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# ARE DOMESTIC FIRMS EXPOSED TO SIMILAR CURRENCY RISK AS INTERNATIONAL TRADING FIRMS?

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## ABSTRACT

This paper reports key findings about currency risk using two samples of listed firms: one sample with zero foreign currency revenues, hence having zero-currency risk; and the other sample with positive revenues in foreign currencies from foreign transactions. The latter is therefore, exposed to currency risk. Asset pricing theories predict that stocks of currency-risk-exposed firms should suffer significant currency risk, while those firms with zero-currency-risk should not have any effect from currency risk since currency transactions across borders is nil. The latter hypothesis has yet to be tested explicitly, so there is a gap in the literature. We report stock returns are significantly affected not just for firms with foreign-currency revenues but also for firms with zero foreign-currency transactions. These findings are useful to top

management of all businesses to undertake currency-hedge plans for both domestic and international trading firms.

**Keywords**: Exchange rates, direct vs indirect exposure, panel regression, Australian dollar, pooled vs fixed vs random effects.

JEL Classification: F23, F31, G12.

## CURRENCY EXPOSURE RISK IS A TOP MANAGEMENT CONCERN

This paper reports new findings on how the Australian dollar movements over 37 years affect *both* Australia's exchange-listed multinational firms, as well as domestic firms with zero foreign-source cash flows. Being an Asia Pacific country, a research using Australian data in the year after a major regime change to free-float currency could yield lessons for businesses in the region's developed countries: Japan, Malaysia, South Korea, Taiwan and Singapore, as well as emerging economies. Currency-risk-effect on stock prices in the Asia Pacific Region has not been studied using theories developed in Jorion (1990) or Solnik (1974), two main asset pricing theories about currency as price-relevant factor for stocks. In contrast, there have been lots of studies using the parity theorems, for example, as in Ariff and Zarei (2019).

Top management of businesses in all countries continues to grapple with the significant currency risk to their firms ever since 1973, after the demise of the Breton Woods fixed-exchange-gold-backed monetary system. A free-floating regime started resulting in upticks in volatility of exchange rates across all currencies. "Do currency movements affect stock returns because a business dependent on foreign-origin cash flows necessarily will reduce/appreciate the value of such flows depending on how the A$ moves up/down when cash flows received or paid are converted to other currencies? Should it affect stocks of international trading Australian firms earning multi-currency cash flows? A neglected research question is the converse: Are stocks of domestic firms with zero exposure to foreign cash flows into their accounts affected by currency movements? This latter question has yet to be addressed satisfactorily, hence businesses generally do not take action to offset currency-originated losses if a

typical firm has zero transactions in the books. A number of offsetting hedging plans are executed by the management of firms transacting in foreign currencies.

Australia adopted a clean free-floating regime in 1984.[1] This led to increased volatility of the Australian dollar (A$). This also happened to several other currencies switching to free floating. Volatility on the one hand and the periodic depreciation of the currency value when down-cycles in economic outputs introduce greater business risk from currency movements to both types of firms. Thus, the top management of investing firms faced with increased currency risk incurs greater costs, which they have to monitor and, if possible to put in place expensive currency hedge management to reduce the impact from the currency risk. If top management ever had evidence that domestic firms are prone to suffer currency risk - a topic on which there has been a lack of research evidence - businesses could have taken remedial actions to engage in hedging the risk. Thus, the domestic firm's zero-foreign cash flow exposure to currency is an area to clarify and also show evidence to the practitioners of business management.

The motivation for this research has been, thus from the need to test the three strands of currency theories, study the currency risk of zero-foreign-source firms, since theories tested to-date assume that such firms are unaffected by currency risk, and adopt a Fama-McBeth type portfolio aggregation method in order to control the idiosyncratic errors in estimated parameters.

Failure to control idiosyncratic errors when individual firm observations were used has been shown in the literature as a possible source of error in almost all past studies to-date. The value of a listed firm with transactions in foreign currencies depends on how much there is *direct currency exposure*. It is reasonable to argue that firms with zero transaction in foreign currencies in the book may have the currency risk coming through other sources, such as when a domestic firm buys items from wholesalers importing foreign items, as it will usually charge a higher price if the currency has depreciated. What management knows from received theories and management literature is that each time a currency value changes, the overall value of a firm's cross-border earnings/funds change. This impacts stock returns and has been studied using samples of firms with direct exposures to currency risk in the United States (US) listed firms (Agrawal &

Harper, 2010). Such is not the case for other Asia Pacific nations of which the Australian economy represents a developed economy larger than most, except China, India and Japan. This paper has been motivated to contribute to the management literature on this important management issue in the Asia Pacific region, especially its focus on the stock market impact of currency movements of two types of firms.[2]

Adler and Dumas (1984) was an early study showing domestic US stocks have a negative influence from currency risk, although ther``e were two other macro-factor that have yet to be tested for the US firms in that same study. Our study hopes to get new findings on whether currency risk is significant in *both* the domestic zero-exposed *and* the directly exposed firms listed on the Australian Stock Exchange over the 2000-2019 period, this time frame was selected because it covered a turbulent exchange rate period. It was during this period, that the value of the USD had depreciated from its pre-2014 rate of US$1.31=A$1.00 to US$ 0.77=A$1.00 in 2019. This paper reports a more refined finding on the degree of currency impacts on different degrees of revenue-exposures by selecting the five portfolios of zero- to high-risk-exposure firms.

The present study found that stock price reaction was greater if a firm had greater cross-border transactions: importantly zero-exposure firms had as much exposure as directly exposed firms to currency risk. This last aspect, namely against the positive exposure of international transacting firms has yet been known for any country using, as in this study, two key asset pricing theories at macro-level instead of at firm level, as relevant for currency studies.

The stock prices of firms exposed *directly* to the exchange rate risk are evidently affected by currency exchange rate changes, as has been predicted by the Adler-Dumas theorem or Solnik (1974). There has been no prior evidence of a significant currency effect on the zero-exposed domestic firms nor has there been a study testing the degree of exposure using portfolio aggregation method. Khoo (1994) is a study of currency exposure of *selected* Australian industries, but not domestic or international trading firms. The econometric method applied in this study also leads to quite robust results. The present study has applied panel regression, using pooled, random and fixed effects procedures, as well as LM tests (Hausman, 1978; Breusch & Pagan, 1980).

The rest of the paper is organized into five sections. The next section is a brief summary of Australian dollar studies using US- and UK-currencies. The third section contains a brief discussion on the underlying theories of asset pricing with exchange rate as a macro factor, while in the ensuing methodology section, details of the test models and research hypotheses, as well as data collection and methodology are discussed.

The results are presented and discussed in the section before the conclusion. The interesting new finding is that the presumed zero-*exposed* domestic firms are also significantly affected by exchange rate changes, as are the *directly-exposed* international firms. In addition, the impact on stock price depends on the degree of currency exposure ranging from heavily-exposed to zero-exposed portfolios of listed firms, unless hedge is in place. This *new* finding ought to urge top management of zero-currency exposed firms to take cover currency hedging, as is already occurring in the case of directly exposed firms.

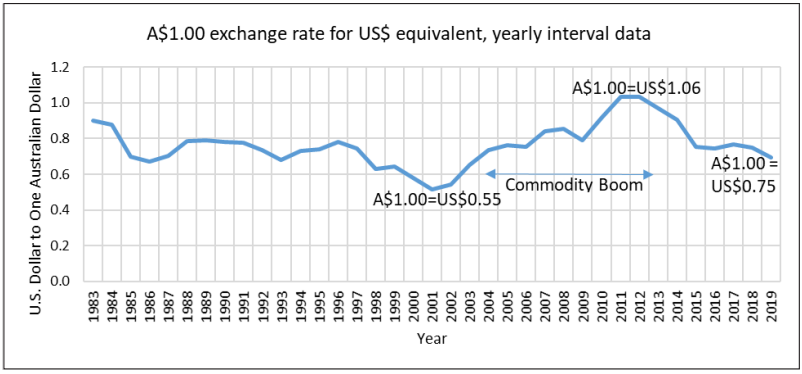
## AUSTRALIAN DOLLAR (A$) EXPOSURE

The AUD exchange rate has been subjected to large fluctuations ever since the commodity boom of the 1963-1980 period ended, as well as the abandonment of managed exchange rate policy of the Reserve Bank of Australia in 1984. This policy change was the first attempt to establish an independent control on monetary policy, with a view to eliminating speculative attacks on the then much stronger AUD prior to 1984.[3]

The AUD was overvalued then and was a favorite reserve currency of central bankers before its significant reform. Ever since 1984, mainly as a result of the reform, firms began to be substantially exposed to exchange rate fluctuations, although no study to-date has fully revealed exchange rate effects on indirectly-exposed domestic firms, indeed even the directly exposed firms (except for one study? citation at industry level). The total value of the stock market was AUD 1.63 trillion with 2,186 listed firms as at 2019. This made the market one of the biggest in the world. Figure 1 is a plot of AUD against the USD and the British Pound over the long period from 1971 to 2019.

**Figure 1**

*A$1.00 Equivalent to US$ Market Closing Rate at End of Each Year, 1983 and 2019*




High volatility was quite evident in the aftermath of 1983, especially in favor of the USD and Great Britain sterling pound until recent few years. On the onset of the establishment of the free-floating exchange rate regime in 1984 and up till the late 1980s, the AUD faced relatively higher inflation compared to most other OECD countries. High inflation at that time was associated with a long-run nominal exchange rate depreciation against major currencies such as the yen, Deutschemark (a free-floating former IMF currencies) and the trade weighted basket of currencies.

**Table 1**

*Descriptive Statistics of Exchange Rates*

| | Mean | Median | Std. Dev. | Skewness | Kurtosis |
|---|---|---|---|---|---|
| A$GBP | 2.072 | 2.080 | 0.380 | 0.124 | 2.071 |
| A$US$ | 1.207 | 1.250 | 0.305 | 0.322 | 2.572 |

Over the period shown in the Figure, the UK pound is worth on average about 2.1 USD, and the USD is worth 1.2 AUD. Starting with the year 2001 onwards, the AUD appreciated significantly on the back of a commodity boom worldwide, as was also the case prior to 1980. Thus, a long period of depreciation was followed by an appreciation of

the currency in part in the recent 12-year period ending in 2017. Both up- and down-movements would severely limit the value of firms, since the perverse effect of currency moves is in both directions. The period chosen is a very recent period, when the AUD appreciated only to depreciate later. Table 1 is summary of descriptive statistics of the Australian exchange rate against the US dollar and the Great Britain pound. The figures are in currency values and not in log change.

Two world-renowned examples are the BHP-Billiton and NAB (National Australia Bank) with more than half their trading revenues coming from non-domestic operations. Any sort of fluctuations in the behavior of AUD will therefore influence the profitability of such companies, thus also affecting the asset value of such firms. On the other hand, domestic Australian firms whose cash flows were fully dominated in the local currency were assumed to have no effect from currency movements. A 2010 article by Aggarwal & Harper *op cit*., was about the US firms with zero foreign incomes. Other than that paper on US firms, no studies have pointed out the behavior of *indirectly* exposed domestic firms.

## ASSET PRICING THEORIES AND EVIDENCE

### Asset Pricing Theories

The present study has examined how stock returns computed from stock prices were influenced by currency exchange rate movements, as well as by other theories that have been based on *macro* level factors, often ignored by finance researchers. There are two streams of literature on this topic: one that uses macro factors to explain movements in a currency and the other that uses firm-specific factors (Di Iorio & Faff, 2002; Aggarwal & Harper, 2010) as driving stock returns. The exchange rate is a macro variable, not a firm-specific variable. There is legitimacy in using macro factors alone – unlike the urge by scholars to choose the beaten track of firm-specific factors (Aggrawal-Harper *op cit*.) using asset pricing theories. In this study, the Jorion and/or Solnik model was applied to study, within the macro factor framework, how the *known* macro factors together will influence stock returns as suggested by the currency-relevant theories. Adler and Dumas (1984) has provided a start in the attempt to develop

a model of macro factors affecting stock prices. In their model, the currency's impact on the firm's stock returns is as expressed in Equation (1):

$$R_{i,t} = \alpha_i + \gamma_i XR_{j,t} + v_{i,t} \quad (1)$$

where, $\gamma_i$ measures the total exposure of firm $i$ to the exchange rate $XR_{j,t}$ and $R_{i,t}$ denotes the returns of the firm $i$ over time period $t$ to the country $j$'s currency changes. This is similar to the approach in the earlier Market Model (Sharpe, 1964), which has aimed at showing how another macro factor systematic risk on the stock market as a whole, could influence individual share values of firms. The Adler-Dumas model has considered the exchange rate risk as an international macro factor in Equation (1), while in Equation (2) from Sharpe (1974), it was considered a domestic macro factor.

The domestic risk variable $\beta_i$ has been modelled as in Equation (2) in Sharpe's (1964) Market Model for an individual firm, as the marginal sensitivity of individual stock returns to a macro stock market factor:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (2)$$

where, $\beta_i$ is the domestic systematic risk and $\varepsilon_{i,t}$ are the residuals of the regression. The residual captures the excluded firm-specific factor effects, whereas the systematic macro factor effect on stock returns is the risk, measured in the stock return sensitivity to market returns as the beta, $\beta_i$ .

Solnik (1974) has specified a model independently – in a sense amalgamating the two equations into one – in which both the macro factors of stock market and exchange rate, a second macro factor, have been incorporated. This is the two-factor model, with a macro stock market as the first factor and the international macro factor as sourced from currency risk represented as Equation (3):

$$E(R_i) = R_f + \beta_{i,1}\left(R_m - R_f\right) + \beta_{i,2}(FCRP)_i \quad (3)$$

where, $FCRP_i$ denotes foreign currency risk premium (that is, the rate of change in foreign currency minus the country's risk-free rate) as an additional factor to the market factor risk premium ,$\left(R_m - R_f\right)$ with i

i indicating individual stocks similar to that of Sharpe *op cit*. Thus, in Solnik's model, an International Systematic Risk (ISR) factor is added as the currency risk while the macro market risk is the $\beta_{i,1}$. This model derives a risk pricing relation for individual stocks as coming from exchange rate risk as in Adler and Dumas (1984).

This has been modeled and tested for a large number of countries (Ariff & Marisetty, 2012). The measure of the ISR, $\beta_{i,2}$, is computed by running a regression using stock returns of a country's market index against the returns from an international stock market index. That is, by rerunning the Equation (2) with returns from an international market index, one may get a measure of the ISR, $\beta_{i,2}$ . In other words, the ISR is estimated first using Equation (4):

$$R_{j,t} = \alpha_i + \beta_i R_{IM,t} + \varepsilon_{i,t} \tag{4}$$

where, $R_{IM,t}$ is the International Index return; and $R_{j,t}$ is the market index return for a country j. (Jorion, 1991) has specified a direct method of testing the two macro factor effects on the individual stocks as in Equation (5):

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \gamma_i XR_{i,t} + \varepsilon_{i,t} \tag{5}$$

Equation (5) incorporates the exchange rate as an additional macro risk factor in an extended International Market Model. The exchange rate is the additional risk factor and $\gamma_i$ (recall Adler & Dumas *op cit*.) is the marginal sensitivity of a firm's stock returns to the changes, $XR_{i,t}$ theorized as having an impact on stock returns. The result is a two-factor Market Model with two macro factors affecting stock returns. The actual return $R_{m,t}$ is a proxy using the market index, and $XR$ is the exchange rate. The impact of the currency exposure is measured by the value of $\gamma_i$ as in Equation (5). Are there other macro factors that could be added to this two-factor macro model? To answer this, reference is made to the intuition in Ross (1976).

At this point, there is the need to review theories using macro factors to build a model in order to link the market factor and the exchange rate factors in an extended Jorion's model. Chen et al. (1986) operationalised a much more general multi-factor test model using Ross's (1976) theory. Chen identified three more macro factors as

having influences on stock returns by identifying the Risk Premium (MP), Industrial Production as growth in GDP, and Term Structure of Interest Rate (UTS) and Unanticipated Inflation (UI), as well as changes in expected inflation (DEI) as significant contributory factors for stock returns, notably all these are macro-level variables as in Equation (6):

$$R = a + b_{MP}MP + b_{DEI}DEI + b_{UI}UI + b_{UPR}UPR + b_{UTS}UTS + e \quad (6)$$

The term structure of interest rates is $(i_L - i_S)$ is the lending and savings rate; inflation; and growth in GDP. Term structure is measured in that article as the difference between (a) yield on a long-dated Treasury, $i_L$ and (ii) yield on a short-dated Treasury, $i_S$. The rate of change in the Industrial Production Index (IPI), on which there are data series readily available as a proxy for economy-wide earnings, can be used as a substitute for GDP growth in the Chen et al. (1986) study. GDP growth rate and the IPI are highly correlated, so they are multicollinear, thus one factor has to be dropped. This line of reasoning provides more macro factors to the already specified two factors in Jorion's (1991) and Solnik's (1974) models.

Thus, there are four macro factors all chosen as non-firm-specific factors, unlike in Aggarwal-Harper (*op. cit.)*, that could be used in building a test model to examine their joint impacts on stock prices, with the exchange rate impact being the main focus of this study. The present study intends to develop a test model in the next section using this line of reasoning, which is consistent with that in Adler-Dumas, Jorion and Chen-Roll-Ross.

**Firm-specific Factors in the Model**

It is instructive at this juncture to also point to another approach taken by researchers to investigate how the exchange rate exposure on stock returns may be measured using firm-specific factors mixed with the exchange rate as a macro factor. The Fama-French model is used by inserting the exchange rate, $XR$, into the Fama-French model, along with $R_m - R_f$, while the *SMB* and *HML* are firm-specific factors. Another is Di Iorio and Faff (2002).

$$R_i - R_f = a + b_i(R_m - R_f) + s_i E(SMB) + h_i E(HML) + \gamma_i XR_{j,t} + \varepsilon_i \quad (7)$$

where, the $(R_m - R_f)$ is the market risk premium factor; $SMB$ is the firm-specific variable of market capitalization of small minus big firms; *HML* is also a firm-specific variable of high minus low book-to-market value firms, and *XR* is the macro factor of exchange rate changes.[4]

Hence there are two different approaches in theory-building on how the exchange rate may affect stock returns. The model to be developed in the next section uses only the macro factors from macro theories and excludes all firm-specific factors just described. In that way, the findings in the present study are based on a multi-factor approach consistent with Ross (1976) and as operationalised in Chen et al. (1986) within the framework of Solnik's and Jorion's contributions to the exchange rate behavior. As can be deduced from this brief review on asset pricing theories, the concern of the present study is more with the macro factors that affect stock returns in the Australian context, and perhaps this is the first such attempt ever made.

**Empirical Evidence on Exchange Rate and Asset Prices**

Among the various studies on foreign exchange rate exposure, most identified only very low correlation between change in the stock prices and the change in the exchange rates; (e.g. Bartov & Bodnar, 1994; Mok, 1993; Griffin & Stulz, 2001; and Ariff & Zarei, 2019) on low causal link. Furthermore, despite the fact that several studies had focused on the foreign exchange exposure of multinational corporations, little is known of the domestic firm with zero-foreign currency exposure (exception is the US study using individual stocks). There appears to be a false belief, because it is presumed that non-exposure to foreign currency cash flows makes domestic firms protected from currency risk, thus it gives a wrong lesson to the top management of domestic firms. Obviously this is not sound reasoning since costs of input items in a modern economy are affected by exchange rate changes, even if a firm does not have cross-country transactions in foreign currencies.

Mok (1993) was an example of building a causality model linking the exchange rate, interest rate and stock price to see their interdependence. The results of that study seemed to suggest that there was an only a weak bidirectional causality between the exchange rate and stock returns. Similar results have been observed in past studies of the exchange rate impact on stock returns.

Adler and Dumas (1984) stated some 36 years ago that firms with no foreign operations, foreign currency assets, and foreign currency liabilities might also be exposed to the exchange rate risk, a claim which has not been followed up. Their intuition has been largely ignored by later researchers. Accordingly, Aggarwal and Harper (2010) refocused on domestic firms and showed that US domestic firms have been equally exposed to the risk of currency risk. Therefore, in reviewing the empirical literature, only those studies that had looked at multinational and domestic firms to measure the currency impact on stock returns have been included.

Following the collapse, in 1973, of the Breton Woods rules on exchange rate management and subsequent introduction of newer exchange rate systems, empirical studies began to focus on the role of the exchange rate in asset pricing valuation in the international context. Jorion (1990) found that the exchange rate risk was priced. Dumas and Solnik (1995) applied the Generalized Method of Moments or GMM to make a conditional specification of the single factor model developed by Adler and Dumas (1984), which had assumed a non-stochastic inflation factor. They found that the model held statistically, and the currency effect could not be rejected. Likewise, De Santis and Gerard (1998) and De Santis et al. (2003) applied a multivariate GARCH-in-mean specification for a conditional estimation of the single factor model. Their findings also verified the usefulness of the model.

Further support for the single exchange rate factor model has been reported in the studies of Capiello and Fearnley (2000) and Dahlquist and Saellstrom (2002). The two factor model of Jorion (1991) has also been applied in a number of studies, such as in Bodnar and Gentry (1993), Bartov and Bodnar (1994), Bartov et al. (1996), and Griffin and Stulz (2001), which covered non-Asia Pacific economies. These studies reported a high-to-modest explanatory power of the model for other-than-market-factors on stock return; except one which reported no seasonal effect. While the results were not strongly significant in terms of the exchange rate exposure, the authors explained that the lack of evidence was due to operational hedges by firms in their samples, which included multinational firms. That had a confounding effect in the results.

Evidence on the exchange rate and asset pricing relationship is scant in the Australian market. One primary research on foreign exchange

exposure (Loudon, 1993) has provided evidence of a significant sensitivity of around one in three Australian *industries* to exchange rate movements. That study applied a multifactor asset pricing approach, using the procedure of Adler and Dumas (1984) and Jorion (1990,1991); the study was carried out before the AUD appreciated. The presence of any sort of premium for currency risk in equity returns was found to be negligible. The finding was considered a bit strange, but this was perhaps due to the simpler statistical methodology. A second study by Khoo (1994) focused on the foreign exchange exposure of Australian *mining* firms and reported only a small degree of stock return sensitivity to exchange rate movements. These are very dated studies and recent data with much stronger volatility have been ignored, leaving the possibility of observing a richer effect of the enhanced volatility of the AUD in the recent two decades.

Likewise, other studies like the one by Di Iorio and Faff ( 2002) found the stability of exchange rate exposure of *industries* by implementing a basic augmented market model, using two series of exchange rates, namely the USD and the Japanese ¥. A cross-sectional test model was used and the foreign exchange exposure was also taken into consideration. While the results seemed to suggest a strong relationship between Australian industry returns and USD-AUD fluctuations, it was not directly evident for the Japanese ¥. Furthermore, the use of bilateral exchange rates was found to be more insightful than the aggregate exchange rate indices.[5] A recent paper by Kang et al. (2016) showed findings which corroborated the claim that there was a significant exposure of firms using two types of risk factors in their estimation procedure.

## DATA, VARIABLES, HYPOTHESES AND METHODOLOGY

In this section, there will be a description of the research design to study the relationship between currency exchange rate changes and stock returns of Australian firms, with a focus on identifying the exchange rate as a significant factor for both zero-exposed and directly exposed firms transacting in foreign currencies. We have a large the latter firms, which have been ranked according to their extent of currency transactions into four *directly* exposed portfolios of stocks from high-to-low exposure. To this the research also added the sample of domestic firms with zero-currency exposure as the next

portfolio. There were thus five portfolios of companies used: the first four comprised about 30 stocks in each portfolio, sorted on the percentage of foreign-sourced revenues, and the fifth portfolio was a group of 50 domestic companies with no foreign-sourced revenues or assets. Data have been sourced from the E-Ikon Thompson-Reuters database.

A few major hypotheses have been developed to address the research questions on whether Australian firms are exposed to currency risk. If exposed, do domestic firms experience currency risk exposure? In selecting the firms for greatest exposure to currency risk, the study had to choose very large firms over others to set up a sample of highly-exposed and less exposed firms. Similarly, it had to choose firms with zero-exposure by targeting those firms that had no foreign transactions. This had limited the study samples which were finally chosen for the study. The following hypotheses have been proposed:

$H_1$ : There is no significant association between the AUD exchange rate changes against the USD, and stock returns of directly exposed multinational corporations represented by the four portfolios.

$H_2$ : There is no significant association between the AUD exchange rate changes against the USD, and stock prices of indirectly exposed domestic corporations.

$H_3$ : The greater is the exposure of balance sheet and profit-and-loss items to the currency changes, the greater is the effect of currency risk on the stock prices. Therefore, the highly exposed firms have greater impact from currency movements compared to the less exposed firms. A .

The first two hypotheses follow the approach using macro factors as criterion variables in a model consistent with that found in Adler-Dumas, Jorion and Chen-Roll-Ross. The exchange rate factor is included alongside a combination of two other macro control variables, which potentially play crucial roles in determining the stock returns. Equation (8) is the main focus of this study:

$$ln\left(\frac{V_t}{V_{t-1}}\right)_{jt} = \alpha_i + \gamma_2 ln\left(\frac{NER_t}{NER_{t-1}}\right)_{jt} + \gamma_3 MR_{jt} + \gamma_4 (i_L - i_S)_{jt} + \gamma_5 ln\left(\frac{IPI_t}{IPI_{t-1}}\right)_{jt} + \varepsilon_{jt} \quad (8)$$

where $V$ denotes the value of assets (stocks), $NER$ represents the nominal exchange rate as in Equation (5), $MR$ represents market return, $i_L$ is the

long-term domestic interest rate measured as the Government Bond Rate, $i_S$ as the domestic short-term rate of Treasury Bills, used to measure the term structure of interest. $IPI$ is a proxy for corporate earnings since the Industrial Production Index over time $t$, while $j$ is the subscript for the companies.

See Table 2 for the theory-predicted signs of the variables. The first two hypotheses were tested by examining the significance of the coefficients on the four exposed firm-portfolios and the fifth zero-exposed domestic portfolio. Hypothesis H3 could be tested by observing monotonically increasing coefficients in the four ranked portfolios representing exposed firms to currency risk, with the domestic firms having least exposure (assuming it has a zero coefficient). An increase in term structure and/or depreciation in currency will have a negative impact on share returns; share returns react positively to increased growth of incomes (IPI), unless the test period is one where the IPI has a significant declining trend, when the sign may then turn negative.

**Table 2**

*Variable Specification, Definitions and Expected Signs*

| No. | Variables | Definition | Expected Sign |
|---|---|---|---|
| 1. | Ln. | Log difference of Stock Prices over time periods | Dependent Variable |
| 2. | TSIR | Long-term minus Short –term interest rate | – |
| 3. | LnIPI | Log difference of Industrial Production over time periods | + |
| 4. | LnNER | Log difference of AUD/USD Nominal Exchange Rate over time periods | – |

The last two factors were used as control variables. The model was tested first with the first two factors as in Jorion (1991), and then separately using the full model.

**Data Sources, Variable Identification and Method Selection**

Data employed in this study were the stock prices of companies, Nominal Exchange Rate, long-term and short-term risk-free interest

rates, Industrial Production Index. The major source of data was from The International Financial Statistics (IFS) CD-ROM. Furthermore, the S&P Capital IQ source was used as data on stock prices. The DataStream financial statements and price series were also used. Data was collected from the monthly and yearly series. The monthly data were the month-end values of the factors over the period 2000 to 2016, and the yearly data were the year-end observations for the same period. The present study has applied both intervals. Given recent findings such as in the study by Ariff and Zarei (2015), it has become clear that the use of low frequency data such as the yearly data series would enable one to observe a high coefficient of variation. This was because such intervaling would remove the temporary components of the time series. This is seen as desirable as the low frequency data series tend to have less noise, so the underlying relationship is more evident. It is also consistent with the length of time for currencies to reach equilibrium values as has been reported in the literature (Manzur & Ariff, 1995).

In the present study the decision to use the USD is based on the premise that it is the international currency most used in Australia's trade, while it is also true that the USD (and to some extent the Japanese ¥) is the currency of hedging in the international futures and forward markets by Australian firms. Though trade statistics suggest that Australian trade with the US is the dominant one, however, invoices for sales and payments are normally done by Australian firms (as do across the world) in USD. Hence, using the USD exchange rate is valid.

The present study has used a panel or longitudinal data set up, with an estimation method based on the choice from Pooled, Random and Fixed effects. This method was selected because it could produce robust parameter estimates compared to cross-sectional or time series regressions. The panel data set has been used in more and more studies in recent years, and is becoming a mainstay of stock market research because of its superior accuracy. It was therefore, only to be expected that this method has been the prime choice over other methods in most exchange rate studies. In addition, this approach allows for the inclusion of data for cross-sections as well as time-series.

The Lagrange Multiplier (LM) test is used to determine the optimum model for estimation based on the choice between pooled and random

effects. In a linear model, these tests are conducted based on the information on pooled OLS residuals, while on the alternative model (random effect model) the estimation would involve generalized least square procedure based on the two-step or maximum likelihood or MLE procedure. Next, in choosing between fixed and random effect, the Hausman (1978) test value was used: the test is based on confirming if the explanatory variables are correlated with individual-specific effects.

## FINDINGS ON DIRECT AND INDIRECT EXPOSURE OF STOCK RETURNS

The central research question is: Does the AUD exchange rate movements have a significant impact on the stock returns of listed firms grouped as (i) four portfolios of currency-exposed firms and (ii) a portfolio of zero-exposed domestic firms? The findings are discussed in this section, starting first with the summary descriptions of variables and data preparation tests. The results from test models follow in subsequent sub-sections.

### Descriptive Statistics on Variables

The mean values of most of the variables were very close to zero, due to the data transformation and with the final data used being log change ratios. The exchange rate variable (*NER*) was calculated using one period log change of domestic over foreign (USD) exchange rate. Similarly, the rate of stock return (*V*) and that of industrial production (*IPI*) were calculated using one period log change of IPI index values, respectively.

Table 3 is a summary of the descriptive statistics on the variables used in the study. This table reports summary of descriptive statistics for the stock return of five quintiles on all the variables. The first four quintiles are constructed based on revenue and total asset as percentage denominated in foreign sources. This table reports summary of descriptive statistics for the stock return of five quintiles on all the variables. The first four quintiles are constructed based on revenue and total asset as percentage denominated in foreign sources.

**Table 3**

*Descriptive Statistics of Annual and Monthly Series on the Quartile Basis*

| Panel A (Annual Series) | | | | | | |
|---|---|---|---|---|---|---|
| | Mean | Median | Std. Dev. | Skew ξ | Kurt ♠ | Obs. ♦ |
| Return (G1†) | 0.063 | 0.065 | 0.393 | 0.467 | 9.512 | 336 |
| G2 | 0.043 | 0.095 | 0.456 | -1.20 | 6.277 | 336 |
| G3 | 0.012 | 0.054 | 0.620 | -0.287 | 4.781 | 336 |
| G4 | -0.222 | -0.218 | 0.674 | -0.447 | 5.474 | 336 |
| GDomestic | -0.030 | 0.041 | 0.674 | -0.522 | 6.965 | 600 |
| MARKET | 0.033 | 0.116 | 0.219 | -1.542 | 4.872 | 336 |
| FX | -0.052 | -0.054 | 0.134 | 0.117 | 2.786 | 336 |
| IPI | 0.022 | 0.021 | 0.029 | -0.046 | 1.757 | 336 |
| TSIR | 0.004 | -0.001 | 0.013 | 0.832 | 2.545 | 336 |
| Panel B (Monthly Series) | | | | | | |
| | Mean | Median | Std. Dev. | Skew ξ | Kurt ♠ | Obs. ♦ |
| Return (G1) | 0.005 | 0.009 | 0.101 | -1.296 | 24.585 | 4592 |
| G2 | 0.002 | 0.006 | 0.110 | -0.637 | 8.654 | 4592 |
| G3 | 0.003 | 0.014 | 0.161 | 0.123 | 12.138 | 4592 |
| G4 | -0.014 | -0.022 | 0.213 | 0.189 | 6.656 | 4592 |
| GDomestic | -0.004 | 0.002 | 0.180 | -1.126 | 39.807 | 8200 |
| MARKET | 0.003 | 0.011 | 0.040 | -1.047 | 5.275 | 4592 |
| FX | -0.002 | -0.003 | 0.039 | 0.799 | 5.497 | 4592 |
| IPI | 0.002 | 0.002 | 0.004 | 0.101 | 3.601 | 4592 |
| TSIR | 0.006 | 0.004 | 0.014 | 0.851 | 3.29 | 4592 |

† G1: group one; GDomestic: domestic Group; Market: market return; FX: foreign exchange changes; ξ Skew: skewness; ♠ Kurt: Kurtosis; ♦ Obs: observations.

The stock return of the fourth portfolio (fourth quintile) showed a negative and relatively bigger mean value (-22 %) change, perhaps due to an overall lower return associated with the stocks included in this portfolio. It may also be interpreted as showing the greatest exposure of portfolio 4 since this sample of firms might have been small enough to have no hedge management for currency risk. The means of other variables were within the expected range, as for example the yearly.

**Table 4**

*Panel Unit Root Tests on the Variables Used in Test Models*

| Variables | Deterministic Terms | Annual | | Monthly | |
|---|---|---|---|---|---|
| | | LL Statistics | IPS Statistics | LL Statistics | IPS Statistics |
| Levels | | | | | |
| Return (G1) | Constant, Trend | -15.68*** | -8.49*** | -82.54*** | -74.85*** |
| G2 | Constant, Trend | -16.10*** | -9.21*** | -75.35*** | -66.63*** |
| G3 | Constant, Trend | -13.22*** | -5.74*** | -79.67*** | -66.27*** |
| G4 | Constant, Trend | -13.40*** | -7.54*** | -90.70*** | -76.18*** |
| GDomestic | Constant, Trend | -20.10*** | -10.54*** | -104.60*** | -87.60*** |
| MARKET | Constant, Trend | -18.97*** | -9.53*** | -56.47*** | -56.62*** |
| FX | Constant, Trend | -16.73*** | -8.02*** | -83.80*** | -64.34*** |
| IPI | Constant, Trend | -27.90*** | -17.34*** | -4.17*** | -21.37*** |
| TSIR | Constant, Trend | -6.26*** | -3.65*** | 5.54 | -0.37 |
| First Differences | | | | | |
| Return (G1) | Constant | -18.09*** | -14.19*** | 2.68 | -60.42*** |
| G2 | Constant | -22.58*** | -16.55*** | -17.26*** | -63.01*** |
| G3 | Constant | -21.70*** | -13.90*** | -4.38*** | -57.75*** |
| G4 | Constant | -26.66*** | -18.63*** | 13.35*** | -55.93*** |
| GDomestic | Constant | -27.26*** | -19.50*** | -25.80*** | -82.23*** |
| MARKET | Constant | -19.33*** | -11.47*** | -30.24*** | -70.02*** |
| FX | Constant | -27.37*** | -15.81*** | -94.64*** | -93.21*** |
| IPI | Constant | -6.32*** | -11.88*** | 29.33 | -30.09*** |
| TSIR | Constant | -17.49*** | -13.37*** | -56.20*** | -49.56*** |

*Note:* The number of lags is determined by the criterion of Schwarz with maximum of five.
** Indicates the significance level at 5%. *** Indicates the significance level at 1%.

Table 4 is a summary of the panel unit-root test results of Levin et al. (2002) (LL) and Im et al. (2003) (IPS) for monthly and yearly data to deal with stationary of criterion factors. The panel unit-root tests showed robust properties compared to the pure time-series test, as they provided consistent estimates of the true values of parameters when both time and cross-sections tended to infinity. As is evident from the statistics, the variables were stationary at level, i.e., I (0), due to data transformation, except the term structure of the interest rate (TSIR) for only monthly series. Hence, the TSIR had to be excluded from the panel regression using monthly data (see Table 4). This Table

reports statistics on Unit root and order of integration of variables. Test for level variables use constant and trend while applying only constant term for first differenced variables. To provide evidence that the factors were not correlated with one another, the variance inflation factor (VIF) was computed, as is shown on Table 5.

**Table 5**

*Variance Inflation Factor and Tolerance Values for Multicollinearity.*

| Multicollinearity | Yearly Data | | Monthly Data | |
|---|---|---|---|---|
| Variables | VIF[a] | Tolerance | VIF | Tolerance |
| MR | 2.12 | 0.472 | 1.36 | 0.733 |
| IPI | 1.43 | 0.697 | 1.06 | 0.946 |
| FX | 2.42 | 0.414 | 1.37 | 0.732 |
| TSIR | 1.67 | 0.600 | 1.08 | 0.928 |

Since these values were less than 10 (10 being the critical value), there was no multicollinearity effect on the estimated parameters. Hence, the test results on parameters in the following tests were found to be robust estimates. This table reveals the information about multicollinearity of the variables used in the study, where low values of VIF are always more accepted, suggesting lower correlation among the variables in the multiple regressions.

**Results from the Analysis of the Monthly and Yearly Interval Data**

The statistics on the entire sample are as reported in Tables 6 and 7. The present study has taken into account two different estimation models: one based on the approach proposed by Jorion (1991) (Equation 5) and the other based on an extended version developed in this study (Equation 7). Table 6 shows the results from the analysis of data with monthly and yearly frequencies from the entire sample of companies. The analysis was carried out using the approach in Jorion (1991). The foreign exchange rate and market return variables showed a statistically significant relationship with stock returns for the entire sample. The coefficient for the exchange rate risk was -0.179, with a t-value of -5.62, which is significant at or above the 0.01 probability level. This was also the case in the larger sample using monthly interval data and the smaller sample of yearly interval

data. The coefficient in the yearly data set was -0.43 with a t-value of -3.50, which is a statistically significant evidence of a currency effect.

The adjusted R-squared value of 22 per cent in the yearly data indicated that the two factors together explained the 22 percent of the variation in stock returns: the corresponding value in the monthly data set was 8 percent. The model fit is suggesting that there is a large currency effect on stock returns while the market factor effect is as expected, around 1. The beta around 1.00 indicates that the sample is a representative market sample. Table 6 reports results based on three specifications of fixed effects models specified in the methodology section of this paper.

**Table 6**

*Results of Entire Sample of Australian Firms based on Jorion's Two-factor Model*

| | Intercept | MR | FX | Adjusted R-Squared |
|---|---|---|---|---|
| Yearly (Fixed Effect) | -0.082 (-5.82)*** | 1.027 (13.59)*** | -0.430 (-3.50)*** | 0.22 |
| Monthly (Fixed Effect) | -0.0046 (-4.29)*** | 0.978 (31.46)*** | -0.179 (-5.62)*** | 0.08 |

*Note:* The model fit is significant at 0.01 or better using the chi-squared value of 184.657 (yearly) and 1607.734 (monthly).

Table 7 is a summary of statistics of the entire sample of firms using the model developed in the present study, using the four theory-suggested (relying on Ross, 1976) macro factors as indicated in the description of the factors in row 1. The additional factors were for earnings across the economy over the test period (recall this period includes several years of negative earnings following the 9/11 event and the global financial crisis years).

As in the previous Jorion-model results, the first two coefficients on the market and exchange rate factors were showing signs that were theory-consistent and the coefficients were statistically significant at 0.01 or better *p*-values. The IPI was not significant in both samples, so its negative signs have been ignored. The earnings of the firms

in the study sample declined substantially in the test period, such that this factor which would be significant in other studies turned out to be insignificant. The term structure factor on interest rate as a control factor had a theory-consistent sign, and was significant at 0.05 acceptance level. The coefficient of variation in this repeated test with more variables remained the same as in Jorion's two-factor model results.

Table 7 reports results based on three specifications of pooled, random and fixed effects models specified in the methodology section of this paper. The unexpected negative sign on IPI is due to the firms reporting losses during most of the post financial crisis period.

**Table 7**

*Results of Entire Sample of Australian Firms, 2000-2016 with Four Factors*

| | Intercept | MR | FX | IPI | TSIR | R-Sq. |
|---|---|---|---|---|---|---|
| Yearly (Fixed Effect) | -0.071 (-3.98)*** | 1.023 (12.10)*** | -0.508 (-3.55)*** | -0.445 (0.85) | -1.280 (-1.77)* | 0.22 |
| Monthly (Fixed Effect) | -0.004 (-3.39)*** | 0.978 (31.46)*** | -0.184 (-5.73)*** | -0.335 (-1.22) | - | 0.08 |

*Note:* "-" indicates that the regression test run excluded this factor due to its non-stationarity property. The model fit is significant at 0.01 or better using the chi-squared value of 187.903 (yearly) and 1609.277 (monthly).

The marginal effect of forex risk ranged from as high as -0.508 (yearly data) in the entire sample to -0.184 in the monthly data set. These were considered significant, given the large t-values of -3.55 and -5.73. The coefficient of determination was 22 per cent in the yearly data sample for the entire sample; it was 8 percent in the monthly data set.

**Portfolio-based Results for Degrees of Exposure**

The results from the five portfolios of companies ranked by the degree of exposure to foreign cash flows are as presented in the ensuing Tables 8 and 9. The first four portfolios were directly exposed samples of firms while the fifth was the zero-exposed domestic sample firms.

**Table 8**

*Results of Five Quartiles of Australian firms based on Jorion's Two-factor Mod*

| | Intercept | MR | FX | R-Sq. |
|---|---|---|---|---|
| Group 1(DE ♠) (Pooled OLS) | 0.0017 (1.28) | 0.953 (24.44)*** | -0.123 (-3.07)*** | 0.16 |
| Group 2(DE) (Pooled OLS) | -0.0012 (-0.83) | 0.916 (20.97)*** | -0.080 (-1.79)* | 0.12 |
| Group 3(DE) (Pooled OLS) | -0.0006 (-0.27) | 0.873 (13.16)*** | -0.184 (-2.70)*** | 0.06 |
| Group 4(DE) (Pooled OLS) | -0.018 (-6.07)*** | 1.170 (13.42)*** | -0.330 (-3.96)*** | 0.06 |
| Group 5 (IE ♣) (Pooled OLS) | -0.008 (-4.64)*** | 1.085 (19.77)*** | -0.289 (-5.12)*** | 0.07 |
| Group 1(DE) (Random Effect) | -0.392 (1.60) | 0.998 (9.69)*** | 0.171 (1.02) | 0.27 |
| Group 2(DE) (Pooled OLS) | -0.011 (-0.53) | 1.009 (8.51)*** | -0.412 (-2.13)** | 0.32 |
| Group 3(DE) (Pooled OLS) | -0.063 (-1.96)* | 0.888 (5.11)*** | -0.90 (-3.17)*** | 0.21 |
| Group 4(DE) (Pooled OLS) | -0.292 (-8.33)*** | 1.211 (6.46)*** | -0.582 (-1.90)* | 0.22 |
| Group 5 (IE) (Pooled OLS) | -.121 (-4.75)*** | 1.086 (7.95)*** | -1.072 (-4.81)*** | 0.26 |

*Note:* ♠DE: directly exposed firms; ♣IE: indirectly exposed firms, adjusted R-Squared values. The model fit is significant at 0.01 or better using the chi-squared values computed for each of the samples. The computed chi-squared values are greater than the critical values.

Table 8, Panel A, contains results from data set used at monthly intervals (hence containing more white noise) while the results shown under Panel B are from yearly interval data. The foreign exchange exposure coefficients of all five portfolios were found to be statistically significant as predicted by theory with the correct signs.

This finding is seen as remarkably different from the weak support in the literature for currency risk in prior studies. This is perhaps due to the use of panel regression combining the portfolio grouping of Fama-McBeth. The only exception to the support for theory is in portfolio 1, which represents the largest listed firms with an ability to hedge currency risk management successfully. It is evident from the statistics that the coefficients of the five ranked portfolios were significant with the domestic firms having the most impact, as judged by its relatively large marginal effect of around -0.289. The exception was portfolio 1, which seemed to have less impact than the other large firms on average, despite being significant, because these firms had active repo hedging procedure in place.

Table 8 reports results from the two factor Jorion's model on 5 groups. The results are indicative of significant market return and foreign exchange exposure of all groups, an exception being group 1 when using yearly series.

The size of the coefficients ranged between -0.08 and -0.33. It appears that the greatest impact of currency effect was on the fourth portfolio, which represented firms with the lower direct exposure to cross-border transactions. Note also that the zero-exposed fifth portfolio of firms had the highest coefficient. This might be due to the fact that the fourth portfolio of firms and the fifth portfolio were smaller firms relative to the first three, with lack of full-hedging for currency exposure risk. The highly exposed portfolio 1 and portfolio 2 had smaller coefficients, perhaps for the opposite reason that these larger firms had successful hedging that reduced the size of the currency risk via hedges.

Table 9 reports results from the two factor Jorion model on 5 groups. The results affirm evidence of significant foreign exchange exposure when using monthly data. As for the yearly data, there is no significant foreign exchange exposure for the group 1 only, which can be due to operational hedging of those companies.

Aggarwal & Harris *op cit*. also reported this peculiarity of smaller coefficients for larger firms, which they attributed to the ability of larger firms having effective hedges in place against currency risk that reduced or nullified the size of the negative effect of currency risk for such firms.

**Table 9**

*Results of Five Quartiles of Australian Firms Based on Extended Jorion's Model*

| | Intercept | MR | FX | IPI | TSIR | R-Sq. |
|---|---|---|---|---|---|---|
| Group 1(DE♠) | 0.003 | 0.954 | -0.133 | -0.680 | N/A | 0.16 |
| (Pooled OLS) | (1.99)** | (24.45)*** | (-3.30)*** | (-1.98)** | | |
| Group 2(DE) | -0.001 | 0.916 | -0.082 | -0.162 | N/A | 0.12 |
| (Pooled OLS) | (-0.58) | (20.97)*** | (-1.83)* | (-0.42) | | |
| Group 3(DE) | -0.0002 | 0.873 | -0.187 | -0.224 | N/A | 0.06 |
| (Pooled OLS) | (-0.08) | (13.16)*** | (-2.72)*** | (-0.70) | | |
| Group 4(DE) | -0.018 | 1.171 | -0.335 | -0.273 | N/A | 0.06 |
| (Pooled OLS) | (-5.37)*** | (13.42)*** | (-3.70)*** | (-0.36) | | |
| Group 5 (IE♣) | -0.009 | 1.085 | -0.284 | 0.324 | N/A | 0.07 |
| (Pooled OLS) | (-4.50)*** | (19.76)*** | (-4.99)*** | (0.67) | | |
| Group 1(DE) | 0.086 | 1.001 | -0.111 | -2.111 | -4.111 | 0.29 |
| (Fixed Effect) | (3.57)*** | (8.55)*** | (-0.55) | (-3.00)*** | (-2.40)** | |
| Group 2(DE) | 0.017 | 1.089 | -0.432 | -1.438 | -0.322 | 0.32 |
| (Pooled OLS) | (0.61) | (7.98)*** | (-1.82)* | (-1.72)* | (-0.16) | |
| Group 3(DE) | -0.086 | 0.895 | -0.746 | 1.037 | 2.242 | 0.21 |
| (Pooled OLS) | (-2.09)** | (4.45)*** | (-2.13)** | (0.84) | (0.76) | |
| Group 4(DE) | -0.310 | 1.125 | -0.639 | 0.965 | -0.800 | 0.22 |
| (Pooled OLS) | (-6.94)*** | (5.19)*** | (-1.69)* | (0.73) | (-0.25) | |
| Group 5 (IE) | -0.150 | 1.008 | -1.046 | 1.385 | 0.573 | 0.26 |
| (Pooled OLS) | (-4.64)*** | (6.74)*** | (-4.26)*** | (1.49) | (0.28) | |

*Note:* ♠DE: directly exposed firms; ♣IE: indirectly exposed firms, adjusted R-Squared values. The model fit is significant at 0.01 or better using the chi-squared values computed for each of the samples. The computed chi-squared values are greater than the critical values.

The summary statistics from the extended model used in this study were from the four-factor model. The results were seen as slightly improved in the case of foreign exchange exposure with significant impact from the IPI and the TSIR for the portfolio 1 companies. Note that the IPI earnings impact was significant for portfolio 1 and portfolio 2 in the yearly data results and only for the case of portfolio 1 using monthly data. The size of the impact was also substantial in the monthly data sets. It is reasonable to explain the yearly-data results as the consequence of stock returns already incorporating annual reports data information on hedge gains and losses reported at the end of the

financial year, but not so in the study results obtained from monthly data.

The results also showed that the domestic firms (portfolio 5) had a significant negative impact of -1.046, which seemed to suggest that the share returns losses for portfolio 5 was about equal to the impact of the currency. This would mean that the top management of these firms did have to have hedge in place for currency risk, an important result for application. Investment firms managing portfolios of domestic firms ought to have currency-hedges in place to ensure that investors are protected against possible losses, if such firms have currency exposures. In the monthly data set too, it was noted that a significant effect for this and other groups as having negative influences from US dollar movements against the Australian currency.

The additional two factors have been used as control factors to refocus the test on the Jorion's two-factor results (refer to the coefficients on the IPI and the TSIR). The corresponding R-squared values for the domestic firms in row 5 in panels A and B were 7 and 26 per cent respectively. The annual data sample showed a modestly higher value for adjusted R-squares, meaning that the addition of additional factors from parity theorems helped to improve the explanatory power of the test.

The zero-exposed domestic firms (portfolio 5) showed about slightly more than half the marginal effect of currency risk compared to the exposed firms. Note that the coefficient of portfolio 5 in the yearly data was -0.282, compared to the slightly higher average for the four portfolios of multinational firms (portfolios 1-4). The statistics from the monthly data set for the groups 1 to 4 had a higher exposure in this model, as had also been observed for the entire sample tests in the previous sub-section. For example, with regard to portfolio 3 in the context of its yearly data set, the middle group of directly exposed firms yielded a marginal value of -0.746, while portfolio 4 had a smaller coefficient.

The smallest value of portfolio 1 for the largest exposed portfolio had a coefficient equal to -0.111, which was much smaller than the size observed for the less exposed firms in other three directly exposed portfolios. This again could have been due to the superior skills of the top management of larger firms to hedge most of the risk

through hedging programs in place. This was obvious from the yearly data tests (see Tables 4 and 5), in which the investors would have access to evaluate hedging effectiveness reported in the Notes to the accounts in the annual reports, so investors would have factored in that information in changing the stock prices.

Thus the *directly* exposed firms all had had significant exposure in during the test period of sixteen turbulent currency years. These results would seem to suggest that the zero-exposed Australian listed firms were also significantly affected by currency risk. The smaller size coefficient for portfolio 1 in this study seemed to suggest that part of the reason for this reduced size could be the same risk-offsetting abilities of the largest firms through active hedging. It could also mean that the Australian firms could not fully offset, hence the effect was still negative, though smaller than the size theorized for most directly exposed firms in portfolio 1.

The industrial production index, as a control variable in the case of the annual data sets, was only statistically significant for the companies classified as portfolios 1 and 2. The R-squared value followed a declining trend from portfolios 1 to 5. This as expected, was a natural occurrence. As in the previous tables, the model fit in the panel regression has been robust, as indicated by the chi-squared values being greater than the critical values.

Overall, the results have provided empirical support for the two-factor model of Jorion (1991). This was even the case when the control variables introduced in this study produced theory-consistent results for Australian listed firms. This means that the currency risk has been significantly priced in the stock returns in the Australian market for both the directly *and* the zero-exposed firms. These results are new findings which will make substantial contributions to the Asia Pacific literature.

## CONCLUSION

This study started with the aim of studying the currency risk of Australian companies exposed to the volatility of the exchange rate by using the monthly and also annual data for the last 16 years. More specifically, the aim was to study currency exposure using theory-

origin macro factors only, and by using the three well-received asset pricing theories away from the firm-specific-factor-based experiments. The test period was also one that had significant up-trends for the currency compared with the pre-2000 period, when the currency depreciated severely starting from 1983 onward to 1997. A significant reason for this study is to measure the exposure of *domestic* firms with no foreign currency in their books, comprising a group of firms which have been ignored in almost all studies. Another question is to measure the size effects of differing risk exposure via portfolios.

The study categorized four portfolios of firms exposed to *direct* currency risk as shown by their revenue size and asset size. The fifth portfolio was made up of firms with no foreign revenue/capital, as such this portfolio had zero currency risk, and hence the aim was to test currency risk effect on stock returns of this fifth group. The data set was split further into yearly and monthly sets to check if the yearly-interval data series improved the coefficients of variation. The proper econometric procedures required tests on several assumptions (stationarity; multicollinearity; etc.) so that results from a refined econometric model should lead to valid data transformation to comply with panel data regression assumptions in actual regression runs. Panel regressions were conducted with individual firms and then in five portfolios forming the panels.

The three main findings of this study have made significant contributions to the foreign exchange literature. First, the exchange rate movements do affect significantly the stock returns of *directly* exposed firms in an orderly manner; the higher the exposure, the higher is the marginal effect. The size of the largest firm's coefficient is smaller, and this may be due to the very large firms taking hedge protection that reduces the size of the currency effect. The second result appears to be a new finding as the previously held belief that domestic firms ought to have a neutral-effect from currency movements is shown to be rejected. Zero-exposed domestic firms have slightly lower risk (when tested as an entire sample), but then in comparison with four portfolios, domestic firms were found to have the highest currency risk effect. It had a coefficient of -0.284 and a significant t-value of 4.99.

These findings are important for the business management of currency by the top management of *both types* of firms operating in a free-floating environment (in Australia, Indonesia, Japan, South Korea,

New Zealand, and the Philippines), and possibly in a managed float as well (Thai Bhat and Malaysian Ringgit). The role of risk management is all the more critical in domestic firms since the tests in this study has revealed that all firms have been significantly affected by the exchange rate movements. The findings presented here on international finance theory seems to suggest that foreign exchange is a pricing factor for stock valuation by investors, as in two rarely tested exchange rate theories.

First, this evidence should spur the top management of businesses to examine risk-reducing measures to offset the international systematic currency risk factor (ISR). Next, it is useful for a policy debate because these findings are expected as natural consequences of the free-floating monetary management of a currency. The operational models developed in this study is worth testing out in more Asia-Pacific free-floating, as well as managed currency regimes to document more evidence to add to the existing literature and thus, provide further guidance to top management in more countries. These results with their high explanatory power and strong significant effects on both types of firms should be recommended as the way to study and document evidence to guide corporate finance policy on exposure risk management.

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## ENDNOTES

[1] The A$ was managed for several decades away from the free-floating exchange rate, oblivious to the fact that this mostly commodity-trading nation's currency was way above its value after the commodity boom of the post-war era was over by the end of 1970s. The A$ was way above the trade-weighted

value, so something needed to be done to make the adjustment to an overvalued dollar. Hence the free-floating law was put in place some 10 years after the breakdown of the fixed-exchange monetary system in 1973.

2 This research finding is relevant to the top management of firms in general – both domestic and currency-exposed firms – listed on the Australian stock exchange. For the first time, there is evidence of an exchange rate movement having devastating effect not just on stock prices of firms exposed to foreign-currency revenues, but also on stock prices of domestic firms with no cash flow exposure in the books. The Australian dollar is a free-floating currency among the 12 so-called clean floating ones, and its behavior changes prior to the 2020 COVID-19 has been investigated. This paper is a first country study using the data cited above.

3 It is strange that monetary authorities wait for speculative attacks instead of taking pre-emptive actions before speculative attacks. For instance, while AUD was under speculative attack several others, such as the Argentine Peso was also under attack in the 1980s. Much later in 1996, speculative attack on the Malaysia's Ringgit also led to a disastrous depreciation in value from MYR2.54 to USD1.0, and USD1.00 for MYR4.10 in 1999, it has plateau ever since.

4 Drew, M.E., Naughton, T. & Veeraraghavan, M., (2003). Firm size, book-to-market equity and security returns: Evidence from the Shanghai Stock Exchange. *Australian Journal of Management,* 28**,** 119-139, computed the returns of firms listed on the Shanghai Stock Exchange using the multifactor asset pricing approach, to control the impact of size and book to market ratio on the return of investors. Again this is a test using firm-specific factors.

5 For this important reason, as supported by the research, the tests in the present study are restricted to bilateral currencies. The test results using trade weighted currency index are available on request, as they are excluded from this report.

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