their model was the inclusion of a dummy variable to capture the well-established January effect[40]. Their model was expressed as follows.

$$R_{t,t+T} = \alpha_0 + \gamma_1 R_{FXt,t+T} + \gamma_2 X_t + \gamma_3 Tprm_t + Jan_{t,t+T} + \varepsilon_{t,t+T} \quad \textbf{(3.6)}$$

As noted above, the model was estimated for horizons T = 1, 2, 3, 6, 12, 24 and 48. Where $R_{t,t+T}$, $R_{FXt,t+T}$ and $Tprm_t$ were identified previously. X_t is either $Dyld_{t-12,t}$ (dividend yield) or $Dprm_t$ (default premium), and $Jan_{t,t+T}$ is the dummy variable included to capture the January effect. Chew et al. (1997b) argued that changes in the real exchange rate are important in explaining the temporal variations in expected returns on stocks and bonds. They found that all assets were exposed to exchange rate risk, but that changes in real exchange rates affected bonds and stocks differently. Since bonds are relatively fixed income securities, they reflected only an interest rate effect, while stocks reflected a combination of interest rate changes and cash flow effects. If the exchange rate changes contained information about future interest rates and cash flows over more than one period, then using short-term horizons might not fully capture exchange exposure, which may explain why prior studies have failed to find an association between changes in exchange rate and stock returns. Using both long-term stock returns and long-term exchange rate changes are more likely to capture exposure compared with using short-horizons.

Following Chow et al (1997a, 1997b), Chow and Chen (1998) tried to eliminate some of the measurement problems associated with estimating the exposure coefficients, by

[40] The January effect is one of anomalous seasonal effects in the U.S. stock market. It has been claimed that one explanation for the phenomenon is that it results from many investors choosing to sell some of their stocks just before the end of the year, in order to claim a capital loss for tax purposes. Once the tax calendar rolls over to a new year on January 1st, those investors quickly go back to reinvest their money in the market, causing stock prices to rise (see Ross et al., 2002, p. 788).

incorporating business condition variables, especially hedging effect variables, in Jorion's augmented model. These variables were the leverage ratio, the liquidity ratio, and the dividend payout ratio. Testing a sample of 1,110 Japanese firms for the period, from January 1975 to December 1992, Chow and Chen (1998) found a significant exchange rate exposure for different return horizons. Their exchange risk factor, as a parsimonious representation of exchange rates, was computed as a weighted average of 14 countries bilateral exchange rates. Overall, they found that Japanese firms were substantially exposed to changes in exchange rates. More than 80% firms were negatively exposed to foreign exchange rate risk, indicating that Yen depreciation adversely affects firms. The number of negatively exposed firms increased with the return horizon. For the 24 months horizon, 88.5% of the firms (982 firms) were negatively exposed. There was also an indication that the number of firms with significant exposures increases with the return horizon. For the one-month horizon, only 30% of firms had significant exposure. This result was consistent with findings in the U.S. by Jorion (1990), Amihud (1994), Bodnar and Gentry (1993), Bartov and Bodnar (1995), and Chow et al. (1997a).

Furthermore, Gao (2000) replaced the market risk factor by six macroeconomic variables. These macroeconomic variables were essential determinants of firm value and were taken into account in order to eliminate overestimating the exchange rate exposure when measuring the impact of exchange rate movements on firm value. His model was specified as follows:

$$R_{it} = \beta_{0i} + \sum_{k=1}^{6} \beta_{ki} M_{kt} + \gamma_{2i} R_{FXt} + \varepsilon_{it} \qquad \textbf{(3.7)}$$

Where M_{Kt} represents the macroeconomic variables: the unemployment rate, producer price index, money supply, energy price index, aggregate wage index and industry-specific wage index. R_{FXt} is the unanticipated exchange rate change resulting from the orthogonalization procedure following Jorion (1990, 1991). By applying this model on a sample of 80 U.S. multinational firms over the period from 1988 to 1993, the empirical investigation showed that the exchange rate exposure coefficients in Equation 3.7 were mostly statistically significant, whereas they were statistically insignificant when the six macroeconomic variables were replaced by the market risk factor. However, none of these macroeconomic variables indicated a significant impact on stock returns.

The final research set in the Second Phase investigated the relationship between foreign exchange rates and stock returns by means of a multi-factor model including an interest rate factor. The relevant research is reviewed in the next section.

e) Using multi-factor model including interest-rate factor

The final research set in the Second Phase consists of a group of empirical studies which modified Jorion's (1990) model by using a three-factor model to estimate foreign exchange rate exposure (e.g., Choi, Elyasiani, & Kopecky, 1992; Prasad & Rajan, 1995). These studies added a third independent variable to the augmented model, which represents a proxy for an interest rate factor. The general model was of the following form.

$$R_{it} = \alpha_{0i} + \beta_{1i} R_{Mt} + \gamma_{2i} R_{FXt} + \delta_{3i} R_{INt} + \varepsilon_{it} \quad \textbf{(3.8)}$$

Where R_{it} refers to the total stock returns of firm *i* in period *t*, R_{Mt} is the overall stock market return in period *t*, β_{1i} measures firm *i*'s stock returns sensitivity to changes in the overall market return, R_{FXt} is the rate of change in the exchange rate orthogonal to the market return, in period *t*, γ_{2i} is the sensitivity of firm *i*'s stock return to changes in the exchange rate, R_{INt} is a proxy for an interest rate factor, and ε_{it} is the error term.

Choi et al. (1992) used a micro model of an international banking firm (the 'banking model') to test for the effect of changes in bilateral exchange rates (CAD, DM, JPY, SWF, and GBP), and a multilateral exchange rate index, on the stock returns of banks. Their study covered the 48 largest of the U.S. banking institutions for the period 1975 - 1987. The results indicated a significantly negative exchange rate coefficient for the period prior to October 1979, and a significantly positive coefficient thereafter.[41]

Using various industry portfolios for the period, from 1981 to 1989, Prasad and Rajan (1995) applied the same model as Choi et al. (1992) above, to test whether exchange rate fluctuations had an impact on stock returns in Germany, Japan, U.K. and the U.S. In general, they found mixed evidence of significant exposure coefficients. Specifically, significant exposure coefficients were: for the U.S.: 25% of 20 industries; for Germany: 50% of 12 industries; for Japan: 4% of 25 industries; for the U.K.: 12% of 17 industries.

[41] Choi et al's (1992) model predicted a negative exchange rate exposure coefficient for the pre-October 1979 period, based on the unhedged net foreign claims position of U.S. banks payable in foreign currency during that period.

The next section focuses on studies which seek to alleviate the failure of Jorion's (1990) augmented model to report consistently significant currency exposure, by addressing the characteristics of foreign exchange rate exposure itself.

3.2.2.3 The Third Phase: The Characteristics of Foreign exchange rate exposure

a) Systematic error

Another potential reason for the failure of Jorion's (1990) model to report significant foreign exchange rate exposure is the presence of systematic error.[42] Firms may reduce the effects of systematic error on the estimation of their currency exposures by making general disclosures of their current operations, which include information relevant to currency risk. As a result, they can reduce the level of information asymmetry[43] between managers and investors. However, the information disclosure policies of managers may be different from those which investors would prefer. For example, managers may have some uncertainty about the firm's future operations and hesitate to disclose certain information resulting in an incorrect evaluation by investors of the firm's net market risk exposure (Beckett, 1997). Consequently, investors may face multiple disclosure methods, which are difficult to interpret as they are compounded by information bias. For example, often investors may not be fully aware of a firm's hedging activities, and of the strategy which the firm plans to implement regarding the competitive environment conditions induced by currency movements (Bartov &

[42] Systematic error, or random error, is generated by any factor which systematically affects measurement of the variable factors across the sample. The reason why complex circumstances might lead to systematic mispricing by investors are not well understood (Bartov & Bodnar, 1996).

[43] Information asymmetry exists when one party, e.g., managers, has more or better access to the information than another party, e.g., investors (Peirson, Rob, Easton, Howard, and Pinder, 2006, p. 266).

Bodnar, 1994). However, over time they may develop full awareness and learn to evaluate the relationship between changes in currency rates and firms' future cash flows more efficiently. That is, eliminating systematic error may lead to significant evidence of the relationship between exchange rate changes and firm value being reported by empirical researchers.

In this particular context, a study by Bartov and Bodnar (1994) tested the relationship between stock returns and both current and lagged percentage changes in currency exchange rates for a sample of 208 U.S. firms, for the fiscal years, 1978 to 1989. Bartov and Bodnar (1994) suggested that one possible explanation for the limited success of prior studies was the existence of mispricing of exchange rate risk, arising from systematic error caused by investors' choices. The following basic regression model was used to measure firm sensitivity to exchange rate changes:

$$AR_{it} = \alpha_0 + \sum_{j=0}^{n} c_j \Delta R_{FXtj} + \varepsilon_{it} \qquad \textbf{(3.9)}$$

Where AR_{it} is the percentage change in the stock return i at time t, R_{FXtj} is the percentage change in the foreign exchange rate index (trade-weighted index) of the U.S. dollar, for the period t to j, and ε_{it}, is the error term for firm i in period t.

The results reported by Bartov and Bodnar (1994) suggested that lagged exchange rate changes (as a proxy for systematic error) had more explanatory power than contemporaneous exchange rate changes. Moreover, this study found that the effect of exchange rate movements on stock returns was not evident until the financial information regarding the past performance of the firm was disclosed. The authors attributed the lagged exchange rate effect to systematic investors' errors in characterising the relationship between exchange rate changes and firm value. Such errors are commonly interpreted as evidence of either market inefficiencies, or time variation in expected stock returns.

Similarly, Di Iorio and Faff (2000) reported strong evidence that systematic errors had an effect in providing significant firm exposure to exchange rate risk. Using daily and monthly data for 24 Australian industry portfolios for the period, from 1988 to 1996, stronger lagged response than contemporaneous response, was reported. Following Fabozzi and Francis (1977), Di Iorio and Faff (2000) added three dummy variables, as proxies for systematic errors, to Jorion's model. It was found that these dummy variables had strong explanatory power in providing significant foreign exchange rate exposure coefficients.

El-Masry (2006) examined the effects of both changes in the exchange rate and the lagged foreign exchange rate exposure (as a proxy for systematic error) for 364 U.K. corporations over the period from 1981 to 2001. The author's findings indicated that a higher percentage of U.K. industries were exposed to contemporaneous exchange rate changes than those reported in previous studies. The study also reported evidence of significant lagged exchange rate exposure. This lagged exchange rate exposure is consistent with findings in previous studies. This evidence may result from the existence of some market inefficiencies in incorporating exchange rate changes into the returns of firms and industries.

However, He and Ng (1998) reported results contradictory to previous studies' findings, using various industry portfolios for the period, from January 1979 to December 1993. He and Ng investigated whether the value of 171 Japanese multinational corporations was affected by changes in exchange rates and whether lagged exchange rate changes had any explanatory power for current stock returns for the period. They found that 17% of these corporations exhibited economically significant positive exposure. In addition, they reported that less than 4% of their sample of Japanese firms experienced a significant lagged response to currency changes. Therefore, weak evidence was reported regarding the variable included as a proxy for systematic errors.

Thus, despite the modifications to the augmented model described above, the reporting of mixed results remains an issue.

b) Temporal instability of the exposure

One of the most critical questions arising in estimating exposure is the temporal instability of firms' currency risk exposures. Jorion (1990) assumed that currency risk exposure was constant over time. But this assumption may be unrealistic because of the many other market variables changing over time, for example, the overall economic environment and a firm's competitive position, operational structure, and hedging strategies (Bartov & Bodnar, 1994). A firm's currency exposure may, therefore, change over time as a result of changes in these other factors. If exchange rate exposure were varying, (e.g., from year to year), it would seem inappropriate to estimate the exposure coefficient over a period of 5 or 10 years, since the estimated coefficient will only reflect the average exchange exposure over the whole estimation period. The exposure volatility over the estimation period may force the coefficient to be insignificant. To alleviate this instability problem, different econometric approaches have been used to model the exposure.

The first approach was to divide the relevant time series data into appropriate sub-periods and test for constant exchange rate exposure in each sub-period (Jorion, 1990; Choi & Prasad, 1995; He & Ng, 1998; Williamson, 2001; Doukas, Hall, & Lang, 2003). Generally, all of these studies supported the assumption of a time varying exposure. A second approach used to address the problem of foreign exchange rate exposure's time variability was the moving window technique, also known as rolling regression. In this technique many windows of the sample periods were used to provide an insight into whether foreign exchange rate exposures varied randomly across these periods or whether clear patterns or trends could be identified (Glaum et al., 2000; Entrof & Jamin, 2004). In general, the empirical evidence points to exposure coefficients varying over time and even experiencing sign changes. This made it difficult to observe any clear trends (Entrof & Jamin, 2004).

A third approach to exploring the time varying behaviour of exchange rate exposure was to identify the origins of the fluctuations of the exposure (Levi, 1994). From an industry portfolio perspective, Allayannis (1996) reported evidence of the systematic correlation between the exchange exposure of U.S. manufacturing firms and their shares of exports and imports in these industries. In turn, from individual firm data, Gao (2000) developed a model that integrated the effects of a depreciation (appreciation) of the parent firm's currency with the impact of foreign sales, and of the firm's share of production located overseas. This model provided a new technique to distinguish between these two effects of exchange rate movements on stock returns. In Gao's model, the exposure to exchange rate risk, γ_{2i}, was designed as a linear function of the firm's share of foreign sales to its total sales, FS_{it}, and the firm's share of foreign inputs to its total output, FX_{it}, as follows:

$$\gamma_{2i} = \delta_{1i} FS_{it} + \delta_{2i} FX_{it} + \tau_{it} \qquad \textbf{(3.10)}$$

The estimated coefficients δ_{1i} and δ_{2i}, measure the effects of currency fluctuations due to foreign sales, and foreign production, respectively, whereas, τ_{it} was the estimated residual effect. As a result of both independent variables, FX_{it} and FS_{it}, varying over time, the exchange rate exposure, γ_{2i}, will also change over time. Gao's results indicated that the exposure coefficients (1) had the expected positive sign for δ_{1i}, and the expected negative sign for δ_{2i}, and (2) were statistically significant. Therefore, the implementation of this model provides two valuable sites into the sales and production decisions made by the firm and how these decisions affect foreign exchange rate exposure.

The observed frequency technique provided a fourth approach to address the time-varying problem. A few research studies examined the possibility that the most used frequency in empirical studies might not be appropriate (Chamberlain et al., 1997; Di Iorio & Faff, 2000). Although there is a theoretical assumption that exchange rate exposure should be independent of the observation frequency used, results indicated that the estimated exposure coefficients differ according to both observation frequency and return horizon. The suggested reasons lying behind this phenomenon were market inefficiencies, and the complex relationship between exchange rate movements and firm value.

Chamberlain et al. (1997) investigated the exposure to currency fluctuations of U.S. and Japanese banking institutions, and reported that the use of daily data captured the exposure more efficiently than monthly data. Their findings were subsequently confirmed by Di Iorio and Faff (2000) and Glaum et al. (2000). In contrast, specifying return horizons of longer than 1 month, Chow et al. (1997a) found more significant exposure cases than in the case of 1 month horizons. Subsequent research studies (e.g., Chow & Chen, 1998; Griffin & Stulz, 2001; Dominguez & Tesar, 2001a; Di Iorio & Faff, 2001; Muller & Verschoor, 2004) documented that the sensitivity of stock returns exchange rate movements was stronger when return horizons were measured over longer intervals. The authors of these studies argued that the possible underlying reason was that the long-horizon regressions capture the long-term currency shocks, and reported the more fundamental long-term relationship between exchange rates and firm value.

Di Iorio and Faff (2001b) extended their previous (2001a) study via different sample periods, to test whether the degree of foreign exchange rate exposure was stable over time, using both bilateral and multilateral exchange rate factors. The authors added a dummy variable to Jorion's (1990) model to assess whether the accumulated evidence of weak sensitivity of stock returns to exchange rate changes might be due to the averaging effect of different sample periods. Their overall results provided strong evidence in both cases (bilateral and multilateral) that foreign exchange rate exposure was changing over time.

Therefore, the empirical evidence indicates that currency exposure coefficients vary over time and even experience sign changes, making it difficult to observe any clear trends in the exposure.

c) The non-linearity and asymmetric behaviour of foreign exchange rate exposure

Another possible reason for the failure of the augmented model to report consistently significant foreign exchange rate exposure is that the function which represents the relationship between stock returns and changes in exchange rate is not linear.[44] A study by Williamson (2001) investigated the potential non-linearity of the exchange rate exposure in a different functional relationship. Based on the assumption that currency depreciations and appreciations have a similar impact in magnitude on firm value, Williamson investigated the effect of industry structure and competition on the relationship between real exchange rates and firm value for the automotive industry in the U.S., Japan and Germany, for the period, from 1973 to 1995.[45] Williamson (2001) considered the currency exposure of a firm to be a function of its foreign sales, the cost structure of its foreign competition as well as the degree of competition, and the firm's hedging practices. To test the exposure of U.S. firms, Williamson (2001) specified his model as follows:

$$\begin{aligned} R_{it,USD} = \beta_{0i} + \beta_{1i} R_{Mt} + \gamma_{1i} \Delta R_{FXt,JPY} \times MS_{JPY,USD} + \gamma_{2i} \Delta R_{FXt,JPY} \times MS_{USD,JPY} + \\ \delta_{1i} \Delta R_{FXt,DM} \times MS_{GR,USD} + \delta_{2i} \Delta R_{FXt,DM} \times MS_{USD,GR} + \varepsilon_{it} \end{aligned} \quad \textbf{(3.11)}$$

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[44] Bartov and Bodnar (1994) briefly referred to this possibility as one of the complexities which may induce investors to make systematic errors in assessing the relationship between a firm's value and exchange rate changes (Di Iorio & Faff, 2000, p. 7).

[45] Williamson (2001) studied firms (automotive) as they are expected to have both high levels of foreign sales and foreign competition.

Where $R_{it,USD}$ is the monthly stock return for U.S. firms, R_{Mt} is the return on the U.S. share market, γ_{1i}, γ_{2i}, δ_{1i} and δ_{2i} are the exposure coefficients of the interaction between the exchange rate and market share, $R_{FXt,JPY}$ is the rate of change in real exchange rates of the Japanese yen in terms of U.S. dollar at time t, $R_{FXt,DM}$ is the rate of change in real exchange rates of the Deutschmark in terms of U.S. dollar at time t, $MS_{JPY,USD}$ is the market share of the portfolio of Japanese companies in the U.S., $MS_{USD,JPY}$ is the market share of the portfolio of U.S. companies in Japan, $MS_{GR,USD}$ is the market share of the portfolio of German companies in the U.S., $MS_{USD,GR}$ is the market share of the portfolio of U.S. companies in Germany and ε_{it} is the error term. Using market shares of the firms in the respective markets, and the competition faced by the firms in each market, Williamson's results showed that domestic competition from foreign firms is an important determinant of currency exposure for U.S. automotive firms.

To test for the effect of foreign sales on the exposure of U.S. and Japanese firms, Williamson (2001) measured the exposure as a function of the export sales and foreign operations in a particular market. His regression model was as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + \gamma_{2i} R_{FXt,JPY} \times FS_{JPY,USD} + \gamma_{3i} R_{FXt,JPY} \times PS_{JPY,USD} + \varepsilon_{it} \qquad \textbf{(3.12)}$$

Where R_{it} is the monthly return for Japanese firms, R_{Mt} is the return on the country-specific market portfolio (Japan), $R_{FXt,JPY} \times FS_{JPY}$ and $R_{FXt,JPY} \times PS_{JPY,USD}$ are the interaction of the change in the yen-to-dollar real exchange rate and the U.S. production to U.S. total sales for Japanese firms and the interaction of the change in the yen-to-dollar real exchange rate and U.S. production to U.S. total sales for

Japanese firms, respectively. The U.S. sales data of the Japanese firms include both exports from Japan and production in the U.S. The study reported significant exchange rate exposure for portfolios of automotive firms from the U.S. and Japan from 1973 to 1995. At the firm level, there is further evidence of significant exchange rate exposure for certain firms and insignificant levels for other firms, that is, consistent with theories of the determinants of exposure. Overall, Williamson (2001) found that the ratio of foreign sales to total sales and competition were considered major determinants of exchange rate exposure and that foreign production decreases exchange rate exposure. Therefore, industry competition and the structure of the firm's operations play essential roles in the exchange rate exposure to firm-value relation.

In response to the possibility of Williamson's assumption that foreign currency depreciation and appreciation have the same effect on firm value being unrealistic, Bartram (2004) approached the assessment of non-linear currency exposure using different generic specifications of non-linear functions. His approach included the cubical function, the sinus hyperbolicus, the cubic root function, and the inverse sinus hyperbolicus.[46] The first two specifications were used to estimate the convexity of exposures, while the latter two were employed to capture concave exposures. His general regression equation is written as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + \gamma_{2i} f(R_{FXt}) + \varepsilon_{it} \qquad \textbf{(3.13)}$$

Where R_{it} represents the stock return of company *j* in period *t*, R_{Mt} is the return on the capital market index in period *t*, R_{FXt} is the percentage change of currency in period *t*,

[46] A cubic function is a function of three independent variables which these variables take consecutively a power of 1, 2, and 3.

$f(R_{FXt})$ is a nonlinear function of the exchange rate. If the relationship between changes in exchange rates and changes in stock prices were not linear, as in the classical model (based on Adler & Dumas, 1984; Jorion, 1990), the effect of changes in a foreign rate on firm value would depend on the size of the exchange rate change itself. Applying his approach to a sample of 490 German listed corporations, Bartram (2004) showed that the firms in his sample exhibited convex exposure. That is, their stock returns reacted differently to positive versus negative foreign exchange rate changes. In addition, he showed that sinus hyperbolicus or cubic functions tend to increase the incidence of significant exposure. Overall, Bartram (2004) reported that nonlinear exposures were statistically significant for all foreign exchange rates than linear exposures.

Priestley and Qdegaard (2007) generated a new model to examine the nonlinear relationship between exchange rates and stock returns using a simple extension of the linear exposure framework, which added the squared values of the U.S. dollar-European Currency Unit (ECU) and U.S. dollar-Japanese yen (JPY) exchange rates changes to Jorion's model. Their model is specified as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + \beta_{2i} R_{FXt,JPY} + \beta_{3i} R_{FXt,ECU} + \beta_{4i} R^2_{FXt,JPY} + \beta_{5i} R^2_{FXt,ECU} + \beta_{6i} z_t + \varepsilon_{it} \quad \textbf{(3.14)}$$

Where R_{it} is the percent change (return) in the stock price of firm i, R_{Mt} is the rate of return from the share market index, $R_{FXt,JPY}$ and $R_{FXt,ECU}$ are the orthogonalised percentage changes in the dollar-JPY and the dollar-ECU exchange rates, $R^2_{FXt,JPY}$ and $R^2_{FXt,ECU}$ are the squared orthogonalised percentage changes in the dollar-JPY and the dollar-ECU exchange rates, respectively. β_{4i} and β_{5i} measure the sensitivity of stock i

to these nonlinear effects. β_{6i} is a vector of coefficients relating the macroeconomic variables, z_t, to the industry returns, and ε_{it} is an error term. Whilst the exact nonlinear relationship may be a complex function of firm specific characteristics such as export and import ratios, export and import price elasticities, and competition, amongst others, they believed that the use of a squared exchange rate may be useful in capturing simple nonlinearities. Applying the data of 28 U.S. industries for a period from 1979 to 1998, their results showed that nonlinear exposure, overall, was statistically significant, but there was weak evidence that industries were exposed to a currency basket.

To conclude, the empirical evidence as to whether changes in stock returns are a nonlinear function of changes in exchange rate remains ambiguous.

Other studies investigated the possibility of an asymmetric behaviour of stock returns in response to the degree of fluctuations (high versus low) of foreign exchange rates. Choi and Prasad (1995) investigated firm valuation under exchange risk exposure using individual stock return data for 409 U.S. multinational firms, and for 20 industry portfolios, for the period, from 1978 to 1989. They found that firm value was significantly affected by both real and nominal exchange rates. Further, these effects varied in terms of the degree and direction across firms. They documented only a small percentage of firms with significant exchange risk sensitivity (15%). Results using SIC portfolio returns indicated no significant exchange rate sensitivity, prompting the authors to suggest that exposure to exchange rate risk depended on firm-specific factors. Over the entire estimation period, only two industries (other retailing and mining) are significantly exposed to currency fluctuations. However, when they studied the behaviour of these exposure coefficients within two dollar regimes (weak-dollar and strong-dollar), they found an asymmetrical effect with higher instances of exchange rate sensitivity during the weak dollar period.

Using 30 U.S industry portfolios to test for asymmetric reactions of stock returns to an unexpected appreciation or depreciation of the U.S. dollar, Pollard and Coughlin (2003) found that both high and low changes in foreign exchange rates, and the direction of these changes, affected firms' stock returns, in terms of pass-through and trade flow effects. Their study found that more than half of the firms in the sample industry portfolios exhibited asymmetric behaviour to appreciation and depreciation of exchange rate, but the direction of asymmetry varied among the firms. Similarly, they found that most firms respond asymmetrically to large and small changes in the exchange rate with pass-through positively related to the size of the change. When the authors took into account both direction and size effects, their results indicated that the size of the exchange rate change had a stronger effect on stock returns than the direction of the change. This finding was confirmed by Di Iorio and Faff (2000) who added a dummy variable to Jorion's augmented model to test for an asymmetric effect induced by firms engaging in non- hedging techniques.

Further evidence of asymmetry in stock market return responses to exchange rate changes was provided by Koutmos and Martin (2003). They modified Jorion's (1990) model to test for asymmetric exposure, as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + (\beta_0 + \beta_{Ds} D_t) R_{FXt} + \varepsilon_{it} \qquad \textbf{(3.15)}$$

Where R_{it} is the percent change (return) in the stock price of firm i, R_{Mt} is the rate of return from the share market index, R_{FXt} is the percentage change in the exchange rate, and ε_{it} is an error term. β_0 is a constant, β_{Ds} is the coefficient which measures the average total exposure of firm i over the sample period, D_t =1 if R_{FXt} < 0 or zero otherwise. A significant β_{Ds} identifies asymmetric exposure. This model relied on the assumption that, at least implicitly, R_{FXt} is exogenous or predetermined. If this assumption does not hold, however, the model would suffer from simultaneity bias. Weekly data of industry sectors of Germany, Japan, the United Kingdom, and the United States were used over the period, from January 8, 1992 to December 30, 1998, at both sector-country and country-market levels. Their results provided evidence that appreciations and depreciations can asymmetrically impact stock returns at the sector-country level. They found that approximately 40% of these sectors models had significant exchange rate exposure (stronger evidence). Evidence of significant exchange rate exposure was reported at the market level, but this exposure was not asymmetric. It was believed that this mixed evidence, at the market and the country-sector levels, resulted from the time varying variance in the error term. Therefore, the presence of second moment time variation and asymmetric exchange rate exposure may explain, to some extent, why most prior studies failed to document significant foreign currency exposure.

To avoid the potential for simultaneity bias present in Equation 3.15, Koutmos and Martin (2007) proposed a dynamic framework for asymmetric behaviour. They suggested that the joint conditional distribution of the percent changes in equity and percent changes in exchange rates, in Equation 3.15, should be undertaken. To avoid the conditional heteroskedasticity in residuals, ε_{it}, which may produce time varying exposures, they used Engle's test, by adding a GARCH (1, 1) specification to the model. Two sets of data were used: (1) daily returns on 10 size-based NYSE/AMEX/Nasdaq portfolios for the period, from January 1973 to December 2002, and (2) daily returns on five Dow Jones sector-based portfolios for the period, from January 1992 to December 2002. Evidence was found that exchange rate exposure of the sample U.S. industrial portfolios was time varying. Also, they found asymmetric exposure to be pervasive across the decile portfolios as well as the financial and industrial sectors. Moreover, the response of the return variance to past innovations is asymmetric for the majority of cases. The average time varying exposure was statistically significant for the size-based and sector-based portfolios.

Priestley and Qdegaard (2006) postulated that, because, theoretically, firm behaviour may differ under depreciating or appreciating currency 'regimes', the stock returns of many firms will react asymmetrically to positive versus negative fluctuations in currency values. Therefore, they claimed that the exchange rate exposure of a firm's stock return should depend on the currency regime. Using a sample of 28 manufacturing industries, with varying degrees of international trade, over the period 1973 to 1998, they estimated the linear and nonlinear exchange rate exposures during periods of depreciation and appreciation of the U.S. dollar. Overall, they found that the exposures of the industries to bilateral exchange rates[47], were statistically significant for each regime and differed in sign between periods of dollar depreciation and dollar appreciation. The researchers reported that, in general, industries extensive international trade had greater incidence of significant currency exposures, but no statistically significant exposure was uncovered for the sample period as a whole. The

[47] Priestley and Qdegaard (2006) found that the exposures of the industries to baskets of currencies were not statistically significant, regardless of regime or the extent of international trade.

non-linear exposures had greater explanatory power of stock returns than the linear exposures and were also not sensitive to the degree of international trade of the respective industry samples.

On the other hand, Dewenter, Higgins, and Simin (2005) indicated that it was difficult to estimate the sensitivity of stock returns to small changes in exchange rates. Using an event-study method to examine the asymmetry of the daily stock market returns of U.S. multinational firms to large changes in the value of the U.S. dollar against the Mexican Peso and against the Thai Baht, they found a weakly significant contemporaneous price response. The authors interpreted this finding as resulting from the hedging activities of their sample firms, rather than from measurement errors prevailing in some prior studies.

In addition, the hypothesis of asymmetric stock price reaction to exchange rate changes was also refuted by Krishnamoorthy (2001) who demonstrated that industrial structure was an important determinant of the exchange-rate exposure of industry portfolio returns. Krishnamoorthy (2001) added an interaction variable, as a proxy for exposure asymmetric behaviour, to Jorion's (1990) model, in an attempt to capture the respective effects of dollar appreciations and depreciations on a sample of 20 U.S. industry portfolio returns. The interaction variable is measured by multiplying the trade-weighed index (the proxy for exchange rate factor) by a dummy variable. This dummy variable took "1' if the dollar depreciate or zero otherwise. After estimating this model for each industry group (competitive industries, oligopoly industries, customers-oriented industries, and institutionally oriented industries)[48] on monthly

[48] These 20 industries were classified as: 11 industries were globally competitive and 9 industries were global oligopolies.

data over a 3-year period (1995–1997), it was found that the exposure coefficient of trade weight index (not the coefficient of the interaction variable) was not significant. They repeated estimating his model (exact Jorion's 1990 without interaction variable) for each industry group using each of three currencies separately in turn (Euro, JPY and CAD). This was because repeated process is more likely to isolate the effects of exposure of certain currencies. The coefficient of foreign exchange-rate factor (for each currency) also was significant.

Therefore, the empirical evidence as to whether changes in stock returns respond asymmetrically to changes in exchange rate remains mixed.

3.2.3 Conclusion

This section has reviewed a sample of the voluminous literature which has investigated the relationship between exchange rate changes and firm value. It can be concluded that, although the findings of the studies are mixed, the weight of evidence suggests that exchange rate fluctuations do affect firm value to some extent and, therefore, the literature has indicated that exchange risk exposure does matter in both a practical and an academic sense.

Although significant advances have been made in the estimation of currency risk exposure, many problems remain. As highlighted in this review of the literature, the findings suggest that a more complete understanding of the time varying, horizon dependent and nonlinear nature of exchange risk exposure is still required. Other unresolved issues include the question of how firms' hedging activities affect their sensitivity to currency fluctuations, or congruently, which firms should hedge or not hedge their foreign currency exposure in order to maximize their market values. In addition, the specific effect on shareholders' wealth of increased exchange rate volatility arising during periods of financial turbulence merits further assessment.

The next section reviews a sample of the published research on the relationship between financial hedging techniques implemented by firms, and their currency exposures.

3.3 THE EFFECT OF THE USE OF FINANCIAL HEDGING ON FOREIGN EXCHANGE RATE EXPOSURE

3.3.1 Introduction

If internal hedging opportunities are not sufficiently available, firms can hedge their exposures to foreign exchange rate risk using external techniques. Although external hedging is more expensive and complicated compared to internal hedging, it has been found to be successful. As noted in Chapter 2, external hedging essentially involves the use of financial derivatives and foreign currency denominated debt. In general, four main relevant topics have been investigated in the research literature to date:

1. The effect of the use of currency derivatives on foreign exchange rate exposure;
2. The effect of the use of foreign debt on foreign exchange rate exposure;
3. The effect of the combined use of currency derivatives and foreign debt on foreign exchange rate exposure;

4. Currency derivatives as complements to, or substitutes for, foreign debt in reducing foreign exchange rate exposure.

The research literature relating to these four topics is discussed in the following subsections.

3.3.2 The Effect of The Use Of Currency Derivatives On Exposure

In Chapter 2, it was noted that under the early theory of Modigliani & Miller (M-M) (1958)[49], hedging should not alter firm value. Several theoretical studies have addressed the issue of the relevance of hedging in the real world of imperfect capital markets, taxes and non-zero agency costs and costs of financial distress (e.g., Myers, 1977; Mayers & Smith, 1982; Stulz, 1984; Smith & Stulz, 1985; Shapiro & Titman, 1985; DeMarzo & Duffie, 1995).[50] These theoretical studies concluded that, in the real world, hedging is likely to be relevant to firm value. With the benefits to shareholders and managers, hedging is likely to differ across firms in ways which depend on various firm-level financial and operating characteristics.

The majority of the empirical studies, which have examined the relevance of hedging to firm value, have concluded that hedging is a value-enhancing exercise for a firm through alleviating costs and minimising risk. (e.g., Bessembinder, 1991; Nance et al., 1993; Froot et al., 1993; Tufano, 1996; Berkman & Bradbury, 1996; Geczy et al.,

[49] It will be recalled that MM (1958) assumed a world of perfect capital markets with no taxes, no agency costs and no costs of financial distress.
[50] Several empirical studies investigated the effects of the use of different types derivative instruments such as forward, futures and options contracts individually on firm value (e.g., Edrington, 1979; Swanson & Caples, 1987; Berkman, Bradbury, Hanckock, and Innes, 2002; Carter, Pantzalis, Simkins, 2003).

1997; Howton & Perfect, 1998; Haushalter, 2000; Di Iorio & Faff, 2002; Hagelin, 2003; El-Masry, 2006a). The aim of this section of the current study will, however, be limited to reviewing those studies which investigate the relationship between the use of currency derivatives and corporate foreign exchange rate exposure.

Two groups of studies have investigated this relationship. Briefly, mixed evidence and results have been reported for this relationship. One group of studies found that the use of currency derivatives *increases* a firm's exposure to foreign currency risk and, ultimately, decreases its market value (Copeland & Joshi, 1996; Hentschel & Kothari, 1997). However, another group of studies found that the use of currency derivatives *reduces* a firm's exposure and ultimately, enhances its market value (Nydahl, 1999; Choi & Elyasiani, 1997; Allayannis & Ofek, 2001; Nguyen & Faff, 2003b; Hegalin, 2003).

In relation to the first group of studies, Copeland and Joshi (1996), using a sample of 198 U.S. corporations which had the highest sales in 1994, investigated the effect of hedging with currency derivatives on the volatility of cash-flows, which was induced by changes in exchange rates. If the use of currency derivatives produced large reductions in volatility, this would suggest high potential benefits; small reductions would indicate low potential benefits. The authors indicated that it was difficult to predict the consequences of hedging since many other economic factors can change at the same time foreign exchange rates change. However, their findings indicated that hedging activities using derivatives produced only small reductions in the volatility of cash flows suggesting low potential benefits. The researchers concluded that hedging activities were wasteful to the firm's shareholders and carried the potential to actually *increase* foreign exchange rate exposure. This finding was confirmed by Hentschel and Kothari (1997) who investigated the effect of the use of currency derivatives on firms' exposures, as measured by the volatility of the firm's stock returns.

However, the vast majority of published empirical studies, belong to the second group of studies, which generally report that hedging via the use of currency derivatives, reduces foreign exchange rate exposure. These studies employed a two-stage market model to investigate the relationship between the use of currency derivatives and foreign exchange rate exposure. However, there were some differences among the studies in their measurements of foreign exchange rate exposure. The vast majority of the studies used Jorion's (1990) augmented model, as a first-stage model, to estimate the exposure coefficients. These foreign exchange rate exposure coefficients were then used as proxies for the dependent variable (exposure to currency risk) in the second-stage model. This second-stage comprises the use of a cross-sectional model, which regresses the absolute value of the estimated exposure coefficients on the use of currency derivatives. The second-stage, linear cross-sectional model, is expressed, generally, as follows:

$$\left|\gamma_{2i}\right| = \delta_0 + \delta_1 FS_i + \delta_2 DER_i + \sum_{j=1}^{J} \delta_{ij} Cont\,\mathrm{var}_j + \varepsilon_i \qquad \textbf{(3.16)}$$

Where $|\gamma_{2i}|$ is the foreign exchange rate exposure coefficient for firm *i*, estimated in the first stage of the model (see Eq 3.2), FS_i is a proxy for foreign involvement, measured by the ratio of foreign sales to total sales for firm *i*, DER_i is a proxy for the use of foreign currency derivatives, measured either by the ratio of the total notional amount of foreign currency derivatives to total assets, or by a dummy variable, for firm *i*, $ContVar_{ij}$ is the *j*th control variable for firm *i* and ε_i the error term.

A study by Nydahl (1999) examined the effects of currency derivatives on foreign exchange rate exposure using a sample of 47 Swedish firms for the year ending 1995. They initially estimated the exposure coefficients using Jorion's (1990) augmented model. In the second-stage, using the model in (Eq 3.16), they regressed the estimated exposure coefficients on the proxies for the use of currency derivatives. They controlled the second-stage model for the wage expenses of employees located abroad to total wages cost, and for the ratio of foreign sales to total assets. It was found that foreign exchange rate exposure was significantly positively related to the degree of foreign involvement and significantly negatively related to the use of currency derivatives. However, foreign direct investments and overseas wage expenses did not significantly affect currency exposure.

Choi and Elyasiani (1997) investigated the impact of both foreign exchange risk and interest rate risk hedging activities, via currency and interest rate derivatives, using a sample of 59 large commercial U.S. banks for the period 1975 to 1992. The relationships were estimate using a modified Seemingly Unrelated Method (SUR). In order to adjust for possible bias due to the model's estimation, the return equations in each group were estimated as a simultaneous equation system.[51] Evidence was found to indicate that the exchange exposure coefficients were more significant than the interest exposure coefficients. More importantly, they found evidence that currency

[51] The modified SUR technique (Chamberlain, 1982; Macurdy, 1981a, 198lb) was a variation of the standard SUR method and produced asymptotically efficient estimates without imposing either conditional homoskedasticity, or serial independence restrictions on the disturbance terms. In addition, the modified SUR procedure enabled the authors to incorporate the interaction of two exposure equations as a system.

derivatives had an effect on foreign exchange rate exposure and this effect was larger than the effect of interest rate derivatives on interest rate risk exposure.

Allayannis and Ofek (2001) investigated the relationship between the use of currency derivatives and foreign currency exposure using a sample of 378 U.S. non-financial firms.[52] After estimating the exposure coefficients using a sample of the three years surrounding the financial year 1993 (1992–94)[53], the potential impact of the use of currency derivatives on these coefficients, with respect to the sample firms' foreign operations (i.e. foreign involvement), was examined using the weighted least squares method (WLS). The use of foreign derivatives was measured by the ratio of the notional amount of foreign currency derivatives to total assets (continuous variable). The study demonstrated that exchange rate exposure was simultaneously determined by a firm's foreign operations (proxied by its foreign sales ratio) and its financial hedging activity via currency derivatives. Specifically, Allayannis and Ofek (2001) found that exposure was positively related to the foreign sales ratio and negatively related to the ratio of foreign currency derivatives to total assets.[54]

Following Allayannis and Ofek (2001), Nguyen and Faff (2003b) used the Generalised Method of Moments (GMM) method to test whether the use of foreign currency derivatives had an impact on reducing the foreign currency exposure of the 77 largest Australian listed corporations, for the 1999 and 2000 fiscal years. Nguyen and Faff's model included proxies for a firm's incentives to hedge currency risk, as

[52] The reason behind the exclusion of the financial firms is that most of these firms were also market-makers in foreign currency derivatives; subsequently, the motives for using derivatives could be very different from that of the non-financial firms' usage.
[53] The reason for using a surrounding period is to measure the contemporaneous impact of foreign currency derivatives on a firm's exchange rate exposure.
[54] These associations were significant at the 1% level and robust to alternative time periods, exchange rate indices and estimation techniques.

control variables. The results of the study showed that the use of currency derivatives reduced exposure for those firms with positive exposure and increased (decrease in absolute value) exposure for those firms with negative exposure. Overall, evidence was found of the negative relationship between the use of currency derivatives and exposure.

Hagelin (2003) used a sample of 160 non-financial Swedish firms to examine the relationship between the use of foreign currency derivatives and two different types of foreign currency exposures (transaction and translation), for the period January 1997 to December 2001. This was of interest because transaction exposure and translation exposure tend to affect firms differently, and the respective rationales for hedging may therefore differ. The absolute value of the exposure coefficients were regressed against a proxy for derivatives use (measured by an indicator or dummy variable) with respect to the following control variables: firm size, a dummy variable equalling '1' if a firm hedged transaction exposure only, or '0' otherwise, a dummy variable equalling '1' if a firm hedged translation exposure only, or '0' otherwise, a four-year indicator variable and ten-industry dummy variable. Hagelin's (2003) results indicated that the use of currency derivatives reduced firms' currency exposures and were consistent with the notion that firms use currency derivatives to hedge transaction exposure to exchange rate risk, in order to increase firm value (by reducing the indirect costs of financial distress or alleviating an underinvestment problem). The results provided no support for the notion that firms hedge translation exposure in order to increase firm value.

Therefore, in conclusion, although the two groups of studies adopted the same or different methodological approaches, mixed evidence and results was reported on the use of currency derivatives in reducing the exposure to foreign currency risk. It is believed that one of the reasons for reporting these contradictory results was related to different measurements used to quantify the proxies for the use of foreign currency derivatives. A second reason for the contradictory results is believed to be the unavailability of data regarding derivatives in the early 1990s. Before 1997, firms were not required to publicly disclose their net derivatives positions in their financial reports.

3.3.3 The Effect of the Use of Foreign Debt on Exposure

This section reviews the literature relating to the relationship between the use of foreign debt and corporate exposure to foreign currency risk. Briefly, mixed results have also been reported for this relationship. One group of studies found that the use of foreign debt *increased* the firm's exposure to foreign currency risk (e.g., Geczy et al., 1997; Chaing & Lin, 2005). However, another group of studies found that the use of foreign debt *reduced* the firm's exposure (e.g., Kedia & Mozumdar, 1999, 2003). As such, the aim of this section is to review these studies and identify any remaining gaps in the literature.

As noted in Chapter 2, Myers (1984), in his Pecking Order Theory, suggested that firms will give a higher priority to issuing debt rather than to issuing equity, when they have to resort to the use of external sources of finance. This suggestion can be modified when a firm's hedging policy is regarded as a component of its financing policy. In this regard, it can be suggested that firms tend to increase the proportion of their debt (or increase foreign currency loan), which is denominated in foreign currencies, to maximise their values through reducing their exposures to foreign currency risk. Issuing foreign debt may be considered the best economical method which can be used to match foreign currency cash inflows and cash outflows, either in the same currency, or, indirectly, via highly correlated currencies. Funding foreign investments in this way, in countries where their production will be sold, thus creates a 'natural' currency hedge for firms. However, the use of foreign currency debt may also be determined by assets and income types consistent with agency costs, taxation costs and financial hedging theories (Allayannis et al., 2003). Firms may also exchange their foreign debt with other firms to offset their exposure positions. Hedging has been shown to be an important motive for issuing foreign currency debt within large firms, although this motive may differ across currencies, or countries, due to differences in the openness of the economies (Kedia & Mozumdar, 1999; Allayannis & Ofek, 2001).

Considering the growing amount of foreign debt used globally, there is a significant lack of studies investigating its relationship with foreign currency exposure, either empirically or theoretically. Hedging is not the only reason why firms may choose to issue debt in a given foreign currency. Many issues, such as taxes, segmented capital markets and liquidity concerns, may also be involved in determining the denomination of debt. As a result, foreign currency denominated debt may enhance, rather than mitigate, foreign exchange rate exposure (Geczy et al., 1997).

Almost all published studies in this field have employed a two-stage regression model as the research methodology. The second stage, cross-sectional regression model, was undertaken, not only to determine the factors which affect the firm's usage of foreign debt, but also to examine whether the use of foreign debt is effective in reducing currency exposure. The standard cross-sectional model used is as follows:

$$|\gamma_{2i}| = \delta_0 + \delta_1 FS_i + \delta_2 FDD_i + \sum_{j=1}^{J} \delta_{ij} ContVar_j + \varepsilon_i \qquad \textbf{(3.17)}$$

Where $|\gamma_{2i}|$ is the exposure coefficients estimated in the first stage of the model for firm i (see Eq. 3.2 in this Chapter), FS_i is the proxy for foreign involvements measured by the ratio of foreign sales to total sales for firm i, FDD_i is the proxy for the use of foreign debt measured either by the ratio of the total notional amount of foreign debt to total assets, or by a dummy variable, for firm i, $ContVar_{ij}$ is the jth control variable for firm i and ε_i the error term.

Studies by Kedia and Mozumdar (1999, 2003) used a sample of 523 large U.S. firms in the 1996 end-year to investigate the role of foreign debt in hedging aggregate and individual levels of currency exposures, for ten hard currencies. The main contribution of their study was the use of two alternative ways to measure foreign exchange rate exposure coefficients. The first method consists of estimating the exposure as the regression coefficient of stock returns on exchange rate changes (Jorion's 1990 augmented model). While the second consists of undertaking the proxy for the firm's degree of foreign involvement as an underlying source of exposure (foreign sales ratio). Kedia and Mozumdar (1999, 2003) measured foreign debt using a continuous variable. Their studies found a strong relationship between foreign currency exposure reduction and the use of foreign currency denominated debt, at both the aggregate and individual currency levels.

Chaing and Lin (2005) used a sample of Taiwanese corporations during 1998 and 2002 to investigate the effects of the use of the foreign debt on currency exposure. The absolute value of the foreign exchange rate exposure coefficients were regressed against a proxy for the use of foreign debt (dummy variable) and a proxy for foreign involvement (foreign sales ratio), with respect to firm size. They found that the use of foreign-currency denominated debt always increased exchange rate exposure and was not an effective instrument for hedging the exposure. The authors attributed their results to that fact that many of Taiwanese firms issued Euro-Convertible Bonds, denominated in U.S. dollars, to raise funds. In addition, the positive significant coefficient for the foreign sales ratio predicted that for a given exposure, an increase in revenue from foreign operations increased exchange rate exposure.

While the above studies used the same research methodology, they reported mixed results in terms of the relationship between the use of foreign debt and exposure. This may due to differences in the measurement techniques used for the variables in those models and to the unavailability of the data[55]. In addition to the mixed results reported by the above studies, a noticeable gap in the literature still remains: the paucity of Australian studies concerning the effect of the use of foreign debt on foreign currency exposure.

[55] For example, because of data unavailability, Chaing and Lin (2005) measured the use of foreign debt by a dummy variable, while Kedia and Mozumdar (1999, 2003) measured it by a continuous variable using the notional amount of the foreign debt, as a proxy for the foreign debt ratio from the firm's total debt.

3.3.4 The Effect of the Combined Use of Derivatives and Foreign Debt on Exposure

The combined use of both financial hedging techniques (foreign currency derivatives and foreign debt) is one of the strategies that may effectively reduce currency exposure. Although there are many empirical studies which have explored the combined use of foreign debt and financial derivatives, they have concentrated on examining *why* firms use hedging strategies, rather than on investigating the impact of this combined use on the exposure to foreign exchange rate risk (Geczy et a., 1997; Heglin, 2003).

In line with previous research in this area, these studies use, as the first stage, Jorion's augmented model to estimate a firm's exchange rate exposure coefficient, $|\gamma_{2i}|$, which is taken from the percentage change in the rate of return on a firm's common stock against the changes in the exchange rate. The potential impact of a firm's combined use of currency derivatives and foreign debt on its exchange rate exposure is examined by running a cross-sectional regression model as identified in the second stage of the model. The dependent variable in this model is the absolute value of the exposure coefficients estimated in the first stage. The explanatory variables as proxies for the use of currency derivatives and foreign debt are included with respect to a set of control variables. The second-stage model is of the following form:

$$|\gamma_{2i}| = \delta_0 + \delta_1 FS_i + \delta_2 DER_i + \delta_3 FDD_i + \sum_{j=1}^{J} \delta_{ij} Cont\,\mathrm{var}_j + \varepsilon_i \qquad \textbf{(3.18)}$$

Where $|\gamma_{2i}|$ is the exposure coefficients estimated in the first stage of the model for firm i, FS_i is the proxy for foreign involvements measured by the ratio of foreign sales to total sales for firm i, DER_i is the proxy for the use of foreign currency derivatives measured either by the ratio of the total notional amount of foreign currency derivatives to total assets or by a dummy variable for firm i, FDD_i is the proxy for the use of foreign debt measured either by the ratio of the total notional amount of foreign debt to total assets or by a dummy variable for firm i, $ContVar_{ij}$ is the jth control variable for firm i and ε_{it} the error term.

Hegalin and Pramborg (2004) studied the relationship between a sample of Swedish firms' hedging practices and foreign exchange rate exposure. Their model regressed the proxies for the use of derivatives and foreign debt on the exposure coefficients with respect to the following control variables: a dummy variable which measures the interaction between the firm's use of foreign currency derivatives and foreign debt; the absolute value of the difference between the share of foreign revenue and foreign costs; the logarithm of average total assets; whether a firm hedged transaction exposure and translation exposure variables; whether a firm hedged transaction exposure only; whether a firm hedged translation exposure only; four-year dummy variable; ten industry dummy variables. Hegalin and Pramborg (2004) found that the combined use of these two financial hedging strategies was effective in reducing currency exposure.

In addition to their investigation into the relationship between the use of debt and exposure, Chaing and Lin (2005) used a sample of Taiwanese corporations to test the hypothesis of whether the combined use of currency derivatives and foreign debt has an impact on exposure reduction. Their model regressed the use of both currency derivatives and foreign debt against the exposure coefficients with respect to foreign sales ratio and firm size. A dummy variable was generated as proxy for the use of foreign debt, which equals ‘1’ if firms use foreign debt or zero otherwise. Firm size was measured by the natural logarithm of the firm’s total assets. Foreign involvement was measured by the ratio of foreign sales to total sales. After including both proxies for the use of currency derivatives and the use of foreign debt, their study reported that the combined use of currency derivatives and foreign debt is not effective in reducing the exposure. This is because of the contradictory results reported in terms of the two proxies. The use of currency derivatives was significantly negatively related to exposure (decreases exposure), while the proxy for the use of foreign debt was significantly positively related to exposure (increases exposure). The authors, therefore, concluded that the combined use of foreign currency derivatives and foreign debt was not effective in reducing exposure.

Nguyen and Faff (2006) also investigated the impact of the combined use of derivatives and foreign debt on exchange rate exposure, using a same sample of Australian industrial firms for 1999 and 2000. There were 238 companies in 1999 and 216 companies in 2000, which generated 481 firm year observations. To examine the impact of the use of foreign debt on a firm’s exchange rate exposure, they ran the cross-sectional regression model illustrated in Eq. 3.18, with the following two explanatory variables: the ratio of foreign debt to total debt, and the extent of foreign currency derivative usage calculated as the total notional value of all foreign currency derivative contracts outstanding scaled by total assets. The control variables used in this study were as follows: the ratio of foreign sales to total sales, firm size, liquidity ratio, and dividend yield. When combining the proxies for the use of currency derivatives and foreign debt, they reported that this combination was not effective in reducing the exposure. This finding is similar to Chaing and Lin’s (2005) finding, but it has opposite signs. Nguyen and Faff (2006) reported that the proxy for the use of foreign debt was associated with a lower level of exchange rate exposure, while the proxy for the use of currency derivatives was positively associated with exposure.

In conclusion, although the above studies have used the same methodologies, they have reported mixed results. While these results may reflect mixed measurements, especially for the use of foreign debt, no clear evidence has been reported as to whether the integrated use of these financial hedging reduced exposure. This mixed evidence, and the lack of Australian studies investigating this topic, are identifiable gaps remaining in the literature. For example, while Nguyen and Faff (2006) investigated this topic using a sample of Australian industrial firms, such firms were not believed to provide good representation of the community of all Australian firms.

3.3.5 Currency Derivatives As Complements To, Or Substitutes for, Foreign Debt

This section reviews the literature relating to the relationship between the use of foreign debt and the use of derivatives. Again, mixed results have also been reported for this relationship in the literature. While one group of studies found that the use of foreign currency derivatives complements the use of foreign debt in reducing exposure to foreign currency risk (Bartram, Brown, & Fehle, 2003; Judge, 2003), another group of studies found that the use of foreign currency derivatives substitutes for the use of foreign debt in reducing exposure (Geczy et al., 1997; Elliott et al., 2003). In addition to these mixed results reported by these studies, there is a lack of Australian studies investigating this topic.

The reported research results indicating that firms with foreign operations do not have a preference between foreign currency derivatives or foreign debt for the hedging of foreign exchange rate risk (Geczy et al., 1997; Allayannis & Ofek, 2001) require further examination. When hedging foreign operations, not all currency derivatives can be effectively substituted by foreign debt. The exposure generated from foreign operations is usually long-term in nature, and it might be more effectively hedged using an instrument with a similar expiration period, such as long-term foreign currency debt or a currency swap. Foreign currency forwards, futures, or options might not be appropriate instruments in these circumstances, because of their short-term maturities.[56] Neither Geczy et al. (1997) nor Allayannis and Ofek (2001) provide an indication of the 'derivative type' composition of their samples of currency derivative users. It is thus possible, for example, that where a firm used a suite of derivatives for hedging purposes, a result reporting that currency derivatives and foreign debt may act as substitutes for each other might be driven by the inclusion of currency swaps in the suite. If this were the case, then it is possible that a firm, which excluded currency swaps from its suite of currency derivatives, might not report the same result. These scenarios, therefore, raise the possibility of there being no clear evidence as to whether currency derivatives act as complements to, or substitutes for, foreign debt in hedging foreign exchange rate risk.

The majority of previous studies used the following cross-sectional regression model to examine the relationship.

[56] Allayannis & Ofek (2001) did find significant evidence that exporters preferred the use of foreign currency derivatives over the use of foreign currency debt. The authors suggested that this could be explained by fact that exporting, by nature, would require customised, short-term hedging instruments, which conditions are better served by derivatives rather than long-term foreign debt.

$$DER_i = \delta_0 + \delta_1 FS_i + \delta_2 FDD_i + \sum_{j=1}^{J} \delta_{ij} ContVar_j + \varepsilon \qquad \textbf{(3.19)}$$

Where DER_i is the proxy for the use of foreign currency derivatives measured either by the ratio of the total notional amount of foreign currency derivatives to total assets or by a dummy variable for firm i, FS_i is the proxy for foreign involvements, measured by the ratio of foreign sales to total sales for firm i, FDD_i is the proxy for the use of foreign debt measured either by the ratio of the total notional amount of foreign debt to total assets or by a dummy variable for firm i, $ContVar_{ij}$ is the jth control variable for firm i and ε_i the error term.

Geczy et al. (1997) found indirect evidence of foreign debt and foreign currency derivatives acting as substitutes for each other in reducing the exposure to exchange rate risk for a sample of 372 U.S. corporations in 1990. All the sample firms had potential exposure to foreign currency risk from foreign operations, foreign debt, or high concentrations of foreign competitors in their respective industries.

A study by Elliott et al. (2003) investigated the relationship between foreign currency debt and foreign currency derivative use for a sample of 88 U.S. multinational firms, which had positive foreign debt in one year, during the period 1994 - 1997. They measured the proxy for the use of derivatives using a continuous variable. They found that the level of foreign debt was negatively related to the level of foreign currency derivatives, indicating that foreign debt acted as a substitute for the use of foreign currency derivatives in the hedging of exchange rate risk. The results of Elliott et al. (2003) were unchanged after the exclusion of currency swap users, which suggested that foreign debt also acts as a substitute for forwards, options, and futures in hedging foreign currency risk.

Judge (2004) utilised a sample of 412 non-financial U.K. firms for the year-end 1995, to test whether different types of currency derivatives (forwards, options, futures and swaps) are substitutes for foreign debt in reducing exposure to foreign exchange rate risk. He reported mixed results for the relationship between the different types of derivatives (excluding foreign currency swap) and foreign debt. Judge (2004) found evidence that firms prefer to use foreign debt rather than foreign currency forwards and/or options to hedge foreign currency risk exposure. For exporting firms, however, he found that such firms prefer to use foreign currency forwards or options rather than using foreign currency debt. When testing the hypothesis by including foreign currency swaps, he found that issuing foreign debt is not a substitute for foreign debt for firms that swap foreign debt into domestic debt. On the other hand, foreign currency swaps are found to be substitute for foreign debt for firms that swap domestic debt into foreign debt. Finally, Judge's results indicated that foreign debt was not an effective substitute for currency swaps for firms with high ratio of debt capital, or for small firms.

However, other studies have reported that the use of currency derivatives complemented the use of foreign debt in reducing currency exposure. In a study of 7,292 sample firms in 48 countries, Bartram, Brown, and Fehle (2003) found a positive relationship between foreign currency derivatives and foreign debt. The authors concluded that foreign currency debt was a source of foreign currency exposure, which required hedging via the use of foreign currency derivatives. This would be the case if foreign debt were issued in a currency in which assets were not held, and consequently, generated currency exposure.[57] However, a positive relationship between currency derivative use and foreign debt might be observed if both were used for hedging different sources of exposure to exchange rate risk.

3.3.6 Conclusion

Overall, although all these studies have employed the same basic research methodology, the results are contradictory. There are some methodological differences in the studies. For example, some studies used dummy variables to measure the use of currency derivatives and of foreign debt, while other, more recent, studies used continuous measures of these explanatory variables. Also the studies failed to include all the possible control variables which represent the firm's incentives to hedge. In relation to data, almost all the studies are U.S.-oriented, and only one study has tested the hypothesis of whether the combined use of derivatives and foreign debt has an impact on currency exposure, using a sample of Australian industrial firms. Since industrial firms do not represent the community of Australian firms, this omission points to a further gap in the literature.

3.4 THE EFFECT OF THE USE OF OPERATIONAL HEDGING ON FORIGN EXCHANGE RATE EXPOSURE

3.4.1 Introduction

[57] In this case currency swaps could be employed to transform the debt into a suitable currency for matching purposes.

While the previous sections extensively reviewed the rich body of literature concerning financial hedging strategies and their effect on foreign currency exposure, the current section reviews the less extensive literature relating to the effect of the use of operational hedging on foreign exchange rate exposure. Since the appearance of the Foreign Direct Investment (FDI) theories, which were based on market imperfections, firms began to acquire proprietary information as a result of their shifting activities to establish foreign affiliates[58]. FDI implies the establishment of, and exertion of significant control over a firm located outside the home country of the parent corporation. Therefore, firms have started using operational hedging (operational flexibility and geographical diversification) for hedging purposes.[59] It can be argued that operational hedging, through operational flexibility and geographical diversification, is advantageous for multinational firms by reducing the volatility of cash flows.

3.4.2 Operational Hedging Studies

Chowdhry and Howe (1999) argued that using financial hedges only cannot effectively manage currency exposure and suggested that operational hedges, as a long-term strategy, are the most effective way to manage long-run operating exposure.[60] A limited number of empirical research studies have examined the effect

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[58] Foreign direct investment (FDI) can be defined as the 'purchase of physical assets, such as plant and equipment, in a foreign country, to be managed by the parent corporation' (Eiteman, Stonehill, & Moffett, 2007, EM-36).

[59] Aabo and Simkins (2005) indicated four operational hedging strategies available for corporations which export and/or have foreign subsidiaries. These strategies are the ability to (1) exploit growth investment opportunities (options) by entering a new foreign market, or by offering new products in an existing foreign market, (2) abandoning a foreign market, (3) shifting input sources abroad or between substitute inputs, and (4) shifting production locations or factors of production.

[60] Empirical research has supported this argument by indicating that firms often use derivative instruments to hedge short-run, but not long-run exposure (Logue, 1995; Lang, Stulz, & Ofek, 1995; Wong 2003).

of operational hedges, as measured by multinational firm's network structure, on foreign exchange rate exposure (Simkins & Laux, 1997; Hassan et al., 2001; Pantzalis et al., 2001; Carter et al., 2001, 2003; Gleason et al., 2005). In addition to reviewing the literature relating to these studies from a research methodology perspective, the present study also identifies the gaps, which remain in the literature.

Numerous theoretical studies argued that operational hedges are more effective in managing long-term foreign currency exposure, whereas financial hedges are more effective in managing short-run exposure (Chowdhry & Howe, 1999; Hommel, 2003; Wong, 2005). Chowdhry & Howe (1999) developed a model which analysed the relationship between operational hedging and both exchange rate risk and the risk of foreign demand on the domestic currency value of revenues. They argued that corporations will become involved with operational hedging only if both foreign exchange rate risk and demand uncertainty exist. Operational hedging is less important for managing short-term exposures, since demand uncertainty is lower in the short term. Operational hedging for corporations, whose main outputs are commodities (e.g., oil, copper, grains), is less important as such corporations are more likely to face price uncertainty not quantity uncertainty. Furthermore, the relevant prices, such as the spot prices of the commodities as well as exchange rates, cannot be manipulated by any single firm. Therefore, they argued that such firms hedge their exposure using mainly financial instruments, while operational hedging by such firms would be rare.[61] Since firms would be able to more accurately forecast their sales in the short term, Chowdhry & Howe (1999) predicted that firms are likely to use

[61] This is confirmed by the finding of Bodnar, Hayt, Marston, and Smithson (1995) who indicated that firms which are classified as Commodity-based firms are more likely to use financial derivatives to hedging exposure than any other firms.

financial instruments to a greater extent to hedge short-term exposure and rely on operational hedging more heavily to hedge long term exposure.

The published empirical literature has employed one specific research method to investigate the effect of the use of operational hedging on foreign exchange rate exposure reduction: a two-stage market model. The first stage is the estimation of the exposure coefficients using Jorion's (1990) augmented model (see Section 3.3). The second stage is the use of a cross-sectional model which regresses the estimated exposure coefficients on operational hedging variables, with respect to set of control variables.

The general second-stage model used is of the following form:

$$|\gamma_{2i}| = \delta_0 + \delta_1 FS_i + \delta_2 OPER_i + \sum_{j=1}^{J} \delta_{ij} ContVar_j + \varepsilon_i \qquad \textbf{(3.20)}$$

Where $|\gamma_{2i}|$ is the estimated absolute value of the exposure coefficients, FS_i is the proxy for foreign operations measured by the ratio of foreign sales to total sales for firm *i*, $OPER_i$ is the operational hedging factor, measured by two dimensions, *Breadth* and *Depth*. This mechanism for measuring operational hedging follows Allen and Pantzalis (1996). *Breadth* is defined as the natural logarithm of the number of foreign countries and of foreign regions, in which a firm operates (two variables).[62] *Depth* refers to the degree of concentration of a firm's network of foreign subsidiaries across countries and geographical regions (two variables, which are measured by the

[62] A high *breadth* means the firm has a comprehensive network of foreign countries and of regions.

Herfindahl-Herdshman concentration index)[63], $ContVar_{ji}$ is the jth control variable for firm i and ε_{it} is the error term.

The empirical studies addressing this topic are scant in number. Pantzalis et al. (2001) examined the impact of the operational hedges of 220 U.S. firms on their foreign exchange rate exposures, for the year 1993, using the model in Equation 3.20. Specifically, the authors investigated whether the ability of multinational firms to construct operational hedges (proxied by the structure of their multinational frameworks) was effective in reducing their currency exposures. Mixed evidence was found of this relationship. In particular, it was found that there was a negative relationship between firms with greater 'breadth', i.e. a greater network spread across countries, and their currency exposures. On the other hand, it was found that a greater 'depth', i.e., a more highly concentrated network was associated with an increase in currency risk. However, Pantzalis et al. (2001) reported that the ability to construct operational hedges resulted in a reduction in currency exposure for the pooled sample of firms, and that this relationship held for firms with positive exposure coefficients and for firms with negative coefficients.

Hassan et al. (2001) investigated whether a multinational firm's value was affected by both its foreign involvements and its foreign network structure. The authors utilised a sample of 420 U.S.-based multinational firms for the years 1997 and 1998, i.e. during and after the Asian financial crisis. They added an extra (fifth) proxy measuring operational hedging to the four measures indicated above. This was a dummy variable taking the form of '1' if the firm owned foreign subsidiaries or '0' otherwise. The

[63] A full description of the Herfindahl-Herdshman indices is provided in Table 4.1 of Chapter 4 of this thesis.

authors used the following control variables in their model: firm size; the ratio of tax paid to total assets; growth opportunities as measured by Tobin's Q ratio; the long term debt ratio; the interest coverage ratio; the firm's liquidity position, captured by the dividend yield. Hassan et al. (2001) found that, while prior to the financial crisis, operational hedges provided by the flexibility of the multinational firm's network, effectively reduced exposure for all firms, during the crisis operating hedges could only reduce exposure for net exporters. Their overall results were consistent with the notion that a multinational firm's ability to construct operational hedges significantly reduces its exposure to foreign exchange risk.

3.4.3 Conclusion

To sum up, although there is a general lack of studies investigating the impact of the use of operational hedging by a multinational firm's dispersion of operating networks on its corporate currency exposure, the evidence suggests that this dispersion of a firm's operating networks results in a lower level of currency exposure. The majority of these studies use U.S. market data, and there is a lack of Australian research studies investigating this topic.

3.5 THE EFFECT OF THE COMBINED USE OF DERIVATIVES AND OPERATIONAL HEDGING ON FOREIGN EXCHANGE RATE EXPOSURE

3.5.1 Introduction

Because in liquid markets the maturities of most futures and options contracts typically do not extend further than the short-term, financial hedges might not, alone, achieve the target of full currency exposure management. Hence, many firms often have to construct "real" or "natural" hedges for their currency exposures.[64] Thus firms will often have both financial and operating hedges in place, simultaneously. This section reviews the published literature investigating the effect of the combined use of foreign currency derivatives and operational hedging on corporate exposure to foreign exchange rate risk.

3.5.2 Studies Of The Combined Use Of Derivatives And Operational Hedging

As noted in an earlier section, Chowdhry and Howe (1999) argued that operational hedges are more effective in managing long-term foreign currency exposure, whereas derivatives are more effective in managing short-run exposure. In light of this, several empirical studies have examined the impact of the combined use of currency derivatives and operational hedges on foreign currency exposure. One group of studies has demonstrated that the use of firmwide risk management strategies[65] decreased firm's foreign exchange rate exposures (Simkins & Laux, 1997; Carter et al., 2001, 2003; Kim et al., 2005; Gleason et al., 2005; Al-Shboul, 2007).

While there is a substantial amount of empirical work focussing on the respective effects of financial and operational hedging on foreign exchange rate exposure, there has been little research attention devoted to directly investigating the impact of the combined use of operational and financial hedging on foreign currency exposure. Those studies which have been published (e.g., Simkins & Laux, 1997; Allayannis et

[64] As noted in section 3.3.3, creating a natural hedge requires firms to re-organise their activities in such a way that either their costs and revenues are generated in the same currency, or are denominated in currency(ies) which are correlated with the firm's local currency.

[65] Firmwide risk management is a term used to describe the coordinated use of financial hedges, including foreign currency derivatives, and operational hedges (Carter et al., 2001, p.1).

al., 2001; Carter et al., 2001, 2003; Al-Shboul, 2007) argued that the combined use of the two hedging strategies is more effective in reducing the exposure, because it addresses the firm's overall exposure in both the short- and long-terms.

In the research literature, the impact of the combined use of operational hedging and financial hedging on foreign exchange rate exposure has been traditionally tested using a two-stage market model. The first stage of this model is the estimation of the foreign exchange rate exposure coefficients using Jorion's (1990) augmented model (explained previously). The second-stage is the implementation of a cross-sectional regression model, which regresses the estimated exposure coefficients on the use of both financial and operational hedges, controlling for the size of foreign operations, and other variables. This cross-sectional regression model is the standard model for this type of study, and takes the following form:

$$|\gamma_{2i}| = \delta_0 + \delta_1 FS_i + \delta_2 DER_i + \delta_3 OPER_i + \sum_{j=1}^{J} \delta_{ij} ContVar_j + \varepsilon_i \qquad \textbf{(3.21)}$$

Where $|\gamma_{2i}|$ is the absolute value of foreign exchange rate exposure coefficients for firm i, FS_i is the ratio of the foreign sales to total sales for firm i (a proxy for foreign operations), DER_i is a proxy for the use of foreign currency derivatives for firm i, $OPER_i$ is the proxy for the use of operational hedging, identified in the previous section, for firm i, $ContVar_{ji}$ are the proxies for the control variables js for firm i and ε_i is the error term.

The relationship between the combination of the use of currency derivatives and operational hedging, and currency exposure was investigated by Simkins and Laux (1997) at both the firm and industry levels. This study used a large sample of 395 U.S.

multinational firms, which actively managed their exposure using operational hedges in 1993. Operational hedging and derivatives proxies were measured by two separate dummy variables. Their findings were consistent with the argument that the use of operational hedging reduces exposure. Their results also indicated that the use of derivatives, in combination with operational hedging, offers further reduction of the exposure.

Using a sample of 265 U.S. multinational corporations over the three years from 1996 to 1998, Allayannis, Ihrig and Weston (2001) adopted the two-stage model described above to investigate the topic. The cross-sectional model was estimated using Ordinary Least Square (OLS) regression. The study measured the use of operational and financial hedging using proxy variables[66]. The study found that geographical dispersion across countries or regions did not reduce foreign currency exposure but financial hedging did do so. In fact, firms with widely geographically dispersed operations were more likely to use foreign currency derivatives. On the basis of these results, Allayannis, Ihrig and Weston (2001) concluded that operational hedging only increases shareholder value when combined with currency derivatives.

Carter et al. (2001) followed the same approach in investigating the effects of the combined use of operational hedging and financial hedging, on the estimated exposure coefficients of a sample of 208 U.S. multinational corporations, over the period 1994 to 1998. Their model controlled for a firm's ownership structure by the inclusion of four separate variables: the percentage of shares owned by insiders, the percentage of

[66] Allayannis, Ihrig and Weston (2001) used four proxies for a firm's operational hedging: (1) the number of countries in which a firm operated, (2) the number of regions in which it was located, (3) the geographical dispersion of its subsidiaries across countries, and (4) the geographical dispersion of its subsidiaries across regions.

shares owned by block-holders, the squared value of the insiders' ownership variable and the percentage of shares held by institutions. The authors also controlled for the impact of long-term leverage on a firm's currency exposure. Carter et al. (2001) measured the use of financial hedging by a continuous variable, which was the total notional amount of currency derivatives divided by total sales. The authors reported strong evidence that the combined use of operational and financial hedging was associated with exposure reduction.

Another study by Carter et al. (2003) also investigated the effects of the combined use of operational hedging and financial hedging on currency exposure. This research study used the same sample and period of study as Carter et al. (2001). Operational hedging was measured by the firm's network structure. A major contribution of Carter et al. (2003) was the comparison of the exposure coefficients from weak and strong dollar states, in order to detect whether the impact of hedges on exposure was either systematic, or asymmetric. The evidence they found indicated that the exposure of the sample U.S. firms was asymmetric in nature. The study also found that the combined use of operational and financial hedges (currency derivatives) was effective in reducing the currency exposure, confirming the findings reported in Carter et al. (2001).

Al-Shboul (2007) investigated the impact of the use of derivatives and operational hedging on the foreign exchange risk exposure for a sample of 181 Australian multinational corporations. A two-stage market model was used, as in equation (3.21), resulting in the implementation of a cross-sectional time series model, to test for the effect of the combined use of those two hedging activities on the exposure coefficients. The author found that that the combined use of these two hedging strategies was effective in reducing the firm's exposure.

While it is true that all of these studies used the same research methodology, they adopted different measures for the proxies for the main explanatory variables, different research methods to estimate the parameters of their models and different sets of control variables. For example, the derivatives proxy was measured in some studies with an indicator variable (e.g., Simkins & Laux, 1997; Hassan et al., 2001; Allayannis et al., 2001), while other studies measured this proxy using a continuous variable (e.g., Pantzalis et al., 2001). Different sets of control variables were used. For example, some studies used variables representing the firm's growth in investment opportunities, while others used variables representing the firm's incentives to hedge. In terms of research methods, some studies (e.g., Simkins & Laux, 1997; Pantzalis et al., 2001), used ordinary least squares (OLS) regression, to estimate the parameters of the models, others used weighted least squares (WLS) regression (e.g., Allayannis et al., 2001) and others, seemingly unrelated regression (SUR) (e.g., Choi & Elyasiani, 1997). It is possible therefore that the mixed evidence reported in the above studies might have been caused by the different measurements, estimation methods and data used.

3.5.3 Conclusion

The above studies were mainly U.S.-oriented, and used the same basic research methodology. Gaps remain in the literature. For example, these studies did not include a proxy for the use of foreign debt in their models, which means that no study to date has investigated the impact of the combined use of the use of foreign debt and operational hedging on currency exposure. Also, to the knowledge of the author of this thesis, there are no published Australian studies which have investigated this topic.

3.6 CURRENCY DERIVATIVES ARE COMPLEMENTS TO, OR SUBSTITUTES FOR, OPERATIONAL HEDGING

The current section reviews the research studies examining whether currency derivatives act as substitutes for, or complements to, operational hedging, in reducing exchange exposure.

In a theoretical study, Lim and Wang (2001, 2006) argued that financial hedging and operational hedging function as complements to, rather than substitutes for, each other. Specifically, the authors argued that financial hedging can be used to reduce the common component of profit variability, while operational hedging (geographic diversification) can reduce firm-specific risk exposures. Several studies have attempted to provide empirical evidence for Lim and Wang's (2001) theory, using the following model:

$$DER_i = \delta_0 + \delta_1 OPER_i + \delta_2 FS_i + \sum_{j=1}^{J} \delta_{ij} Cont\,\text{var}_j + \varepsilon_i \qquad \textbf{(3.22)}$$

Where the variables of this model are as identified in Section 3.5.2.

The first relevant study was that of Allayannis et al. (2001), which was discussed in the previous section. Using the logistic regression method[67], financial hedging was measured by a dummy variable and operational hedging was measured by geographical dispersion, also using a dummy variable (as indicated previously). Overall, their finding was that operational hedging is not an effective substitute for financial hedging. In addition, while firms' operational hedges alone were not associated with higher firm value, the use of operational hedges in conjunction with foreign currency derivatives improves firm value. These results supported the complementary hypothesis.

In addition to testing for the effect of the combined use of financial and operational hedging, Carter et al. (2001, 2003) also examined whether financial hedging acted as a complement to operational hedging in reducing foreign currency exposure, for the 208 U.S. multinational corporations, for the year 1996. The proxies for operational hedging were measured by the four alternative variables, identified in the previous section (the firm's ability to construct foreign subsidiaries network). The proxy for financial hedging was measured using the ratio of the total notional amount of foreign currency derivatives to total assets (continuous variable). The authors found that operational hedging was a complementary strategy to financial hedging in reducing the foreign exchange rate exposure of their sample firms.

Using a sample of 424 U.S. firm observations, which consisted of 212 users of operational hedging and a size and industry matched sample of 212 non-users of

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[67] The Logistic regression model is employed when the dependent variable is discrete (i.e., not continuous), such as voting, participation in a public program, business success or failure, morbidity …etc. This model is adopted to avoid the econometric problems which may occur with other regression models, for example: (1) heteroskedasticity, (2) non-normality in the error term, and (3) the value of the predicted probability may be greater than 1, or less than zero.

operational hedging, Kim et al. (2005) adopted the standard model (Equation 3.22) to investigate the firms' usage of operational hedging, and how this type of hedging was related to financial hedging over the period 1996 to 2000. They measured the financial hedging variable by the total notional amount of currency derivatives divided by foreign sales or export sales (continuous variable). Operational hedging usage was proxied by four variables reflecting the firm's subsidiaries in countries and regions. The overall finding of the study was that both hedging strategies were effective in reducing currency exposure

Gleason et al. (2005) examined whether financial hedging was a complement to, or a substitute for, operational hedging in reducing exposure for 216 U.S. high technology firms, divided into 108 operationally-hedged firms, and a size and industry matched sample of 108 non-operationally-hedged firms.[68] The control variables represented the firms' investment growth opportunities. The researchers used the three-stage Least Squares Method (3SLS) to control for the endogeneity between hedging and foreign exchange risk exposure.[69] The use of financial hedging was measured by continuous variable and a set of control variables. Their overall results showed that operational hedging was complementary to financial hedging in reducing currency exposure.

To conclude, the majority of the studies reviewed in this section argue that financial hedging is a complementary hedging strategy to operational hedging rather than being substitutive. A cross-sectional regression model was used with various regression techniques (e.g., WLS and 3SLS) to test the hypothesis of this interaction. While these

[68] The reasons why their study chose to investigate a sample of high technology firms are explained in Gleason et al. (2005).

[69] 3SLS method is a statistical technique to estimate nonlinear or linear equations. It combines the two stage least squares (2SLS) with seemingly unrelated regression (SUR).

studies add to the literature by using different sample firms and periods of the U.S. market data sets, some gaps in the literature remain. Firstly, while the studies did investigate whether financial hedging (derivatives and foreign debt) is a complement to, or a substitute for, operational hedging, no study to date has specifically investigated the relationship between the use of foreign debt and operational hedging in reducing the exposure. Secondly, to the author's knowledge, no published Australian studies to date have investigated the general topic.

3.7 SUMMARY OF LITERATURE REVIEW AND EXPECTED CONTRIBUTION OF PRSENT STUDY TO KNOWLEDGE

3.7.1 Introduction

In this chapter, an extensive review of the published literature relevant to the current study has been presented. Some confronting and mixed empirical evidence on the relationship between the use of financial and operational hedging, and the exposure to foreign currency risk was provided. However, as noted in Chapters 2 and 3, one classical style of research methodology has been used to investigate the five research themes, the two-factor market model (identified in Section 3.2).

3.7.2 The Relationship Between Exchange Rate Changes And Firm Value

As noted in Section 3.2, the most popular method used to estimate the foreign exchange rate exposure coefficients is Jorion's (1990) augmented model. The various relevant studies reported mixed and limited evidence of a contemporaneous relationship between stock returns and changes in exchange rates. This means that Jorion's (1990) augmented model has generally failed to provide evidence of a relationship between changes in exchange rates and firm value. This failure, evidenced by earlier studies, may have been caused by measurement errors. Some studies attempted to estimate foreign exchange rate exposure using different models. These models, which are identified and extensively discussed in Section 3.2 of this Chapter, focus on using both the capital market model and cash flows approaches.

The specific model believed to be more efficient in estimating the exposure coefficients is Jorion's (1991) model. This model attempted to alleviate the failure of Jorion's (1990) model by taking the asset pricing model approach. The 1991 model takes into account the market risk premium which is very important for managers. The present study contributes to the literature by using Jorion's (1991) model to estimate the exposure coefficients for a sample of Australian multinational corporations during the period from January 2000 to December 2004.

3.7.3 The Effect of Financial Hedging on Exposure

3.7.3.1 The effect of the use of currency derivatives on exposure

The relevant studies are limited and have left gaps in the literature. Firstly, mixed results were reported in the literature investigating currency derivatives and exposure. As noted in Section 3.3.2, one group of studies documented that derivative instruments were value enhancing for the firm as they have the potential to reduce their foreign exchange rate exposures. However, another group of research studies reported that the use of derivative instruments was wasteful and value destructive for firms. A further limitation of Australian studies in this area (e.g., Nguyen & Faff, 2003b) is that they have not controlled their models to test for the effect the firm's ownership structure on the desirability of hedging. A contribution of the present study to the literature is the inclusion of extra control variables representing the firm's ownership structure to its model.

3.7.3.2 The effect of the use of foreign debt on exposure

Although the studies reviewed above, in Section (3.3.3), used the same research methodologies, they reported mixed results and were limited in terms of studying the effect on exposure of foreign debt in terms of Australian market. Nguyen and Faff (2004, 2006) did not investigate the relationship between the use of foreign debt and exposure, separately from the use of foreign derivatives. Therefore, the current study contributes to the literature by specifically examining the use of foreign debt and its impact on exposure reduction for Australian multinational corporations.

3.7.3.3 The effect of the combined use of derivatives and foreign debt on exposure

Again, although the studies in Section 3.3.4 used the same research methodologies, they reported mixed evidence of this relationship. In addition to the mixed evidence, another limitation in the literature is the paucity of Australian studies investigating this topic. The sample used in the only Australian study to investigate this topic (Nguyen & Faff, 2004, 2006) did not represent the community of all Australian firms and to this extent no clear evidence exists on whether the use of foreign debt reduces exposure. Consequently, the present study contributes to the literature by re-examining this hypothesis using a fuller community of Australian multinational corporations. It follows that the present study includes the financial hedging interaction variable to its model to test whether the interaction of financial hedging proxies reduces exposure.

3.7.3.4 Currency derivatives as complements to, or substitutes, for foreign debt

As noted previously, the literature relating to this topic reported contradictory results. One group of studies reported that the use of derivatives was a complement to the use of foreign debt in reducing foreign exchange rate risk, while another group of studies reported that the use of currency derivatives was a substitute for the use of foreign debt in reducing this exposure. In addition to reporting contradictory results, the studies were U.S.-oriented and the present study contributes to the literature by examining whether these two financial hedging strategies are, simultaneously, complements to, or substitutes for, operational hedging using Australian data.

3.7.4 The Effect of the Use of Operational Hedging on Exposure

As noted in Section 3.3.6, operational hedging is a comprehensive exercise. Previous studies investigating this topic are subject to some limitations. For example, they report mixed evidence of the relationship between the use of operational hedges and foreign currency exposure. Another limitation is that, to date, to the knowledge of the author, there have been no published Australian studies investigating this topic. The present study contributes to the literature by examining whether the use of operational hedging, separately from financial hedging, reduces exposure to foreign currency risk, using a sample of Australian multinational corporations.

3.7.5 The Effect of the Combined Use of Currency Derivatives and Operational Hedges on Exposure

The combined use of foreign currency derivatives (as a proxy for financial hedging) and operational hedging in reducing the exposure has been examined by a number of U.S. studies, which have left some gaps in the literature. Firstly, the results reported by these studies were mixed. Secondly, no study to date has investigated the impact of the combined use of foreign debt (as another financial hedging proxy) and operational hedging on exposure. The present study contributes to the literature by investigating the combined use of financial hedging (measured by proxies for the use of foreign currency derivatives and the use of foreign debt) and operational hedging on the currency exposures of a sample of Australian multinational corporations.

3.7.6 Currency Derivatives as Complement to, Substitute for, Operational Hedging

As noted in Section 3.6, almost all studies reported that the use of foreign currency derivatives was a complement to the use of operational hedging strategy, in reducing currency exposure. These studies are U.S.-oriented with no Australian study to date having investigated this topic using Australian data. Another gap in the literature relates to the fact that the existing studies have ignored testing whether the use of foreign debt (as another financial hedging technique) is a complement to, or a substitute for, the use of operational hedging, in reducing exposure. Addressing these gaps is a major contribution of the current study.

The next chapter in the study, Chapter 4, discusses the data, and the research methods used, to test the hypotheses stated in Chapter 1.

CHAPTER FOUR

DATA AND METHODOLOGY

4.0 STRUCTURE OF CHAPTER FOUR

This Chapter describes the relevant data and outlines the research methodologies used in the study. The data is presented in Section 4.2 including the sample selection procedure and the sources of data collection. Section 4.3 addresses the methodologies used and discusses the variables and the models designed to test each of the following research hypotheses for Australian multinational corporations:

1. that there exists a relationship between stock returns and exchange rate changes;
2. that the use of currency derivatives reduces foreign exchange rate exposure;
3. that the use of foreign currency debt reduces foreign exchange rate exposure;
4. that the combined use of currency derivatives and foreign currency debt reduces foreign exchange rate exposure;
5. that the use of foreign currency derivatives is a complement to foreign currency debt in reducing foreign exchange rate exposure;
6. that the use of operational hedges reduces foreign exchange rate exposure;
7. that the combined use of financial and operational hedges reduces foreign exchange rate exposure;
8. that financial hedges complement operational hedges in reducing foreign exchange rate exposure;

4.1 INTRODUCTION

In Chapter 3, it was stated that the evidence found to support a general hypothesis that the use of financial and operational hedging effectively reduces exposure to foreign currency risk was mixed in nature. Therefore, the models used in the present study to test this hypothesis could possibly provide significant supporting evidence if the following conditions applied:

1. the measurement errors in the variables in the original models were eliminated;
2. another sample of firms, or industries, from different market environments, were used;
3. an updated period of study was used;
4. other control variables were included (this could be achieved either by adding new control variables to the models used previously, or by replacing these variables with other specific variables more representative of the new business environments of firms).

4.2 DATA

Sample Selection

The present study implements four criteria in its sample selection procedure designed to minimise problems which might cause bias in the results from the subsequent analyses.

The sample firms for the study were primarily sourced from the Australian Stock Exchange (ASX) database consisting of the largest 500 Australian listed firms. Applying a reference point of January 2004, 485 firms were initially identified. Since a main interest of the study is to investigate the foreign exchange rate exposure of Australian multinational firms, four specific selection criteria were applied in finalising the number of firms to be included in the sample. Firstly, firms with headquarters located outside Australia were excluded so as to eliminate potential differences between firms, arising from differences in accounting standards and regulations between countries. Secondly, financial firms (banks, financial institutions, insurance firms, and other financial services firms) were also excluded from the sample study.[70] The information required to apply these and some of the subsequent selection criteria, was sourced from the Aspect Financial and Connect4 databases.[71] Elimination of financial firms, and firms with headquarters located outside Australia, resulted in a sample of 377 companies. As a further refinement, designed to restrict the sample to those companies which were "multinational" in nature, and thus likely to use operational strategies to hedge their foreign currency exposures, a third criterion was applied. It focused on including only those firms which had foreign subsidiaries with sales of more than 10 per cent of the total sales of the company, as a whole, in the sample.[72] After manually reviewing the segmental information reported in the Notes to the Financial Statements section of the annual financial reports of each

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[70] Financial firms were excluded because the focus of the study is on end-users rather than producers of financial services. For example, financial firms are likely to be involved in financial dealings such as the issuance of foreign currency debt as part of their core businesses rather than to hedge foreign exchange-rate exposure. This exclusion practice has been widely adopted in the research literature (e.g., Minton & Schrand, 1993; Hentschel & Kothari, 2001; Nguyen & Faff, 2006; Hagelin & Pramborg, 2004).

[71] Connect4 has been used as the prime and/or confirming database for existing empirical research studies (see Holland & Ramsay, 2003; Nguyen & Faff, 2003, 2004, among others).

[72] One of the criteria specified by Australian accounting reporting standards to identify a segment of a business entity as *reportable*, is where the majority of that segment's revenue is earned from sales to external customers and its revenue from sales to external customers, plus transactions with other segments, is 10 per cent or more of the total revenue, external and internal, of all segments of the entity.

of the sample firms with financial year-ends in 2004, 181 multinational corporations were identified as having subsidiaries located outside Australia, and subsequently limiting inclusion to those companies with more than 10 per cent of their total sales as foreign sales, resulted in a sample of 125 multinational corporations. The average ratio of foreign sales to total sales for companies remaining in the sample at this stage was 59 per cent.

Next, a fourth inclusion criterion was applied, designed to restrict the sample to those corporations, using both foreign currency derivatives and foreign currency denominated debt (hereafter referred to as "foreign debt") as part of their financial hedging strategies. The relevant information was obtained by manual inspection of the annual reports of the remaining 125 companies. This exercise reduced the sample size by 38.4% to 77 firms (61.6 per cent[73]). Finally, because of the prevalence of firms entering and leaving the database, due to mergers, delistings, share price and price relative data were not available for the whole study period, January 2000 to December 2004. The elimination of those firms for which data was not continuously available for the relevant 5-year period, resulted in a final sample of 62 large, Australian multinational corporations. Data relevant to the computation of individual firms' stock returns, the returns on the All Ordinaries share market index and the returns on a trade-weighted exchange-rate index, were obtained from the Australian Graduate School of Management (AGSM) Share Price and Price Relatives Database.

The criteria used for selecting the sample firms were considered to be appropriate, for four reasons. Firstly, the firms remaining in the final sample were more likely to

[73] This percentage is consistent with Nguyen and Faff (2003b) who reported that, in the 1999 financial year, 53.47% of their final sample firms used foreign currency derivatives.

cover all the characteristics of Australian corporations formally involved in using both financial and operational hedges[74]. Secondly, the present study takes the consolidated financial statements into account when collecting the financial accounting (cross-section) data for this study. This eliminates the misrepresentation of the economic influence of exchange-rate changes on a firm value which was a feature of some prior studies (Bartov & Bodnar, 1994; Bodnar & Gentry, 1993; Al-Shboul & Alison, 2007, 2008).

The third justification for the selection criteria applied in the study relates to confining the sample to Australian multinational corporations. Restricting the sample firms to multinational corporations is more likely to avoid the problems, which may arise from the inclusion of firms with limited worldwide linkages and/or which might not fully reflect all firms in the market. For example, Bodnar and Gentry (1993), for their estimation of foreign currency exposure, used portfolios within a particular industry. Since some of these firms within a given industry were not formally involved in international trade, the results of their study may contain an element of bias, as changes in foreign exchange-rates are more likely to have a negative impact on their market values (Bartov & Bodnar, 1994).[75]

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[74] The selection criteria can be favourably compared with, for example, those of Carter et al. (2001), who studied the impact of the combined use of financial and operational hedging on currency exposure. Their final sample firms consisted of firms having at least one subsidiary located overseas for which complete financial hedging and ownership data were available. There is an element of doubt, therefore that their final sample was representative of the community of firms using both financial and operational hedges.

[75] In addition, Jorion (1990) and Amihud (1994) studied both U.S. (non-oil) multinational firms with reported foreign operations and large U.S. exporting firms, respectively. Their sample firms did not fully reflect all the firms in the market and the estimated exposure coefficients might well be biased. However, their sample firms may be able to hedge their exposure at low costs, or are more likely to undertake more hedging activities. Therefore, their exposure coefficients might differ systematically from those of another firm sample, specifically those firms used by Bodnar and Gentry (1993).

Lastly, the procedure of selecting historical time series data for the period, from 2000 to 2004 is considered an appropriate selection criterion. This is because the time series data, which was used to estimate the sample firms' currency exposure coefficients at one point in time (the 2004 financial year), is thus more likely to be representative of the sample firms. This differs from some other studies (e.g. Allayannis et al., 2001)[76] which used data from surrounding time periods for this purpose.

Sources of Data Collection

The data for the present study were collected from several public sources, which are identified in the following subsections.

Time Series Data

The data relating to the first-stage model, Eq (4.1), were collected from three different sources. The monthly firms' stock market returns and the monthly share market index returns (Australian All Ordinaries Index or AOI) were accessed from the Australian Graduate School of Management (AGSM) Share Price and Price Relatives File, for the time period from January 2000 to December 2004. The selected foreign exchange-rate index of the Australian dollar (AUD) is the Trade-Weighted Index (TWI) which was sourced from the monthly issues of the Bulletin of the Reserve Bank of Australia (RBA). To generate the excess returns for the time series data, the

[76] To test their hypothesis of whether the use of financial and operational hedging had an impact on foreign exchange rate exposure reduction, Allayannis et al. (2001) selected their sample firms at a single point in time (financial year 1993). However, they estimated the relevant exposure coefficients using data for the period from 1991 to 1994. This procedure is likely to be inappropriate, as, for example, firms listed in 1994 might not be listed in 1993.

risk-free interest rate proxy chosen was the 3-year Australian Commonwealth Government Bond yield, again sourced from the monthly issues of the Bulletin of the Reserve Bank of Australia.

Cross-sectional data

This type of data was used to generate the variables included in the cross-sectional regression models to investigate the relationship between the use of financial and operational hedges on the absolute values of the foreign currency exposure coefficients (see Section 4.3 for further information). The relevant data was sourced from the published Annual Reports of each firm in the sample. These annual reports were accessed from the Aspect Financial and Connect4 databases.[77] The annual reports of all the sample firms were manually reviewed to obtain the total notional amount of both foreign currency derivatives and long-term debt denominated in foreign currencies.[78]

The other group of cross-sectional data relates to the generation of the proxies for operational hedging variables, such as foreign involvements and the diversification and dispersion of firms' subsidiaries abroad. To generate the proxy for foreign involvement, the annual total foreign sales were firstly obtained manually from the geographical revenues segment report contained attached in the Notes to the Financial

[77] This historical database contains the annual financial reports of 500 firms listed on the Australian Stock Exchange.
[78] The total notional amount of currency derivatives is shown in the Notes Section to the Annual Report, separately in terms of each instrument. To capture the consolidated total of amount of currency derivatives, the amounts of these separate instruments were summed. The total foreign currency denominated debt is shown in the annual reports separately in terms of each currency. These were converted to Australian dollars at average exchange rates and then summed.

Statements section of each firm's annual report.[79] The total amount of foreign sales was then divided by the total sales of the group, to obtain the proxy for foreign involvements. The information and numerical data relevant to generating the operational hedging strategies proxies were also obtained manually from the Notes to the Financial Statements, again, specifically, the geographical segments report for each firm. Within this geographical report, firms are required to disclose the numbers and location(s) of their foreign subsidiaries since the number of subsidiaries per country and region were collected and used for this purpose.

Finally, the data used to generate proxies for the other control variables included in the cross-sectional regression models were obtained both directly from the Financial Statements (e.g., statements of Cash flow, income, and balance sheet) and from the Notes to these statements, in the annual reports of each firm. The former data group included total sales, total assets, current and liquidity ratios, research and development expenditure, dividend yield, and the leverage ratio. The second group included the number of business segments and the ownership structure data, such as the percentage of shares owned by institutions, block-holders, and directors (collected from the Top Twenty Shareholders segment).

4.3 METHODOLOGY

4.3.1 Introduction

As noted in Chapter 3, the vast majority of prior studies, conducted in the field of the present study, used a two-stage market model to examine the impact of the use of

[79] This segment report records the annual total revenues generated abroad, across regions and countries.

financial and operational hedges on corporate foreign exchange rate exposure. In the first stage, a two-factor linear regression model was used to estimate the exposure coefficients of the foreign exchange risk factor. These coefficients represent estimates of the potential effects of changes in exchange rates on a firm's stock returns. The second stage is a cross-sectional regression model which examines the impact of financial and operational hedging variables on these exposure coefficients. The two-stage market regression model has been widely used in the literature to capture the effects of hedging strategies on foreign currency exposure. Therefore, the present study adopts this procedure.

4.3.2 First-stage Model: The Two-Factor Linear Regression

As indicated in Chapter 2, Adler and Dumas (1984) defined foreign currency risk exposure as the magnitude of the sensitivity of stock returns to random fluctuations in the foreign exchange-rate over a specific time period. If this relationship is linear, the exposure can be measured by the slope coefficient between stock returns and the changes in the exchange-rate. Thus, Adler and Dumas (1984) argued that random changes in exchange rates potentially affect firm value. However, the seminal study by Jorion (1990) did not particularly support this theory, and reported only weak evidence of the relationship between the two variables[80].

In the light of the weak evidence reported in his 1990 study, Jorion (1991) adopted the Capital Asset Pricing Model (CAPM) approach (a two-factor asset pricing model) to estimate corporate foreign exchange rate exposure. This two-factor asset pricing

[80] Jorion (1990) extended the model of Adler and Dumas (1984) by controlling for the effect of general market risk on stock returns with the inclusion of an extra variable: the return on the relevant stock market (see Eq 3.1 in Chapter 3).

model regressed the excess return on the common stock of 20 industry portfolios of listed U.S. firms on the excess return of the share market index and the component of the exchange-rate changes orthogonal to the market return.

Following Jorion (1991), the current study estimated the currency exposure coefficients for a sample of 62 Australian multinational firms for the period, from January 2000 to December 2004. That is, a two-factor model – namely, a market risk factor, and a foreign exchange factor - was adopted to estimate the foreign exchange-rate exposure coefficients, γ_{2i}, in Eq 4.1.

$$R^*_{it} = \beta^*_{0i} + \beta_{1i} R^*_{Mt} + \gamma_{2i} R^*_{FXt} + \varepsilon_{it} \qquad \textbf{(4.1)}$$

Firm: $i = 1, 2, 3, \ldots, I$; Time: $t = 1, 2, 3, \ldots, T$

Where R^*_{it} is the monthly excess return of firm i's common stock at time t, R^*_{FXt} is the monthly excess return of the trade-weighted foreign exchange-rate index, orthogonal to market return, at time t, for the Australian dollar (AUD) against a basket of foreign currencies, R^*_{Mt} denotes the excess return from the accumulated share price market index of Australian shares at time t and ε_{it} is the error term for firm i at time t. The OLS was used to estimate the parameters of the model with some adjustments, where needed, to deal with econometric problems. Since this model was considered a modified version of the Capital Asset Pricing Model (CAPM), the present study assumes that the model is tested with respect to the inclusion of an intercept term, in contrast to the CAPM rules. Therefore, the intercept term was included in Equation 4.1, although the CAPM itself includes no intercept term in its theoretical model.

4.3.2.1 The asset-excess return generating process

(i) The inclusion of the risk-free rate of interest

To generate the excess returns for all the observed time series rates of return (i.e. firm's stock, stock market index, and exchange-rate index), the current study adopted the monthly returns on 3-year Australian Commonwealth Government bonds as a proxy for the risk-free interest rate (or risk-free return).[81]

The deduction of the risk-free interest rate (or risk-free return) from the returns on the model variables was carried out to prevent an asymptotic misspecification bias in the estimation of the beta coefficients (Elton & Gruber, 1991). A downward bias in the slope coefficients in the adjusted CAPM model will result if the returns on the explanatory variables and the risk-free return are negatively correlated (Miller & Scholes, 1972). This bias can be alleviated by subtracting the risk-free rate of interest from the returns on individual firms' stocks, from the stock market returns and from the returns on the exchange rate index[82]. The possibility that the use of "excess" rates of return will significantly impact the results of the analysis is an empirical issue. However, to avoid any potential bias resulting from misspecification, all returns in this study are expressed in excess formats.

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[81] Many prior Australian empirical studies (e.g., Loudon, 1993a; Di Iorio & Faff, 2002; Benson & Faff, 2003) used the rate on 13-week Treasury Notes as a proxy for the risk-free interest rate. However, the data for the rates on Treasury Notes were not available for the full sample period of the current study, as the Reserve Bank of Australia suspended the issue of these securities (RBA, 2002a, 2002b).

[82] It is assumed that the returns on the market portfolio, on the individual firms' returns and on the exchange rate index, during a particular time period are independent of the risk-free interest rate at the start of the period and there is no change in the risk-free rate of interest during the period.

As noted above, in this study, the equivalent monthly risk-free rates of interest were derived from the nominal annualised yields on the 3-year Government bond. The risk-free interest rate was subtracted from the actual monthly (logarithmic) returns on individual stocks, the share market index, and the exchange-rate index, respectively, to obtain excess returns for all these variables.[83]

(ii) Logarithmic returns

All the returns series used in Eq (4.1) were calculated in logarithmic form as opposed to proportionate form. The logarithmic returns were computed as the natural logarithms, ln, of the price relatives of the variable observations. The monthly price relative of an individual stock, for example, was computed by dividing the current observation of the market price of the stock, P_{it}, by the previous monthly observation of the stock's market price, P_{it-1}. The price relatives of all the variables used in (Eq 4.1) were calculated as follows:

1) P_{it} / P_{it-1} is the monthly price relative for stock *i* in period *t*.

   Where P_{it} is the monthly market price of firm *i*, for period *t*, after making any adjustments necessary for events which have taken place since the last observation, such as dividends paid, rights issues, share placements etc., or any other adjustment which may cause changes in the firm's share price. For example, if the only relevant event were the payment of a dividend, Div_{it}, the price relative

83 To avoid the nontrivial problems of obtaining an inflation proxy, and of forecasting exchange-rate changes, this current study uses the nominal exchange-rate index, as proposed by Jorion (1991). An unobservable inflation rate would otherwise, have to be estimated, as the Australian consumer price index (CPI) is only available at quarterly horizons (Loudon, 1993a). As nominal values are highly correlated with real values obtained with commonly adopted deflators for inflation (Jorion, 1990), it is assumed that the use of nominal values is not likely to yield significantly different results.

for stock i for period t, would be computed using the following formulae: $((P_{it} - P_{it\text{-}1} + Div_{it})/P_{it\text{-}1})$.

2) $P_{Mt} / P_{Mt\text{-}1}$ is the monthly price relative of the accumulated share market index for period t.

3) $P_{FXt} / P_{FXt\text{-}1}$ is the monthly price relative for the foreign exchange-rate index (TWI) for period t.

Proportionate returns can take values between $-\infty$ and $+\infty$. This feature can lead to a positive skewness in their distributions. For example, Beedles et al. (1986) indicated that there was some evidence of such skewness for Australian listed securities. If the population distribution of the returns for both individual securities and market portfolio is skewed to the right, the measurement error in a model containing these variables will be robust. According to Miller and Scholes (1972), this error of measurement makes a contribution to a bias towards zero in the slope coefficients in the model. To eliminate any errors arising from potential skewness in proportionate returns, the present study computes all returns in continuously compounded format.

In a compounding situation, the logarithmic return is the summation of several independent short-term logarithmic returns. Therefore, as central limit theorem indicates, if the short-term returns are identically distributed and have limited variance, the distribution of the logarithmic return should approach normality in terms of the length of horizon. This implies a natural logarithmic distribution for the equivalent proportional returns should be undertaken (Rosenberg & Marathe, 1979). The continuously compounded returns for all the variables in Eq (4.1), using the logarithmic technique, were computed as follows:

$R_{it} = \ln(P_{it} / P_{it-1})$: the return on firm *i*'s common stock for month *t*. The nominal price relative was sourced directly from the AGSM database.

$R_{Mt} = \ln(P_{Mt} / P_{Mt-1})$: the return on the accumulated share market index for month *t*. The nominal price relative of the relevant All Ordinary Index (AOI), was sourced directly from the AGSM database.

$R_{FXt} = \ln(P_{FXt} / P_{FXt-1})$: the monthly return on the foreign exchange-rate index for month *t*. This nominal continuously compounded return was generated by taking the natural logarithm of the price relative for the foreign exchange-rate index (TWI), for period *t*, collected directly from the relevant Bulletin of the Reserve Bank of Australia (RBA).

(iii) Computation of excess returns

The excess monthly logarithmic returns, used to estimate the parameters in Equation (4.1), were calculated as follows.

The logarithmic risk-free interest rate for month *t*, R'_{ft}, was computed as:

$$R'_{ft} = \ln(1 + R_{ft})$$

Where R_{ft} is the equivalent nominal risk-free interest rate for month *t*.

To calculate the logarithmic excess returns of all the time series variables, the relevant logarithmic risk-free interest rates are subtracted from the logarithms of the relevant price relatives, of each variable used in the model in Equation 4.1.

The excess logarithmic return of firm *i*'s stock[84], in month *t*, is given by:

$$R_{it}^{*} = \ln(1 + R_{it}) - \ln(1 + R_{ft}^{'})$$

The excess logarithmic return on the share market index, in month *t*, is given by:

$$R_{Mt}^{*} = \ln(1 + R_{Mt}) - \ln(1 + R_{ft}^{'})$$

The excess logarithmic return on the exchange rate index, in month *t*, is given by:

$$R_{FXt}^{*} = \ln(1 + R_{FXt}) - \ln(1 + R_{ft}^{'})$$

4.3.2.2 Estimation of the first-stage model

Recall that the relationship between firms' stock returns and the exchange-rate risk factor, with respect to the market risk factor, for the sample of 62 Australian multinational corporations for the period from January 2000 to December 2004, was examined in Equation 4.1. The Ordinary Least Squares (OLS) technique was used to estimate the exchange-rate exposure coefficients, γ_{2i}, which illustrate the sensitivities of the firms' stock returns to changes in exchange rates.

To alleviate the effects of the main econometric problems which may be encountered with time series observations, several statistical techniques were employed to obtain the Best Linear Unbiased Estimators (BLUE) of the parameters of the model. These techniques were deployed as follows:

[84] Note that $(P_{it} / P_{it-1}) = (1 + R_{it})$.

Stationarity

1. To test for any nonstationarity in the data employed in the study, the Dickey-Fuller (DF) test was used. The test was conducted on the monthly excess returns of the share market index, the exchange rate index, and the sample firms' stocks.
2. If the existence of nonstationarity was found, the Augmented Dickey–Fuller (ADF) was used to eliminate the effects of the problem.

Collinearity and/or Multicollinearity:

1. Collinearity and/or multi-collinearity exist(s) when two or more explanatory or independent variables are highly correlated. To diagnose this phenomenon, Pearson's correlation coefficients were used. This was to determine the sign and the degree of any correlation between the two explanatory variables in Equation 4.1.
2. If the problem was found to exist, it was dealt with by omitting one of the two explanatory correlated variables from the model, using a general-to-specific approach.

Auto-correlation:

1. Serial correlation or autocorrelation of a first order autoregressive AR(1) scheme was tested for by implementing the Durbin-Watson (1950) technique (D-W). If required, the iterative Cochrane-Orcutt (1949) procedure was applied to re-estimate the model.
2. Autocorrelation of higher order lags was jointly tested for using the Ljung-Box Q-statistics through Maximum Likelihood Estimates (MLE). To reduce the effect of autocorrelation cases found, the Generalised Least Square (GLS) method was used to modify the model and re-estimate it.

Heteroskedasticity

1. To test for heteroskedasticity, White's (1980) general model was used.
2. To eliminate the effects of heteroskedasticity, White's heteroskedastic-corrected standard errors estimators were used.

Conditional heteroskedasticity

1. When the prices of financial assets, such as bonds or shares, exhibit non-constant volatility, but periods of low or high volatility are generally not known in advance, it is called conditional heterosekdasticity. To test for conditional heterokedasticity, the Autoregressive Conditional Heteroskedastic model (ARCH), as proposed by Engle (1982), was used.
2. As the ARCH model is not able to eliminate conditional heteroskedasticity, the Generalized Autoregressive Conditional Heteroskedastic model (GARCH), as generated by Bollerslev (1986), was used, if necessary, to eliminate the effects of the problem.

4.3.3 Second-stage Model (Cross-Sectional Regression Model)

4.3.3.1 Description of the variables used in the second-stage model

Before making a discussion to the models designed to test all the hypotheses, full descriptions of the model variables, and the rationales for their use, is presented in the current section. Initially, the variables are identified and briefly defined in Table 4.1.

1) The foreign exchange rate exposure coefficients (dependent variable)

The absolute values of the foreign exchange-rate exposure coefficients, $|\gamma_{2i}|$, estimated in Equation (4.1), were used as the dependent variable in the cross-sectional regression models. As discussed earlier, since firms are either negatively or positively exposed to currency risk, the implementation of the absolute values of the coefficients were adopted to measure the effectiveness of operational and financial hedges in reducing the firms' absolute currency exposures. The exposure coefficients were estimated using Jorion's (1991) augmented model.

2) Financial hedging variables

In contrast to earlier studies, the present study measures the proxy for the use of foreign currency derivatives (*DER*) as the total notional amount of foreign currency derivatives, scaled by the firm's total assets. Under the assumption that the use of foreign currency derivatives is effective in hedging exposure, then it is expected that the more foreign currency derivatives a firm uses, the less exposed it will have to exchange-rate risk. Allayannis and Ofek (2001) indicated that the use of foreign currency derivatives decreases exposure for firms with positive exposure and increases (decrease in absolute value) exposure for firms with negative exposure. That is, this usage may increase firm value by reducing both the variability of a firm's cash-flow and the costs of financial distress. These reductions can be achieved by minimizing the number of states in which firms may encounter some hedging difficulties (Nguyen & Faff, 2002). Further, it was indicated that hedging programs (derivatives) can also reduce the expected costs of financial distress by minimizing

Table 4.1

Description of the variables used in the second -stage regression	
The Foreign exchange rate exposure. $\lvert\gamma_{2i}\rvert$	The absolute value of the currency exposure coefficient, for firm *i*, estimated in the first-stage regression model (Eq. 4.1).
Financial Hedging Variables	
DER	The total notional amount of foreign currency derivatives, divided by total assets, for firm *i*.
FDD	The total notional amount of foreign-currency denominated debt, divided by total debt, for firm *i*.
INTERACTION	The interaction variables, computed by multiplying the foreign currency derivatives ratio (*DER*) multiplied by the foreign-currency denominated debt ratio (*FDD*), for firm *i*.
Operational Hedging Variables	
NRC	The natural logarithm of the number of foreign countries, in which firm *i* has subsidiaries.
NRF	The natural logarithm of the number of geographical regions in which firm *i* has subsidiaries.
HERF1	The Herfindahl Index 1, calculated as follows: HERF1=1-$[[\sum^{K}_{k=1}(NRS_{i,k})^2]/[TNFS_{i,TK}]^2]$, where: NRS_i, is the number of foreign subsidiary(ies) of firm *i* per country *k*; $TNFS_{i,TC}$, is the total number of foreign subsidiaries of firm *i* operating in all foreign countries.
HERF2	The Herfindahl Index 2, calculated as follows: *HERF*2=1-$[[\sum^{J}_{j=1}(NRS_{i,r})^2]/[TNFS_{i,TJ}]^2]$, where: NRS_i, is the number of foreign subsidiary(ies) of firm *i* per region, *r*; $TNFS_{i,TJ}$, is the total number of foreign subsidiaries of firm *i* operating in all the geographical regions.
Control Variables	
a) ***Hedging Incentive variables***	
LEV	The leverage ratio, measured by the ratio of total debt to total assets, for firm *i*.
CR	The current ratio, measured by the ratio of current assets to current liabilities, for firm *i*.
SIZE	The size of the firm, calculated by the natural logarithm of the total assets, for firm *i*.
b) ***Ownership Structure variables***	
DIR	The percentage of shares owned by the Directors, for firm *i*.
INS	The percentage of shares owned by Institutions, for firm *i*.
BLO	The percentage of shares owned by Block-holders, for firm *i*.
c) ***Control variables***	
FS	The ratio of foreign sales divided by total sales, for firm *i*.
CAPEX	The ratio of capital expenditures to the total assets, for firm *i*.
NSGM	The number of business segments in which firm *i* operates.
RD	The ratio of research and development expenditure to total assets, for firm *i*.
ROA	The return on assets is measured as the ratio of net profit after tax to total assets, for firm *i*.

the conflict of interest between bond-holders and shareholders, when financial distress has taken place (Bessembinder, 1991). Therefore, the use of foreign currency derivatives is expected to be negatively associated with the exposure.

In addition to currency derivatives, some firms use foreign-currency denominated debt (*FDD*) to reduce exposure (Keloharju & Niskanen, 2001; Kedia & Mozumdar, 1999, 2003). It is measured by the ratio of foreign debt to total debt. The issuance of foreign debt in the multiple foreign currencies, in which the firm operates, is used to hedge the underlying currency exposure (Keloharju & Niskanen, 2001; Kedia & Mozumdar, 2003). This requires a firm to have net debt in the currencies in which it has positive exposure, or net debt in currencies which are highly correlated with the exposed currency. This effectively means issuing foreign debt is more likely to reduce exposure. Therefore, it is expected that the use of foreign debt will be negatively related to (i.e. is associated with a reduction of) currency exposure.

As both financial hedging strategies (currency derivatives and foreign debt) are separately expected to be negatively related to the exposure, combining them is more likely to be associated with exposure reduction. To test the effectiveness of this combination, the present study generates an interaction variable (*INTERACTION*) by multiplying the proxy of the use of currency derivatives by the proxy for the use of foreign debt. A cross-sectional regression model is designed by replacing the proxies for currency derivatives and foreign debt, by the interaction variable (see Eq. 4.7). It is expected that this interaction variable will be negatively related to currency exposure.

These two hedging strategies may also act as substitutes for, or complements to, each other in reducing exposure. It can be argued that large firms, with high foreign currency exposures, are more likely to engage heavily in foreign currency derivatives programs and operational hedging programs, rather than using foreign debt to manage their currency exposures. However, the use of foreign currency denominated debt, as a natural hedging technique, may be considered a feasible (i.e. affordable) way of hedging longer-term currency exposure for small firms, which may not have the resources to be involved with comprehensive operational hedging. However, large firms may have the opportunity to choose between the two techniques, in which the expectation would be that they act as substitutes for each other. In this regard, Geczy et al. (1993) and Elliott et al. (2003) found that the use of foreign debt is a substitute for foreign currency derivatives in reducing the exposure. Therefore, it is expected that these two financial hedging strategies are substitutes for each other.

The four proxies for operational hedges which represented the firm's ability to construct a network of foreign subsidiaries abroad (Allen & Pantzalis, 1996; Doukas et al., 1999) are discussed below. These four operational hedging proxies were measured by the following two dimensions: *Breadth* (the degree of diversification across many countries) and *Depth* (the degree of concentration in a few countries). *Breadth* contains the first two proxies, which are related to the diversification of the firm's foreign subsidiaries across countries and/or geographical regions.[85] As noted in Table 4.1, these two proxies were measured by the natural logarithm of the total number of a firm's subsidiaries operating in each individual foreign country and/or

[85] The study divides the world into nine geographical regions: the European Union, NAFTA (North America Free Trade Agreement), Western Europe, Central America and the Caribbean, East Europe, South America, Africa, Asia-Pacific including the Asia crisis region, and Asia others.

region (*NFC* and *NFR* respectively). The higher the number of foreign countries (regions) in which the firm has subsidiaries, the higher the exposure to foreign currency risk (Allayannis et al. 2001). Thus, a positive relationship might be expected between those two hedging variables and currency exposure. However, firms with higher number of foreign subsidiaries across countries (regions) may be better placed to develop and deploy operational hedging strategies to manage foreign exchange rate risk than less diversified firms. For example, highly geographically diversified firms will be able to shift production, sources of inputs and sales to mitigate the effects of fluctuating exchange rates (Dunning & Rugman 1985). Allen and Pantzalis (1996) and Pantzalis et al. (2001) found that those two variables (*NFC* and *NFR*) were negatively related to exposure to foreign currency risk, for their respective firm samples. Therefore, the use of those two variables is expected to be negatively related to currency exposure.

Depth contains the second two proxies for operational hedging, which are related to the geographical dispersion of a firm's foreign subsidiaries across countries and/or geographical regions. These two proxies are *HERF*1 and *HERF*2, measured by the Herfindahl-Hirschman concentration index at both the country and regional levels. The formulae underlying the computation of both variables are shown in Table 4.1. If the values of the two variables, for firm *i*, are close to 1, it can be interpreted as the firm has a higher number of its foreign subsidiaries concentrated in a large number of countries and/or regions. On the other hand, if the values of the two variables are close to zero, the firm has subsidiaries operating in only one country and/or region. Applying the same reasoning discussed previously with respect to the *breadth* variables, the relationship between currency exposure and the two *depth* variables could be expected to be either positive or negative. That is, if firms can deploy their geographical dispersion as an operational hedging variable, then a negative relationship would be expected. However, the greater a firm's geographical dispersion, the greater will be the proportion of revenue which is earned in foreign currencies, and the higher will be the exposure. Allayannis et al. (2001) reported a positive relationship between exposure and both *HERF*1 and *HERF*2. Similarly, Pantzalis et al. (2001) found a positive relationship between their *depth* proxies and the absolute value of a firm's exposure coefficient, which prompted the authors to comment on the '...the importance of the multinational corporations (MNC) network structure in enabling the MNC to devise operational hedging strategies' (Pantzalis et al., 2001, p 806). In the light of this prior empirical evidence, there is an expectation in the current study of a positive relationship between the *depth* proxy and currency exposure.

a) Hedging incentives variables

The first group of control variables used comprised proxies for a firm's incentives to hedge foreign exchange rate risk. These proxies were: firm size, leverage, and current ratio. The size of the firm (*SIZE*) was measured by the natural logarithm of the market value of total assets. Block and Gallagher (1986) pointed out that large firms which have comprehensive financial and human resources at their disposal, were more likely to engage in hedging programs, and several empirical studies have found a strong positive relationship between firm size and the propensity to hedge currency exposure (e.g., Geczy et al., 1997; Allayannis & Ofek, 2001; Heaney & Winata, 2005). Thus, it would be expected that a negative relationship would exist between size and exposure. In addition, Nance et al. (1993) indicated that large firms are more likely to have incentives to hedging as such firms have greater foreign exchange rate exposure compared with small firms. This is because small firms are more likely to hedge transaction exposure, as the costs of financial distress are more likely to be higher for large firms compared with small firms (Warner, 1977). Furthermore, Ang, Chua and McConnell (1982) suggested that costs of financial distress increase less proportionally as firm size increases. Therefore, smaller firms are more likely to have greater incentives to hedge to reduce the probability of encountering financial distress, which would be more costly for them compared with large firms (Nguyen & Faff, 2002). Thus, smaller firms are expected to have less exposure than larger firms as a result of using hedging programs.

The second proxy variable in the hedging incentive group proxy is the leverage ratio (*LEV*). It is calculated as the firm's total debt divided by its total equity. A firm with a high leverage ratio is assumed to be more likely to encounter higher costs of financial distress, and hence, have a greater incentive to smooth its earnings variability by hedging its currency risk. In other words, high levered firms have incentives to use, for example, foreign currency derivatives, which are expected to reduce the exposure. Geczy et al. (1997) provided evidence that firms use derivatives to reduce the costs of financial distress. If leverage ratio is a valid proxy for the cost of financial distress, this would indicate that relationship between the leverage ratio and currency exposure should be negative. In addition, any foreign debt component in the leverage ratio could provide a natural hedge against foreign currency exposure which would reinforce the expectation of a negative relationship between leverage and the absolute values of the exposure coefficients (Kedia & Mozambar, 1999, 2003; Carter et al., 2001).

The third hedging incentive control variable is the current ratio (*CR*), which serves as a proxy for firm's liquidity, and measured by the ratio of current assets to current liabilities. A firm's hedging programs may be partially derived from liquidity risk as firms may not be able to convert their growth options into assets to satisfy their short-term financial obligations (Froot et al., 1993). Nguyen and Faff (2002) stated that liquidity can be viewed as a substitute for hedging. This is because a high level of liquidity lessens the pressure on a firm to use derivatives to smooth earnings in an attempt to reduce the costs of financial distress associated with borrowing to finance growth options. That is, if a firm has sufficient internal funds to finance all available positive NPV projects, there will be negligible benefits obtained from hedging programs (Nguyen & Faff, 2002). In the present study, therefore, the current ratio is expected to increase the exposure as it dilutes the pressure associated with the use of hedging programs.

The second group of variables included to control for firms' incentives to hedge currency risk, relates to ownership structure. In this particular context, it has been reported that managerial incentives and outside monitoring have an effect on the decision to use currency derivatives (Whidbee & Wohar, 1999). In addition, if it is assumed that foreign exchange-rate risk is priced in the stock market, then shareholders may be concerned as to the currency risk exposure of the firms in which they are invested. Thus, a combination of shareholder concern and managerial risk-aversion may be a reason why firms choose to employ foreign-exchange risk hedging programs (Doukas et al., 1999).

As noted in Section 4.2.2.2, the data relevant to the ownership structure variables were collected from the top twenty shareholders information in the Notes to the Financial Statements contained in the annual reports of each sample firm. The specific information sets extracted from the 'top twenty' segment were as follows:

1- Directors and employees, within the top twenty, who own outstanding shares;
2- Block-holders, who own more than 5 % of the outstanding shares;
3- Financial institutions and other bodies, which own shares;
4- To avoid double counting, if some of block-holders are directors, this study considers them as block-holders;

The first ownership variable is the percentage of shares held by the directors (*DIR*). Since the marginal utility of their wealth will be reduced by fluctuations in profits, risk-averse managers who possess large numbers of shares in their own firms (i.e., when they are entrenched), are expected to direct the firms to hedge currency risk exposure, as long as they consider that the firm can do this more cheaply than they can themselves (Smith & Stulz, 1985). Empirical evidence reported by Tufano (1996), who studied a sample of firms in the North American gold-mining industry, lends qualified support to this hypothesis in relation to incentives to hedge against random fluctuations in the market price of gold,[86] and, in the present study, the *DIR* variable is expected to be negatively related to the exposure.

[86] However, Geczy et al. (1997) did not find significant evidence between exchange-rate exposure hedging activity and managerial incentives to hedge.

The second ownership variable is the percentage of shares held by block-holders (*BLO*). Block-holders, who are classified as owning 5% or more of a firm's common stock, have an incentive to monitor the managers' activities to protect their own investment in the firm. Because of the disproportionately large fraction of their wealth invested in the firm's risk capital, block-holders will favour risk management strategies which will reduce exposure to risk, including foreign exchange rate risk (Carter et al., 2001). Thus, assuming that corporate hedging is successful, the current study expects that the percentage of shares held by block-holders (*BLO*) will be negatively associated with currency exposure.

Finally, the percentage of shares owned by institutions (*INS*) is also expected to impact on the exposure. Although institutional shareholders may not be block-holders, they also have an interest in the managerial actions inside the firms in which they hold shares. This is because institutions, through their portfolio management activities, have a fiduciary responsibility to their own clients (Fok et al., 1997). They are also equipped with the resources to analyse managerial actions (Carter et al., 2001). As a consequence, it can be expected that institutional shareholders will seek to monitor the actions of the firm's managers, to a greater degree than individual shareholders. The disciplinary pressure on managers to act on behalf of shareholders, via the corporate governance process, can expect to increase as institutional ownership increases. In turn, risk reduction activity, such as currency hedging, should increase accordingly. Thus, assuming that such hedging was successful, there would be an expectation that the relationship between the shares owned by institutions and currency exposure is negative.

However, it is also possible that, because of their portfolio management expertise, institutions themselves will be able to reduce idiosyncratic risk on behalf of their clients. In this situation, it could be anticipated that they would exert less pressure on managers to hedge currency exposure. In this case it might be observed that a high percentage of institutional share ownership would be associated with higher currency exposure. Therefore, because of this potential ambiguity, the current study has no specific expectation of the relationship between the percentage of shares owned by institutions (*INS*) and the absolute value of the currency exposure coefficient.

b) Other control variables

The ratio of foreign sales (*FS*) is a proxy for the degree of a firm's foreign involvement, which is assumed to be a source of foreign exchange rate exposure[87] (Jorion, 1990; Choi & Prasad, 1995; Allayannis & Ofek, 2001), and, following previous empirical studies in the area, is included as such in the current study. It is measured by the ratio of foreign sales to total sales. As our study represents the foreign exchange-rate index (Eq 4.1) in terms of Australian dollars (AUD) per unit of foreign currency, an appreciation of the AUD would decrease the index. If the multinational firm receives revenue from foreign sales, it is more likely to be adversely affected by an exchange-rate appreciation, and thus a *positive* coefficient on the *FS* variable would be expected in the second-stage cross-sectional regressions. On the other hand, if the multinational firm acts as an importer, then, it should benefit from an appreciation of the AUD, generating a *negative* exposure. Therefore, as the

[87] Foreign exchange rate exposure is considered to be simultaneously determined by its real operations (via its foreign involvement) and its hedging activities.

absolute values of the exposure coefficients generated in the first-stage model are taken as the dependent variable in the appropriate second-stage models, it is expected that an increase in the foreign sales ratio will be associated with an increase in exposure.

The number of business segments variable (*NSGM*) was used as a proxy for the industrial diversification. Many theoretical studies argue that industrial diversification enhances firm value (e.g., Williamson, 1970), while others suggest that it is an outgrowth of agency costs and, therefore, destroys value (e.g. Jensen, 1986; Lang & Stulz, 1994; Servaes, 1996). To control for the effect of a firm's industrial diversification (i.e. its ability to manage its currency exposure via diversification across multiple business lines), a number of business segments variable (*NSGM*) was used as a proxy for the industrial diversification of firm *i*. This variable was generated using numbers equal to the number of business segments in which a sample firm operates. That is, if a firm operates in, for example, four business segments, the variable *NSGM* will take the number '4', and so on. This information was collected from the business segment report in the annual reports of each firm. Following the assumption that the more a firm diversifies its industry's activities, the more likely it is to be involved with various foreign operations and, therefore, the greater its ability to reduce currency exposure, the current study expects a negative relationship between exposure and the number of business segments.

In addition, two variables were employed as proxies for investment growth opportunities: the ratio of capital expenditures to total assets, *CAPEX* and *RD*, the ratio of research and development expenditure to total assets. Each of these variables was included as further controls for a firm's incentive to hedge currency exposure. This inclusion is related to the fact that firm value relies on future investment opportunities (Myers, 1977; Smith & Watts, 1992). Further, Froot et al. (1993) suggested that firms implementing hedging programs are more likely to have greater investment opportunities.

Following Allayannis and Weston (2001), the present study includes the capital expenditure ratio, as a first proxy for investment opportunities. Firms with high ratios of capital expenditures are more likely to diversify their operations abroad[88] and to use financial hedging programs, which will reduce their foreign exchange rate exposures. Again, assuming that these hedging strategies are successful, there is an expectation in the current study that the *CAPEX* variable will be negatively related to currency exposure.

The second variable, the ratio of research and development costs to total assets (*RD*) as a proxy for investment in opportunities, was included to control for the agency costs manifested in a reluctance by a firm's managers to invest in (risky) growth opportunities. In general, successful *RD* investments may enable firms to create shareholder wealth by reducing their production costs, expanding their sales revenues to gain larger market shares, and thus to make more profits. However, the outcomes from investing in research and development may take a long time to become evident in a firm's income statement. Unlike investment in tangible assets (e.g. property, plant, equipment, and inventory), research and development investments are characterised by potentially large gains and high risk (including foreign exchange

[88] These firms will also benefit from the opportunities for operational hedging which such diversification brings.

risk) in the firms' future cash flows (Xu & Zhang, 2004). In an efficient stock market these features would, of course, be reflected in the firm's share price. Reluctance by a firm's management to invest in growth opportunities with a similar risk-return profile to research and development is thus a potential agency cost to the firm's shareholders. It can be argued, therefore, that, in the absence of hedging, firms with high *RD* expenditures could be more susceptible to underinvestment than those with low *RD* expenditures, and would thus benefit more from hedging (Stulz, 1984). Again, if it is assumed that this hedging is successful in reducing currency risk, there would be an expectation of a negative relationship between the *RD* ratio and the absolute value of the exposure coefficient.

The final variable included in the cross-sectional models was the return on assets (*ROA*) measured as the ratio of profit before interest, taxes and dividends, to total assets, as a proxy for the profitability. That is, the higher the return on assets, the higher is the firm's profitability. Firms with higher profitability are less likely to encounter financial distress situations as a result of borrowing to fund investment, and are, therefore, likely to have less risk exposure. Therefore, the current study has an expectation of a negative relationship between return on assets and exposure to currency risk.

This section discusses the cross-sectional regression models used to test the seven hypotheses concerning the effects of the use of financial and operational hedges on exposure, indicated in Section 4.0. For presentation purposes, these models are divided into three groups as follows:

- Sub-section (4.3.3.2) describes the designing of the financial hedging models used to test the four financial hedging hypotheses;
- Sub-section (4.3.3.3) describes the designing of the operational hedging models used to test the operational hedging hypothesis;
- Sub-section (4.3.3.4) discusses the financial and operational hedging models designed to test the last two hypotheses relating to financial and operational hedging;

4.3.3.2 Financial hedging models

1) The effect of the use of currency derivatives on exposure

As noted in Chapter 3, the results reported by the published studies were generally supportive to the hypothesis that the use of currency derivatives effectively reduces foreign exchange risk exposure, although there were some inconsistencies in these results. An example of this is provided by the studies of Allayannis and Ofek (2001) and Nguyen and Faff (2003b). Adopting the premise that the level of a firm's foreign exchange rate exposure is determined, simultaneously, by the nature of its operations and the extent of its hedging activity, both studies incorporated the relevant variables in their models. In each study the nature of the operations was proxied by the ratio of foreign sales to total sales. Both studies found that the use of derivatives was significantly negatively related to foreign exchange rate exposure. However, contradictory findings were reported with regard to the relationship between the foreign sales ratio and the exposure itself. Allayannis and Ofek (2001) reported a strong significant positive relationship, while Nguyen and Faff (2003b) reported a positive, but insignificant relationship.

The current study, first, seeks to achieve some clarification of this inconsistency by re-examining the relationship between the use of foreign currency derivatives and the absolute value of the exposure, for a sample of Australian multinational firms. The present study generates two cross-sectional regression models for this purpose. The first model used to test the hypothesis of whether the use of foreign currency derivatives reduces corporate exposure takes the following form:

$$|\gamma_{2i}| = \delta_0 + \delta_1 DER_i + \delta_2 FS_i + \varepsilon_i \qquad \textbf{(4.2)}$$

Firm: $i = 1, 2, 3, \ldots, I$

Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficient for firm i, estimated over the period from January 2000 to December 2004, DER_i is the total notional amount of currency derivatives divided by total assets for firm i, FS_i is the total foreign sales divided by total sales for firm i, and ε_i is the error term.

To formulate the second model to test the same hypothesis, the present study includes, to Eq 4.2, the firm's ownership structure variables as a control for the effects of the firm's incentives to hedge. The inclusion of these variables arises from Fok et al. (1997), who analysed the role of ownership structure in the relationship between hedging and firm value, and suggested that corporate ownership structure may have an effect on the desirability of hedging. The ownership structure factor enclosed is proxied by three explanatory variables: the respective percentages of shares held by the directors, block-holders, and institutions. The reasoning behind the inclusion of these control variables is that, the higher the percentages of shares held by directors, block-holders, and institutions, respectively, the greater will be the pressure for corporate governance and, therefore, the greater will be the incentive for the firm to manage its foreign currency risk. The other two variables included to control for the firm's incentive to hedge currency risk, are the firm's leverage ratio and current ratio. The second cross-sectional model is structured as follows:

$$\begin{aligned}|\gamma_{2i}| &= \delta_0 + \delta_1 DER_i + \delta_2 FS_i + \delta_3 SIZE_i + \delta_4 DIR_i \\ &+ \delta_5 BLO_i + \delta_6 INS_i + \delta_7 LEV_i + \delta_8 CR_i + \varepsilon_i\end{aligned} \tag{4.3}$$

Firm: $i = 1, 2, 3, \ldots, I$

Where $SIZE_i$ is the size of the firm, measured by the natural logarithm of the total assets for firm i[89], DIR_i is the percentage of the shares held by directors for firm i, BLO_i is the percentage of the shares held by block-holders for firm i, INS_i is the percentage of the shares held by institutions for firm i, LEV_i is the leverage ratio, measured by the ratio of total debt to total equity for firm i[90], CR_i is the current ratio, measured by the ratio of the total current assets to total liabilities for firm i[91], and ε_i is the error term.

The parameters of the models in Equations 4.2 and 4.3 were estimated using the weighted least squares (WLS) method. This method assigns more weight to the estimated exposure coefficients, and can, therefore, give more efficient estimators. When applying WLS, the explanatory variables used in the two models were transformed by a weighting factor, which is the reciprocal of the standard error of the

89 The total assets are taken at the end of 2004 financial year.

90 If it is assumed that the leverage ratio acts as a proxy for the costs of financial distress, then the relationship between leverage and exposure should be negative. This is because the bondholders may put pressure on the directors to hedge this exposure and, thus, reduce cash flow volatility (Carter et al., 2001).

91 Hedging may be value enhancing for a firm as it can reduce the costs of foregoing profitable investment opportunities due to lack of finance (Froot et al., 1993). The current ratio is included as a proxy for the availability of internal funding to finance growth opportunities available to the firm. If the firm can finance positive net present value projects internally then the benefit from hedging currency risk will be minimal (Nguyen & Faff, 2002).

exposure coefficients, estimated in Eq (4.1).[92] A further potential econometric problem is collinearity. A high correlation among the explanatory variables in the above two models may produce biased estimates of the model parameters in each case. To test for this problem, the study uses Pearson's correlation coefficients to determine the degree of correlation between the relevant variables. If the variables are highly correlated (i.e., collinearity exists), one of the two high correlated variables was omitted.

2) The effect of the use of foreign debt on foreign exchange rate exposure

It was noted in Chapter 3 that one of the motives lying behind the issue of foreign currency denominated debt ("foreign debt" hereafter for short) by firms was to hedge their foreign currency exposures (Kedia & Mozumdar, 1999, 2003). In light of this, the impact of foreign debt on the foreign exchange rate exposure of multinational U.S. corporations was investigated by Elliott et al. (2003) and Chaing & Lin (2005). Overall, these studies reported contradictory results.[93] The present study attempts to bring clarity to this issue by reinvestigating whether the use of foreign debt effectively reduces currency exposure for a sample of Australian multinational corporations. This is based on the assumption that foreign debt is used as a proxy for financial hedging to manage corporate foreign exchange rate risk in contrast to prior studies which used foreign debt as a natural hedging.[94]

[92] For a fuller explanation see Greene (1990, p. 405). This technique has been used in several other empirical studies (e.g. Pantzalis et al., 2001; Carter et al., 2003; Kim et al., 2005).
[93] One reason for the contradictory results might be differences in the measurement of the foreign debt variable, across the relevant models used.
[94] Several studies assumed that firms use foreign debt as a natural hedging which is as a part of swaps (Nguyen & Faff, 2003a; Carter et al., 2001; 2003). However, our study assumes foreign debt is a normal hedging strategy.

To examine whether the use of foreign debt is an effective hedging strategy in reducing currency exposure, the current study uses two models. The first model tests this hypothesis under the assumption that the issue of foreign debt by a firm and the degree of its foreign involvement, proxied by its foreign sales ratio, concurrently determine the exposure. The first model is described by the following cross-sectional regression:

$$|\gamma_{2i}| = \delta_0 + \delta_1 FDD_i + \delta_2 FS_i + \delta_3 SIZE_i + \varepsilon_i \quad \textbf{(4.4)}$$

Firm: i = 1, 2, 3, …, I

Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficient for firm i, FDD_i is the total foreign currency denominated debt for firm i scaled by its total long-term debt, FS_i is the total foreign sales divided by total sales for firm i, $SIZE_i$ is the size of firm i, measured by the natural logarithm of its total assets[95] and ε_i is the error term.

Following Chen and Chow (1998) the present study generates the second model by extending the first model (Eq 4.4) to control for the effects of the firm's incentives to hedge. The additional control variables are the leverage and current ratios. The second model takes the following form:

$$|\gamma_{2i}| = \delta_0 + \delta_1 FDD_i + \delta_2 FS_i + \delta_3 SIZE_i + \delta_4 CR_i + \delta_5 LEV_i + \varepsilon_i \quad \textbf{(4.5)}$$

Firm: i = 1, 2, 3, …, I

Where CR_i is the current ratio, measured by the ratio of the total current assets to total liabilities, for firm i, LEV_i is the leverage ratio, measured by the ratio of total debt to

[95] Size is included to control for the firm's prowess in constructing hedging strategies (see Booth, Smith, & Stulz, 1984; Carter et al., 2001).

total equity, for firm i and ε_i is the error term. To estimate those two models, the Weighted Least Square (WLS) regression technique is used.

3) The effect of the combined use of currency derivatives and foreign debt on exposure

In contrast to the uncoordinated use of these two financial hedging strategies, it has been noticed that firms combine foreign currency denominated debt and foreign currency derivatives, presumably in an attempt to more effectively manage their currency exposures. As noted in Chapter 3, several studies investigated the direct relationship between the combined use of these two financial hedging strategies and exposure (Elliott et al., 2003; Chaing & Lin, 2005; Nguyen & Faff, 2006). However, these researchers reported mixed results, which were perhaps due to the differing measurement bases, especially for the explanatory and control variables.

To further investigate this relationship, the present study generates two cross-sectional regression models. The first model tests the hypothesis of whether the combined use of currency derivatives and foreign debt effectively reduces currency exposure. Following Allayannis and Ofek (2001) and Jorion (1990)[96], the present study utilises the ratio of foreign sales to total sales, as a proxy for the degree of foreign operation involvement. The model also includes two variables to control for the incentive to hedge: the leverage and current ratios, and a size variable to control for hedging prowess. The first model takes the following form:

[96] Allayannis and Ofek (2001) and Jorion (1990) argued that the degree of foreign involvement was one of the most important variables in explaining cross-sectional variation in corporate exchange rate exposure.

$$|\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 FDD_i + \delta_5 LEV_i + \delta_6 CR_i + \varepsilon_i \qquad \textbf{(4.6)}$$

Firm: $i = 1, 2, 3, \ldots, I$

Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficients for firm *i*, $SIZE_i$ is the size of firm *i*, measured by the natural logarithm of its total assets, FS_i is the total foreign sales divided by total sales, for firm *i*, DER_i is the total notional amount of currency derivatives divided by total assets, for firm *i*, FDD_i is the total foreign currency denominated debt for firm *i*, scaled by its total debt, LEV_i is the leverage ratio, measured by the ratio of total debt to total equity, for firm *i*, CR_i is the current ratio, measured by the ratio of the total current assets to total liabilities for firm *i*, and ε_i is the error term.

To formulate the second model, the present study replaces the two proxies for financial hedging with an interaction variable. This interaction variable, $INTERACTION_i$, is generated by multiplying the currency derivatives variable by the foreign debt variable. This variable is expected to have a negative relationship with exposure, as the interaction between these two financial hedges is likely to reduce exposure. The second model is structured as follows:

$$|\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 INTERACTION_i + \delta_4 LEV_i + \delta_5 CR_i + \varepsilon_i \qquad \textbf{(4.7)}$$

Firm: $i = 1, 2, 3, \ldots, I$

Where $INTERACTION_i$ is the proxy for the interaction between the use of both foreign currency derivatives and foreign debt, generated by multiplying DER_i by FDD_i, for firm *i*. The above two models were estimated using the Weighted Least Square (WLS) regression technique.

4) Currency derivatives as complements to, or substitutes for, foreign debt

The published empirical studies, investigating the hypothesis of whether currency derivatives act as complements to, or substitutes for, foreign debt in reducing exposure, have produced mixed results.[97] To the knowledge of the current author, there is a dearth of published Australian studies examining this hypothesis and the current study aims to address this deficiency.

To examine the issue, the current study uses two cross-sectional regression models. Both models are designed to test the hypothesis of whether foreign currency derivatives and foreign debt are, simultaneously, complements to, or substitutes for, each other in reducing currency exposure. Both models control for the effects of the firm's incentives to hedge, and for foreign involvement. The first model, designed to test whether currency derivatives act as complements to foreign debt, is structured as follows:

$$FDD_i = \delta_0 + \delta_1 DER_i + \delta_2 FS_i + \delta_3 SIZE_i + \delta_4 DIV_i + \delta_5 LEV_i + \delta_6 CR_i + \delta_7 RD_i + \varepsilon_i \quad \textbf{(4.8)}$$

Firm: i = 1, 2, 3, …, I

The second model, designed to test whether foreign debt acts as a complement to foreign currency derivatives, is structured as follows:

$$DER_i = \delta_0 + \delta_1 FDD_i + \delta_2 FS_i + \delta_3 SIZE_i + \delta_4 DIV_i + \delta_5 LEV_i + \delta_6 CR_i + \delta_7 RD_i + \varepsilon_i \quad \textbf{(4.9)}$$

Firm: i = 1, 2, 3, …, I

[97] It was noted in Chapter 3 that the mixed results reported by these studies might be attributable to the differing control variables used, and/or measurement differences among the proxy hedging variables.

The other variables (dependent and independent) used in the two models are identified in preceding sections. Both models are estimated using the Ordinary Least Square (OLS) regression technique.

If a negative relationship exists between the use of foreign debt and currency derivatives, it would suggest that the two hedging techniques act as substitutes for each other. For example, exposure to foreign assets is normally long-term in nature and firms might prefer to hedge this exposure with instruments of similar maturities, such as foreign debt or currency swaps, rather than with shorter-term derivative instruments, such as currency options, currency futures, or forward market hedges. On the other hand, firms which are more heavily oriented towards exporting will have extensive transaction exposures, which is more suited to hedging with short-term currency derivatives rather than foreign debt or currency swaps[98].

4.3.3.3 Operational hedging models

1) The effect of the use of operational hedging on foreign exchange rate exposure

Another strategy used to manage long-term exposure to currency risk, is operational hedging. As noted in Chapter 2, operating exposure refers to the impact on a firm's future operating cash flows of unexpected changes in exchange-rates. This exposure to foreign exchange rate risk is long-term in nature and is normally managed by implementing, longer-term, operational hedging strategies (Flood & Lessard, 1986). Measuring operational hedging is a difficult task and is a priority of any research

[98] Judge (2004) suggested that his finding that foreign debt and short-term currency derivatives were substitutive for hedging purposes, to these reasons.

study designed to examine its effectiveness in reducing currency exposure. The measurement of operational hedging, adopted by Allen and Pantzalis (1996), and subsequently in other studies, is based firm's ability to construct a network of foreign subsidiary across foreign countries and geographical regions. This degree of diversification and dispersion is measured in two dimensions, *Breadth* and *Depth*, which were described in Chapter 3.

Following Allen and Pantzalis (1996), the current study examines the effect of operational hedging on the exposure by generating a cross-sectional regression model which takes the following form:

$$\begin{aligned} |\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 OPER_i + \delta_4 ROA_i \\ + \delta_5 NSGM_i + \delta_6 RD_i + \delta_7 CAPEX_i + \varepsilon_i \end{aligned} \quad \textbf{(4.10)}$$

Firm: $i = 1, 2, 3, \ldots, I$

Where $|\gamma_{2i}|$ is identified previously, $SIZE_i$ is a control variable measured by the natural logarithm of total assets for firm *i*, FS_i is a control variable measured by the ratio of foreign sales to total sales, as proxy for the foreign involvement of firm *i*, $OPER_i$ is the operational hedging factor for firm *i*, which is measured by four proxies. The four proxies are those included in both the *Breadth* and *Depth* dimensions. The first two proxies relate to *Breadth* are measured by the natural logarithms of the number of foreign countries (*NFC*) and geographical regions (*NFR*) in which firm *i*, respectively, has subsidiaries. The other two proxies relate to *Depth*, and are measured by the Hefindahl-Herdshman concentration index[99] (see Table 4.1). These

[99] Several studies have examined a firm's ability to construct a foreign subsidiaries network and its impact on changes in exchange-rates (Allen & Pantzalis, 1996; Doukas et al., 1999; Pantzalis et al., 2001).

second two proxies for geographical concentration, *HERF*1 and *HERF*2, are measured, respectively, as follows:

$$HERF1 = 1 - \left[\left(\sum_{k=1}^{K} NFS_{i,k}^{2} \right) / \left(TNFS_{i,TC} \right)^{2} \right]$$

Where $NFS_{i,k}$, is the number of foreign subsidiary(ies) of firm *i* per country *k* and $TNFS_{i,TC}$, is the total number of foreign subsidiaries of firm *i*.

$$HERF2 = 1 - \left[\left(\sum_{r=1}^{R} NRS_{i,r}^{2} \right) / \left(TNRS_{i,TR} \right)^{2} \right]$$

Where $NRS_{i,r}$, is the number of foreign subsidiary(ies) of firm *i* per region *r*; and $TNRS_{i,TR}$, is the total number of foreign subsidiaries of firm *i*.

The remaining control variables are: ROA_i is the return on assets, which is a proxy for the profitability of firm *i*, $NSGM_i$ is the number of business segments in which firm *i* operates, a measure of its industrial diversification[100], RD_i is the ratio of research and development expenditure to total assets, for firm *i*, $CAPEX_i$ is the capital expenditure to total assets for firm *i* and ε_i is the error term. To estimate the models, the Weighted Least Square (WLS) was used.

4.3.3.4 Operational and financial hedging models

1) The effect of the combined use of financial and operational hedges on exposure

The fact that operational hedges and the use of foreign debt are more suited to the hedging of longer-term currency exposures, while currency derivatives, such as forwards, futures and options, are more appropriate for hedging shorter-term

[100] The number of industrial segments variable is included to control for a firm's ability to manage its currency exposure via diversification across multiple business lines (see Pantzalis et al., 2001, p. 798).

exposures, was noted earlier in this study. In their empirical study, Allayannis et al. (2001) found that the more geographically dispersed a firm was, the more likely it was to use both operational and financial hedges.

In light of this, several studies have investigated the impact of the combined use of financial and operational hedges on currency exposure. As noted in Chapter 3, these studies were generally supportive of the use of combined hedging in reducing foreign exchange risk exposure, although there was some evidence of inconsistency in the reported results. While all of these studies investigated the effect of the combined use of currency derivatives and operational hedging on exposure, they did not include in their models a proxy for foreign debt as a financial hedging strategy. Extending the model of Allayannis et al. (2001), the present study examined the effect of the combined use of financial hedging (including both currency derivatives and foreign debt proxies) and operational hedging on corporate currency exposure. In addition, the current study extends Allayannis et al.'s (2001) model by including additional control variables.

The model generated by the current study, to examine the impact of the combined use of financial and operational hedging on foreign currency exposure is expressed as follows:

$$|\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 FDD_i + \delta_5 OPER_i + \delta_5 NSGM_i + \delta_6 RD_i + \delta_7 CAPEX_i + \varepsilon_i \qquad \textbf{(4.11)}$$

Firm: $i = 1, 2, 3, \ldots, I$

Where all the variables are as identified in preceding sections. The Weighted Least Square (WLS) method is used by transforming the explanatory variables as indicated in Section (4.3.1.1).

2) Financial hedging as a substitute for, or a complement to, operational hedging

The published research studies examining the issue of whether financial hedging and operational hedging strategies are complementary or substitutive in the management of corporate foreign exchange rate exposure, were reviewed in Chapter 3 (Section 3.4.2). Most of the studies reported that the two hedging strategies acted in a complementary capacity. Chowdhry and Howe (1999) who argued that using only financial hedges cannot effectively manage the exposure, and suggested that, operational hedges as a long-term strategy are the most effective way to manage long-run operating exposure. However, Lim and Wang (2001, 2007), based on a 'stakeholder' rather than a shareholder perspective, argued that shareholders could diversify firm specific, or idiosyncratic, risk by investing in portfolios of firms, while employees, suppliers and other stakeholders could not do this. They explained their results[101] in terms of financial hedges being effective in reducing the common, or systematic, element of currency risk, while operational hedging (geographic diversification of operations) was used to manage the idiosyncratic, or firm-specific, element of currency risk. Following the procedure of Allayannis et al. (2001), the present study re-examines the issue of whether the two hedging strategies are complementary or substitutive, in the case of Australian multinational firms. The study expands the model of Allayannis et al. (2001) by adding hedging incentive control variables which represent the effects of a firm's investment growth opportunities.

[101] Lim and Wang (2006) reported that financial hedges, more often than not, acted as complements to, rather than substitutes for operational hedges, in reducing corporate currency exposure.

The current study generates two separate models to test the complementary/substitutive issue. The first model is designed to test the hypothesis of whether the use of foreign currency derivatives is a complement to, or a substitute for, the use of operational hedging, in reducing currency exposure. This approach, which is different from the approaches used by previous studies[102], regresses the financial hedging variable using a continuous variable (especially to measure the use of foreign currency derivatives as a proxy for financial hedging) on the operational hedging variable plus the control variables. The financial hedging variable is measured in continuous format and is intended as a proxy for the use of foreign currency derivatives. The first model is formulated as follows:

$$\begin{aligned} DER_i &= \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 FDD_i + \delta_4 OPER_i \\ &+ \delta_5 NSGM_i + \delta_6 RD_i + \delta_7 CAPEX_i + \varepsilon_i \end{aligned} \quad \textbf{(4.12)}$$

Firm: i = 1, 2, 3, …, I

Where all variables were identified previously.

The second model is designed to test the hypothesis whether the use of foreign debt is a complement to, or a substitute for, operational hedging, and is structured as follows:

$$\begin{aligned} FDD_i &= \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 OPER_i \\ &+ \delta_5 NSGM_i + \delta_6 RD_i + \delta_7 CAPEX_i + \varepsilon_i \end{aligned} \quad \textbf{(4.13)}$$

Firm: i = 1, 2, 3, …, I

Where, again, all the variables are as identified previously. Both models above are estimated using the Ordinary Least Square (OLS) regression method.

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[102] In contrast to prior studies, which have not included the proxy for the use of foreign debt in their model, when testing the relationship between currency derivatives and operational hedging, the present study enclosed the proxy for the use of foreign debt along with operational hedging proxies to testing their effects on the use of currency derivatives.

4.4 CONCLUSION

In this chapter the data employed in the thesis has been described. Also, the models designed and methods used to test the eight hypotheses relating to the effect of the use of financial and operational hedges on foreign exchange rate exposure, have been presented. In addition, the sample selection procedure and the sources of data for the different types of data used have been discussed. After applying the selection criteria, 62 Australian multinational corporations were identified as being involved in using both operational and financial hedging strategies.

A two-stage market model has been implemented to test all the possible hypotheses identified previously. The first-stage model was used to test the first hypothesis of whether there is a relationship between changes in exchange rates and a firm's stock market returns. This two-factor asset pricing model regressed the excess returns on the firm's stock on the excess returns of the exchange-rate index and the share market index. The model was used to estimate the foreign exchange rate exposure coefficients (over the period from 2000 to 2004), the absolute values of which were used as the dependent variables in the second-stage model. To obtain the best linear unbiased estimators (BLUE) of the parameters of the first-stage model, the following econometric problems relating to time series regressions, were tested for and alleviated: stationarity, auto-correlation, heteroskedasticity, conditional heteroskedasticity, and collinearity. By alleviating these problems, it is believed that the model was more effective in testing the hypotheses.

The second-stage model was used to test the other seven hypotheses identified previously, which are related to the effect of the use of financial and operational hedges on the exposure coefficients estimated in the first stage model. The models used to test these hypotheses were estimated for the 2004 financial year. The second four hypotheses were related to the effect of the use of financial hedges (currency derivatives and foreign debt) on the absolute value of the exposure coefficients. The sixth hypothesis was related to the effect of the use of operational hedges on exposure. The last two hypotheses were related to the effect of financial and operational hedges on exposure, and whether these two hedges strategies are substitutes for, or complements to each other in this regard. Both the OLS and WLS regression techniques were used to estimate these models.

Therefore, the present study has attempted to produce efficient models to test the relationship between the use of financial and operational hedges and exposure. In the next chapter, the results and the data analysis of the study will be presented.

CHAPTER FIVE

DATA ANALYSIS AND RESULTS

5.0 STRUCTURE OF CHAPTER FIVE

This Chapter presents the results and the data analysis of this study. For each stage of the two-stage market model, the data analysis and results are reported in terms of both univariate and multiple regression analyses. Appendices, from 5.1 to 5.5, attached to the end of the thesis report the results of the econometrics problems relating to the first-stage model data analysis and the distribution of the Australian foreign subsidiaries.

5.1 INTRODUCTION

After developing the research hypotheses and designing the models in Chapter 4 of the study, the purpose of Chapter 5 is to report results of the data analysis relating to the eight hypotheses used to test the relationship between the use of financial and operational hedges and the exposure. For each stage of the two-stage market model, the data analysis is reported in two forms: 1) univariate analysis and 2) multiple regression analysis. The univariate consists of: a) summary descriptive statistics, and b) Pearson correlation coefficients matrix. The univariate analysis was used to provide summary statistics and to test the relationship between the variables used in modelling the research hypotheses. The multiple regression analysis reports the estimated parameters of the cross-sectional regression models and their statistical tests.

5.2 THE EMPIRICAL RESULTS OF THE FIRST-STAGE MODEL

As noted in Chapter 4, a two-factor linear regression model (Jorion's (1991) model) was implemented to test the first hypothesis of whether the firm's stock returns are sensitive to changes in foreign exchange rates (see Eq 4.1, Chapter 4). This model regresses the firm's stock excess returns on both the component of trade-weighted index (TWI) value excess relative to the AUD in month *t*, orthogonal[103] to the market at month *t*, and the excess returns of the share market index (AOI). The rate of changes in TWI was measured in foreign currency per one unit of AUD. This sensitivity was represented by the estimated foreign exchange rate index coefficient, which was tested for significance using two-tailed *t* test statistics. After estimating the model using the OLS method, it was found that there is evidence that the stock returns are sensitive to changes in the trade-weighted index of the AUD for a sample of 62 Australian multinational firms during the period from January 2000 to December 2004. But, this evidence is weak as 8.06% of these firms exhibit significant exposure coefficients.

Table 5.1 reports the summary statistics of estimated exposure coefficients, γ_{2i}, for all the sampled firms. The mean (median) exposure coefficients of the full sample firms is 0.0822 (0.0895) with the range of coefficients falling between -1.688 and 1.4306.

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[103] This orthogonal case means that the market returns are a function of the returns from the AUD trade-weighted index. Thus, the residuals resulted from estimating this model are saved and taken as the foreign exchange risk factor "R_{FXt}" (see Jorion, 1991; Loudon, 1993b; Hagelin & Pramborg, 2004).

The results reported by the present study are similar to the exposure coefficients obtained by Loudon (1993a) and Jorion (1990). The sign of the mean (median) is consistent with Loudon who found that the mean (median) exposure coefficient is 0.028 (-0.061) for 23 Australian multinational firms. Loudon's mean exposure equals 0.028, which is less than the mean exposure reported by the present study 0.0822. Although the range of coefficients of the current study is wider 3.12, Loudon's distribution was more dense around the centre, i.e., the range of observations was at 2.32. This positive mean exposure suggests that an appreciation in the value of AUD is more likely to be associated with the firm's stock returns. However, the results of the current study have a different sign from Jorion (1990) who found that the mean (median) exposure of the 287 U.S. non-oil multinational firms is -0.078 (0.06). Jorion's findings indicate that stock returns are negatively related to changes in exchange rates as appreciation of the U.S. dollar would reduce the firm's stock returns. However, the results of the present study indicate that, on average, stock returns are associated with an appreciation of the AUD for Australian multinational firms.

After reporting the results of the distribution of exposure coefficients, it is also essential to study how many of these exposures are significantly different from zero. In fact, Table 5.1 reveals the distribution of the exposure coefficients for the full sample of firms, which are significantly different from zero at the 0.05 level of confidence. The current study finds that 5 firms out of 62 Australian multinational firms, approximately 0.0806 (i.e., 8.06%) of the full sample, are significantly different from zero. This finding indicates that there is weak evidence that a firm's stock return is sensitive to changes in the exchange rate. This result is consistent with

Loudon (1993a) and Jorion (1990) who found 0.064 and 0.052 of their firms, respectively, have significant exposure coefficients. The current study reports that only 1 out of 5 significant exposure coefficients has a negative sign. However, 4 out of 5 significant exposure coefficients have a significant positive sign. Therefore, these positive and negative sign coefficients conform to the view that the stock returns of Australian multinational corporations are positively and negatively sensitive to changes in exchange rates.

Table 5.1

The TWI Exposure Coefficients (γ_{2i}) (Summary Statistics)

	Our Sample Australian Multinational Firms	**Loudon (1993a) Australian Multinational Firms**	**Jorion (1990) U.S. Non-oil Multinational Firms**
I = firms	**62**	**23**	**287**
Mean (t-statistics)	0.0822 (1.039)	0.028 (0.430)	-0.078*** (-3.74)
Standard Deviation	0.6224	0.312	0.353
Minimum	-1.688	-0.487	-1.94
First Quartile	-0.3358	-0.220	-0.25
Median	0.0895	-0.061	0.06
Third Quartile	0.4272	0.305	0.13
Maximum	1.4306	0.641	1.17
No. of Positive cases	35	1	N.A.
No. of Sig. (+ ve) cases	4	1	N.A.
No. of Negative cases	27	22	N.A.
No. of Sig. (- ve) cases	1	0	N.A.
% of Sig. cases	0.0806	0.043	0.052
Adjusted R^2	0.18	0.38	N.A.
D-W	2.039	N.A.	N.A.

The model used to compute the exposure coefficients, γ_{2i}, is as follows: $R_{it} = \delta_{0i} + \beta_{1i}R_{Mt} + \gamma_{2i}R_{FXt} + \varepsilon_i$. Where R_{it} is the monthly excess returns of firm i's common stocks, R_{Mt} is the monthly excess return on the ASX accumulated All Ordinary Index in month t, R_{FXt} is the monthly excess return on the exchange rate Trade-Weighted Index (TWI) value of AUD in month t, ε_{it} is the disturbance term, normally, and independently distributed with mean zero and constant variance. In addition, all these variables are calculated on a nominal continuously compounded basis as explained in Chapter 4. The parameters of this model were estimated using the Ordinary Least Square (OLS) for a sample of 62 Australian multinational firms for a period from January 2000 to December 2004. Note: the levels of significance (1%, 5%, and 10%) are: ***, **, and *, respectively.

While the results show how many coefficients are reliably different from zero, it is obvious that there is a need to discuss the results after adjusting for the main econometric problems, which may create bias estimates to the exposure coefficients. As a first step, to test for nonstationarity, the Dickey-Fuller (1979) (DF) unit root was used. In order to apply the DF test on each variable used in Eq 4.1, the present study runs the following auxiliary models:

1) Regression without intercept: $\Delta Y_t = \delta_1 y_{t-1} + \nu_t$ **(1)**

2) Regression with intercept: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \nu_t$ **(2)**

3) Regression with intercept and trend: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \delta_2 t + \nu_t$ **(3)**

Where ΔY_t is the first difference of the original observations of excess returns of firm's stocks or excess returns of AOI or rate of changes of TWI, y_{t-1} is the first lagged period taken from one of these time series variables, t is the time trend, δ_0, δ_1, and δ_2 are the coefficients of the intercept, the first lag variable, and the trend, respectively. These coefficients were statistically tested, for the three time series variables used in Eq 4.1, with the following three groups of null hypotheses:

For model (1), the following null hypothesis was tested using the unit root τ test statistic.[104]

H$_0$: $\delta_1 = 0$, nonstationarity exists.

For model (2), the following two null hypotheses were tested using τ_μ and ϕ_1 statistics, respectively.[105]

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[104] The observed values of τ-statistic are obtained by dividing the value of the estimated coefficient, e.g., δ_1, by its standard error.

H_0: $\delta_1 = 0$, nonstationarity exists.

H_0: $\delta_0 = \delta_1 = 0$, nonstationarity exists.

For model (3), the following null hypotheses were tested using τ_τ, ϕ_2, and ϕ_3 statistics, respectively.

H_0: $\delta_1 = 0$, nonstationarity exists.

H_0: $\delta_1 = \delta_2 = 0$, nonstationarity exists.

H_0: $\delta_0 = \delta_1 = \delta_2 = 0$, nonstationarity exists.

In light of testing these hypotheses, it was found that 31 cases out of 62 firms and the two indices (TWI and AOI) exhibited non-stationarity as both the null and the joint null hypotheses were accepted, at the 0.10 level of confidence. This is because the observed values of τ, τ_μ, τ_τ, ϕ_1, ϕ_2, and ϕ_3 (in its absolute term) were less than their critical values (see Appendix 5.1, for the reported results). Therefore, this indicates that nonstationarity exists.

Based on the existence of these nonstationarity cases, the Augmented Dickey-Fuller (ADF) was used to eliminate nonstationarity by including four new explanatory variables in the auxiliary models stated above (Eqs 1, 2, and 3). These four new explanatory variables were extracted from four lags of the dependent variable, ΔY_t, (the first difference of the original observations). Therefore, the study estimates the following new three auxiliary models to test for stationarity. These models are as follows:

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[105] ϕ_1-statistics is a test developed by Dickey and Fuller. The critical values of this test can be found in any time series analysis book.

1) Regression without intercept: $\Delta Y_t = \delta_1 y_{t-1} + \sum_{j=1}^{4} \beta_j \Delta Y_{t-j} + \nu_t$ **(1)'**

2) Regression with intercept: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \sum_{j=1}^{4} \beta_j \Delta Y_{t-j} + \nu_t$ **(2)'**

3) Regression with intercept and trend: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \sum_{j=1}^{4} \beta_j \Delta Y_{t-j} + \delta_2 t + \nu_t$ **(3)'**

Where all the variables were identified and defined previously.

The three groups of null hypotheses stated previously were also applied to test whether the estimated coefficients, δ_0, δ_1 and δ_2, of the models (1', 2', and 3') show nonstationarity. These models were applied for the three time series variables used in Eq 4.1. After including these four lags, the study finds that the coefficients of these new models were statistically significant. This indicates that the 31 firms' stock returns and the return from both the exchange rate index and the share market index exhibited stationarity as all the null hypotheses were rejected at the 0.10 level of confidence (see Appendix 5.1, for all the reported results). Therefore, after applying the ADF with four lags, stationarity now exists.

To avoid the collinearity problem, which may arise among the independent variables, the Pearson correlation coefficients were used to test the degree of correlation between the two explanatory variables indicated in Eq. (4.1). It was found that the correlation coefficient, *r*, between the excess returns of the share market index and the excess returns of the foreign exchange rate index equals 0.204. Next, these correlation coefficients were tested using a two-tailed t-statistics test to determine whether they were different from zero as follows:

$H_0 : r = 0$, no collinearity exists

After applying this test, it was found that the observed value of the t-statistic of the correlation coefficient, *r*, between these two explanatory variables, was 1.616. This observed value was less than the critical value (t = 2.020, obtained from *t* table at a 0.05 level of confidence). This means that the null hypothesis was accepted as, *r*, was not statistically different from zero. That is, no collinearity exists between the two independent variables used in the two-factor regression model. Therefore, including these two explanatory variables in the model would have no critical effect in obtaining the Best Linear Unbiased Estimators (BLUE).

In order to test for serial correlation, the Durbin-Watson (D-W) (1950) and the Maximum Likelihood Estimates (MLE) techniques were used to test the error of model Eq 4.1. To test for the first order autoregressive AR(1) scheme, D-W was used. An auxiliary model was generated as follows:

$$\varepsilon_{it} = \rho_1 \varepsilon_{it-1} + \nu_{it} \qquad \textbf{(4)}$$

Where ε_{it} is the estimated error from Eq 4.1, ρ_1 is the autocorrelation coefficient of the first lag from the estimated error (ε_{it-1}), ν_{it} is the error of this auxiliary model, which is assumed to be normally distributed. Therefore, to test for autocorrelation, ρ_1 is statistically tested using *d* test statistics with the following null hypothesis:

$H_0 : \rho_1 = 0$, no autocorrelation exists

The study finds that 6 out of the 62 firms have negative and positive serial correlation problems - AR(1) scheme. These 6 cases were associated with rejecting the null hypothesis at the 0.05 level of confidence. If the observed value of D-W test (*d*-statistic) is close to 2, there will be no autocorrelation. It was found that 3 of these 6 cases exhibited negative autocorrelation with observed values of *d*-statistic equal to 2.539, 2.660 and 2.570, respectively. These observed values of testing, ρ_1, were compared with the critical value of *d* obtained from the D-W table with a 0.05 level of confidence, 62 observations, and a model with 3 explanatory variables. The critical values of *d* in lower (upper) bounds were 1.503 (1.696). Therefore, all of these negative autocorrelation cases had an observed *d* with a value more than the upper bound of critical value d = 1.696, which means that autocorrelation exists. However, the other three cases exhibited positive AR(1) situations. The observed values of *d* were: 1.316, 1.418, and 1.451, respectively. The critical values of *d* in lower upper (bounds) were: 1.567 (1.629) at the 0.05 level. Therefore, all of these positive autocorrelation cases had less observed values of *d* than the lower bound of the critical value of d = 1.567, which means that autocorrelation exists. Therefore, the existence of serial correlation within these cases is more likely to produce bias in the estimated parameters of the model.

To eliminate this bias in these estimated parameters, the regressions were re-estimated (transformed) using the Cochrane Orrcut (1949) iterative procedure for the first order autocorrelation in each of these 6 cases. This procedure attempts to transform the original model (see Table 5.1) by including the first order AR(1) error process. The average D-W value for our full sample firms is 2.039 (all of these values were close to d = 2). This indicates that no AR (1) exists.

A diagnostic test was conducted using the Maximum Likelihood Estimates (MLE) to test for serial correlation (AR(8) of the estimated error terms) by implementing Ljung-Box Q-statistics for up to eight lags. This Q-statistic test follows a chi-square distribution. The auxiliary model is as follows:

$$\varepsilon_{it} = \rho_1 \varepsilon_{it-1} + \rho_2 \varepsilon_{it-2} + \rho_3 \varepsilon_{it-3} + \ldots + \rho_8 \varepsilon_{it-8} + \nu_{it} \qquad \textbf{(5)}$$

With all variables identified previously, it is assumed that ν_{it} is normally distributed. After estimating this model, these autocorrelation coefficients, $\rho_1, \rho_2, \rho_3, \ldots, \rho_8$, were statistically tested using Q-statistics test with the null hypothesis as follows:

H_0: $\rho_1 = \rho_2 = \rho_3 =, \ldots, = \rho_8 = 0$, no autocorrelation exists.

This study finds that there was an increase in the number of serially correlated cases to 10 cases (i.e., approximately 0.16) of the total sample. These 10 cases had an observed value of Q-statistic for the joint test of these autocorrelation coefficients where more than the critical value of $\chi^2_{8(\text{d.f.}),\ 0.05\ (\text{confidence level})} = 15.51$. This means that the null hypothesis for these 10 cases was rejected, signaling that serial correlation exists. Therefore, the existence of serial correlation within these cases is more likely to produce bias in the estimated parameters of the model (Eq 4.1).

To eliminate this serial correlation, the Generalised Least Squares (GLS) method was implemented. This method suggests including several lagged periods of the dependent variable as independent variables in the model.[106] Thus, the present study transforms the original model, Eq 4.1, to a new version model by adding a maximum of six lagged periods of the dependent variable (stock excess returns) as independent variables. Therefore, the new model is as follows:

$$R_{it}^{*} = \beta_{0i} + \beta_{1i} R_{Mt}^{*} + \gamma_{2i} R_{FXt}^{*} + \theta_{3i} R_{it-1}^{*} + \theta_{4i} R_{it-2}^{*} + \ldots + \theta_{8i} R_{it-6}^{*} + \eta_{it} \qquad \textbf{(6)}$$

Where all of the variables were defined previously in this section and $R^{*}_{it\text{-}1}$ is the first lag period of the dependent variable, R^{*}_{it}. The error term of this model is assumed to be normally distributed with no serial correlation and with no multi-collinearity. After applying the MLE method again to test the error term of this model, η_{it}, for serial correlation for up to AR(8), the current study finds that the autocorrelation cases disappeared. This is because the observed values of Q-statistics for all of these 10 firms were less than the critical value of $\chi^{2}_{8,\ 0.05}$ = 15.51. Hence, the joint null hypothesis was accepted as no autocorrelation exists (see Appendix 5.2).

To conclude, use of both correction procedures (Cocharne Orcutt and GLS) reveals that the number of serially correlated cases is diminished, while there is no increase in the number of significant exposure coefficients cases.

The other econometric problem, which may be encountered in modelling time series data, is heteroskedasticity. This problem results from the violation of one of the CLRM (Classical Linear Regression Model) assumptions that the variance of the

[106] The procedure of including some lagged periods of the dependent variable and using them as explanatory variables is an appropriate popular econometric technique to eliminate the main econometric problems indicated previously. It is known as the Autoregressive Moving Average (ARMA) (Enders, 2004, p.51).

error term was no longer constant, so the parameters estimated using the OLS will not give the Best Linear Unbiased Estimators accurately. This is because OLS, through its estimation schemes, assigns equal "weights" to all the observations used even though these observations may come, sometimes, from populations with greater or smaller variability. To solve this equal weighting problem in such a manner that the observation must be weighted in terms of their size variability, the WLS, as proposed by White's (1980) general heteroskedasticity test, was used as it does not rely on normality assumptions.

To test for heteroskedasticity, the White's general test was applied for each firm by undertaking an auxiliary regression, which regresses the squared residuals (taken from the original model Eq 4.1) against all the explanatory variables used, in Eq 4.1, with an intercept term as follows:

$$\varepsilon_{it}^{2} = \alpha_0 + \alpha_1 R_{Mt}^{*} + \alpha_2 R_{FXt}^{*} + \alpha_3 R_{Mt}^{*2} + \alpha_4 R_{FXt}^{*2} + \alpha_5 R_{Mt}^{*} \times R_{FXt}^{*} + \eta_{it} \qquad \textbf{(7)}$$

Where all the variables were identified previously. The following joint null hypothesis was tested:

H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$, no heteroskedasticity exists.

Under this hypothesis, White's test showed that the R^2 (coefficient of determination) value obtained from this regression times the sample size (n = 60), follows asymptotically the chi-square χ^2 distribution, with degrees of freedom (d.f.) equal to 5 ($n \times R^2 \sim {}_{asy}\chi^2_{\text{df, level of confidence}}$). After computing the Lagrange Multiplier (LM)

($n \times R^2$), it was found that 7 firms were subject to heteroskedasticity problems as the observed values of LM were more than the value of chi-square χ^2 with 5 (d.f.) and a 0.05 level of confidence (see Appendex 5.3 for results). Therefore, the null hypothesis was rejected so heteroskedasticity is likely to exist.

To correct the standard errors of the exposure coefficients against heteroskedasticity, the White's heteroskedasticity-corrected consistent estimators of the standard error test was used. This test relies on an estimation of the variance and covariance of the least square coefficient estimators even if heteroskedasticity exists.[107] Then, after this correction, the same procedure of ML was applied again to test for heteroskedasticity. It was shown that the 7 heteroskedasticity cases were diminished, indicating no heteroskedasticity exists (see Appendix 5.3 for results). Therefore, although the heteroskedasticity cases have been eliminated, the number of significant exposure coefficients of the original model has not increased.

Apart from heteroskedasticity, the other econometric problem especially associated with financial time series data is conditional heteroskedasticity. For example, stock or bond returns tend to be conditionally heteroskedastic. The prices exhibit non-constant volatility, but periods of low or high volatility, are generally not known in advance. To test for Conditional Heteroskedasticity, the Autoregressive Conditional Heteroskedastic (ARCH) model, as proposed by Engle (1982), was used. An auxiliary model (ARCH (1)) was generated, which regresses the variance of the residuals of the original model, Eq 4.1, against one lagged period of the squared

[107] Although this test is normally used for testing the heteroskedasticity of the cross-sectional data and for the large samples, this study finds it to be an appropriate test to correct for heterosekdasticity in modelling time series data.

residuals, ε^2_{it-1}, with intercept term, assuming that the error term of this auxiliary model is normally distributed as follows:

$$\sigma_{it}^2 = \alpha_0 + \alpha_1 \varepsilon_{it-1}^2 + \mu_{it} \qquad \textbf{(8)}$$

After estimating this auxiliary model, the Lagrange Multiplier (LM), $n \times R^2$ was computed for this model, which follows a chi-square χ^2 distribution, to test for conditional heterskedasticity. Therefore, the null hypothesis is as follows:

H_0: $\alpha_1 = 0$, no conditional heteroskedasticity exists.

It was found that 4 firms were conditionally heteroskedastic where the observed value of LM was more than the critical value of χ^2 (1 d.f. and 0.05 level of significance). Therefore, this hypothesis of no conditional heteroskedasticity was rejected.

In relation to the existence of conditional heteroskedasticity even after testing the null hypothesis of the coefficients of ARCH model, the Generalized Autoregressive Conditional Heteroskedastic (GARCH) model, as proposed by Bollerslev (1986), was used. Following GARCH, as a new version of the ARCH model, the study derives an auxiliary model using GARCH (1, 2) to test for conditional Heteroskedasticity. The auxiliary model regresses the error variance against both one lag period of the squared estimated errors and two lagged periods of the estimated error variance, with a normally distributed error term as follows:

$$h_t^2 = \alpha_0 + \alpha_1 \varepsilon_{it-1}^2 + \alpha_2^{'} h_{it-1}^2 + \alpha_3^{'} h_{it-2}^2 + \mu_{it} \qquad \textbf{(9)}$$

Where α_1 is the coefficient of the first lagged period of the squared residuals, $\acute{\alpha}_2$ is the coefficient of the first lagged period of the error variance, $\acute{\alpha}_3$ is the coefficient of the second lagged period of the error variance. After the application of this model, the following null hypothesis of the auxiliary was tested as GARCH follows the chi-square χ^2 distribution:

H_0: $\alpha_1 = \acute{\alpha}_1 = \acute{\alpha}_2 = 0$, no conditional heteroskedasticity exists.

After estimating this model, the Lagrange Multiplier (LM) $n \times R^2$, which symbolically follows the chi-square χ^2 distribution, was computed. The LM value was less than the critical value of $\chi^2_{3,\ 0.05}$, indicating that no conditional heteroskedasticity exists. It was noticed that the 4 conditional heteroskedasticity cases were diminished, while the number of significant cases of exposure coefficients did not rise (see Appendix 5.3 for reported results before and after using the GARCH model). Although the study tries to correct against heterosekdasticity and conditional heterosekdasticity, no extra significant foreign exchange rate exposure coefficients were obtained.

To conclude, after all of these attempts to transform the model in order to deal with these econometric problems, no extra significant foreign exchange rate exposure coefficients were obtained. The number of significant and insignificant exposure coefficients remains the same (8.06%). This level of significant coefficient cases indicates that there is weak, but significant evidence of the sensitivity of stock returns to changes in the foreign exchange rate. All of these econometric techniques used previously were to correct for the main problems encountering with analysis of time series data. This correction or transformation of the model was implemented in order to report, as accurately as possible, the best linear unbiased estimators to foreign exchange rate exposure coefficients.

5.3 THE EMPIRICAL RESULTS OF THE SECOND-STAGE MODEL

After estimating the foreign exchange rate exposure coefficients, a cross-sectional regression procedure was used to test whether the use of financial and operational hedges has an impact on the foreign exchange risk exposure. The absolute value of the exposure coefficients was regressed against proxies for using both financial and operational hedging variables together with a set of control variables. Implementation of this absolute value was related to the fact that, for positive exposures, the use of a hedging program actually increases the level of foreign exchange rate exposure. However, a positive relationship in the context of negative exposures means that the use of hedging programs reduces such risk. To eliminate this ‘sign confusion effect’, the absolute value of the estimated foreign currency exposure coefficients was used instead of the raw values of the exposure coefficients.

5.3.1 The Effect of The Use of Financial Hedging on The Exposure

5.3.1.1 Univariate Analysis

a) Summary statistics of financial hedging variables

Table 5.2 provides summary descriptive statistics for the financial hedging variables included in the cross-sectional regression models for the sample of 62 Australian multinational corporations for the 2004 financial year. The Table shows the mean, standard deviation, first quartile, median, third quartile, maximum, and minimum, for all the variables used in the financial hedging models. Since the use of currency derivatives can be used as a financial hedging strategy, it is essential to report the mean of the ratio of the total notional amount of currency derivatives to total assets (*DER*) for all the 62 firms, which is 0.114.[108] In addition, the mean of the proportion of foreign-currency denominated debt to total debt is 0.343. Taken together, these results suggest that sample firms rely heavily on foreign currency derivatives instruments and foreign debt to manage exposure to exchange rates.

The ratio of foreign sales to total sales is an important factor to be explained as it is one of the determinants of exposure. This ratio is a proxy for foreign involvement strategies, which would increase exposure (Jorion, 1990). The mean of the ratio of total foreign sales to total sales (*FS*) for the present study full sample firms is 0.48. This result is somewhat consistent with Nguyen and Faff (2006) who found the mean of foreign sales ratio to total sales is approximately 0.40 for their sample of 144 Australian firms in 1999. This indicates that Australian multinational firms have a strong foreign sales proportion of the total sales, which may entice them to hedge foreign currency exposure.

Relative to the firm's incentives to hedge variables, the mean of the total assets is AUD $4,115 million with the mean of firm size (*SIZE*) measured by the natural logarithm of total assets, is 8.32. The mean of leverage ratio (*LEV*) for all sampled

[108] The total value of currency derivatives was computed as the total value of forward contracts, futures and options for each firm. The present study does not include currency swaps in the collective measure of derivatives for the reason that it is not a popular instrument and is mostly used in association with foreign debt.

firms is 0.56. This indicates that firms with high debt in their capital structure are more likely to be engaged in financial hedging activities to eliminate costs of financial distress. The mean of the current ratio (*CR*) is 1.72 for the sample firms. As the mean of this ratio is more than 1, this indicates that Australian multinational corporations have high liquidity. Finally, the mean of the ratio of research and development to total assets (*RD*) is 0.01.

Table 5.2

Summary Statistics of Financial Hedging Variables For The 2004 Financial Year

I = 62 firms	Mean	STD	Q1	Median	Q3	Minimum	Maximum
T. Assets ($M)	4,115	9,359	257.2	992.6	4,153.3	39.0	58,088.3
SIZE	8.32	9.14	5.55	6.90	8.33	3.66	10.97
T. Sales ($M)	3,136	6,290.3	250.2	1,035.8	3,298.9	5.3	32,266.8
FS	0.480	0.726	0.153	0.265	0.714	0.116	0.664
DER	0.114	0.172	0.013	0.056	0.144	0.002	0.299
FDD	0.343	0.241	0.164	0.253	0.513	0.065	0.908
DIR	0.016	0.024	0	0.008	0.022	0	0.124
BLO	0.436	0.180	0.324	0.449	0.537	0.054	0.997
INS	0.212	0.091	0.149	0.194	0.261	0.001	0.460
DIV	0.215	0.250	0.045	0.14	0.32	-0.351	1.050
LEV	0.548	0.485	0.310	0.437	0.660	0	3.162
CR	1.722	1.052	1.131	1.411	1.966	0.624	7.745
RD	0.013	0.033	0.0003	0.002	0.007	0	0.185

Since the firm's ownership structure might have an effect on the desirability of hedging, the variables of ownership structure were included in the model to test this effect. The current study reports that the mean of the percentage of shares held by directors and management (*DIR*) is 0.016 of the total capital investment of the sampled firms. This study also finds that the mean of the block-holders ownership proportion of the shares (*BLO*) outstanding is 0.436. The institutional ownership percentage of shares outstanding (*INS*) has a mean equals to 0.212. Therefore, it is very clear that block-holders and institutions own substantial amount of shares of the

Australian multinational firms, which may allow them to influence the decision of implementing hedging strategies by management.

b) The correlation coefficient matrix of the financial hedging variables

Table 5.3 shows a Pearson correlation coefficients matrix for financial hedging variables in this study. It reveals the correlation coefficients among the variables used in the models to test the research hypotheses that the use of financial hedges effectively reduces exposure. This matrix was generated to provide a preliminary view of the nature of the relationships among financial hedging variables and between these variables and the exposure coefficients. The nature of the correlation coefficients reported in this matrix is discussed to confirm the predictions of finance theory. In addition, the other aim of generating this matrix is to identify the significant correlations among variables, which may indicate if multi-collinearity exists.

The sign of correlations coefficients between the financial hedging variables and the exposure coefficients is an important finding of this section. Table 5.3 shows that the proxy for the use of currency derivatives (*DER*) is negatively related to the exposure to foreign currency risk. This indicates that the use of currency derivatives is more likely to reduce exposure. The negative sign between the proxy for the use of foreign-currency denominated debt (*FDD*) and exposure would indicate that this proxy is an effective in hedging strategy. However, the Table reports that these two proxies for financial hedging strategies are significantly negatively correlated to each other. This evidence supports the argument that these two financial hedging strategies are more likely to be substitutive for each other in reducing the exposure.

Table 5.3

The Pearson Correlation Coefficients Matrix For the Financial Variables used

	SIZE	FS	DER	FDD	LEV	CR	DIR	BLO	INS	RD	$\|\gamma_{2i}\|$
SIZE	1										
FS t-statistic	0.013 (0.10)	1									
DER	-0.16 (-1.22)	-0.02 (-0.18)	1								
FDD	0.17 (1.32)	-0.14 (-1.07)	-0.25[(b)] (-2.1)	1							
LEV	0.25[(b)] (2.0)	-0.040 (-0.31)	-0.09 (-0.71)	0.29[(a)] (2.37)	1						
CR	-0.22[(c)] (-1.78)	-0.004 (-0.03)	-0.11 (-0.80)	-0.17 (-1.30)	-0.33[(a)] (-2.74)	1					
DIR	-0.43[(a)] (-3.71)	-0.11 (-0.81)	0.025 (0.20)	-0.001 (-0.01)	-0.146 (-1.14)	0.04 (0.31)	1				
BLO	0.1269 (0.99)	-0.002 (-0.02)	0.20 (1.58)	-0.123 (-0.96)	0.032 (0.25)	-0.24[(b)] (-1.92)	-0.26[(b)] (-2.1)	1			
INS	-0.136 (-1.1)	0.06 (0.454)	-0.155 (-1.219)	0.0252 (0.20)	-0.018 (-0.139)	0.08 (0.56)	0.13 (1.01)	-0.53[(a)] (-4.8)	1		
RD	-0.31[(a)] (-2.52)	0.047 (0.364)	0.50[(a)] (4.36)	-0.22[(c)] (-1.75)	-0.090 (-0.702)	-0.048 (-0.38)	-0.012 (-0.1)	-0.012 (-0.091)	-0.04 (-0.33)	1	
$\|\gamma_{2i}\|$	-0.30[(a)] (-2.4)	0.05 (0.36)	-0.07 (-0.53)	-0.035 (-0.27)	-0.024 (-0.181)	0.015 (0.12)	0.18 (1.52)	-0.152 (-1.191)	0.0657 (0.51)	-0.03 (-0.3)	1

Note: the levels of significance (1%, 5%, 10%) are: (a), (b), and (c), respectively. A two-tailed *t*-statistic is used to test the correlation coefficients (*r*). The *t* is computed as follows $t = (r\sqrt{I-2})/(\sqrt{1-r^2})$, where (I) is the number of observations (62 firms).

The proxy for foreign involvement (*FS*), measured by the ratio of foreign sales to total sales, is positively correlated with exposure. This indicates that firms involved with a large proportion of foreign sales are more likely to encounter higher foreign exchange rate exposure. Also, it is shown that the size of the firm (*SIZE*) is negatively correlated with exposure. Large firms are more likely to have lower exposure as they may be engaged in hedging programs when compared with small firms. This confirms that large firms with greater financial and human resources are more likely to engage in hedging programs, which reduce both their costs of financial distress and foreign exchange rate exposure.

In addition to firm size, the other hedging incentive variables used in the models are the leverage ratio (*LEV*) and the current ratio (*CR*). The leverage ratio is measured by the firm's total debt to its total equity, as a proxy for financial distress. Table 5.3 reports that *LEV* is negatively related to the exposure, indicating that firms with high debt in their capital structure are more likely to have a lower risk exposure. This is because these firms have the incentive to use foreign currency derivatives, which are expected to reduce exposure throughout reducing the costs of financial distress (e.g., Stulz, 1984; Simth & Stulz, 1985; Geczy et al., 1997). However, the current ratio, as a proxy for liquidity, is found to be positively associated with exposure. Firms with high levels of liquidity may lessen pressure on the firm to use derivatives to smooth earnings and therefore increase the exposure. Therefore, a higher level of liquidity should be associated with a higher level of exposure in absolute terms, which contradicts Froot et al.'s (1993) finding.

Table 5.3 also reveals significant relationships between the ownership structure variables and the exposure. The percentages of shares held by directors (*DIR*) and institutions (*INS*) are positively related to exposure. The percentage of shares owned by block-holders (*BLO*) is negatively associated with the exposure. Block-holders may have an incentive to monitor the manager's activities to protect their own investment in the firm through overseeing hedging decisions. This is normally the case because block-holders own a substantial portion of the firm's shares, which is more than 5% of the firm's common shares. It follows that they may monitor managerial hedging decisions and may tend to favour hedging activities that reduce foreign exchange rate exposure.

5.3.1.2 Multiple Regression Analysis

a) The effect of the use of currency derivatives on foreign exchange exposure

A multiple regression analysis was undertaken to report the empirical results of testing the hypothesis that the use of currency derivatives effectively reduces the exposure (see Table 5.4). The general model of this hypothesis was designed by regressing the absolute value of the exposure coefficients against the proxy for the use of currency derivatives (*DER*) and the foreign sales ratio (*FS*) with respect to two groups of control variables. These two groups of control variables are: 1) the firm's incentives to hedge such as firm size (*SIZE*), leverage ratio (*LEV*), current ratio (*CR*), and 2) the firm's ownership structure such as directors (*DIR*), block-holders (*BLO*) and institutions (*INS*). In general, the present study finds that the use of foreign currency derivatives is significantly negatively related to exposure in all the models (4a – 4h). This means that foreign currency exposure adheres to theoretical expectations and suggests that firms use foreign currency derivatives with a view to hedging short-term exchange rate exposure. This result is consistent with the findings of Allayannis and Ofek (2001) and Nguyen and Faff (2003b).

In Table 5.4, Model 4a shows that exposure coefficients are regressed against *DER* and *FS* (see Eq 4.2). It is found that *DER* is negatively related to exposure, signalling that currency derivatives are effective in reducing exposure. However, *FS* is insignificantly positively related to exposure. This indicates that *FS* has no significant effect on exposure, which is consistent with Jorion (1990) finding. To control Model 4a for firms' hedging incentives, the following three variables (*SIZE*, *LEV* and *CR*) were included (see Model 4b). Model 4b reveals that the use of foreign currency derivatives remains significantly negatively related to exposure at the 0.05 level. *SIZE* appears to be significantly positively related to the exposure, signalling that large firms are more likely to have a higher exposure. Large firms are likely to have a higher foreign exchange rate exposure because such firms may engage in higher transactions and a greater number of business activities denominated in foreign currencies which may increase the firm's costs of financial distress and finally having a higher exposure. *LEV* is negatively significantly related to the exposure at a 0.10 level, indicating that firms with high debt in their capital structure are more likely to engage in hedging programs to reduce their costs of financial distress, and hence, have a lower exposure. However, this finding is consistent with the results of Chow and Chen (1998) who found that Japanese firms with high *LEV* have a higher exchange rate exposure. No significant evidence was found of the negative relationship between the *CR*, as a proxy for the firm's liquidity, and exposure. To conclude, inclusion of firms' incentives to hedge variables generally has no major influence on their foreign currency derivatives use.

Table 5.4

The Effect of The Use Of Currency Derivatives on Exposure

	Model 4a	Model 4b	Model 4c	Model 4d	Model 4e	Model 4f	Model 4g	Model 4h
I = Firms	62	62	62	62	62	62	62	62
Intercept t-statistics	0.555*** (9.238)	0.621*** (7.999)	0.626*** (8.057)	0.627*** (8.107)	0.638*** (8.135)	0.599*** (8.443)	0.587*** (8.786)	0.565*** (8.818)
DER	-0.109* (-1.973)	-0.132** (-2.179)	-0.116* (-1.886)	-0.127** (-2.145)	-0.091* (-1.678)	-0.120** (-2.183)	-0.13*** (-2.316)	-0.09* (-1.67)
FS	0.002 (1.551)	-0.009 (-1.271)	-0.008 (-1.274)	-0.009 (-1.324)	-0.006 (-1.337)	-0.008 (-1.193)	-0.009 (-1.197)	-0.007 (-1.221)
SIZE		0.002** (2.043)	-0.001 (-0.853)	-0.000 (-0.257)	-0.001 (-0.472)	-0.000 (-1.500)	-0.003** (-2.005)	-0.002 (-1.291)
DIR			-0.232 (-0.932)			-0.264 (-1.491)		
BLO				0.036* (1.696)			0.044** (2.142)	
INS					0.124*** (2.610)			0.102* (1.920)
LEV		-0.015* (-1.761)	-0.015* (-1.669)	-0.014* (-1.672)	-0.022*** (-2.464)			
CR		-0.005 (-1.282)	-0.001 (-0.120)	-0.004 (-1.009)	-0.005 (-1.029)			
Adjusted R^2	3%	3.2%	2.9%	3.5%	5.5%	2.4%	2.8%	2.8%
F-statistics	2.210*	1.921*	1.863*	1.962*	2.136*	1.986*	1.999*	1.1998*

This table provides parameter estimates for the models $|\gamma_{2i}| = \delta_0 + \delta_1 FS_i + \delta_2 DER_i + \delta_3 DIR_i + \delta_4 BLO_i + \delta_5 INS_i + \delta_6 SIZE_i + \delta_7 LEV_i + \delta_8 CR_i + \varepsilon_i$. Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficients, estimated by Eq (4.1), FS_i denotes the ratio of foreign sales to total sales for firm *i*, DER_i refers to the ratio of the notional amount of foreign currency derivatives to total assets for firm *i*, DIR_i is the percentage of shares held by the directors for firm *i*, BLO_i is the percentage of share held by block-holders for firm *i*, INS_i is the percentage of shares owned by institutions for firm *i*, $SIZE_i$ is the size of the firm, measured by the natural logarithm of market value of total assets for firm *i*, LEV_i is the leverage ratio, measured by the firm's total debt divided by its total equity for firm *i*, CR_i is the current ratio, computed by the ratio of current assets to current liabilities. These models (4a – 4h) were estimated using the WLS for the 2004 financial year. Note: the values in parenthesis are critical values of *t*-statistic with two-sided *t*-statistics. The levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

In an attempt to investigate the effect of the firm's ownership structure variables on exposure and managerial hedging decisions, the present study includes the three corporate governance variables to control the basic model (Eq 4.2, Chapter 4). These variables were namely the shares held by the three specific groups of shareholders: directors (*DIR*), block-holders (*BLO*) and institutions (*INS*). This attempt results from following Fok et al. (1997) and Whidbee and Wohar (1999) who documented that managerial incentives and outside monitoring have an effect on the decision of using derivatives. Since there is strong correlations (multi- collinearity possibly exists) among the ownership structure variables (see Table 5.3), the model, identified in Table 5.4, was re-estimated by including these three ownership structure variables, individually, as in all the models (4c – 4e). The study reports that *DER* remains significantly negatively related to exposure for all models. In Model 4c, the percentage of shares owned by directors (*DIR*) is found to be insignificantly negatively related to exposure. Prior research studies suggested that directors, as one group of shareholders who are concerned with the risk associated with their own assets, are expected to adopt hedging programs to reduce currency risk exposures (Smith & Stulz, 1985). Therefore, this finding of the present study contradicts the findings of prior studies, indicating that there is no clear effect of the percentage of shares held by directors on exposure reduction.

Relative to the percentage of share held by block-holders (*BLO*) and exposure, block-holders, as they own more than 5% of the firm's total shares, may have strong incentive to monitor the manager's activities to protect their own investment in the firm through overseeing hedging decisions. Therefore, they seek to monitor managerial hedging decisions and tend to favour hedging activities that reduce exposure. In Model 4d, the percentage of shares owned by block-holders is significantly positively related to exposure (at a 0.10 level), signalling that this percentage increases exposure. This means that block-holders hedge by diversifying their own portfolios with less concern about hedging the firm's exposure in which they own shares. Therefore, diluting the pressure on monitoring the managers' hedging decisions is more likely to increase exposure to foreign exchange risk. Therefore, the percentage of shares held by block-holders increases exposure.

Further, in Table 5.4, it appears that there is a positive significant relationship between the percentage of shares owned by institutions (*INS*) and exposure at the 0.01 level (see Model 4e). This means that this percentage is higher in firms with high exchange exposure. This result is consistent with the study of Carter et al. (2001) who documented that institutional ownership is significantly positively related to exposure. These results can be interpreted as a signal that institutional owners are not apprehensive about a firm's exposures. They are concerned about diversifying their own personal portfolios through holding well-diversified portfolios. Consequently, they place less pressure on managerial hedging decisions and therefore the firm-specific exposure increases.

In the case of the hedging incentives variables in Models (4c - 4e), the leverage ratio remains significantly negatively related to exposure, while the other variables, such as firm size and the current ratio are negative but insignificant.

As some of these hedging incentives variables (*SIZE*, *LEV* and *CR*) were significantly correlated (see Table 5.3), the parameters of the model were re-estimated after omitting one variable of each of the two highly significantly correlated variables. As a result of these significant correlations, *LEV* and *CR* were omitted from the general model. The use of derivatives variables together with each individual ownership structure variable are regressed against the exposure in Models (4f – 4h). In Model 4f, the results of both the proxy for use of derivatives and the percentage of shares held by directors remain the same. In the case of including the percentage of shares owned by block-holders (see Model 4g), it is recorded that derivatives use is deeply significant at the 0.01 level. In addition, the percentage of shares owned by block-holders is significant at the 0.05 level. Finally, in Model 4h, both derivatives use and shares held by institutions remain significant.

To conclude, the current study finds evidence of the relationship between use of foreign currency derivatives and exposure to exchange rate risk. However, it should be noted that all the models possess very low explanatory power (adjusted R^2) and are barely significant, when using F-statistics. Low explanatory power is common in many related studies. This relationship has been investigated with respect to foreign operations and the firm's incentives to hedge firstly and secondly with respect to the ownership structure variables. Although there was a lack of evidence that foreign operations increase a firm's foreign exchange rate risk exposure, the empirical evidence suggests that the use of foreign currency derivatives significantly reduces the exposure. The present study reported a limited relationship when the firm's hedging incentives variables were included. Strong evidence was reported for the ownership structure variables against the exposure. The percentages of shares held by block-holders and institutions were significantly positively related to exposure, while the percentage of shares owned by directors was not significant to exposure.

b) The Effect of the Use of Foreign Debt on Exposure

Table 5.5 summarises the empirical results of the estimated coefficients for the models (5a – 5e) which measure the effect of the use of foreign debt on absolute value of the exposure coefficients after controlling for the foreign sales ratio, firm size, leverage ratio and the current ratio. Overall, this study provides evidence that the use of foreign debt effectively reduces exposure (at the 0.01 level or better), indicating that the use of foreign debt is effective in hedging foreign exchange rate exposure. This finding is consistent with Elliott et al. (2003) who find that the coefficient on foreign currency denominated debt is significantly negatively related to exposure. However, this result contradicts the findings of Chaing and Lin (2005) and Nguyen and Faff (2006) who indicated that foreign debt has no significant effect on exposure.

As foreign operations are also considered one of the determinants of firms' hedging strategies, the ratio of foreign sales to total sales was included in the model. The present study reports that the foreign sales ratio is negatively related to the foreign exchange rate exposure, but with no clear evidence to support the hypothesis of whether foreign operations effectively reduce the exposure. This result is not consistent with Chiang and Lin (2005) who indicated that firms with a high foreign sales ratio are more likely to have less exposure as such firms use foreign currency derivatives to hedge the exposure created via foreign sales. The Table shows that there is strong evidence that firm size is positively significantly related to the exposure at the 0.01 level or better. This can be interpreted as the larger the size of the firm the higher the exposure.

Table 5.5

The Effect Of The Use of Foreign-Currency Denominated Debt On Exposure

	Model 5a	**Model 5b**	**Model 5c**	**Model 5d**	**Model 5e**
I = Firms	62	62	62	62	62
Intercept t-statistics	0.532*** (9.213)	0.543*** (8.081)	0.527*** (8.728)	0.501*** (9.732)	0.501*** (9.752)
SIZE	0.002*** (2.633)	0.002* (1.771)	0.001* (1.709)		
FS	-0.008 (-1.015)	-0.009 (-1.062)	-0.008 (-1.006)	-0.074*** (-10.85)	-0.073*** (-10.87)
FDD	-0.082*** (-2.394)	-0.083*** (-2.511)	-0.093*** (-2.649)	-0.068* (-1.850)	-0.068* (-1.997)
CR		0.002 (0.485)		0.000 (0.024)	0.007*** (2.304)
LEV		-0.010 (-1.101)	0.002 (0.683)	0.007*** (2.156)	
Adjusted R^2	4.6%	5.5%	4.8%	3%	3%
F-statistics	2.123*	2.236*	2.142*	2.056*	2.078*

This table provides parameter estimates for the model: $|\gamma_{2i}| = \delta_0 + \delta_1 FS_i + \delta_2 FDD_i + \delta_3 SIZE_i + \delta_4 CR_i + \delta_5 LEV_i + \varepsilon_i$. Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficients, estimated by Eq (4.1), for the sample period from January 2000 to December 2004, FS_i is the ratio of foreign sales to total sales for firm *i*, FDD_i denotes the ratio of the notional amount of foreign-currency denominated debt to total debt for firm *i*, $SIZE_i$ is the size of the firm, measured by the natural logarithm of market value of total assets for firm *i*, LEV_i is the leverage ratio, measured by the firm's total debt divided by its total equity for firm *i*, CR_i is the current ratio, computed by the ratio of current assets on current liabilities. All these models are estimated using the WLS for the 2004 financial year. Note: the levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

To control for the effect of firms' hedging incentives, firm size along with foreign debt use and the foreign sales ratio were included to the model (see Model 5a, Table 5.5). The results indicate that the foreign debt use remains significantly negatively associated with the exposure at the 0.01 level. However, no significant evidence is found of a relationship between foreign sales and exposure. As noted earlier, firm size is found to be significantly positively related to exposure at the 0.01 level. When all the hedging incentives variables (firm size, leverage ratio, and current ratio) were included in Model 5b, it shows largely the same results for foreign debt use which is significantly negatively related to the exposure at the 0.01 level. The foreign sales ratio is once again insignificant. Firm size remains significantly positively related to the exposure albeit, at the 0.10 level, instead of the 0.01 level. In addition, the same results are reported in Model 5c.

To avoid multi-collinearity, as noted in the correlation coefficients matrix (Table 5.3), among hedging incentives variables (*SIZE*, *CR*, and *LEV*), the parameters of the model were re-estimated after omitting the significantly correlated variables in several models in Table 5.5. In the matrix, it appeared that there were two strong correlation coefficients (see Matrix 5.3). First, *LEV* was significantly positively correlated with the size of the firm and the foreign debt usage (*FDD*) was significantly negatively correlated with *CR*. Second, the current ratio was negatively significantly correlated with *SIZE*. Furthermore, to alleviate collinearity between *LEV* and the *CR*, the general model was re-estimated after omitting *SIZE* and *CR* as in Model 5d. The foreign debt variable is still negatively significant at the 0.01 level, while the *SIZE* variable is significantly positive, but now at the 0.10 level. The variables of *LEV* and *FS* remain insignificant.

The empirical results, in Model 5d (Table 5.5) - after omitting *SIZE*, reveal that the degree of significance of the negative relationship between *FDD* use and the exposure is significant at the 0.10 level, while *LEV* and *FS* become deeply significant to the exposure, at the 0.01 level. The latter result indicates that firms with greater debt in their capital structure have higher exposure. If *LEV* is positive, it increases the costs of financial distress (Geczy et al., 1997), and the relationship between *LEV* and exposure should be positive. In Model 5e, *SIZE* and *LEV* variables are omitted from the general model. Foreign debt remains significant, but now at the 0.10 level, and the foreign sales ratio remains significant, at the 0.01 level. In addition, *CR* becomes deeply positively significant at the 0.01 level. A firm with a high *CR* is expected to increase its exposure as this dilutes the pressure on the use of hedging programs. If a firm has sufficient financial slack - financing all available positive NPV projects – it may encounter a large demand for implementing hedging programs and financial distress for these projects and thus this may increase the exposure (Nguyen & Faff, 2002).

To sum up, this study has reported that the use of foreign-currency denominated debt is significantly associated with foreign exchange rate exposure reduction, which indicates that firms are more likely to use foreign debt as a strong financial hedging strategy to eliminate exposure.

c) The Effect of the Combined Use of Currency Derivatives and Foreign Debt on Exposure

Table 5.6 reports the empirical results of the parameters estimated by running the regression of the combined use of foreign currency derivatives together with the use of foreign debt on the absolute value of the exposure coefficients. Overall, the present study finds evidence that the use of currency derivatives (*DER*) and foreign debt (*FDD*) are significantly negatively related to the exposure. These findings indicate that the combined use of these two financial hedging strategies is likely to be effective in reducing the exposure. This result is consistent with Nguyen and Faff (2004).

In Model 6a (in Table 5.6), the exposure coefficients were regressed against both *DER* and *FDD* with respect to *SIZE* and *FS*. It is found that these two proxies of the use of financial hedging strategies are significantly associated with the exposure reduction (*DER* is significant at the 0.10 level, while *FDD* is significant at the 0.05 level). *SIZE* is positively significantly related to the exposure at the 0.05 level, while the proxy for foreign sales ratio is not significantly related to the exposure reduction for all models (6a – 6e). This positive relationship of firm size and exposure means that large firms may have extensive domestic and foreign operations activities with insufficient human and financial resources leading to high probability of financial distress, and finally, increasing exposure. This finding is inconsistent with Chow and Chen (1998) and Nguyen and Faff (2003b) who found that the size of the firm is negatively associated with exposure. These results are consistent with the idea that larger firms tend to have higher exposure in the short-run because these firms are more efficient than small firms in performing long-term economic hedges. It may also occur if the decision to use derivatives is impacted by the costs of establishing a hedging program (Nguyen & Faff, 2002).

When the present study adds the other two control variables *LEV* and *CR* to the basic model 6a (in Table 5.6), *DER* and *FDD* remained significantly negatively associated with the exposure at the 0.10 level (see Model 6b). These control variables were insignificant for all models. It would appear that these latter control variables have little impact on the relationship between financial hedging variables and the exposure.

Table 5.6

The Effect of The Combined Use of Currency Derivatives and Foreign Debt on Exposure

	Model 6a	Model 6b	Model 6c	Model 6d	Model 6e
I = Firms	62	62	62	62	62
Intercept t-statistics	0.594*** (9.083)	0.602*** (8.239)	0.552*** (9.568)	0.550*** (9.647)	0.564*** (8.622)
SIZE	0.001** (2.202)	0.001** (2.025)	0.000 (1.051)		0.000 (1.017)
FS	-0.008 (-1.202)	-0.008 (-1.206)	-0.006 (-0.869)	-0.004 (-0.722)	-0.006 (-0.894)
DER	-0.103* (-1.820)	-0.102* (-1.734)			
FDD	-0.099** (-2.049)	-0.094* (-1.755)			
INTERACTION			-2.433*** (-2.804)	-2.463*** (-2.866)	-2.348*** (-2.656)
LEV		-0.013 (-1.121)		0.002 (0.927)	-0.010 (-0.831)
CR		-0.001 (-0.309)			-0.003 (-0.715)
Adjusted R^2	4.6%	9.6%	3.8%	4.7%	6.4%
F-statistics	1.965*	1.863*	2.065*	2.291*	1.982*

This table provides parameter estimates for the model: $|\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 FDD_i + \delta_5 INTERACTION_i + \delta_6 LEV_i + \delta_7 CR_i + \varepsilon_i$. Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficients, estimated by Eq (4.1), FS_i is the ratio of foreign sales to total sales for firm *i*, DER_i refers to the ratio of the notional amount of foreign currency derivatives to total assets for firm *i*, FDD_i denotes the ratio of the notional amount of foreign-currency denominated debt to total debt for firm *i*, $INTERACTION_i$ is the interaction variable, generated from multiplying DER_i by FDD_i, $SIZE_i$ is the size of the firm, measured by the natural logarithm of market value of total assets for firm *i*, LEV_i is the firm's total debt divided by its total equity for firm *i*, CR_i is the current ratio, computed by the ratio of current assets on current liabilities. All these models were estimated using the WLS for the 2004 financial year. Note: the levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

Furthermore, to test for the effects of the interaction between these two financial hedging strategies and the exposure, an interaction variable was generated and was added to the model instead of the two individual financial hedging variables (*DER* and *FDD*) (see Models 6c – 6e in Table 5.6). This interaction variable was generated by multiplying the foreign currency derivatives variable by the foreign debt variable.[109] After estimating the latter models, this study finds, overall, that there is strong significant evidence of a negative relationship between the interaction variable and exposure coefficients (at the 0.01 level – two tailed t-statistics test) for all of these models. This finding indicates that the interaction between the financial hedging strategies is effective in reducing the exposure.

To avoid multi-collinearity, the variables with high significant correlations are omitted. In light of this, the parameters of Model 6c (Table 6.5) were estimated after including only firm size as a control variable in the model. It is found that the interaction variable for financial hedging is significantly negatively associated with the exposure at the 0.01 level. However, there is no evidence of a significant positive relationship between the size of the firm and the exposure. As *LEV* and *CR* are significantly correlated with *SIZE*, Model 6d is estimated after omitting the firm size and current ratio variables, but with only including *LEV* as a control variable. The significant relationship for the interaction variable remains the same as in Model 6c. In Model 6e, all control variables are included and it shows similar empirical results to the previous models with the interaction variable being a significant predictor of the exposure.

To conclude, the present study finds that the combined use of both foreign currency derivatives and foreign debt is significantly negatively related to exposure. This suggests that these two strategies are jointly effective hedging strategies for the firm against the exposure generated by the foreign exchange rate risk. However, it should

[109] The current study follows the view of Simkins and Laux (1997) who including an interaction variable to their models.

be noted that while all models are significant their explanatory power is limited as measured by the adjusted R^2 statistics.

d) Foreign Currency Derivatives as Complements To, or Substitutes For, Foreign Debt

Table 5.7 reports empirical results of testing simultaneously whether the use of currency derivatives use (*DER*) is a complement to the use of foreign debt (*FDD*). The relationship between these two financial hedging strategies is tested simultaneously. This Table provides the estimated parameters of the models (7a – 7f). In Panel A of Table 5.7, the estimated parameters of the models (7a – 7c) are reported. In these models, the proxy for foreign debt use (dependent variable) is regressed against the proxy for the use of currency derivatives with respect to several control variables (i.e., *SIZE*, *FS*, *LEV*, *CR* and *RD*). As a primary attempt, the main model (see Table 5.7) is estimated first without omitting the control variables (see Model 7a). The current study finds that the use of foreign debt is significantly negatively related to the use of foreign currency derivatives (at the 0.01 level or better – two tailed t-statistics test). This finding suggests that the use of foreign debt is a substitutive hedging strategy for the use of foreign currency derivatives.

To avoid the multi-collinearity problem, as in Table 5.3, the models stated in Table 5.7 are re-estimated with omitting the significantly correlated explanatory variables. In Model 7b, the estimated parameters, after omitting three control variables i.e. *LEV*, *CR* and *RD*, show that the results are still largely the same as the use of foreign debt is negatively significant (at the 0.01 level or better – two tailed t-statistics test). In addition, after omitting the following three control variables, i.e. *SIZE*, *CR*, and

RD, from the model (see Models 7c), the results are still largely the same as the use of foreign debt is negatively significant (at the 0.01 level or better – two tailed t-statistic test). Therefore, the multi-collinearity problem that appears to exist among the explanatory variables of this general model does not have a critical impact on the estimated parameters of the model. In light of this, it can be concluded that the use of foreign debt is a substitutive hedging strategy for the use of foreign currency derivatives.

Table 5.7

Foreign Currency Derivatives As Substitutes For, or Complement To, Foreign Debt

	Panel A: *Dependent Variable =FDD*			**Panel B:** *Dependent Variable=DER*		
	Model 7a	**Model 7b**	**Model 7c**	**Model 7d**	**Model 7e**	**Model 7f**
I = Firms	62	62	62	62	62	62
Intercept t-statistics	0.026 (0.609)	-0.007 (-0.180)	0.036*** (3.868)	0.038 (0.121)	0.279 (1.084)	0.224*** (4.057)
SIZE	0.001 (0.430)	0.003 (1.413)		0.007 (0.496)	-0.004 (-0.355)	
FS	-0.005*** (-2.775)	-0.006*** (-2.622)	-0.052*** (-26.09)	-0.009 (-0.479)	-0.006 (-0.241)	-1.732*** (-70.64)
DER	-0.041*** (-2.681)	-0.049*** (-3.916)	-0.047*** (-3.600)			
FDD				-1.21*** (-2.520)	-1.60*** (-2.499)	-1.725*** (-2.484)
LEV	0.014 (0.800)		0.017 (1.031)	-0.014 (-0.551)		
CR	-0.003 (-0.907)			-0.009 (-0.552)		-0.015 (-1.152)
RD	-0.080 (-1.081)			2.068 (1.502)		
Adj. R^2	10%	7.7%	12.6%	15%	3.9%	4.6%
F-stat.	2.214**	2.707**	3.937***	2.814**	2.213*	2.135*

This table provides parameter estimates for the models: **Panel A**: $FDD_i = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 LEV_i + \delta_5 CR_i + \delta_6 RD_i + \varepsilon_i$. **Panel B**: $DER_i = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 FDD_i + \delta_4 LEV_i + \delta_5 CR_i + \delta_6 RD_i + \varepsilon_i$. Where FS_i is the ratio of foreign sales to total sales for firm *i*, $SIZE_i$ is the size of the firm, measured by the natural logarithm of market value of total assets for firm *i*, DER_i refers to the ratio of the notional amount of foreign currency derivatives to total assets for firm *i*, FDD_i is the ratio of the notional amount of foreign-currency denominated debt to total assets for firm *i*, LEV_i is the leverage ratio, measured by the firm's total debt divided by its total equity for firm *i*, CR_i is the current ratio, computed by dividing the current assets by current liabilities for firm *i*, RD_i is the research and developments costs to total assets for firm *i*. All these models were estimated using the WLS for the 2004 financial year. Note: the levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

Since the relationship between the various control variables and the proxy for use of foreign debt (*FDD*) are reported previously in Tables 5.4, 5.5 and 5.6, the present study will not be discussing the estimated parameters of these varaibles again.

In Panel B of Table 5.7, the estimated parameters of the models (7e – 7f) are reported after regressing the proxy for foreign currency derivatives use (dependent variable) on the proxy for use of foreign debt with respect to the same control variables stated previously (i.e., *SIZE*, *FS*, *LEV*, *CR* and *RD*). Panel B reports that, overall, there is strong evidence that the use of foreign currency derivatives acts as a substitute for the use of foreign debt in reducing the exposure. As a first attempt, the model is re-estimated without omitting any control variables (see Model 7d) (the proxy for the use of currency derivatives is regressed against the proxy for the use of foreign debt). The present study finds that foreign currency derivatives use is significantly negatively associated with foreign debt (at the 0.01 level or better – two tailed t-statistics test). Therefore, this finding indicates that foreign currency derivatives use is a substitutes hedging strategy for foreign debt.

Further, to avoid the multi-collinearity problem noted in Table 5.3, the model is re-estimated after omitting the significantly correlated explanatory variables from the general model (see Table 5.7). In Model 7e, the estimated parameters, after omitting three control variables, i.e., *LEV*, *CR*, and *RD*, show that the results are still largely the same as the use of foreign currency derivatives is negatively significant (at the 0.01 level or better – two tailed t-statistic test). In addition, as a second attempts after omitting the following three control variables, i.e. *SIZE*, *LEV*, and *RD*, from the model, as in Models 7f, the results remain largely the same. Therefore, to the extent multi-collinearity exists among the explanatory variables of this general model, this does not seem to have a critical impact on the estimated parameters of the model. Therefore, it would appear that foreign currency derivatives use is a substitutive hedging strategy for foreign debt.

To conclude, this research study finds that use of both currency derivatives and foreign debt is significantly negatively simultaneously related to each other in reducing exposure.

5.3.2 The Effect Of The Use Of Operational Hedging On The Exposure

5.3.2.1 Univariate Analysis

a) Summary descriptive statistics of the variables

Table 5.8 provides the summary descriptive statistics for all variables, including operational hedging proxies to test the hypothesis that the use of operational hedges effectively reduces exposure. The information provided in this Table are specifically related to operational hedging proxies, such as the numbers of foreign countries and geographical regions in which the sample firms operate in (foreign diversification) and the dispersion of our firms' foreign subsidiaries across countries and geographical regions (geographical dispersion).[110] The foreign subsidiaries of one of 62 corporations, in the present study, are spread, in maximum, across 43 foreign countries and 8 geographical regions. In terms of the degree of foreign diversification

[110] See Appendix 5.5, for more information about the survey of the present study in terms of the number of Australian foreign subsidiaries across countries and regions. The Ausralian foreign subsidiaries are spread across 88 froeign countires and 9 geographical regions.

of the firm's subsidiaries (*Breadth*, namely: *NFC* and *NFR*), the mean of the number of foreign countries in which the firms operate is 8.15 countries. In addition, the mean of the number of geographical regions in which the 62 firms operate is 3.42 across regions.[111] This would suggest that the higher the number of foreign subsidiaries across countries (*NFC*) and regions (*NFR*), the higher the firm diversification of foreign subsidiaries. Therefore, these results indicate that Australian multinational firms are broadly diversified and heavily dispersed across foreign countries and geographical regions.

Table 5.8

A Summary Descriptive Statistics for Operational Hedging Variables

I = 62 Firms	Mean	STD	Q1	Median	Q3	Minimum	Maximum
T. Assets ($M)	4,115	9,359	257.2	992.6	4,153.3	39.0	58,088.3
SIZE	8.32	9.14	5.55	6.90	8.33	3.66	10.97
T. Sales ($M)	3,136	6,290.3	250.2	1,035.8	3,298.9	5.3	32,266.8
FS	0.480	0.726	0.153	0.265	0.714	0.116	0.664
NFC	8.15	8.52	3	5	9	1	43
NFR	3.42	1.73	2	3	4	1	8
HERF1	0.740	0.271	0.667	0.818	0.9363	0	0.998
HERE2	0.646	0.311	0.5	0.713	0.894	0	0.998
ROA	0.085	0.084	0.048	0.069	0.099	-0.097	0.595
RD	0.013	0.033	0.003	0.002	0.007	0	0.185
CAPEX	0.005	0.005	0.002	0.003	0.004	0	0.005
NSGM	3.177	1.779	1.25	3	5	1	6

The mean of geographical dispersion of foreign subsidiaries (*Depth*, namely: *HERF*1 and *HERF*2) are also presented (see Table 5.8). The mean of the concentration of subsidiaries across foreign countries (*HERF*1) is 0.7403 and the concentration of subsidiaries across foreign regions (*HERF*2) is 0.6461.[112] The higher the value of

[111] For their sample of 208 U.S multinational firms, Carter et al. (2001) reported that the mean of *NFC* was approximately equal to 13.35 countries, and the mean of *NFR* was equal to 4.22 regions.

[112] For the same sample firms, Carter et al. (2001) reported that the mean of *HERF*1 was approximately equal to 0.2369 and the mean of *HERF*2 was approximately equal to 0.4477. This result indicates that Australian multinational firms are heavily concentrated across foreign countries and regions, much more than U.S. multinational firms.

these two indices is the higher the concentration of the firm foreign operations across countries (regions). This dispersion of foreign subsidiaries across countries and regions indicates that the concentration of subsidiaries of the sampled firms is high as these two indices (*HERF*1 and *HERF*2) are close to 1. However, if the value of these two indices is close to 0, the firm has a small number of foreign subsidiaries and less geographical concentration in both countries. Therefore, it can be argued that Australian firms exhibited foreign subsidiaries that are dispersed across a lot of foreign countries and geographical regions. The other foreign operation proxy is the foreign sales ratio (*FS*). This proxy represents the firm's foreign involvement in foreign sales or exports. It is noted that the mean is around 0.48 of total sales. This result suggests that the firms, in the sample of the current study, are broadly involved in foreign operations for hedging purposes.

The other variable included in the model is firm size (*SIZE*), measured by the natural logarithm of the firm's total assets (see Table 5.8). The size of the firm gives an indication of the size effect on using foreign operations. It was found that, on average, the size of the firm is quite high as it equals approximately AUD$4,114.7 million. The other variables used to test the effect of the use of operational hedging on the exposure are return on assets, research and development, capital expenditure and the number of business segments. In the case of return on assets (*ROA*), it is recognised that the higher the return on assets, the higher the firm's profitability. This study finds that the mean of the returns on assets is 0.085. In addition, the higher the research and development ratio (*RD*) is the higher the firm growth investment opportunities. The mean *RD* is 0.013.[113] The mean of capital expenditures

[113] From their sample of 188 U.S. firms using operational hedging for the 1998 financial year, Kim et al. (2005) reported that the mean ratio of research and development to total assets was equal to 0.023.

(*CAPEX*) is 0.005. The last variable is the number of business activities (*NSGM*) the firm is engaged in. The current study reports that the mean of *NSGM* is 3.18 industries, with maximum *NSGM* is 6.[114] Therefore, it appears that Australian multinational firms are heavily engaged in foreign diversification and geographical dispersion. It follows that Australian multinational corporations are engaged with operational hedging and have incentives to implement these types of hedging activities.

b) The correlation coefficient matrix of the operational hedging variables

Table 5.9 presents the Pearson correlation coefficients matrix of all the variables involved in modelling the relationship between the use of operational hedging and exposure. The matrix is important as it shows the nature of the relationship among the explanatory variables as well as the relationship between these variables and the dependent variable (the absolute value of foreign exchange rate exposure coefficients) included in the model. As seen in Table 5.9, four significant correlations were found. The first correlation is the negative correlation between the proxies for operational hedges and the exposure coefficients. These negative correlations indicate that, for hedging purposes, firms are more likely to diversify and disperse their foreign operations across countries and geographical regions. The second significant relationship is a positive correlation between exposure and both foreign sales and capital expenditure ratios. So, firms with a high foreign sales ratio (exports) and large amounts spent on capital assets (establishing new investment projects) are

[114] From the same sample firms, Kim et al. (2005) recorded, on average, the number of business segments equals 2.43 industries. In addition, Pantzalis et al. (2001) reported that the mean number of business segments in which their sample of 220 U.S. multinational firms were involved with was 2.48 industries.

more likely to have higher exposure. This is because firms with higher capital expenditure and foreign involvement may encounter high costs of financial distress which may eventually expose them to foreign exchange rate exposure.

The third significant relationship, in Table 5.9, results from a positive correlation among the operational hedging proxies: *NFC*, *NFR*, *HERF*1 and *HERF*2. These positive correlations indicate that if the number of foreign subsidiaries increases across geographical regions, it is more likely that the number of subsidiaries of these firms increases across foreign countries and visa versa. In addition, if the geographical concentration of the firms' operational activities increases across regions, the concentration may also increase across countries. The final significant positive correlation was found among these operational hedging variables, which would reveal that they are complements to each other.

The fourth relationship results from a significant correlation between these operational hedging variables with other control variables used (Table 5.9). In relation to this, the matrix presents significant positive correlations between the firms' number of subsidiaries across foreign countries and regions and the number of business segments. This positive correlation would suggest that firms engaged in a higher number of business segments across industries are more likely to have a greater number of subsidiaries operating across foreign countries and foreign regions. This is because firms with a greater number of business activities are more likely to have more opportunity to diversify their operations locally and internationally (across regions and countries). Therefore, firms with greater number of business

Table 5.9

The Pearson Correlation Coefficients Matrix For Operational Hedging Variables

	SIZE	FS	NFC	NFR	HERF1	HERF 2	ROA	NSGM	RD	CAPEX	$\lvert\gamma_{2i}\rvert$
SIZE	1										
FS t-statistics	0.013 (0.099)	1									
NFC	0.555(a) (4.695)	0.079 (0.61)	1								
NFR	0.518(a) (5.164)	0.122 (0.96)	0.852(a) (12.62)	1							
HERF1	0.227(c) (1.804)	-0.164 (-1.29)	0.465(a) (4.066)	0.553(a) (5.140)	1						
HERF2	0.201 (1.593)	-0.170 (-1.33)	0.574(a) (5.430)	0.466(a) (4.079)	0.813(a) (10.79)	1					
ROA	0.233(c) 1.858	-0.147 (-1.15)	0.041 (0.316)	-0.023 (-0.18)	-0.029 (-0.22)	0.0934 (0.727)	1				
NSGM	0.525(a) (4.774)	0.159 (1.243)	0.335(a) (2.75)	0.401(a) (3.388)	0.078 (0.604)	-0.0137 (-0.11)	-0.027 (-0.21)	1			
RD	-0.31(c) (-2.52)	0.047 (0.36)	-0.01 (-0.06)	-0.023 (-0.18)	0.0511 (0.396)	0.0148 (0.115)	-0.46(a) (-3.97)	-0.123 (-0.96)	1		
CAPEX	-0.158 (-1.24)	-0.007 (-0.06)	-0.188 (-1.49)	-0.24 (b) (-1.91)	0.085 (0.659)	0.1080 (0.841)	0.099 (0.77)	-0.1370 (-1.07)	-0.093 (-0.73)	1	
$\lvert\gamma_{2i}\rvert$	-0.30(a) (-2.40)	0.046 (0.357)	-0.187 (-1.48)	-0.092 (-0.72)	-0.053 (-0.41)	-0.131 (-1.02)	-0.182 (-1.43)	-0.037 (-0.29)	-0.033 (-0.26)	0.168 (1.318)	1

Note: the levels of significance (1%, 5%, and 10%) are: (a), (b), and (c), respectively. A two-tailed *t* test statistics is used to test the correlation coefficients (r). The t-statistic is computed as follows: t= (r√I-2)/(√1-r^2), where I = 62 firms.

segments are more likely to be exposed to foreign exchange risk which leads them to increasing their operational hedging activities.

The size of the firm was found to be positively correlated to these operational hedging variables (see Table 5.9). This positive relationship would suggest that the greater the size of the firm, the higher the firm's involvement and concentration of operating subsidiaries across foreign countries and regions. Larger firms are more likely to have the opportunity to engage in large investment projects and to diversify their foreign subsidiaries across wide range of countries and regions. However, the capital expenditure ratio was found to be negatively correlated with the number of subsidiaries across countries. This means that firms with a higher number of subsidiaries across countries are more likely to spend less on capital expenditure. Therefore, it is more likely that capital expenditure is a substitute for engaging in operational hedging activities.

A fifth significant relationship was found to exist among the control variables (see Table 5.9). It appears that firm size is correlated with the return on assets, the number of business segments and research and developments. The positive correlations between firm size and return on assets and the number of business segments indicates that the greater the size of the firm, the higher the return on assets and the number of industries in which the firm operates. It can be interpreted that firms with higher profitability and investment growth opportunities are more likely to have higher diversification across industries. In addition, large firms are more likely to engage in different industry sectors or activities. Therefore, these significant correlations between control variables are taken into account when estimating the cross-sectional regression models to alleviate multi-collinearity. It should be noted that the research and development cost variable was found to be negatively correlated with firm size.

To conclude, the correlation coefficients matrix was included to determine the nature of the relationship between the explanatory variables. Thus, when estimating the parameters of the models, the present study attempts to avoid multi-collinearity in order to obtain the Best Linear Unbiased Estimators for the coefficients of the explanatory variables.

5.3.2.2 Multiple Regression Analysis

Table 5.10 reports the empirical results of the models used to test the hypothesis that the use of operational hedging effectively reduces exposure. In the models (10a – 10h), the absolute value of the foreign exposure coefficients were regressed on the four operational hedging proxies individually with respect to the following control variables: *FS*, *SIZE*, *ROA*, *CAPEX*, *NSGM*, and *RD*. This individual use of operational hedging proxies was undertaken as a consequence of the significant correlations among these variables, as stated in Table 5.9. The control variables were used to control for the firms' incentives to hedge, such as proxies for firm size, returns on assets (profitability), foreign involvement, growth investment opportunities, and industrial diversification. To conclude, the present study finds that the use of operational hedging is effective in reducing exposure. This result contradicts previous research which concluded that operational hedging increases exposure (Allayannis et al., 2001; Kim et al., 2005; Gleason et al., 2005).

In the first instance, the absolute value of the exposure coefficients are regressed on four operational hedging proxies individually with respect to the control variables, stated previously. Four models (10a – 10d) were generated. In Models 10a and 10b, the natural logarithm of the number of subsidiaries in both foreign countries (*NFC*) and foreign regions levels (*NFR*) is used, respectively, with all the control variables. By using these two models the present study aims to test for the foreign diversification of the firms' operations across countries and regions (*Breadth*). The present study reveals that there is strong evidence that *NFC* and *NFR* are negatively related to exposure, signalling that the firms' foreign diversification, on both foreign countries and geograpphcial regions, are associated with exposure reduction at the 0.10 and 0.01 levels, respectively. However, these results are consistent with Pantzalis et al. (2001), Carter et al. (2001, 2003), and Al-Shboul (2007) who found an adverse relationship between *Breadth varaibles* and exposure coefficients. However, these results contradict the findings of the studies of Allayannis et al. (2001). Thus, these two operational hedging (*Breadth*) as proxies for the firms' level of foreign diversification were found to be effective hedging strategies for exposure.

To test whether the dispersion of foreign subsidiaries across both foreign countries and/or regions (*Depth*: *HERF*1 and *HERF*2) is effective in reducing the exposure, two models were estimated (see Models 10c and 10d).[115] These models were estimated by running the regression of these two proxies individually with respect to the control variables indicated above, against exposure coefficients. Based on

[115] The computation mechanism of these two proxies was explained (see Chapter 4, Section 4.2.2.1).

Table 5.10

The Effect of The Use of Operational Hedging on Exposure								
	Model 10a	**Model 10b**	**Model 10c**	**Model 10d**	**Model 10e**	**Model 10f**	**Model 10g**	**Model 10h**
I = Firms	62	62	62	62	62	62	62	62
Intercept t-statistics	0.598*** (8.429)	0.741*** (8.621)	0.636*** (8.508)	0.615*** (8.551)	0.538*** (7.581)	0.672*** 8.168	0.539*** (7.142)	0.628*** (7.707)
SIZE	0.003*** (3.338)	0.002*** (2.567)	0.003*** (4.175)	0.003*** (4.106)				0.006*** (3.639)
FS	-0.006 (-0.762)	0.001 (0.268)	-0.007 (-1.033)	-0.008 (-1.080)	-0.011 (-1.021)	-0.002 -1.101	-0.009 (-1.051)	-0.008 (-1.031)
NFC	-0.007* (-1.784)				-0.006* (-1.850)			
NFR		-0.03*** (-4.154)				-0.03*** (-4.427)		
HERF1			-0.04*** (-2.591)				-0.037* (-1.947)	
HERF2				-0.032** (-2.134)				-0.028* (-1.998)
ROA	-0.210* (-1.884)	-0.20*** (-2.513)	-0.193* (-1.768)	-0.184* (-1.657)				
NSGM	-0.008** (-2.074)	-0.003 (-1.094)	-0.004 (-0.961)	-0.005 (-1.276)			0.005* (1.695)	-0.003 (-0.855)
RD	0.730*** (2.468)	0.736*** (3.008)	0.736*** (2.719)	0.713*** (2.509)	0.491 (0.270)	0.896 (0.571)	0.920 (0.554)	0.254 (0.155)
CAPEX	-0.42*** (-3.21)	-0.35*** (-3.15)	-0.44*** (-3.55)	-0.43*** (-3.511)	-0.269** (-2.240)		-0.234* (-1.792)	-0.52*** (-3.869)
Adjusted R^2	0.044	0.23	0.13	0.12	0.03	0.147	0.06	0.067
F-statistics	1.875*	3.44***	2.337**	2.139*	1.960*	4.504***	1.890*	1.92*

This table provides parameter estimates for the model: $|\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 OPER_i + \delta_4 ROA_i + \delta_5 NSGM_i + \delta_6 RD_i + \delta_7 CAPEX_i + \varepsilon_i$. Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficients, estimated by Eq (4.1). $SIZE_i$ is the size of the firm for firm *i*, FS_i denotes the ratio of foreign sales to total sales for firm *i*, $OPER_i$ is the four operational hedging proxies for firm *i* (*NFC*, *NFR*, *HERF*1 and *HERF*2), ROA_i is the returns on assets, $NSGM_i$ is the firm's number of business segments, RD_i is the ratio of research and developments to total assets, and $CAPEX_i$ is the ratio of capital expenditures to total assets. All these models are estimated using the WLS for the 2004 financial year and their parameters were tested by a two-tailed t-statistic test. Note: The levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

estimating these two models, the results show that these two variables were significantly negatively related to exposure reduction at the 0.01 and 0.05 levels, respectively. This result suggests that geographical dispersion of the firm's foreign subsidiaries abroad, either on country- level, or region-level, is associated with exposure reduction. In other words, firms with higher concentration of foreign operations abroad are more likely to have lower exposure to foreign currency risk. This finding contradicts with the findings of prior studies such as Pantzalis et al. (2001), Allayannis et al. (2001), Carter et al. (2001, 2003) and Kim et al. (2005) who found that these two operational hedging proxies (*HERF*1 and *HERF*2) were positively related to exposure.

The results reported by the present study, for the models 10a to 10d, indicate that *RD* is positively significantly related to the exposure at the 0.01 level or better. This might be due to the outcomes of investing in *RD* taking a long time to be noticed in either currency gains or losses. Unlike normal capital investment (property, plants, equipment, and inventory), *RD* investments feature potentially high revenues, but with great uncertainty in firms' future cash flows (Xu & Zhang, 2004). Therefore, the total risk of returns increases with the *RD* intensity, therefore, firms may encounter a higher foreign exchange rate exposure.

For all models, it is found that *CAPEX* is significantly negatively related to exposure. This finding supports Froot et al. (1993) and Geczy et al. (1997) who suggested that firms implementing hedging programs are more likely to have greater investment opportunities. Thus, firms with a high ratio of capital expenditure are more likely to diversify their operations abroad, by using operational and financial hedging programs, thereby, reducing foreign exchange rate exposure. Therefore, the ratio of capital expenditure and the ratio of research and development, as proxies for the firms' growth in investment opportunities, have a strong effect on exposure, either negatively, or positively. This was confirmed by Myers (1977) and Smith and Watts (1992) who stated that firm value relies on future investment opportunities. To conclude, although some of the control variables, included in these models were significantly correlated, the present study finds that the four proxies for operational hedging are effective in reducing exposure for all models.

For robustness, the hypothesis that the use of operational hedging effectively reduces exposure was tested after omitting the significantly correlated variables (see Models 10e – 10h). Table 5.9 indicated that the coefficients of some of the control variables are highly correlated in the Pearson correlation coefficients matrix. Thus, the parameters of the generated models are re-estimated using the operational hedging proxies individually, and omitting the highly correlated control variables from the general model, to alleviate the effect of multi-collinearity. The general model was estimated firstly by omitting *ROA* and *NSGM* (see Model 10e). The results indicate that the relationship between *NFC* and exposure remains negatively significant at the 0.10 level - similar to the results of Model 10a. When the variables (*ROA*, *SIZE*, *NSGM* and *CAPEX*) are omitted from the general model (see Model 10f), the firm's number of foreign subsidiaries across geographical regions (*NFR*) remains significantly associated with exposure reduction at the 0.01 level, as per Model 10b.

The general model is also re-estimated after omitting *SIZE* and *ROA* (see Model 10g). The present study indicates that the geographical concentration of the firm's operations across foreign countries (*HERF*1) is insignificantly associated with exposure reduction. This means the degree of significance to *HERF*1 is reduced compared with Model 10c, which indicates that geographical dispersion of the firm's subsidiaries across countries has crucial effects on exposure at 0.10 level. In addition, to alleviate multi-collinearity which might have produced bias estimators in terms of the last alternative operational hedging variable (*HERF*2) the general model is re-estimated after omitting *ROA* and *NSGM*, as in model 10h. Since *HERF*2 is a proxy for geographical dispersion of the firm's foreign operations across regions, the results show that *HERF*2 is significantly related to exposure reduction, at the 0.10 level, which is similar to the result of Model 10d. To conclude, despite of the existence of multi-collinearity, the re-estimated parameters of the models remain significant. Therefore, this study provides strong evidence that the use of operational hedging is effective in reducing exposure to foreign currency risk.

To conclude, the present study finds strong evidence that the use of operational hedging is effective in reducing exposure, suggesting that operational hedging variables are more likely to be used as effective hedging strategies to reduce exposure. This can be interpreted as follows: firms with a high number of subsidiaries spread and disperse across foreign countries and geographical regions are more likely to have less exposure. This result is inconsistent with Allayannis et al. (2001), Carter et al. (2001, 2003) and Kim et al. (2005) who indicated that operational hedging variables are positively related to exposure. However, the findings of the present study are consistent with Hassan et al. (2001) and Al-Shboul (2007) who found mixed results of the relationship between operational hedging variables and exposure. Pantzalis found that only the natural logarithm of the number of foreign countries and geographical regions had an inverse relationship with exposure, while *HERF*1 and *HERF*2 were positively related to exposure.

5.3.3 The Effect of the Combined Use of Financial and Operational Hedging on Exposure

5.3.3.1 Univariate Analysis

a) Descriptive Statistics of Financial and Operational Hedging Variables

As the summaries of descriptive statistics for all operational and financial hedging variables were previously reported and analysed in Tables 5.2 and 5.8, there will be no re-discussion for these summaries to avoid any unnecessary repetition.

b) The Correlation Coefficient Matrix of Financial and Operational Hedging Variables

Before testing whether the combined use of financial and operational hedging is effective in reducing foreign exchange rate exposure, it is essential to examine the relationships between the proxies for these two hedging strategies. In light of this, the Pearson's correlation coefficients matrix is recorded in Table 5.11 in order to test for possible multi-collinearity. There are several significant correlations between the variables used in testing the hypotheses relating to financial and operational hedging. The first positive significant relationship appears among operational hedging variables. All proxies for the firm's ability to construct a network of foreign subsidiaries are found to be positively related to each other. This indicates that these operational hedging proxies are complementary to each other in reducing exposure. For example, if the number of foreign subsidiaries increases across regions, it is likely that this increase of subsidiaries for these firms may spread across countries and vice versa. In addition, if the geographical concentration of the firms' operational activities increased across regions, this suggests that the concentration may increase across countries. However, these proxies were found to be negatively related to the exposure coefficients, indicating that they are more likely to reduce the firm's foreign exchange risk exposure.

The second relationship reported is that there are significant correlations among the control variables. Firm size is correlated with the return on assets, the number of business segments and research and development. The positive correlations between firm size, return on assets and the number of business segments indicate that the greater the size of the firm, the higher the return on assets and the number of industries which the firm operates in. Firms with higher profitability and higher investment growth opportunities are more likely to have higher diversification across industries. Large firms are more likely to engage in different industries. It should be noted that this study takes into account the significant correlations between control variables when estimating the cross-sectional regression models to alleviate multi-collinearity. Research and development is found to be negatively correlated with firm size. This suggests that large firms may have less cost of research and development compared with small firms. This is because large firms may already have invested in projects and installed their different hedging programs (operational and financial), which may be not costly if they are compared with the market capitalisation of such firm. However, when small firms invest in *RD*, they may face relatively higher costs compared with large firms. Therefore, large firms are likely to have a lower research and development ratio.

Table 5.11

The Pearson Correlation Coefficients Matrix For Financial And Operational Hedging Variables

	SIZE	FS	DER	FDD	NFC	NFR	HERE 1	HERE 2	ROA	NSG M	RD	Capex	$\lvert\gamma_{2i}\rvert$
SIZE	1												
FS t-statistics	0.013 (0.10)	1											
DER	-0.156 (-1.22)	-0.02 (-0.18)	1										
FDD	0.168 (1.32)	-0.13 (-1.06)	-0.3(b) (-2.03)	1									
NFC	0.56(a) (5.16)	0.079 (0.61)	0.041 (0.32)	0.083 (0.64)	1								
NFR	0.52(a) (4.69)	0.1223 (0.95)	0.012 (0.09)	0.094 (0.73)	0.85(a) (12.6)	1							
HERE1	0.23(c) (1.81)	-0.164 (-1.29)	0.080 (0.63)	0.034 (0.27)	0.55 (a) (5.14)	0.47(a) (4.1)	1						
HERE2	0.202 (1.59)	-0.168 (-1.33)	0.023 (0.18)	0.046 (0.36)	0.47(a) (4.08)	0.57(a) (5.43)	0.81(a) (10.7)	1					
ROA	0.23(c) (1.86)	-0.147 (-1.15)	0.047 (0.37)	0.120 (0.94)	-0.023 (-0.2)	0.041 (0.32)	-0.028 (-0.22)	0.093 (0.23)	1				
NSGM	0.53(a) (4.77)	0.159 (1.24)	-0.259 (-2.08)	0.178 (1.40)	0.40(a) (3.4)	0.34(a) (2.75)	0.077 (0.60)	-0.014 (-0.11)	-0.027 (-0.21)	1			
RD	-0.3(a) (-2.52)	0.047 (0.36)	0.49(a) (4.36)	-0.2(c) (-1.75)	-0.023 (-0.2)	-0.007 (-0.05)	0.051 (0.39)	0.015 (0.12)	-0.5(a) (-3.96)	-0.123 (-0.96)	1		
CAPEX	-0.158 (-1.24)	-0.007 (-0.06)	0.032 (0.25)	-0.181 (-1.42)	-0.24 (-1.9)	-0.188 (-1.48)	0.084 (0.65)	0.1079 (0.84)	0.099 (0.77)	-0.137 (-1.07)	-0.093 (-0.73)	1	
$\lvert\gamma_{2i}\rvert$	-0.3(b) (-2.40)	0.046 (0.36)	-0.068 (-0.53)	-0.04 (-0.27)	-0.092 (-0.7)	-0.187 (-1.47)	-0.053 (-0.41)	-0.131 (-1.02)	-0.182 (-1.43)	-0.038 (-0.29)	-0.033 (-0.25)	0.168 (1.32)	1

Note: the levels of significance (1%, 5%, 10%) are: a, b, c, respectively. A two-tailed t-statistics test is used to test the correlation coefficients (r). The t-statistics regarding this matrix is computed as follows: $t = (r\sqrt{I-2}) / (\sqrt{1-r^2})$, where I = 62.

The third relationship found was positive significant correlation between operational hedging proxies and financial hedging proxies. It appears that all operational hedging proxies are positively correlated with the two financial hedging proxies. This would indicate that firms use financial and operational hedging as complementary hedging strategies to eliminate foreign exchange rate exposure.

The last relationship discussed in Table 5.11 is the positive significant relationship between firm size and operational hedging proxies. In addition, the size of the firm is found to be positively correlated to these operational hedging variables. This positive sign suggests that the greater the size of the firm, the higher the firm's involvement and concentration of subsidiaries across foreign countries and regions. Firms with greater size may have the opportunity to engage in large investment projects and concentrate their foreign subsidiaries in countries and regions. Further, it was found that capital expenditures costs were negatively correlated with the number of subsidiaries across countries. This means that firms with higher numbers of subsidiaries across countries are more likely to spend less on capital expenditure.

5.3.3.2 Multiple Regression Analysis

a) The Effect of the Combined Use of Financial and Operational Hedging on Exposure

Table 5.12 reports results of the relationship between the combined use of financial and operational hedging variables and foreign exchange rate exposure. The estimated parameters in models 12a – 12h were negatively related to exposure. This means this combined use of the two hedging strategies is considered an effective hedging mechanism to reduce exposure. These results are consistent with Allayannis et al.

(2001), Carter et al. (2001, 2003) and Kim et al. (2005). This suggests that Australian multinational corporations are more likely to reduce their total exposure when they use this combination. This supports the suggestion that financial hedging can be used to eliminate transaction exposure (short-term), while operational hedging is used to reduce (long-term) exposure. Furthermore, the combination of these hedging strategies is likely to eliminate the firm's overall exposure.

In Panel A of Table 5.12, the absolute value of exposure coefficients were regressed against both financial hedging variables and operational hedging proxies together with a set of control variables, representing the firm's growth in investment opportunities. Generally, in this Table, it appears that the combined use of financial and operational hedging is negatively related to exposure with significant evidence at mixed levels of confidence level (0.05 and 0.10). Both financial hedging proxies (*DER* and *FDD*) are found to be significantly negatively associated with exposure reduction at mixed levels of confidence (0.05 and 0.10). However, not all of the proxies for operational hedging are significant. *NFR* and *HERF*1 are significantly negatively related to exposure. This suggests that firms with high foreign sales involvement, high diversification of the number of foreign subsidiaries across regions, and high concentration of these subsidiaries across foreign countries are more likely to have less exposure. This evidence is consistent with previous studies which reported geographical dispersion and financial hedging associated with exposure reduction (see Allayannis et al., 2001; Pantzalis et al., 2001; Carter et al., 2001, 2003; Kim et al., 2004; Gleason et al., 2005; Al-Shboul, 2007). This supports the suggestion that the diversification of foreign operations within regions, together with financial hedging variables is used as an effective hedging strategy to reduce exposure (Chowdhry & Howe, 1999; Lim & Lang, 2001, 2007).

Table 5.12

The Effects Of The Combined Use Of Financial And Operational Hedging On Exposure								
Firm I = 62	**Panel A**				**Panel B**			
	Model 12a	**Model 12b**	**Model 12c**	**Model 12d**	**Model 12e**	**Model 12f**	**Model 12g**	**Model 12h**
Intercept	0.631***	0.728***	0.638***	0.627***	0.594***	0.699	0.597	0.594
t-statistics	(8.81)	(8.68)	(8.57)	(8.64)	(9.072)	8.772	8.978	9.040
SIZE	0.002**	0.0008	0.0016**	0.0015**	0.001	0.000	0.001**	0.001*
	(2.55)	(1.421)	(2.476)	(2.404)	(1.464)	(0.853)	(2.078)	(1.908)
FS	-0.006	0.0002	-0.0067	-0.0073	-0.008	0.002	-0.007	-0.008
	(-1.23)	(0.042)	(-1.290)	(-1.328)	(-1.177)	(0.445)	(-1.127)	(-1.178)
DER	-0.098**	-0.0543	-0.0833*	-0.0913**	-0.102*	-0.052	-0.093	-0.098*
	(-2.27)	(-1.341)	(-1.784)	(-1.929)	(-1.813)	(-1.001)	-1.592	(-1.67)
FDD	-0.108**	-0.0696*	-0.0835*	-0.0920*	-0.099**	-0.040	-0.082	-0.089*
	(-2.236)	(-1.79)	(-1.734)	(-1.867)	(-2.051)	(-0.939)	(-1.531)	(-1.673)
NFC	-0.005				-0.001			
	(-0.99)				(-0.153)			
NFR		-0.03***				-0.029***		
		(-3.476)				(-3.529)		
HERF1			-0.0209*				-0.012	
			(-1.706)				(-0.771)	
HERF2				-0.0116				-0.007
				(-0.751)				(-0.434)
NSGM	-0.0011	0.0001	-0.0003	-0.0010				
	(-0.285)	(0.028)	(-0.068)	(-0.231)				
RD	1.079***	0.926***	1.029***	1.0483***				
	(2.79)	(2.58)	(2.578)	(2.594)				
CAPEX	-0.390	-0.37***	-0.40***	-0.383***				
	(-3.15)	(-2.96)	(-3.17)	(-3.123)				
Adjusted R^2	0.13	0.21	0.14	0.13	0.11	0.113	0.13	0.11
F-statistics	2.154*	3.076***	2.205**	2.130*	2.05*	2.10*	2.40**	2.00*

This table provides parameter estimates for the following model: $|\gamma_{2i}| = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 FDD_i + \delta_5 OPER_i + \delta_6 NSGM_i + \delta_7 RD_i + \delta_9 CAPEX_i + \varepsilon_i$. Where $|\gamma_{2i}|$ is the absolute value of the foreign exchange rate exposure coefficients for the sample period from January 2000 to December 2004. $SIZE_i$ is the size of the firm, measured by the natural logarithm of market value of total assets for firm *i*, FS_i denotes the ratio of foreign sales to total sales for firm *i*, DER_i is the total notional amount of foreign currency derivatives scaled to total assets, FDD_i is the notional amount of foreign denominated debt, scaled to total assets for firm *i*, $OPER_i$ is the four alternative operational hedging variables (*NFC, NFR, HERF1,* and *HERF2*), $NSGM_i$ is the number of business segments for firm *i*, RD_i is the ratio of research and developments to total assets for firm *i*, $CAPEX_i$ is the ratio of capital expenditures to total assets for firm *i*. Note: The levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

In relation to the control variables, Table 5.12 (Panel A) reports a significant positive relationship between exposure and the ratio of research and development. This indicates that firms with higher research and development expenditure are more likely to have higher exposure. The positive significant relationship between exposure and the ratio of research and development indicates that firms with higher ratios of research and development are more likely to have higher exposure. (consistent with Xu and Zhang (2004). It could be implied that outcomes (profit or loss) from investing in foreign projects (affiliates) would take a long time to reverse, compared with investing in normal capital investment (properties, plant, equipment, and inventory). Therefore, firms may face higher exposure in terms of this type of expenditure for establishing subsidiaries abroad, which may exhibit uncertainty in future cash flows. However, a negative relationship between exposure and both the capital expenditure ratio and the number of business segments was reported. In terms of the significant negative coefficient of capital expenditure, this suggests that firms with higher capital expenditure are more likely to have less exposure, due to being involved in using hedging programs to eliminate exposure. However, no significant evidence was reported for the negative relationship between the number of business segments and exposure, signalling that diversifying and having a higher number of business activities does not have an impact on reducing exposure.

In Panel B of Table 5.12, it is reported that the combined use of financial and operational hedging reduces exposure. Since it was noted that there are signs of multi-collinearity between some of the control variables, the present study omits these control variables from the model in order to avoid this econometric problem.

Following the omission of these control variables, the general relationship between financial and operational hedging proxies remains largely the same. However, there is an impact on the degree of significance reported for this relationship. It was found that excluding these variables resulted in less explanatory power of the estimated models. For example, in Models 12e – 12h, financial and operational hedging proxies have lost their significance.

5.3.4 Financial Hedging As A Complement To Operational Hedging

5.3.4.1 Univariate Analysis

a) Descriptive statistics of financial and operational hedging variables

The descriptive summary statistics for all operational and financial hedging variables have been reported in Tables 5.2 and 5.8. Thus, to avoid repetition, this section will not discuss the same summary descriptive reported in these Tables.

b) The correlation coefficient matrix of financial and operational hedging variables

In Table 5.11, Pearson's correlation coefficients among the independent variables used in the models to the last hypothesis tested - whether the firm's financial hedging strategies act as complements to operational hedging strategies in reducing exposure to foreign currency risk were reported. To avoid any unnecessary repetition, this section will not be discussing these correlations as they were already discussed in Table 5.3 and 5.9.

5.3.4.2 Multiple Regression Analysis

The present study has tested the hypothesis that financial hedging acts as a complement to operational hedging in reducing exposure was tested. In Table 5.13, Panel A shows that the use of currency derivatives (*DER*) was found to be significantly positively related to operational hedging proxies (*NFC*, *NFR*, *HERF*1, and *HERF*2) (see Models 13a – 13d). This evidence suggests that the use of foreign currency derivatives is considered an effective complementary strategy to operational hedging in reducing exposure to foreign currency risk. This finding is consistent with Allayannis et al. (2001), Carter et al. (2001, 2003), Kim et al. (2004), Gleason et al. (2005), and Al-Shboul (2007).

Panel B in Table 5.13 reveals the empirical results of the hypothesis that foreign-currency denominated debt (*FDD*) is a complement to operational hedging in reducing exposure. The proxy for the use of *FDD* was regressed against the proxies for the use of operational hedges (*NFC*, *NFR*, *HERF*1, and *HERF*2) with respect to various control variables (*SIZE*, *FS*, *NSGM*, *RD*, and *CAPEX*). The study finds that there is a positive significant relationship between the use of *FDD* and each of the operational hedging variables. This evidence supports the claim that the use of foreign currency derivatives is considered an effective complementary strategy to operational hedging.

Table 5.13

Financial hedges Are Substitutes For, Or Complement To, Operational Hedging								
Firms I = 62	Panel A: *Dependent Variable* = DER				Panel B: *Dependent Variable* = FDD			
	Model 13a	**Model 13b**	**Model 13c**	**Model 13d**	**Model 13e**	**Model 13f**	**Model 13g**	**Model 13h**
Intercept t-statistics	0.1649 (1.56)	-0.0249 (-0.22)	0.0776 (0.71)	0.1217 (1.129)	0.298*** (2.603)	0.0827 (0.874)	0.1487 (1.406)	0.190* (1.947)
SIZE	-0.006** (-2.041)	-0.004* (-1.663)	-0.01*** (-2.68)	-0.01*** (-2.73)	0.0038* (1.829)	0.004*** (2.647)	0.0012 (0.664)	0.0009 (0.514)
FS	-0.00133 (-0.0565)	-0.0126 (-0.615)	-0.0028 (-0.1391)	0.0005 (0.0236)	-0.0101 (-0.578)	-0.025* (-1.67)	-0.0146 (-1.121)	-0.011 (-0.796)
FDD	-0.0583 (-0.315)	-0.0311 (-0.172)	-0.0708 -0.4310	-0.074 (-0.459)				
DER					-0.0587 (-0.318)	-0.032 (-0.172)	-0.0675 (-0.429)	-0.0685 (-0.450)
NFC	0.042* (1.964)				0.043* (1.94)			
NFR		0.045*** (2.343)				0.0479* (1.896)		
HERF1			0.113** (2.185)				0.1331** (2.036)	
HERF2				0.1038* (1.826)				0.1328** (2.237)
NSGM	0.0268** (2.014)	0.0224* (1.8012)	0.0188* (1.6097)	0.0211* (1.798)	0.0217** (2.210)	0.0172* (1.7492)	0.0116 (1.090)	0.0133 (1.353)
RD	3.978*** (3.219)	3.94*** (3.438)	3.910*** (3.496)	3.978*** (3.572)	-0.553 (-0.525)	-0.2178 (-0.220)	-0.0955 (-0.104)	-0.0073 (-0.008)
CAPEX	1.102** (2.441)	0.979** (2.3466)	1.156*** (2.77)	1.133*** (2.735)	-0.3613 (-0.749)	-0.298 (-0.647)	-0.0511 (-0.125)	-0.066 (-0.172)
Adjusted R^2	0.77	0.79	0.79	0.79	0.75	0.78	0.79	0.79
F-statistics	30.28***	33.6***	34.18***	33.28***	29.95***	31.67***	33.4***	34.2***

This table provides parameter estimates for the models: **Panel A**: $DER_i = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 FDD_i + \delta_4 OPER_i + \delta_5 NSGM_i + \delta_6 RD_i + \delta_7 CAPEX_i + \varepsilon_i$; **Panel B**: $FDD_i = \delta_0 + \delta_1 SIZE_i + \delta_2 FS_i + \delta_3 DER_i + \delta_4 OPER_i + \delta_5 NSGM_i + \delta_6 RD + \delta_7 CAPEX_i + \varepsilon_i$. Where $SIZE_i$ is the size of the firm, measured by the natural logarithm of market value of total assets for firm *i*, FS_i denotes the ratio of foreign sales to total sales for firm *i*, DER_i is the total notional amount of foreign currency derivatives scaled to total assets; FDD_i, the notional amount of foreign denominated debt, scaled to total assets, NFC_i is the number of countries in which the firm operates subsidiaries, NFR_i is the number of regions in which the firm operates subsidiaries, $HERF1_i$ is the geographical concentration of foreign subsidiaries on country level (*Herfindahl* 1), $HERF2_i$ is the geographical concentration of foreign subsidiaries on region level (*Herfindahl* 2), $NSGM_i$ is the firm's number of business segments, RD_i is the ratio of research and developments to total assets, and $CAPEX_i$ is the ratio of capital expenditures to total assets. Note: the levels of significance (1%, 5%, 10%) are: ***, **, *, respectively.

To sum up, the proxies for the use of operational hedging were found to be positively significantly related to the proxy for the use of financial hedging. This signals that these two hedging techniques are more likely to be complementary to each other in reducing exposure.

As noted in the correlation coefficients matrix, Table 5.11, there are many significant correlations among the explanatory variables used in the cross sectional models, which were designed to test the relationship between the use of both financial and operational hedging and the exposure. Apart from the positive correlations among the operational hedging variables, there is also significant correlation among the financial hedging variables (*DER* and *FDD*). For example, the use of currency derivatives is found to be negatively correlated with the use of foreign debt which confirms, in principle, that the use of currency derivatives is more likely to act as a substitute for the use of foreign debt. In addition, significant correlations were found between firm size and other control variables included in the model.

As a test of robustness, the parameters of the models were re-estimated by omitting some of the significant correlated explanatory variables to avoid multi-collinearity. The re-estimated parameters are reported in Panel C and D of Table 5.14. Panel C shows the re-estimated parameters in Models 14a – 14d. The operational hedging variables were regressed against the use of currency derivatives with respect to the capital expenditures ratio. All other explanatory variables were omitted. Following the omission of these correlated variables, the degree of significance of the parameters of these models remained largely similar to results in Panel A of Table 5.14. To sum up, the proxy for the use of operational hedges remained complement the proxy for currency derivatives use in reducing exposure.

Table 5.14

Financial hedges Are Substitutes For, Or Complement To, Operational Hedging… continued

	Panel C: *Dependent Variable* = DER				Panel D: *Dependent Variable* = FDD			
	Model 14a	**Model 14b**	**Model 14c**	**Model 14d**	**Model 14e**	**Model 14f**	**Model 14g**	**Model 14h**
I = Firms	62	62	62	62	62	62	62	62
Intercept t-statistics	0.49*** (4.359)	0.148 (1.507)	0.50*** (3.756)	0.31*** (2.554)	0.050 (0.359)	-0.68*** (-2.405)	0.115 (1.149)	0.137 (1.262)
SIZE				-0.015* (-1.996)				-0.004 (-0.796)
FS	0.013 (0.367)	-0.011 (-0.592)	0.002 (0.073)	-0.183 (-1.206)	0.007 (0.236)	0.152 (1.324)	-0.016 (-1.233)	-0.013 (-1.024)
FDD	-0.028 (-0.137)	-0.076 (-0.733)	-0.171 (-0.859)	-0.002 (-0.109)				
DER					-0.033 (-0.138)	-0.229 (-0.616)	-0.111 (-0.823)	-0.136 (-1.271)
NFC	0.009 (0.675)				0.078*** (7.933)			
NFR		0.067*** (2.486)				0.040 (0.941)		
HERF1			0.068* (1.767)				0.148*** (2.579)	
HERF2				0.108* (1.843)				0.157*** (2.853)
NSGM			-0.006 (-0.701)	0.015 (1.269)			0.016 (1.668)	0.021** (2.256)
RD								
CAPEX	0.431 (0.755)	0.521 (0.993)	0.278 (0.433)	0.987** (2.121)	0.562 (0.956)	3.818*** (5.327)	0.112 (0.291)	0.232 (0.666)
Adj. R^2	0.70	0.74	0.70	0.74	0.68	0.73	0.70	0.74
F-stat.	36.89***	44.60***	29.73***	30.41***	32.95***	39.27***	29.39***	31.10***

This table provides parameter estimates as robustness tests for the models specified in Table 5.14 through Panel C and Panel D. All the variables are identified in Table 5.13. All these models are estimated using OLS for one point in time of the 2004 financial year. To control for heteroskedasticity, White's (1980) test procedure was implemented. Note: the levels of significance (1%, 5%, and 10%) are: ***, **, and *, respectively.

The re-estimated parameters of the general model are reported as Models 14e – 14h in Panel D. The first two operational hedging proxies (*NFC* and *NFR*) were regressed against the use of foreign debt with respect to the capital expenditures ratio (*CAPEX*). All other explanatory variables were omitted. The degree of significance of the parameters of these models remained similar to results in Panel B of Table 5.14. This means that these two operational hedging variables were still positively and significantly related to exposure. However, the other two operational hedging variables (*HERF*1 and *HERF*2) were regressed against the use of foreign debt with respect to the capital expenditures ratio and the number of business segments. The degree of significance of the parameters of these models increased to be deeply significant, at the 0.01 level, when compared to the results in Panel B of Table 5.14. As found previously, these two operational hedging variables were positively significantly related to exposure. Therefore, results suggest that the use of operational hedging is a complementary strategy to financial hedging.

Therefore, after testing for robustness against multi-collinearity this study still finds strong evidence of a positive relationship between financial and operational hedging techniques in reducing exposure. This signals that these two strategies act as complements to each other in eliminating exposure.

5.4 CONCLUSION

This Chapter has reported the results of the data analysis for this research study. A two-stage market model was used to test the eight hypotheses in the study, which were related to foreign exchange rate risk management. The first-stage model (a two-factor asset pricing model) was used to examine the relationship between foreign exchange rate changes and stock returns. The study reported that the firm's stock returns were somewhat sensitive to changes in exchange rates. The present study finds weak evidence for a relationship between foreign exchange rate changes and stock returns, indicating that Australian multinational firms consistently hedge their foreign exchange rate exposures.

The results of the second-stage model were related to the effect of the use of financial and operational hedging on exposure. In the case of the effect of the use of financial hedging on exposure, the current study reports results of the four hypotheses tested in this regard. Strong negative significant evidence was reported for the relationship between the use of foreign currency derivatives and exposure. The other hypothesis tested was related to the relationship between the use of foreign denominated debt and exposure reduction. A strong negative significant relationship between the use of foreign debt and the exposure was reported. These latter findings suggest that financial hedging strategies are associated with exposure reduction.

The other two hypotheses tested relating to financial hedging and exposure are the effect of the combined use of foreign currency derivatives together with foreign debt on exposure, and whether these two strategies act as substitutes for, or complements to, each other in reducing exposure. This study found that the combined use of currency derivatives and foreign debt was significantly and negatively related to exposure, indicating that it was effective in reducing the exposure. However, these two financial hedging strategies were found to be significantly negatively related to each other. They act as substitutes for each other in reducing exposure. Strong evidence was reported of the use of operational hedges is effective in reducing exposure. In addition, the combined use of financial and operational hedges is effective in reducing exposure. Finally, positive significant evidence was found between financial and operational hedging in reducing exposure, indicating that financial hedging is complementary to operational hedging strategies.

The current study has reported evidence that the use of financial and operational hedging variables is positively associated with exposure reduction. Australian multinational firms use these two hedging strategies to effectively reduce exposure to currency risk, regardless of whether they use them either in isolation or in combination with each other. Therefore, the use of financial and operational hedging strategies is effective in reducing exposure to foreign currency risk.

CHAPTER SIX

CONCLUSIONS AND IMPLICATIONS

6.0 STRUCTURE OF CHAPTER SIX

The final chapter of the study summarises the findings of the hypotheses tests, noted in Chapter 5, and explores, on a preliminary basis, the implications of these findings for the further understanding of the basic problem, stated in Chapter 1. An overview of the research hypothesis and findings is identified in Section 6.2. The contributions of the study to the research literature are stated in section 6.3. The contributions of the study's findings to the general body of knowledge are explained in Section 6.4, while the limitations of the study are outlined in Section 6.5. The implications for further research directions are identified in section 6.6. Finally, the parties, who would potentially benefit from this study, are considered in Section 6.7.

6.1 INTRODUCTION

This study has investigated the general research problem of whether the use of financial and operational hedging is effective in reducing foreign exchange rate risk exposure. The study applies a two-stage market model to test the relevant research hypotheses. The first stage of this model is the use of a two-factor linear regression model to estimate the exposure to foreign exchange rate risk of a sample of Australian multinational corporations, during the period, 2000 - 2004. The second stage of this market model is the use of a cross-sectional regression model to examine the impact of the use of financial and operational hedging on foreign exchange rate exposure. In general, there is a lack of Australian research studies in this field, which have examined the impact of the use of financial and operational hedges on foreign exchange rate exposure. Therefore, the originality of this study stems from the paucity of Australian research work at the time that Australian firms have a substantial adoption of these hedging strategies. In light of these reasons, the investigation of the impact of the use of financial and operational hedging on foreign exchange rate risk exposure has become an issue of considerable interest.

6.2 OVERVIEW OF HYPOTHESES AND FINDINGS

From Chapter 5, it is very clear that this study has found that the use of financial and operational hedges is negatively related to foreign exchange rate exposure. This indicates that the combined or the separate use of financial and operational hedges is effective in reducing foreign exchange rate exposure. In other words, Australian multinational corporations use foreign currency derivatives and foreign debt and diversify and/or disperse their foreign subsidiaries across geographical regions and foreign countries for hedging purposes.

This section discusses the research findings, extensively reported in Chapter 5, in relation to the hypotheses tested in the study. These hypotheses were formally summarised in Section 4.0 of Chapter 4.

Hypothesis 1: Relationship between changes in exchange rate and stock returns

This first hypothesis tested was that there is no significant relationship between the firm's stock returns and exchange rate changes. A two-factor model (see Eq 4.1, Chapter 4) was used to test this hypothesis. The monthly stock excess return for each sample firm was regressed on both the monthly excess returns of Australian market index (the All Ordinaries Index) and the component of trade-weighted index (TWI) value excess relative to the AUD, orthogonal to the market. After estimating this model, the study found that there is a significant relationship between foreign exchange rate and stock returns of Australian multinational corporations. This significant relationship reflects how sensitive a firm's stock returns to changes in the value of the Australian dollar. Only 5 out of 62 corporations had significant foreign exchange rate exposure coefficients. This means that 8.06% of the sample firms showed a significant relationship between changes in exchange rate and stock returns (weak evidence). 1 out of 5 significant exposure coefficients had a negative sign, indicating that appreciation (depreciation) in the Australian currency would reduce (increase) the Australian firms' stock returns. However, 4 out of 5 significant exposure coefficients had a significant positive sign, signalling that appreciation (depreciation) of the Australian dollar would increase (decrease) the stock returns of such firm. Therefore, these positive and negative sign coefficients conform to the view that the stock returns of Australian multinational corporations are positively and negatively sensitive to changes in exchange rates. This weak relationship may result from the fact that Australian multinational corporations consistently hedge their foreign exchange rate exposures.

Hypothesis 2: The use of currency derivatives reduces exposure

To test whether the use of currency derivatives reduces foreign exchange rate exposure, two cross-sectional regression models were estimated (see Eqs 4.2 and 4.3, Chapter 4). The first model regressed the proxy for the use of foreign currency derivatives (the total notional amount of foreign currency derivatives divided by total assets) on the absolute value of the exposure coefficients. After estimating the first model, the study found that foreign currency derivatives are negatively significantly related to foreign exchange rate exposure coefficients, indicating that Australian multinational corporations use foreign currency derivatives for hedging purposes. In addition, when the first model was extended to control for the firm's ownership structure and the firm's characteristics, the study found, similar results, that there is a negative significant effect of the use of currency derivatives on foreign exchange rate exposure. This means that there is significant evidence that the use of currency derivatives was related to foreign exchange rate exposure, indicating that this usage effectively reduces exposure. Overall, Australian multinational corporations use currency derivatives for hedging purposes.

After estimating the second model, which the desirability of hedging and the firm's characteristics variables were added, the use of foreign currency derivatives remain negatively significantly related to exposure. Since the ownership structure may have an effect on the desirability of hedging, the hypothesis whether there is no significant effect of the firm's ownership structure on exposure to foreign exchange rate risk. Mixed evidence was found for the relationship between these three parties (directors, block-holders, and institutional) and exposure. The study found that the percentages of shares held by block-holders and institutions were significantly positively related to foreign exchange rate exposure. This indicates that block-holders and institutions shareholders do hedge their own portfolios' foreign exchange rate exposures and they have less concern about their firm's risk exposure in which they own shares. However, no evidence was found to the negative relationship between the percentages of shares held by directors and exposure. This means that Australian directors, who are concerned about the risk associated with their own assets, are expected to adopt hedging programs to reduce currency risk exposures. Although there were mixed evidence of the relationship between these three parties and exposure, the use of currency derivatives remained strongly significantly negatively related to exposure. Therefore, Australian multinational firms are more likely to use currency derivatives for hedging purposes.

Hypothesis 3: The use of foreign debt reduces exposure

In a similar vein to the previous hypotheses, two cross-sectional regression models were generated to test whether the use of foreign currency denominated debt significantly reduces exposure (Eqs 4.4 and 4.5, Chapter 4). The first model regresses the absolute values of the exposure coefficients against the proxies for the use of foreign currency denominated debt (foreign debt divided by total debt), foreign involvement (foreign sales divided by total sales) and firm size (the natural logarithm of market capitalization) (see Eq 4.4). To test this hypothesis further, the second model extended the basic model by including a set of control variables, representing the firms' hedging incentives (see Eq 4.5). After estimating these models, the study found evidence that the proxy for the use of foreign debt was significantly negatively related to foreign exchange rate exposure, indicating that this proxy effectively reduces exposure. This means that Australian multinational corporations are more likely to hold baskets of foreign currency to reduce foreign exchange rate exposure. This means that Australian firms use foreign debt for hedging purposes. Overall, the study found that the proxy for the use of foreign debt effectively reduces foreign exchange rate exposure.

Hypothesis 4: The combined use of currency derivatives and foreign debt reduces exposure

After testing the hypothesis that the combined use of currency derivatives and foreign debt effectively reduces exposure, the present study found that both the proxy for the use of currency derivatives (the total notional amount of foreign currency derivatives divided by total assets) and the proxy for the use of foreign debt (foreign debt is divided by total debt) (see Eqs 4.6, Chapter 4) are negatively significantly related to exposure. This indicates that the combined use of foreign currency derivatives and foreign debt is an effective hedging strategy. When the interaction variable, generated by multiplying the two proxies by each other, was added to replace the two individual financial hedging proxies (foreign derivatives and foreign debt), the study found that the interaction of both proxies for foreign currency derivatives and foreign debt was significantly negatively related to exposure. This suggests that the interaction between these two proxies has an effect in reducing exposure. Overall, the study found that this combined use of both foreign currency derivatives and foreign debt was significantly negatively related to exposure, i.e. was significantly related to exposure reduction. This means that Australian multinational firms are more likely to use the combination of both currency derivatives and foreign debt for hedging purposes.

Hypothesis 5: Currency derivatives complement foreign debt in reducing exposure

To test the hypothesis of whether, simultaneously, the use of currency derivatives is a complement to, or a substitute for, the use of foreign debt, in reducing exposure, two models were developed (see Eqs 4.8 and 4.9, Chapter 4). The study found that there is a negative significant relationship between the use of foreign debt and the use of currency derivatives, indicating that these two financial hedging strategies are substitutes for each other in reducing exposure. In addition, the use of foreign debt was also significantly negatively related to currency derivatives. This indicates that the use of foreign debt is an effective substitute for the use of currency derivatives in reducing the exposure. Therefore, Australian multinational corporations these two financial hedging strategies are simultaneously substitutive for each others to hedge exposure.

Hypothesis 6: The use of operational hedging reduces exposure

After testing the hypothesis that the use of operational hedging reduces exposure (see Eq 4.10, Chapter 4), the study found that operational hedging is negatively significantly related to foreign exchange rate exposure. This indicates that the four operational hedging proxies (foreign subsidiaries diversification (*NRC* and *NRF*) and foreign subsidiaries geographical concentration (*HERF*1 and *HERF*2)) were negatively related to exposure, signalling that these proxies are used to hedging foreign exchange rate exposure. Therefore, Australian multinational corporations diversify and disperse their foreign subsidiaries across foreign countries and geographical regions to hedge foreign exchange rate exposure.

Hypothesis 7: The combined use of financial and operational hedges reduces exposure

To test the hypothesis that the combined use of financial and operational hedging reduces exposure, a model was developed as illustrated in Equation 4.11 (Chapter 4). The model regressed the exposure coefficients on the two proxies for the use of financial hedging (currency derivatives and foreign debt) and on the proxies for operational hedging together with a set of control variables representing the firm's growth investment opportunities. After estimating the model, the study found strong evidence that these financial and hedging proxies were significantly related to exposure, indicating that the combined use of financial and operational hedges is associated with exposure reduction. This means that Australian corporations are more likely to combine their use of financial and operational hedging for hedging long- and short-term foreign exchange rate exposure.

Hypothesis 8: Financial hedges are complements to operational hedges in reducing exposure

After testing whether the use of financial hedging complements to, or substitutes for, operational hedging in reducing exposure (see Eq 4.12 and 4.13, Chapter 4), the following findings were stated. When the use of foreign currency derivatives is considered to complement, or substitute, the use of operational hedging, in reducing currency exposure, the current study found that the use of foreign currency derivatives is positively significantly related to the use of operational hedging. This means that the use of foreign currency derivatives was a complement to the use of operational hedging in reducing exposure. In addition, when the use of foreign debt is considered as a complement to, or a substitute for, operational hedging, in reducing currency exposure, the present study found that the use of foreign debt is positively significantly related to the use of operational hedging. This means that Australian multinational corporations use foreign debt as a complement to the use of operational hedging in reducing exposure.

Overall, the current study found that the use of foreign currency derivatives was significantly positively related to operational hedging, indicating that the use of foreign currency derivatives was complementary to the use of operational hedging in reducing foreign exchange rate exposure. In addition, strong evidence was found of a positive relationship between the use of foreign debt and operational hedging. This indicates that the use of foreign currency debt was complementary to operational hedging in reducing foreign exchange rate exposure.

6.3 CONTRIBUTION OF THE STUDY TO THE RESEARCH LITERATURE

There are several contributions that this study brings to the literature, herewith as follows:

6.3.1 Estimation of Foreign Exchange Rate Exposure (First-stage Model)

The first contribution of this study is the implementation of Jorion's (1991) model (asset pricing model approach) to estimate foreign exchange rate exposure coefficients. The overuse of Jorion's 1990 augmented model and the appropriateness of Jorion's 1991 model were the reason for replacing Jorion's (1990) augmented model.

6.3.2 Cross-sectional Regression Model (Second-stage Model)

There are also several contributions to research methodologies which this study brings to the literature. These contributions generally focus on the cross-sectional regression models. They are herewith, as follows:

1) The use of currency derivatives reduces foreign exchange rate exposure

The study contributes to the literature by investigating the effect of the use of currency derivatives on exposure reduction. To test the hypothesis of whether the use of currency derivatives reduces foreign exchange rate exposure, this study generated two models (see Eqs 4.2 and 4.3, Chapter 4). The major contribution of this study to the existing research methodologies is that it adds a set of control variables to the model to test whether the firm's ownership structure has an effect on the desirability of hedging the exposure. Therefore, the present study adds, to Allayannis and Ofek's (2001) and Nguyen and Faff (2003b) model, several control variables representing the firm's incentive to hedge (two gropus of variables representing the firm's characteristics and the firm's owenership structure). Specifically, it adds three proxies of the firm's ownership structure were included representing the percentages of shares held by directors, block-holders, and institutions, to test for the effect of the firm's ownership structure on the desirability to hedge, following Fok et al. (1997).

2) The use of foreign debt reduces foreign exchange rate exposure

The study contributes to the literature by investigating the effect of the use of foreign debt on exposure. To test whether the use of foreign debt has an effect in reducing exposure to foreign exchange rate risk, two models were generated (see Eqs 4.4 and 4.5). The major contribution of this study is the generation of these two models to test this hypothesis. Prior Australian studies (Nguyen & Faff, 2004, 2006) (see Section 3.3.3, Chapter 3) investigated the effect of, only, the effect of the combined use of both proxies for the use of foreign debt and currency derivatives on exposure without testing whether, only, the use of debt reduces exposure. Therefore, since there is a lack of Australian studies to test this hypothesis, the present study contributes to the literature by examining whether the use of foreign debt is effective in reducing exposure.

3) The combined use of currency derivatives and foreign debt reduces exposure

The study contributes to the literature by investigating the effect of the combined use of currency derivatives and foreign debt on exposure. When testing this hypothesis that the combined use of currency derivatives and foreign debt reduces exposure, the present study estimates two models (see Eqs 4.6 and 4.7, Chapter 4). The first model was the basic model, which regressed the absolute values of the foreign exchange rate exposure coefficients against the proxy for use of foreign debt and the proxy for foreign debt with respect to control variables representing the firm's incentives to hedge. Since there is also a lack of Austrlian study generally in this debate, the main contribution of this study is that it replaces the hedging proxies in the first model (foreign derivatives and foreign debt) with an interaction variable, generated by multiplying those two proxies by each other, as no Australian study to date has adopted this approach. In addition, it contributes to methodologies by measuring these two financial hedging proxies using continuous variables.

4) Currency derivatives are a complement to foreign debt in reducing exposure

The study contributes to the literature by investigating whether the use of currency derivatives and foreign debt simultaneously complement to, or substitute for, each other in reducing exposure. As noted in Chapter 3, the literature focussed on investigating whether the use of currency derivatives is a complement to, or substitute for, the use of foreign debt in reducing exposure. However, prior Australian studies (e.g., Nguyen & Faff, 2004, 2006) did not investigate whether these two financial hedging strategies simultaneously complement or substitute each other in reducing exposure (see Section 3.3.5, Chapter 3). Therefore, the present study contributes to existing research methodologies by generating two models to test whether foreign currency derivatives and foreign debt simultaneously complement, or substitute, each other in reducing exposure to foreign exchange rate risk (see Eqs 4.8 and 4.9, Chapter 4). These two models used a continuous variable procedure to measure the proxies for the use of the two financial hedging techniques.

5) The use of operational hedging reduces foreign exchange rate exposure

The study contributes to the literature by investigating the effect of the use of operational hedging on exposure. The main contribution of the study to the methodology is that it generates a model to test the hypothesis of whether operational hedging reduces exposure to foreign exchange rate risk (see Eq 4.10, Chapter 4). Prior studies examined this hypothesis through a model that included a proxy for financial hedging (currency derivatives) (see Section 3.4, Chapter 3). The inclusion of this proxy for financial hedging by prior studies is because it was considered as a motive for implementing operational hedging strategies. So, these studies did not investigate the effect on exposure of operational hedging only. In addition to the lack of Australian studies in this debate, the present study generates a model (see Eq 4.10) to test the effect of the use of operational hedging on exposure without including a financial hedging proxy.

6) The combined use of financial and operational hedging reduces exposure

As noted above, this study contributes to the literature by investigating the effect of the combined use of financial hedging (currency derivatives and foreign debt) and operational hedging on exposure. To test the hypothesis of whether the combined use of financial and operational hedging reduces exposure, the present study generated a model which regressed the foreign exchange rate exposure coefficients on proxies for the use of, foreign currency derivatives, foreign debt, and operational hedging (see Eq 4.11, Chapter 4). The contribution of this study to existing methodologies is that it adds a proxy for the use of foreign debt to the model. In addition to there a lack of Australian studies investigated this topic, prior studies also have left a gap in the literature as they investigated the effect of the combined use of currency derivatives (only as a financial hedging tool) and operational hedging on exposure (see Section 3.5, Chapter 3) without including a proxy for the use of foreign debt. Therefore, the present study examines the effect of the combined use of financial hedging (currency derivatives and foreign debt) and operational hedging on exposure

7) Financial hedging is a complement to operational hedging in reducing exposure

The study also contributes to the literature by investigating whether financial hedging use proxies individually complement, or substitute, operational hedging proxies in reducing exposure. The contribution of this study to the research methodologies is that it generates two models to test whether proxies for the use of foreign currency derivatives and use of foreign debt, individually, are complements to proxies for the use of operational hedging in reducing foreign currency exposure (see Eqs 4.12 and 4.13, Chapter 4). The first model regressed the proxy for use of foreign currency derivatives on operational hedging, a proxy for the use of foreign debt, and a set of control variables. The second model regressed a proxy for the use of foreign debt on the operational hedging, the proxy for the use of foreign currency derivatives and the same control variables used in the first model. This contribution stems from the lack of Australin studies and that prior studies (see Section 3.6, Chapter 3) have tested only the hypothesis that currency derivatives act as complements to operational hedging. However, these studies did not test whether use of foreign debt complements operational hedging. As there is no study, to date, has investigated whether the use of foreign debt is a complement to, or a substitute for, operational hedging, the contribution of this study is the generation of a model to test this hypothesis (Eq 4.13).

6.4 CONTRIBUTION TO THE BODY OF KNOWLEDGE

One of the underlying purposes of this study is to provide clear empirical evidence regarding the incidence of corporate foreign exchange rate risk, and how its management might be improved. This study makes a contribution to the existing body of knowledge by broadening the level of understanding relating to the management of foreign exchange rate risk, and by presenting new empirical results in relation to the impact of the use of financial and operational hedging on exposure. The mixed nature of the empirical evidence provided by prior studies and the lack of Australian studies conducted in this field have been a major motivation for carrying out the study.

The first contribution that this study makes to the body of knowledge is provision of new empirical evidence on the relationship between changes in exchange rate and firm value. Despite Australian multinational firms' extensive involvement in international activities, and the volatility of the Australian dollar, most previous studies found only limited evidence of a contemporaneous relationship between their stock returns and changes in exchange rates. For example, some studies reported weak evidence of this relationship (Loudon 1993a, 1993b; Benson & Faff, 2003), while another group of studies have reported stronger evidence of this relationship (Di Iorio & Faff, 2000, 2001a, 2001b, 2002). The present study provides new evidence of foreign exchange rate exposure at a firm-specific level of Australian multinational corporations.

The second contribution of the study is the information it provides on the impact of the use of financial hedging on corporate foreign exchange rate exposure. It is hoped that the empirical results provided by the study will generate, among corporate managers, investors, regulators, financial policy makers, and other financial markets participants, an appreciation of the need for improving financial market operations such as designing financial derivatives and re-evaluation of these financial instruments together with their responsibilities and obligations. Although there is a long history of documenting the use of derivatives, the past three decades have witnessed a substantial increase in the variety and complexity of these instruments. Many research studies have found that the range of derivatives instruments available today has increased the potential for firms to reduce their foreign exchange rate exposure. However, the wide range of these instruments, now available, has also increased the potential for risk-taking by firms. Consequently, the task of overseeing financial derivatives activities within firms has become more complicated. For these reasons, the new empirical evidence, provided by the present study, regarding firms' use of derivatives, might be considered a valuable contribution to the body of knowledge.

The present study also contributes to knowledge by providing new empirical evidence concerning the effect of the use of foreign-currency denominated debt on foreign exchange rate exposure. While firms use foreign debt to create a 'natural' hedge against foreign exchange rate risk, foreign debt is also, itself, a source of such risk. Consequently, it is expected that the results of this study will strengthen the appreciation among corporate managers of the importance of the task of overseeing the use of foreign debt.

A further contribution of the study to this existing literature relates to its investigation of how firms' foreign exchange rate exposures are affected by operational hedging. This is achieved by broadening the level of understanding relating to operational hedging matters and by presenting empirical results of the relationship. This information is of interest to managers, investors, and regulators. The study provides some useful information relating to the number of foreign subsidiaries of Australian multinational firms for the 2004 financial year. To the author's knowledge there are no Australian sources, publicly available, which provide data regarding the numbers of such foreign subsidiaries, across countries and geographical regions. For example, the Australian Bureau of Statistics has published only one survey of the number of foreign subsidiaries of Australian firms.[116] In addition, the ABS (2004) survey does not give details of foreign subsidiaries per firm, only subsidiaries per industry sector. The new empirical results of the relationship between the use of operational hedging and exposure, therefore, provide evidence, for Australian firms, that diversifying their foreign subsidiaries across countries and geographical regions is, potentially, one of the most comprehensive and powerful hedging strategies.

6.5 LIMITATIONS

This study contains the following fundamental limitations and assumptions:

[116] The Australian Bureau of Statistics published a survey about the number of Australian owned subsidiaries spread across foreign countries and geographical regions by industry level. For more information see ABS (2004, 2004a).

The assumptions are:

- Logarithmic utility specification for investors;
- Identical risk-free rates of interest in Australia;

The limiations are:

- The research methods used to estimate the first- and second-stage models;
- The same control variables used in the cross-sectional regression models;
- The measurements used to quantify the proxies for financial and operational hedges;
- The sample period selected to conduct this study;
- Using the absolute value of foreign exchange rate exposure coefficients instead of non-absolute value of these coefficients when estimating the cross-sectional regression models.

The findings of the study are therefore qualified to the extent that a violation of any of these assumptions may invalidate the test results.

6.6 IMPLICATIONS FOR FURTHER RESEARCH DIRECTIONS

This study has identified several areas which are worthy of further research.

1) Different data sets from different countries

In addition to the use of different models to estimate the exposure coefficients, the present study could be extended to other countries with open economies such as

Japan and some European countries. In addition, it could be extended to smaller Australian corporations.

2) Analysis at the Australian industry sector level

As noted in Section 6.6 of this Chapter, there is a general lack of Australian data relating to the number of Australian firms' foreign subsidiaries, across foreign countries and geographical regions. In light of this, the current study conducted its own survey of the number of such subsidiaries across foreign countries, based on the 2004 financial year. Using the single survey published by the Australian Bureau of Statistics, as a basis, the current study could be extended by examining foreign subsidiaries at an industry sector level, instead of a firm-level.

3) Using different models to estimate the exposure coefficients

There are several other models which could be used to estimate corporate exposure to foreign exchange rate risk, as alternatives to Jorion's (1990 and 1991) models (see Section 3.2 of Chapter 3). Many studies have derived different models and frameworks to estimate risk exposure (for example, Choi et al., 1992; Bartov & Bodnar, 1994; Chew et al., 1997a, 1997b; Chow & Chen, 1998; Gao, 2000; Williamson, 2001; Bartram, 2004; Priestley & Odegaard, 2007). The latter models adopt either a capital market approach, or a cash flow approach, to estimate the exposure coefficients. In this light, therefore, a useful future research contribution could be made by using the approach of one, or more, of these alternative models.

4) Control variables

The present study has used certain sets of control variables in its cross-sectional models, such as the firm's incentives to hedge. These variables belong to groups such as the firm's ownership structure, the firm's characteristics, and the firm's investment growth opportunities as determinants of exposure. However, there are many control variables that have not been included in this study such as tax carried forward, Tobin's Q ratio, Price-to-Earnings ratio, market-to-book ratio, and interest cover ratio…etc. Therefore, including new sets of control variables may be considered one of the issues that could be applied to further studies.

5) Analysis using non-absolute values for the exposure coefficients (exploring sign effects)

Another issue, which might merit investigation in future research studies, is the use of non-absolute values for exposure coefficients. The current study demonstrates that the sign of exposure coefficients gives an insight into the relationship between the firm's stock returns (firm value) and changes in exchange rate. If the exposure coefficient is negative, this indicates that the value of the firm (the stock returns) increases as the value of the Australian dollar (the exchange rate) depreciates. However, if the exposure coefficient is positive, this indicates that the value of the firm (the stock returns) increases as the value of the Australian dollar appreciates. In measuring the exposure, the present study uses the absolute value of these exposure coefficients to eliminate this "sign confusion effect". Since the use of an absolute value of exposure coefficients, as a proxy for foreign exchange risk exposure, is one of the limitations of the present study, it might be possible for future studies to use the original exposure coefficients without employing their absolute values. Exploring the sign effect is a potentially important topic as it might provide additional insight into the relationship between foreign exchange rate exposure and the use of financial and operational hedging.

6) Alternative measurements of operational hedging proxies

A future research direction, which could be applied within cross-sectional models, to investigate the impact of the use of financial and operational hedging on exposure, is the application of different measures for the use of operational hedging. For example, some prior studies measured operational hedging by alternate ratios of capital expenditure, research and development, and advertising expenditures.

7) Different research estimation methods

In addition, future research could implement the use of different estimation methods of the cross-sectional regression model. There are several alternatives to the Weighted Least Squares (WLS), which is used in the current study. For example, the Seemingly Unrelated Method (SUR) and the Generalised Method of Moments (GMM) might be used. Since these techniques are claimed to be more powerful than other techniques, they might produce different results from those reported in this study.

8) Hedging translation exposure

This study has concentrated on the hedging of economic exposure to foreign exchange rate risk. Another important topic, which could be subject to future research studies, is the management of foreign currency translation exposure. At the present time there is a lack of published Australian studies conducted in this area. The question of the management of translation exposure does merit further research as it is not without controversy, and is of interest to corporate financial managers.

6.7 WHO WOULD BENEFIT FROM THIS THESIS?

1) Corporate Treasurers

The empirical evidence provided by this study reports that the use of financial and operational hedges is effective in reducing the exposure to foreign currency risk for a sample of Australian multinational corporations. Hedging foreign currency risk exposure has two practical implications for corporate treasurers, relating to minimising costs and reducing risks.

While implementing corporate hedging strategies is expensive, some firms could be advantaged by using these hedging strategies to minimise the costs of agency problems, financial distress, taxes, and managerial aversion costs. This is because minimising these costs could more than compensate for the costs incurred by engaging in hedging strategies. The benefits of hedging are likely to differ across firms in ways which depend on various firm-level financial and operating characteristics. Further, firms would be potentially advantaged, in terms of increased share market valuations, by using financial and operational hedging to reduce their currency risk exposures.

To conclude, the findings of this study strengthen the confidence of corporate treasurers that use of hedging strategies is effective in reducing exposure and enhancing firm value.

2) Designers of derivative products

The present study could also be beneficial for designers of these financial instruments. This is because it provides evidence that derivatives are effective in hedging foreign currency risk. The potential utility of financial derivatives is dependant on many factors, such as their terms of exercise, their expiration dates, and the prices of the underlying assets over which they are written. In addition, there are other factors which also determine how efficient these products are, such as the computer programs used to price them. The evidence provided by this study, that the use of derivatives is effective in reducing exposure, gives an assurance to the designers of these products, and also to those who operate the markets in which they are traded, that they are proving beneficial to their intended end users.

3) Market Regulators

The use of derivatives for speculation purposes has caused an increase in corporate losses across time (see Chapter 2). Consequently, financial regulators have been calling for mandatory disclosures of trading activities in these instruments, for two decades. For example, the Australian Securities and Investment Commission (ASIC) and the Australian Prudential and Regulatory Authority (APRA) have made clear desire to see financial institutions and corporations, which have significant involvement in trading and derivatives activities, adopting the same standards of disclosure. This is because disclosing meaningful information about a firm's derivatives exposure is beneficial to investors, depositors, creditors, and others, in evaluating activity and performance, and in deciding whether to invest in, or do business with, the firms involved. Therefore, providing meaningful information for market participants can impose strong market discipline on those firms to manage their trading and derivatives activities in a prudent fashion and in line with stated business objectives.

The findings of this study might be beneficial to financial regulators as they engender more confidence that these financial products are being deployed effectively by firms, for hedging purposes, at least.

4) Investors

It was indicated previously that foreign currency hedging is of critical importance for individual and institutional investors. In summary, Australian investors have the potential to increase their personal utility by investing in a firm with a superior risk-return tradeoff. In terms of foreign exchange rate risk, they could do this by investing in firms which successfully hedge their foreign currency exposures. Of course, not all investors may wish to rely on the management of the firm to manage foreign exchange rate risk, as they consider that they can do this more cheaply through their personal portfolio diversification strategies.

A lack of evidence of the potential for risk reduction through the use of both financial and operational hedging strategies serves to foster doubt about the positive outcomes of hedging. The reported results of this study indicate that the use of both financial and operational hedging is effective in reducing foreign exchange risk exposure. One implication of the study results for investors, therefore, is that they can invest in multinational firms with confidence that they can enjoy a superior risk-return tradoff due to hedging activities.

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APPENDICES

Appendix 5.1: Stationarity Tests Results

The Results Of Using Dickey-Fuller (DF) Test of Nonstationarity versus Stationarity

Firm	No intercept	intercept		Intercept and trend		
	H_0: $\delta_1 = 0$	H_0: $\delta_1 = 0$	H_0: $\delta_1 = \delta_2 = 0$	H_0: $\delta_1 = 0$	H_0: $\delta_0 = \delta_1 = \delta_2 = 0$	H_0: $\delta_1 = \delta_2 = 0$
	observed τ	Observed τ_μ	observed ϕ_1	observed τ_τ	observed ϕ_2	Observed ϕ_3
ADA	-8.072	-3.2295	5.215	-3.1903	3.4316	5.1473
ALL	-6.852	-1.6784	1.4345	-1.8722	1.3056	1.9323
AMC	-8.862	-2.0872	2.1782	-2.5229	2.1280	3.1920
BIL	-8.768	-2.3891	2.8664	-2.5566	2.3419	3.5004
CNA	-7.639	-3.2152	5.1701	-3.2791	3.6065	5.4084
COH	-8.739	-1.8334	1.6844	-1.3367	1.1055	1.6546
CPB	-5.218	-1.8945	2.4233	-2.3026	2.2799	2.7904
CPU	-7.371	-2.8819	4.1854	-3.2265	3.5264	5.2561
CSL	-6.608	-2.4929	3.1209	-2.4725	2.0475	3.0580
CSR	-7.075	-2.5341	3.2276	-2.4740	2.1748	3.2458
CTY	-5.404	-1.9696	1.9903	-2.6609	2.5633	3.7916
CXP	-7.548	-3.3381	5.8197	-2.8407	3.8015	5.4596
DRA	-5.931	-3.1950	5.1389	-3.3341	3.7311	5.5619
GUD	-6.792	-3.1580	5.1124	-3.1439	3.4652	5.0734
HDR	-7.841	-2.0732	2.1960	-1.9923	1.4621	2.1472
HNG	-6.803	-2.4973	3.1857	-2.7754	2.6442	3.8982
HVN	-8.202	-3.2138	5.1744	-3.1850	3.4320	5.1380
HWI	-8.202	-2.9766	4.4613	-3.9302	2.9189	4.3484
KYC	-7.412	-2.7081	3.6707	-3.0687	3.1438	4.7117
LCL	-7.209	-2.7111	3.7279	-2.8629	2.8629	4.2413
MCP	-9.206	-2.6127	3.5622	-2.6765	2.5282	3.6565
MRL	-7.947	-2.0484	2.0980	-3.3544	4.4474	6.6711
ORI	-6.505	-2.0781	2.1987	-2.4586	2.0641	3.0565
PBL	-7.998	-2.0372	2.1998	-3.0309	3.2967	4.8099
PMP	-6.516	-2.3976	2.8933	-2.8682	2.7581	4.1195
PPX	-6.274	-2.8727	4.1269	-3.2205	3.4784	5.2168
RIC	-7.731	-1.8756	1.7596	-2.4029	1.9761	2.9567
RSG	-7.332	-2.9228	4.3309	-3.0991	3.2933	4.8802
SEV	-8.284	-2.8951	4.2209	-2.8535	2.8800	4.2902
SSX	-7.576	-3.2056	5.2289	-3.2877	3.7139	5.4851
VSL	-7.096	-2.4046	2.8920	-2.2615	1.9033	2.8540
AOI	-7.922	-2.7713	4.0166	-2.9726	3.0770	4.4384
TWI	-5.726	-2.9240	4.3321	-3.0204	3.1550	4.6754
Crit. values	**-1.61**	**-2.60**	**3.94**	**-3.18**	**4.31**	**5.61**

DF test is firstly used to test for stationarity as in the following three situations as: (1) without intercept: $\Delta Y_t = \delta_1 y_{t-1} + \varepsilon_t$; (2) with intercept: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \varepsilon_t$; (3) intercept and trend: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \delta_2 t + \varepsilon_t$. From the results, it appears that nonstationarity exists as the observed values of using τ and ϕ tests of the coefficient (in their absolute terms) are less than the critical values (crit.) at 10% level of confidence. Therefore, the null hypothesis is rejected.

The Results After Using Augmented Dickey-Fuller (ADF) Procedure

Firm	No intercept	intercept		Intercept and trend		
	H_0: $\delta_1 = 0$	H_0: $\delta_1 = 0$	H_0: $\delta_0 = \delta_1 = 0$	H_0: $\delta_1 = 0$	H_0: $\delta_0 = \delta_1 = \delta_2 = 0$	H_0: $\delta_1 = \delta_2 = 0$
	observed τ	observed τ_μ	Observed ϕ_1	observed τ_τ	observed ϕ_2	observed ϕ_3
ADA	-3.263	-7.3395	26.958	-7.3211	17.882	26.799
ALL	-3.173	-5.2085	13.627	-5.1829	9.0541	13.520
AMC	-3.892	-6.1675	19.706	-6.1675	12.942	19.207
BIL	-2.968	-6.001	18.070	-6.0252	12.157	18.220
CAN	-3.591	-5.4667	14.948	-5.4083	9.7865	14.674
COH	-2.688	-4.9054	12.036	-4.9744	8.3070	12.456
CPB	-1.483	-4.4083	9.7280	-4.4607	7.0085	10.501
CPU	-2.408	-5.6070	15.778	-5.6941	10.866	16.240
CSL	-2.325	-6.0539	18.453	-6.1032	12.743	18.985
CSR	-2.805	-7.8352	30.762	-7.7875	20.335	30.437
CTY	-2.438	-6.3208	20.031	-6.3051	13.348	19.968
CXP	-2.957	-5.6060	15.725	-5.6399	10.640	15.948
DRA	-2.642	-4.2961	9.2390	-4.2925	6.2925	9.4283
GUD	-1.822	-4.6706	11.004	-4.6392	7.3472	10.925
HDR	-3.045	-5.8753	17.260	-5.8149	11.366	17.048
HNG	-3.219	-6.0297	18.179	-5.9769	11.915	17.872
HVN	-3.290	-5.4556	14.884	-5.4670	9.9664	14.947
HWI	-3.290	-3.6401	6.6645	-3.5927	4.3754	6.5245
KYC	-2.627	-5.1621	13.328	-5.1173	8.7345	13.097
LCL	-3.232	-6.5956	21.757	-6.5625	14.360	21.534
MCP	-2.693	-6.3926	20.438	-6.3448	13.423	20.129
MRL	-1.990	-6.6735	22.48	-6.6302	14.819	22.019
ORI	-2.755	-6.8341	23.371	-6.7584	15.297	22.927
PBL	-2.299	-6.7441	22.797	-9.7566	15.252	22.825
PMP	-3.573	-6.2972	19.829	-6.2322	12.949	19.422
PPK	-2.153	-5.1822	13.445	-5.1185	8.8007	13.184
RIC	-3.921	-5.9507	17.815	-5.8649	11.648	17.364
RSG	-2.751	-4.6509	10.822	-4.6574	7.2353	10.847
SEV	-2.632	-4.4363	9.8508	-4.5170	6.8081	10.202
SSX	-3.691	-6.3652	20.260	-6.3172	13.305	19.956
VSL	-2.119	-5.2586	13.834	-5.4754	10.068	15.125
AOI	-2.463	-5.7177	16.369	-5.7237	11.037	16.535
TWI	-2.768	-5.8267	17.006	-5.7767	11.141	16.690
Crit. Values	**-1.61**	**-2.60**	**3.94**	**-3.18**	**4.31**	**5.61**

ADF test is secondly used to test for stationarity as in the following three situations as: (1) without intercept: $\Delta Y_t = \delta_1 y_{t-1} + \sum^{4}_{i=1} \delta_j \Delta Y_{t-i} + \varepsilon_t$; (2) with intercept: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \sum^{4}_{i=1} \delta_j \Delta Y_{t-i} + \varepsilon_t$; (3) intercept and trend: $\Delta Y_t = \delta_0 + \delta_1 y_{t-1} + \delta_2 t + \sum^{4}_{i=1} \delta_j \Delta Y_{t-i} + \varepsilon_t$. From the results, it appears that stationarity exists as the observed values of using τ and ϕ tests of the coefficient (in their absolute terms) are now more than the critical values at 10% level of confidence. Therefore, the null hypothesis is accepted.

Appendix 5.2: Auto-correlation Tests Results

Summary of Statistical Test of The 10 Autocorrelation Cases
These Results as appeared in the Ljung-Box Q-statistics used to test for auto-correlation

		1	2	3	4	5	6	7	8	9	10
	Firms	**ADZ**	**BHP**	**BIL**	**BLD**	**BPC**	**CTY**	**DRA**	**HWI**	**MCP**	**NUF**
Lag 1	**Obs. Q**	2.80	4.85	1.84	10.85	0.48	7.36	4.28	4.10	7.80	5.47
	Crit. Q	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Obs. P	0.09	0.028	0.175	0.001	0.49	0.007	0.039	0.043	0.005	0.019
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 2	**Obs. Q**	8.15	4.92	2.57	11.19	7.14	10.45	4.43	5.72	8.24	5.70
	Crit. Q	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
	Obs. P	0.02	0.085	0.276	0.004	0.028	0.005	0.109	0.057	0.016	0.058
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 3	**Obs. Q**	18.6	4.97	5.33	11.38	8.52	13.04	4.75	8.04	8.26	5.81
	Crit. Q	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76
	Obs. P	0.00	0.174	0.149	0.01	0.036	0.005	0.191	0.045	0.041	0.121
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 4	**Obs. Q**	20.6	6.24	5.34	11.38	8.65	13.35	5.09	8.10	8.28	5.92
	Crit. Q	2.53	2.53	2.53	2.53	2.53	2.53	2.53	2.53	2.53	2.53
	Obs. P	0.00	0.182	0.254	0.023	0.07	0.01	0.278	0.088	0.082	0.205
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 5	**Obs. Q**	26.4	7.89	9.96	11.62	12.48	15.05	6.72	8.62	9.42	5.97
	Crit. Q	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
	Obs. P	0.00	0.162	0.076	0.04	0.029	0.01	0.243	0.125	0.094	0.309
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 6	**Obs. Q**	31.3	11.41	16.28	12.66	13.21	19.7	6.93	11.87	10.96	6.95
	Crit. Q	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
	Obs. P	0.00	0.076	0.012	0.049	0.04	0.003	0.327	0.065	0.09	0.326
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 7	**Obs. Q**	32.9	12.45	20.16	13.71	15.43	19.7	7.44	14.64	13.07	9.63
	Crit. Q	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
	Obs. P	0.00	0.087	0.005	0.057	0.031	0.006	0.384	0.041	0.07	0.21
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 8	**Obs. Q**	36.2	13.28	20.8	14.13	20.26	21.25	7.46	21.5	16.26	13.43
	Crit. Q	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
	Obs. P	0.00	0.102	0.008	0.078	0.009	0.007	0.488	0.006	0.039	0.098
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

After estimating our original model, Eq 4.1, to test the hypothesis whether no auto-correlation exists for up to AR(8), the results in the Ljung-Box Q-statistics are reported above and they appear significant as the joint null hypothesis is rejected as no auto-correlation exists. The joint null hypothesis is as follows: H_0: $\rho_1 = \rho_2 = \rho_3 =, \ldots, = \rho_8 = 0$, no autocorrelation exists. The critical value of Q-statistic (Crit. Q) for 3 (explanatory variables) and n = 60. It appears that the observed values of Q-statistic of the 10 firms, at 0.05 level of confidence, are more than the its critical values. This indicates that these 10 firms have auto-correlation as the joint null hypothesis is rejected.

The Diminishing of The 10 Auto-Correlation Cases stated in the Previous Table

These Results as appeared in the Ljung-Box Q-statistics After Using the Maximum Likelihood Estimates (MLE) Method for transforming against auto-correlation

		1	2	3	4	5	6	7	8	9	10
	Firms	**ADZ**	**BHP**	**BIL**	**BLD**	**BPC**	**CTY**	**DRA**	**HWI**	**MCP**	**NUF**
Lag 1	**Obs. Q**	0.00	2.36	0.02	0.35	0.00	0.02	0.01	0.06	0.05	0.02
	Crit. Q	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Obs. P	0.970	0.124	0.879	0.555	0.988	0.886	0.907	0.800	0.827	0.900
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 2	**Obs. Q**	0.02	2.56	0.13	2.41	0.00	0.02	0.04	0.09	0.58	0.53
	Crit. Q	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
	Obs. P	0.988	0.278	0.935	0.299	0.999	0.990	0.978	0.957	0.747	0.769
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 3	**Obs. Q**	2.92	2.63	3.09	5.09	0.77	0.85	1.00	1.63	0.80	0.71
	Crit. Q	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76	2.76
	Obs. P	0.405	0.452	0.377	0.165	0.855	0.838	0.801	0.652	0.849	0.870
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 4	**Obs. Q**	4.96	4.45	3.12	5.21	1.43	1.08	1.23	1.85	0.80	0.81
	Crit. Q	2.53	2.53	2.53	2.53	2.53	2.53	2.53	2.53	2.53	2.53
	Obs. P	0.291	0.348	0.538	0.267	0.839	0.897	0.873	0.763	0.938	0.937
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 5	**Obs. Q**	9.28	5.15	6.08	6.17	2.66	1.72	1.87	1.96	1.71	0.92
	Crit. Q	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
	Obs. P	0.098	0.398	0.299	0.290	0.753	0.886	0.867	0.854	0.887	0.968
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 6	**Obs. Q**	9.69	9.12	9.79	8.21	3.39	6.28	1.87	4.46	1.78	2.79
	Crit. Q	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
	Obs. P	0.139	0.167	0.134	0.223	0.758	0.392	0.931	0.614	0.939	0.835
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 7	**Obs. Q**	13.16	10.43	12.56	9.85	3.58	7.73	2.86	4.97	2.02	4.27
	Crit. Q	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
	Obs. P	0.068	0.165	0.083	0.197	0.827	0.357	0.897	0.664	0.959	0.748
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lag 8	**Obs. Q**	15.43	11.23	13.21	14.09	8.21	8.05	2.89	8.73	6.35	7.16
	Crit. Q	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
	Obs. P	0.051	0.189	0.105	0.079	0.414	0.429	0.941	0.366	0.608	0.520
	Crit. P	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

After re-estimating the auxiliary model generated to test the hypothesis whether our original model, Eq. 4.1, including a maximum of eight lags periods from the dependent variable as explanatory variables in the model, the results in the Ljung-Box Q-statistics shown above appear significant as the joint null hypothesis is accepted indicating that there is no auto-correlation exists. This is because the observed value of Q-statistics (Obs. Q) is less than the critical value (Crit. Q) at the 0.05 level. Therefore, compared with the previous table all the auto-correlation coefficients are appeared statistically not different from zero signalling that no auto-correlation exists.

Appendix 5.3: Heteroskedasticity Tests Results

Summary Results Of The Statistical Test Using White's (1980) General Test Model To Test For Heteroskedasticity

Firms	Obs. χ^2	Crit. χ^2	df	Obs. P-value	Crit. P-value
CTY	16.801	9.48773	4	0.03225	0.05
DRA	15.965	9.48773	4	0.04289	0.05
GNS	14.329	9.48773	4	0.00632	0.05
PPX	15.092	9.48773	4	0.00451	0.05
QCH	10.236	9.48773	4	0.03663	0.05
TEL	9.752	9.48773	4	0.04483	0.05
VSL	13.818	9.48773	4	0.00790	0.05

In this table the seven cases having heteroskedasticity are reported. The White's (1980) is implemented and the joint hypothesis of the estimated coefficients of the auxiliary model, generated by running the regression of the squared residual of the original model, Eq 4.2, against all the explanatory variables used in Eq 4.2 with intercept term, is tested. Therefore, these estimated coefficients of this auxiliary model are tested jointly with null hypothesis: H_0: $\alpha_0 = \alpha_1 = \alpha_2 = 0$: no heteroskedasticity exists. It is found that the 7 firms above having heteroskedasticity as this joint null hypothesis is rejected at 0.05 level of confidence using chi-square (χ^2) test. If the Observed value (Obs. χ^2) of chi-square is less than the critical value of chi-square (0.05), the null hypothesis is rejected as heteroskedasticity exists. Therefore, all the above results show that observed p-value is less that 0.05.

Summary Of Heteroskedastictiy Results After Transforming Using The White's Heteroskedasticity-Corrected Consistent Estimators Of The Standard Error

Firms	Obs. χ^2	Crit. χ^2	d.f.	Obs. P-value	Crit. P-value
CTY	6.170	9.48773	4	0.18683	0.05
DRA	5.735	9.48773	4	0.21981	0.05
GNS	7.236	9.48773	4	0.16582	0.05
PPX	4.987	9.48773	4	0.2564	0.05
QCH	3.986	9.48773	4	0.31256	0.05
TEL	8.012	9.48773	4	0.12564	0.05
VSL	5.236	9.48773	4	0.22125	0.05

The seven heteroskedastic cases, stated in the previous table, are now not heteroskedasticity. This is due to the transformation of the original model using White's heteroskedasticity-corrected consistent estimators of the standard error. This test relies on an estimation of the variance and covariance of the least square coefficient estimators even if heteroskedasticity exists. In this case, the White's estimators for the variance of the coefficients of the independent variables are obtained by replacing the known, σ^2, by the squares of the least squares residuals, ε_{it}^2. Therefore, the estimated coefficients of this original model, stated in the null hypothesis in the previous table, are tested jointly. It is found that these 7 cases, now, have no heteroskedasticity as this joint null hypothesis is accepted at 0.05 level of confidence using chi-square (χ^2) test. If the Observed value (Obs. χ^2) of chi-square (White's test) is more than the critical value of chi-square (0.05), the null hypothesis is accepted as heteroskedasticity exists. Therefore, all the above results show that observed p-value is more than 0.05. Lagrange Multiplier (LM) has been used.

Appendix 5.4: Conditional Heteroskedasticity Tests Results

The empirical results of conditional heteroskedasticity cases are addressed as follows:

Summary Results Of The Statistical Test Using ARCH (1) Models To Test For Conditional Heteroskedasticity					
Firms	**Obs.** χ^2	**Crit.** χ^2	**df**	**Obs. P** χ^2	χ^2 level of conf.
APN	10.583	5.9914	2	0.00114	0.05
CTY	10.515	9.4878	4	0.00118	0.05
LCL	11.236	9.4878	4	0.00102	0.05
SBC	9.9856	9.4878	4	0.00809	0.05
These four conditional heteroskedastic cases have observed values of ARCH (1) less that the critical value of chi-square (χ^2) with d.f. and 0.05 level of confidence, indicating that the joint null hypothesis, H_0: $\varphi_0 = \varphi_1 = \varphi_2 = 0$, is rejected stating that conditional heteroskedasticity exists.					

The empirical results of the transformed conditional heteroskedasticity cases are addressed as follows:

Summary Of Conditional Heteroskedastictiy Results After Transforming Using Lagrange Multiplier (LM) of GARCH (1, 2)					
Firms	**Obs.** χ^2	**Crit.** χ^2	**df**	**Obs. P** χ^2	χ^2 level of conf.
APN	3.86552	5.9914	2	0.1564	0.05
CTY	6.2356	9.4878	4	0.1092	0.05
LCL	5.3261	9.4878	4	0.2014	0.05
SBC	6.8791	9.4878	4	0.1123	0.05
The 4 conditional heteroskedastic cases, stated in the previous table, are now with no conditional heteroskedasticity, after applying GARCH (1, 2). The Lagrange Multiplier (LM) observed values, as it follows chi-square distribution (Obs. χ^2) for these 4 cases are appeared more that the critical value chi-square (χ^2) at 0.05 level of confidence with 4 d.f. This indicates that the null hypothesis is accepted as no conditional heteroskedasticity exists.					

Appendix 5.5: Survey of the Number of Foreign Subsidiaries

A Summary of The Number of Subsidiaries Operate Abroad Across Countries and Regions for The 2004 Financial Year

Asian Crisis		**Asian others**		**NAFTA**		**European Union**		**Western Europe**		**Eastern Europe**		**Central America & Caribbean**		**South America**		**Africa**	
China	50	Bangladesh	3	Canada	54	Austria	10	Cyprus	2	Slovenia	2	Antigua & Barbuda	3	Argentina	14	Algeria	3
Hg Kg	82	Brunei	3	Mexico	28	Belgium	14	Gibraltar	3	Cyprus	1	Aruba	1	Bolivia	2	Botswana	1
Indonesia	50	Fiji	25	US	405	Denmark	17	Ireland	21	Estonia	1	Bahamas	13	Brazil	24	Egypt	1
Japan	14	India	27			Finland	6	Jersey	1	Jersey	3	Barbados	4	Chile	12	Ghana	5
Malaysia	98	Kyrgyzstan	5			France	48	Switzerland	11	Poland	5	Cayman Islands	28	Colombia	6	Guinea	2
Philippine	16	Mongolia	2			Germany	80	Turkey	3	Turkey	1	Dominican Rep.	3	Ecuador	2	Malawi	1
S. Korea	5	NZ	370			Greece	4			Cz. Rep.	5	El Salvador	2	Guyana	1	Mali	3
Singapore	152	Pakistan	2			Italy	16					Guatemala	2	Peru	4	Mauritania	1
Taiwan	10	Papua N G	57			Luxembourg	6					Honduras	3	Uruguay	6	Mauritius	7
Thailand	30	S. Arabia	1			Netherlands	87					Panama	1	Venezuela	3	Morocco	1
		Solomon Is.	3			Portugal	12					Puerto Rico	1			Namibia	3
		Sri Lanka	5			Norway	3					Trinidad & Tobago	1			S. Africa	43
		UA Emir’s	2			Switzerland	11					Virgin Islands	16			Tanzania	9
		Vanuatu	7			Spain	9									Zimbabwe	4
		Vietnam	3			Sweden	9										
						UK	352										
Total	**507**		**515**		**487**		**684**		**41**		**18**		**78**		**74**		**84**

Note: The number of firms is 181 Australian firms operating subsidiaries overseas for the financial year 2004 is 2489.

The Distribution Of Foreign Subsidiaries Across Foreign Countries and Geographical Regions For the 181 Australian corporations

	No. of foreign Countries hosting subsidiaries	Our Survey of No. of foreign subsidiaries 2004 (N=181)	Weight	ABS Survey 2002/2003 of No. of foreign subsidiaries	Weight
Asian-Pacific and Crisis Region[a]	15	970	0.390	1,586	0.395
European Union[b]	16	691	0.278	1,108	0.276
NAFTA[c]	3	487	0.196	1111	0.277
Africa[d]	14	84	0.034	151	0.038
Central America & Caribbean[e]	14	75	0.030	106	0.026
South America[f]	10	74	0.030	66	0.016
Asian Region others[g]	10	57	0.023	122	0.031
Western Europe[h]	5	21	0.008	45	0.011
Eastern Europe[i]	4	13	0.005	22	0.005
Total	**88**	**2,489**	**1.00**	**4,012**	**1.00**

Since the number of foreign subsidiaries per country has not been clearly identified in the ABS survey, the following number of foreign subsidiaries only for our study's 2004 survey for 181 Australian multinational corporations per country and region.

a) China (50), Fiji (25), Hong Kong (82), Indonesia (50), Japan (14), Malaysia (98), NZ (375), PNG (57), Philippines (16), S. Korea (5), Singapore (152), Sol. Island (3), Taiwan (10), Thailand (30), and Vietnam (3).

b) Austria (10), Belgium (14), Cyprus (2), Denmark (17), Finland (6), France (48), Germany (80), Greece (4) Ireland (21), Italy (16), Luxembourg (6), Netherlands (87), Portugal (12), Spain (9), Sweden (9), and U.K. (352).

c) U.S. (405), Canada (54), and Mexico (28).

d) Algeria (3), Botswana (1), Egypt (1), Ghana (5), Guinea (2), Malawi (1), Mali (3), Mauritania (1), Mauritius (7), Morocco (1), Namibia (3) S. Africa (43), Tanzania (9), and Zimbabwe (4).

e) Antigua & Barbuda (3), Aruba (1), Bahamas (13), Barbados (4), Cayman Islands (28), Dominican Rep. (3), El Salvador (2), Guatemala (2), Honduras (3), Panama (1), Puerto Rico (1), Trinidad & Tobago (1), and Virgin Islands (16).

f) Argentina (14), Bolivia (2), Brazil (24), Chile (12), Colombia (6), Ecuador (2), Guyana (1), Peru (4), Uruguay (6), and Venezuela (3).

g) Bangladesh (3), Brunei (3), India (27), Kyrgyzstan (5), Mongolia (2), Pakistan (2), S. Arabia (1), Sri Lanka (5), UA Emirates (2), and Vanuatu (7).

h) Gibraltar (3), Jersey (1), Norway (3), Switzerland (11), and Turkey (3).

i) Cz. Rep. (5), Estonia (1), Poland (5), and Slovenia (2).

It appears that the vast majority of Australian foreign subsdiaries are spread across Asian-Pacific and Crisis Region, European Union and NAFTA regions.

The Distribution of Foreign Subsidiaries Across Foreign Countries and Geographical Regions For the 62 Australian corporations					
	No. of foreign Countries hosting subsidiaries	**Our Survey of No. of foreign subsidiaries 2004 (N=62**	**Weight**	**ABS Survey 2002/2003 of No. of foreign subsidiaries**	**Weight**
Asian-Pacific and Crisis Region[(a)]	15	514	0.380	1,586	0.395
European Union[(b)]	16	406	0.300	1,108	0.276
NAFTA[(c)]	3	246	0.182	1111	0.277
Africa[(d)]	11	45	0.033	151	0.038
Central America & Caribbean[(e)]	11	38	0.027	106	0.026
South America[(f)]	10	54	0.041	66	0.016
Asian Region others[(g)]	7	19	0.057	122	0.031
Western Europe[(h)]	5	17	0.022	45	0.011
Eastern Europe[(i)]	7	18	0.013	22	0.005
Total	**85**	**1,357**	**1.00**	**4,012**	**1.00**

Since the number of foreign subsidiaries per country has not been clearly identified in ABS's (Australian Bureau of Statistics) survey, the following number of foreign subsidiaries only for our study's 2004 survey for 62 Australian multinational corporations per country and region.

a) China (22) Fiji (12), Hong Kong (44), Indonesia (29), Japan (7), Malaysia (42), NZ (223), PNG (43), Philippines (9), S. Korea (2), Singapore (57), Sol. Island (3), Taiwan (6), Thailand (14), and Vietnam (1).

b) Austria (7), Belgium (6), Cyprus (1), Denmark (13), Finland (5), France (33), Germany (52), Greece (1) Ireland (14), Italy (10), Luxembourg (1), Netherlands (58), Portugal (10), Spain (7), Sweden (8), and U.K. (180).

c) U.S. (186), Canada (40), and Mexico (20).

d) Algeria (3), Egypt (1), Ghana (4), Guinea (1), Mauritius (3), Morocco (1), Namibia (1), S. Africa (28), Tanzania (2), and Zimbabwe (1).

e) Bahamas (10), Barbados (2), Cayman Islands (14), Dominican Rep. (1), El Salvador (1), Guatemala (2), Honduras (3), Panama (1), Puerto Rico (1), and Virgin Islands (2).

f) Argentina (10), Bolivia (2), Brazil (13), Chile (10), Colombia (5), Ecuador (2), Guyana (1), Peru (4), Uruguay (6), and Venezuela (3).

g) Bangladesh (2), India (8), Pakistan (1), S. Arabia (1), Sri Lanka (1), UA Emirates (1), and Vanuatu (4).

h) Gibraltar (2), Jersey (1), Norway (3), Switzerland (8), and Turkey (3).

i) Cz. Rep. (4), Estonia (1), Poland (5), Croatia (1), Slovenia (2), Russia (3), and Hungary (2).

It appears that the vast majority of Australian foreign subsdiaries are spread across Asian-Pacific and Crisis Region, European Union and NAFTA regions.