Modelling Time-Varying Asymmetric Foreign Exchange Exposures: An Application to the Australian Stock Market

Robert D. Brooks*
Jonathan Dark*
Amalia Di Iorio**
Robert W. Faff***

*Department of Econometrics and Business Statistics, Monash University, Melbourne, Australia
**Department of Economics, Finance and Marketing, RMIT University, Melbourne, Australia
***Department of Accounting and Finance, Monash University, Melbourne, Australia

Acknowledgements: The research in this project was funded by a Monash University Faculty of Business and Economics Research Grant.

Correspondence: Amalia Di Iorio,
School of Economics, Finance & Marketing,
RMIT University
GPO Box 2476V
Melbourne, Victoria, 3001
Australia

Tel: +61-3-9925 5900
Fax: +61-3-9925 5986
E-mail address: amalia.diiorio@rmit.edu.au

Modelling Time-Varying Asymmetric Foreign Exchange Exposures: An Application to the Australian Stock Market

Abstract

In this investigation we model the time-varying exchange rate exposure of thirty-two Australian industry portfolios for the period June 1992 to August 2005. Using daily data, we implement a multivariate GARCH approach that explicitly allows for time variations in the correlation structure between portfolio returns, the market return and exchange rate returns. Further, we accommodate a potential asymmetric volatility response by using a GJR GARCH specification. First, our time-varying conditional correlation results suggest a strong persistence in correlation in the Australian stock market with statistically significant estimates in 90% of cases. Second, while three-quarters of the sample industry portfolios exhibit a statistically significant volatility response to positive shocks, approximately 40% of the portfolios record an intensified volatility response to negative shocks. Finally, although we find strong negative exchange rate exposure across all industries, we observe considerable evidence of 'sign switching' during the sample period.

Keywords: Time-varying Exchange Rate Risk Exposure; GJR GARCH; Asymmetry; Australian Stock Market

JEL Classification: G12

Draft: January 2006

1. Introduction

Standard financial theory implies that exchange rate fluctuations affect a firm's value through the impact those changes have on the firm's cash flows and its discount rate. A large body of literature addresses the theoretical issues and investigates the numerous parameters that are associated with determining the impact of changes in exchange rates on stock returns [see, for example, Shapiro (1975); Hodder (1982); Hekman (1985); Flood and Lessard (1986); Levi (1994); and Marston (2001)]. To date, however, the empirical findings in this area of international finance research have been weak – most fundamentally, there is only limited support of a significant relationship between the value of the firm and exchange rate fluctuations. From the early work of Adler and Dumas (1984) and Jorion (1990) to the more recent studies by Bartov and Bodnar (1994); Chow et al (1997a,b); Di Iorio and Faff (2000, 2001); Williamson (2001); and Muller and Verschoor (2004) results have been mixed and generally inconclusive.

However, notwithstanding the limited empirical support for the economic importance of exchange rate exposure, there is considerable indication from industry settings that is strongly suggestive of the practical influence of exchange rate fluctuations on firms and financial decision-making. For example, a survey conducted by the Australian Industry Group of the Australian manufacturing sector in late 2003, at a time when the Australian dollar was appreciating rapidly, found that the exchange rate was the single factor most often identified as impacting negatively on production. Interestingly, approximately 20 per cent of the 800 respondents stated that a persistence of an appreciation in currency value would be enough to drive them to move some of their production offshore.[1] Indeed, at a macroeconomic level the exchange rate is a major economic issue on a global scale [see, for instance, Hung (1992), and Rosenberg (2003)].

[1] Australian Industry Group PricewaterhouseCoopers *Quarterly Survey of Australian Manufacturing*, December quarter, 2003.

Exposure to foreign currency risk has become an increasingly important issue to investors and financial managers alike with the globalisation of markets, and particularly in the wake of the events such as the Asian financial crisis in the late 1990s. Although direct exposure (i.e. transaction and translation exposure) can be effectively managed by well structured hedging strategies, indirect, or economic exposure can induce considerable variability in cash flows for most companies world-wide.

We have a puzzle: given the undeniable practical relevance of exchange rate risk exposure to the value of the firm, how do we explain the lack of empirical support given the practical evidence? While a range of possible answers to this question have been proposed, in the current paper we focus our attention on the basic proposition that the underlying exchange rate-equity price relation is complex and non linear and, as such, it is largely obscured by simple/restrictive models that impose constant parameters. Notably, such simple models (as a primary example) do not accommodate the likely time variation in exchange rate exposure that more realistically portrays the complex setting which confronts modern day corporations in highly globalised and competitive markets.

As a consequence, a strand of literature has emerged that reports on investigations addressing this issue by using various econometric approaches with the aim of allowing parameters to vary through time, for instance, Tai (1999, 2000); Allayannis and Ihrig (2001); Williamson (2001); Di Iorio and Faff (2001); Patro, Wald and Yangru (2002); De Santis, Gerard and Hillion (2003). Specifically, Tai (2000) applies three different econometric techniques to determine whether exchange rate risk is priced in the US market and reports that of the three, the multivariate GARCH in mean (MGARCH-M) approach produced "strong evidence of time-varying interest rate risk and exchange rate risk." [Tai (2000, p. 397)]. A GARCH approach is also employed by Patro et al., (2002) who find significant currency risk exposures in the equity index returns of 16 OECD countries. In

their analysis of the relevance of currency risk in the EMU, De Santis et al. (2003) implement a conditional version of the ICAPM and conclude that currency risk and its impact on returns varies over time as a function of changes in economic conditions and the institutional environment. Williamson (2001) examines the time varying nature in exchange rate exposure in the automotive industry by using a 7-year sub-period analysis and for each separate subperiod the exchange rate exposure is related to the prevailing competitive environment of the sector. However, the findings of this study provide only weak evidence of exposure. Similarly, Di Iorio and Faff (2001) partition a ten-year dataset into one-year subperiods and find some evidence of changing exchange rate exposure in Australian stock market returns.

The primary objective of our paper is to model the time-varying exposure of equity market returns. To this end we choose to undertake our analysis within the GARCH model framework, given that it is well documented that such models (in particular multivariate GARCH models) are highly suited to modelling time varying exposures. A key problem in applying multivariate GARCH models is the number of parameters to be estimated [Pagan (1996)] and, while a range of solutions exist, we opt for a powerful approach that allows for a time varying correlation structure advocated by Tse and Tsui (2002). Hence, our study applies this model in a trivariate setting between portfolio stock returns, the market return and the exchange rate. Further we choose the Australian market for our analysis, given its richly varying industrial setting – covering a broad range of meaningful economic activity across resources and mining, as well as manufacturing, retail, services, banking and financial services.[2]

[2] Much of the empirical research in the area of exchange rate exposure has concentrated on the US financial markets [see, for example, Jorion (1990,1991), Bodnar and Gentry (1993); Amihud (1994); Choi and Prasad (1995); and Chow et al. (1997a,b)]. Analysis of other markets has been limited but has included other developed countries such as Japan [see He and Ng (1998); Chamberlain et al (1997); and Chow and Chen (1998)] as well some emerging markets, for instance Kiyamaz (2003) investigates the Turkish stock market.

A further critical issue that we embrace is the potential asymmetric response of the firm's value to changes in the exchange rate. Previous studies have investigated this issue in several ways. For example, some studies have investigated the potential difference in the response of a firm's stock returns to positive and negative exchange rate shocks [see, for example, Choi and Prasad (1995); Booth (1996); Baba and Fukao (2000) and Koustmos and Martin (2003)]. These studies, however, provide inconclusive evidence. Booth (1996) examines the role of transaction costs and the asymmetry produced in the firm's profit function in an attempt to provide a more realistic analysis of the use of hedging strategies, specifically currency options, that provide the downside protection while allowing the upside potential. These asymmetric payoffs leads one to hypothesise that exchange rate exposure may display an asymmetric behaviour and it is for this reason that previous studies may not have uncovered overwhelming evidence of exchange rate sensitivity of equity securities.

In the context of exchange rate changes, it can be argued that for an importing (exporting) firm the appreciation of the local currency is good (bad) news while the depreciation is bad (good) news.[3] Bad news may lead to higher volatility in stock prices than good news [Black (1976)]. While several asymmetric GARCH models have been developed to accommodate such an effect, we choose to implement the GJR-GARCH model [Glosten, Jaganathan and Runkle (1993)].

In summary, our analysis contributes to the existing literature in a number of key ways. First, we model the time varying exposure of industry portfolios in a relatively unexplored developed market, namely the Australian stock market, with recent daily data.

Notably, studies of the Australian market have been relatively scarce [see Loudon (1993a, b); Khoo (1994); and Di Iorio and Faff (2000, 2001)].

[3] Bodnar and Gentry (1993) investigate industry-level exchange rate exposure for Canada, Japan and the USA. Using economic theory, they attempt to predict the effect of changes in the exchange rate based on industry characteristics and conclude that an appreciation of the home currency will have a positive impact on the cash flows of (i) importers, (ii) producers of non-traded goods and (iii) users of internationally priced inputs but a negative impact on exporters, import competitor goods and foreign investors.

Second, we implement a multivariate GARCH approach that explicitly allows for time variations in the correlation structure between asset returns, the market return and two Australian-based exchange rates – against the US dollar and against the Japanese Yen. Finally, we test the asymmetric response of stocks to changes in the exchange rate.

The remainder of this paper is structured as follows. Section 2 addresses the issue of predicting the foreign exchange exposure across Australian industries. Section 3 outlines the empirical framework and data, while the results are presented and discussed in Section 4. The analysis is summarised in Section 5.

2. Exchange Rate Exposure Predictions

While firms may hedge foreign exchange contracts, thereby minimising transaction and translation exposure, they are still subject to a longer term operating/economic exposure. Operating exposure occurs because the future profits from operating as an importer or exporter depend on exchange rates and due, to its nature, this type of exposure is difficult to eliminate. There are a multitude of factors that must be considered including i) whether the firm is an importer or an exporter (since the real appreciation of a country's currency will generally reduce the home price of imports and raise the price of exports); ii) the degree of competition faced by the firm (operating exposure depends on the elasticity of demand for products); iii) which currency is used in the analysis of operating income. [4]

Devaluations increase an exporter's profits by increasing export prices in home currency terms and simultaneously export sales. However, when an exporter is in a competitive environment, the profits are only short-term since gains may be significantly reduced by the use of imported inputs and /or by new competitor firms. On the other hand, imports (and subsequently importers' profits), will decrease in the case of devaluation.

[4] Levi (1983, pp. 317-319).

To characterise broad level predictions of exchange rate exposure across Australian industries, the Australian Input-Output Tables for 1998-1999 were consulted. Specifically, we obtained data relating to the different industries' export (import) activities, together with the aggregate value of final demand (total value of Australian Production) of each industry. These data are used to calculate an Input-Output Coefficient (IOC) with regard to Exports and Imports for all of the ABS industries: ($Exports)/($Final Demand) and ($Imports)/($Aust. Production), respectively. The relevant details are reported in Tables 1: Panel A for exports and Panel B for imports. To make the Input-Output Coefficient information more easily interpretable across industries, the second column in each panel reports the relative IOC which is calculated as the ratio of a particular industry's IOC to the average IOC across all industries.

Table 1 reveals that the Australian Bureau of Statistics broadly classifies Australian industries into thirty-five different sectors. Unfortunately, this scheme does not readily translate to the Datastream classification system employed in this study. However, the final column of Table 1 aims to link the Datastream industrie(s) to an ABS industry counterpart(s).[5]

It can be seen from the Panel A that, not surprisingly, the Mining Industry [ABS 3 and DSI 18] and Basic Metals and Products [ABS 15 and DSI 29] have a very high relative Input-Output Coefficient with respect to exports. Further, there are two other ABS industry classifications for which the Relative Input-Output Coefficient for exports value exceeds two. These are: (i) ABS 1: Agriculture and Hunting [DSI 7 Diversified Industrials and DSI 11 General Industrials]; and (ii) ABS 9: Wood and Wool Products [DSI 2 Basic Industries].

[5] In some cases the match seems quite tight, for example, ABS industry 12 and Datastream industry 4 are both labelled "Chemicals". In other cases the relationship seems less than ideal, or at least influenced by the potential mixing affect of other areas of activity. For example, ABS industry 27: "Communication Services" is matched with Datastream industry: "Cyclical Services" on the basis that Datastream includes several communication companies in this classification. Consequently, the matching of ABS and Datastream industry classifications needs to be treated with due caution.

For these industries, other things equal, a negative exchange rate exposure relative to an appreciation of the exchange rate factor (defined in domestic currency terms) is predicted.

[Insert Table 1 about here]

Panel B summarises the Input-Output Coefficients of import importance across the Australian Industry Classifications. As in Panel A, the Relative IOC was calculated and five industries are noted to have coefficients greater than two - ABS 11 Petroleum and Coal Products, ABS 17 Transport Equipment, ABS 8 Clothing and Footwear, ABS 12 Chemicals and ABS 18 Other Machinery and Equipment. In these cases, all things being equal, it would be expected that there would be a positive exchange rate exposure relative to an appreciation in the exchange rate factor.

Exposure predictions need to balance the import/export information contained in Table 1 and to this end Table 2 provides a summary of our predictions. We classify predictions into six broad groups: (a) strongly negative; (b) negative; (c) negative/negligible; (d) positive/negligible; (e) positive; and (f) strongly positive. Of the thirty two Datastream industries, we would expect thirteen to exhibit strong exchange exposure and seven of these to demonstrate negative exposure. In addition, eight industries are predicted to have a (moderate) positive exposure, while two a moderate negative exposure. A further nine industries record a negligible result although eight of these exhibit a marginal negative response. The strongest exposure is noted in the following cases: (i) a strong negative response is noted for the industries in the resource sector (Gold Mining, Mining, Resources, Steel & Other Metals), the industrial sector (Diversified Industrials, General Industrials), and Transport; and (ii) a strong positive exposure is observed in a broader cross-section of industries, some of which rely significantly on imported inputs (such as Chemicals, Oil and Gas, Other Construction, Publishing and Printing, Retail and Utilities).

[Insert Table 2 about here]

3. Data and Empirical Framework

3.1 Data

The data employed in this study are continuously compounded daily returns on thirty-two Australian industry indices obtained from Datastream.[6] The period of the analysis involves 3457 observations for the period June 1992 to August 2005. The proxy for the market is the All Ordinaries accumulation index and the exchange rate factor returns are based on the Australia dollar to the US dollar (AUDUSD) and the Australian dollar to the Japanese Yen (AUDJPY) also obtained from Datastream. The choice of exchange rates is supported by the fact that the US and Japan are Australia's most important trade partners.[7]

3.2 Empirical Framework

To specify the model, let *i*=1 for the industry portfolio, *i*=2 for the currency (AUDUSD or AUDJPY) and *i*=3 for the AOI. The estimated model is specified as follows

$$R_t = \Phi_0 + \Phi_1 R_{t-1} + \varepsilon_t \qquad (1)$$

where $R_t = \left(R_{1t}, R_{2t}, R_{3,t}\right)'$, $\Phi_0 = \left(\phi_{0,1}, \phi_{0,2}, \phi_{0,3}\right)'$, $\Phi_1 = \left(\phi_{1,1}, \phi_{1,2}, \phi_{1,3}\right)'$, $\varepsilon_t = \left(\varepsilon_{1,t}, \varepsilon_{2,t}, \varepsilon_{3,t}\right)'$ and

$$Var\left(\varepsilon_t \middle| \Omega_t\right) = H_t = D_t \Gamma_t D_t \qquad (2)$$

where Ω_t is the information set available at time t, H_t is the 3x3 conditional covariance matrix, D_t is the 3x3 diagonal matrix where the *i*th diagonal element is the conditional standard deviation, $\sigma_{i,t}$, and Γ_t is the time varying conditional correlation matrix with off diagonal element $\rho_{ij,t}$. This implies that $\varepsilon_t = D_t \eta_t$, where $\eta_t = \left(\eta_{1,t}, \eta_{2,t}, \eta_{3,t}\right)'$, is the vector

[6] Several investigations report that relatively stronger evidence of exchange rate exposure is observed when using daily data and not monthly or weekly data [see, for instance, Chamberlain et al. (1997); Di Iorio and Faff (2000) and Glaum et al., (2000)]. Consistent with these studies, we use daily data in this analysis.
[7] Australian Bureau of Statistics: International Merchandise Trade Cat. No. 5422.

of standardized residuals that are assumed to be serially independently distributed with mean zero and covariance matrix Γ_t.

To capture asymmetries in variance, the GJR specification is employed

$$\sigma_t^2 = E\left(\varepsilon_t^2 \left| \Omega_t \right.\right) = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma\varepsilon_{t-1}^2 D_{t-1} \tag{3}$$

where $\sigma_t^2 = \left(\sigma_{1,t}^2, \sigma_{2,t}^2, \sigma_{3,t}^2\right)'$, $\omega = \left(\omega_1, \omega_2, \omega_3\right)'$, $\alpha = diag\left(\alpha_1, \alpha_2, \alpha_3\right)$, $\beta = diag\left(\beta_1, \beta_2, \beta_3\right)$, $\gamma = diag\left(\gamma_1, \gamma_2, \gamma_3\right)$, and $D_t = \begin{cases} 1, \textit{ if } \varepsilon_t < 0 \\ 0, \textit{ otherwise} \end{cases}$. All the elements of α and β are non-negative and each element of ω is positive. The time varying conditional correlation matrix Γ_t follows Tse and Tsui (2002)

$$\Gamma_t = (1 - \theta_1 - \theta_2)\Gamma + \theta_1\Gamma_{t-1} + \theta_2\Psi_{t-1} \tag{4}$$

where $\Gamma = \left(\rho_{ij}\right)_{3\times 3}$ is a positive definite parameter matrix with unit diagonal elements,

$$\Psi_{t-1} = B_{t-1}^{-1} E_{t-1} E_{t-1}^{'} B_{t-1}^{-1} \tag{5}$$

where $B_{t-1} = diag\left(\left(\sum_{h=1}^{3} \eta_{i,t-h}^2\right)^{1/2}\right)_{3\times 3}$ and $E_{t-1} = \left(\eta_{t-1}, \eta_{t-2}, \eta_{t-3}\right)$. To ensure that the model is well defined and is covariance stationarity the following constraints were imposed via the SQPF algorithm of Lawrence and Tits (2001); $\left|\phi_{0,i}\right| < 1$ and $\left(\alpha_i + \beta_i + \gamma_i/2\right) < 1$ for all *i*, (see Ling and McAleer (2002)) and $0 \le \theta_1, \theta_1 \le 1$ and $\theta_1 + \theta_2 \le 1$. The specification reduces further to the CC model of Bollerslev (1990) if $\theta_1 = \theta_2 = 0$.

From the estimates of the covariances and variances produced by this model, we are able to calculate both the time-varying betas (relative to the market return) and the time-varying exchange rate exposure coefficients. This is done for each of the thirty-two industries in our empirical analysis. In our analysis we estimate the trivariate system for each of the thirty-two groupings of industry portfolio, market return and exchange rate.

4. Results and Discussion

4.1 AUDUSD Analysis

Table 3 presents a summary of the results of our multivariate GJR-GARCH model AUDUSD analysis. To begin with Panel A reports (i) the estimated coefficients of the GARCH process and the GJR parameters of the thirty-two Australian industry portfolios; (ii) the correlation estimates between the industry portfolio returns and the percentage change in AUDUSD and AOI respectively; and (iii) the time-varying correlation parameters. First, when considering our results, we note that the coefficients of the constant term (μ) are positive for each of the industry portfolios and statistically significant for fourteen (nineteen) of the thirty-two industry portfolios at the 5% (10%) level. In addition, we also observe that all the estimated coefficients of the ARCH, or α, term are positive. However, in this case we note statistically significant parameter estimates are only obtained for nineteen (twenty-four) portfolio returns at the 5% (10%) level. Further, as expected, the estimated GARCH, or β, parameter measures are all positive and statistically significant at the 5% level. Thus, when taking both the ARCH and GARCH parameters together, approximately 75% of the Australian stocks have a statistically significant volatility response to positive shocks.

According to the GJR-GARCH model, if bad news has greater impact on volatility than good news, a "leverage" effect exists and we expect $\delta > 0$. Hence, the GJR parameter indicates how stock price volatility changes due to negative shocks. When we consider δ_1 as reported in Panel A of Table 3, therefore, we find that negative shocks have a significant positive impact on nine (twelve) industries that are statistically significant at the 5% (10%) level. Consistent with the findings of other empirical studies, bad news has a greater affect on the volatility than good news. Our results, therefore, suggest that there is some evidence of volatility asymmetry in the Australian stock market. In fact, almost 40%

of Australian industry portfolios investigated in this study exhibit an asymmetric response to AUDUSD fluctuations. Specifically, evidence of an asymmetric response to fluctuations in the AUDUSD is found in the construction industry (Construction & Building and Other Construction); the finance sector (Insurance and SPC & Finance); the resource sector (Gas Distribution, Mining, and Resources); and industrials (Basic Industries, Diversified Industrials, and General Industrials). Interestingly, however, the parameters of an additional three industry portfolios are also statistically significant albeit negative in sign. These portfolios are Other Utilities, Utilities and Gas Distribution. This result seems counter-intuitive since it suggests that, in fact, for these portfolios good news has a greater impact on the volatility of these stock returns than bad news.

Finally, when we consider the parameter values α, β and δ together, we observe that in most of the twenty-four cases where both α and β are statistically significant, the sum of these two parameters is less the one. In those cases where the sum exceeds unity, namely Gas Distribution and Other Utilities, the sum of α, β and δ is less than one. This therefore indicates that in all statistically significant instances the volatility shock is expected to dissipate over time and the model is not 'explosive'.

Panel A of Table 3 also reports the correlation coefficient between each industry portfolio and both the exchange rate and the market. It also reports the parameters θ_1 and θ_2, driving the time-varying specification for conditional correlations. First, we observe a statistically significant correlation coefficient between returns on the industry portfolios and the AUDUSD ($\rho_{A,C}$) in six (nine) cases at the 5% (10%) level. In relative terms, this represents almost 30% of the Australian stock market. Interestingly, the strongest incidence of correlation between the portfolio and exchange rate returns is seen in the financial sector, namely, Banks, Financials, Insurance, and SPC & Finance. Our results also suggest that the returns of the following industries are correlated to the AUDUSD

return - Chemicals, Cyclical Services, Gold Mining, Publishing and Printing, and Retail. Further, we find that the correlation is negative in all cases thus indicating an inverse relationship between the change in exchange rates and the return on assets. This result is reflected in Panel B of Table 4 in which the summary statistics of the correlation coefficient between the exchange rate and the market are reported ($\rho_{C,M}$). Here we observe a negative relationship between the AUDUSD and the Australian stock market returns, where the mean value is -0.1128 and the median is -0.0986. Of the thirty-two industry portfolios, twenty (twenty-five) cases are statistically significant at the 5% (10%) level. Conversely, and not surprisingly, we find a strong positive relationship between the portfolio returns and the market returns ($\rho_{A,M}$). This finding is reported in Panel A where we note that all thirty-two industry portfolios exhibit a statistically significant coefficient at the 5% level.

[Insert Table 3 about here]

The varying correlation GARCH (1,1) Tse and Tsui (2002) model implemented in this study parameterises the time-varying correlation between the asset returns, the exchange rate returns and the market returns as an ARMA (1,1) process. Hence, it considers the extent to which the current values and the error terms in each case are dependent on past values. The results are reported in Panel A of Table 3. The key parameter in driving the behaviour of the time-varying conditional correlation in the specified GARCH model is θ_1. Consistent with the general findings reported in other studies, we observe that twenty-nine of the estimates are positive, highly significant and close to one, suggesting a strong persistence in conditional correlation (approximately 90% of the market). In addition, our results suggest time varying correlation in the error term. Specifically, we observe the θ_2 estimates to be positive and statistically significant at the 5% (10%) level in thirty (thirty-one) of the thirty-two cases. The industries that do not

exhibit a statistically significant relationship in these results are (i) Chemicals, Insurance and Retail in the case of in the findings for θ_1, and (ii) Non Cyclical Consumption Goods and Chemicals in the case of in the findings for θ_2. Further, again consistent with the results reported in the literature, we note that the θ_2 estimates are considerably smaller than θ_1 counterparts.

Panel B of Table 3 reports a summary of the exchange rate and equity market GJR-GARCH model results. These summary statistics are provided because there are thirty-two separate estimators involving both variables and, in general, the parameter estimates are very similar across all thirty-two separate estimates. Specifically, in both cases all the mean estimates are positive and statistically significant. In addition, while the mean α and β values are 0.0300 and 0.9702, respectively, for the exchange rate, the comparable values for the market are 0.0248 and 0.9187. As expected, in both instances the sum of mean/median values of α and β are either equal to one (as in the case of the exchange rate), or relatively close to one (as in the case of the market).

Panel B of Table 3 also reports the average results of the AUDUSD GJR-GARCH parameters δ_2 and δ_3 that measure the impact of negative shocks on the exchange rate return and the Australian stock market return, respectively. Interestingly, while the GJR parameter δ_2 is negative for all industry settings (with a minimum value of -0.0111 and a maximum value of -0.0097), not one of the parameters is statistically significant. The implication of this result is that there are no asymmetric effects in the AUDUSD foreign exchange market. This finding is not surprising given that all transactions undertaken in this market involve two currencies and thus any negative shock associated with one currency simply results in a positive effect on the other. Moreover, asymmetry is commonly viewed as a reflection of a leverage effect – an effect that should not be evident in exchange rate returns. Put quite simply, our results indicate that generally the volatility

of prices in the foreign exchange market is not prone to the effects of negative shocks. Conversely, the GJR parameter δ_3 is positive and statistically significant at the 5% level for all industries. Again, this result is not surprising since it implies that negative shocks in the stock market as a whole have a greater effect on the volatility of stock prices than do positive shocks – quite likely driven by a leverage effect.[8]

Table 4 reports the descriptive statistics for the time-varying currency betas relative to the AUDUSD exchange rate. Consistent with the results reported above, the exchange rate exposure observed across the thirty-two industry portfolios is strongly negative. The only exception is Pharmaceuticals which has a positive mean (and median) currency beta estimate. However, when we consider the percentage of positive currency betas for this industry, we note that the positive finding is a marginal one since only 55% of the betas are in fact positive. Another marginal case is Food Processing. Although the mean and median values are observed to be negative in this case, the final column of Table 4 reports that only 52% of the currency beta values are in fact negative. There are, however, a number of strong negative cases. These are found in the financial sector (Banks and Financials); the resource sector (Gold Mining; Mining; Oil and Gas; and Resources), and other industries such as Chemicals, Investment Companies, Publishing and Printing, Retail and Utilities. Notably, the strong negative predictions for General Industrials; Gold Mining; Mining; Resources; and Steel and Other Metals are supported by larger negative mean currency betas. However, contrary to some of our predicted signs detailed in Table 2, our results suggest that in general there exists an inverse relationship between a movement in the AUDUSD and portfolio returns. Specifically, a(n) depreciation (appreciation) of the AUD would lead to a increase (decrease) in asset prices. Notably, the industries of

[8] Once again when we consider the parameter values α, β and δ together we observe that in both cases, namely with respect to the exchange rate and the Australian stock market, the model is not 'explosive'. In both cases either the sum of α and β or the sum of α, β and δ is less than one, therefore suggesting the effect of any shock is expected to dissipate over time.

Chemicals, Investment Companies, Publishing and Printing, Retail and Utilities for which we predicted a strong positive reaction to an appreciation to the AUDUSD in Table 2 have some of the highest incidences of negative currency betas reported in final column of Table 4.

[Insert Table 4 about here]

Finally, Table 4 reports that Construction & Building has a wide range of currency betas (with a minimum value of -2.0890 and a maximum value of 0.2108). Other relatively wide ranges are reported for Gold Mining (-1.3040 and 0.0716); Insurance (-1.1685 to 0.0772); Pharmaceuticals (-0.5268 to 0.3791); Resources (-0.6490 to 0.1850); and Steel and Other Metals (-0.5998 to 0.2750). Interestingly, we observe a sign switch in all industries. As evident from the minimum and maximum values reported in Table 4, all industry portfolios report a negative minimum and a positive maximum currency beta. The lowest minimum result is observed for the industry portfolio of Construction & Building (-2.0890) while the highest maximum result is reported for Health (0.4973). These findings are consistent with empirical evidence thus far which indicates that exposure coefficients not only exhibit significant swings over time but also experience sign changes [see for example Di Iorio and Faff (2000)].

To further investigate the time-varying nature of the industry portfolios examined in this study, graphs of the exposure are constructed and selected plots are reported in Figure 1. Again consistent with the other empirical studies, no clear pattern is detected either for any individual industry or across the market in general. Some authors have suggested that the absence of discernible patterns in the time varying behaviour of exchange rate exposure may be attributable to several factors, including changes in real operations (that is the share of imports and exports in the respective industries) [Allayannis (1995)]; a firm's share of production located in foreign countries [Gao (2000)]; changes in

macroeconomic variables [Entorf and Jamin (2004)]; or changes in a firm's hedging policy over time [Levi (1994)].

[Insert Figure 1 about here]

The AUDUSD market beta estimates are reported in Table 5. As anticipated, the mean (median) beta coefficients in this instance are positive and range from a mean (median) for Media and Entertainment of 1.5846 (1.4228) to Food Processing with a value of 0.5372 (0.5410). Of note are the extreme kurtosis (skewness) values of three industry portfolios – Retail [28.3149 (3.2358)]; Other Construction [11.8175 (2.002)]; and Insurance [10.5234 (1.9772)]. Several industries have similar Minimum/Maximum ranges [for example Insurance, Other Construction, Pharmaceuticals, and Steel & Other Metals] while only one Minimum value is negative [Gold Mining: -0.2871].

[Insert Table 5 about here]

4.2 AUDJPY Analysis

Table 6 begins the reporting of the results where the AUDJPY exchange rate return is used in the analysis. As in Table 4, in which we report the GJR-GARCH parameters for the AUDUSD investigation, Table 6 reports the equivalent parameters for the AUDJPY examination. Interestingly, the results for all parameters are consistent across the two exchange rates in terms of sign, magnitude and statistical significance. As in the AUDUSD analysis, when we consider the δ_1 parameter reported in Panel A of Table 6, we find that almost 40% of Australian industry portfolios investigated in this study exhibit an asymmetric response to AUDJPY fluctuations. The only industry portfolio to exhibit a different response in the AUDJPY analysis is Other Construction, which is not significant in this case. Further, as was the case with the AUDUSD analysis, the industries in which we find evidence of an asymmetric response to fluctuations in the AUDJPY are in the

construction, resource and industrial sectors. Hence, the results across both exchange rates are closely aligned.

The correlation between each industry portfolio and the exchange rate and market respectively is also detailed in Panel A of Table 6. First, as with the AUDUSD analysis, the correlation coefficient $\rho_{A,C}$ that measures the correlation between each industry portfolio and the exchange rate (in this case the AUDJPY), is negative in all cases. Nine (sixteen) industry portfolios exhibit statistically significant correlation at the 5% (10%) levels. This represents about 50% of the Australian equities market. Interestingly, almost twice as many industries are correlated to the AUDJPY as are correlated to the AUDUSD (reported in Panel A of Table 3). Moreover, while the industry portfolios of Banks, Chemicals, Financials, Gold Mining, Insurance, Publishing & Printing, and Retail are significantly correlated to both exchange rates, we observe the industrial sector (Basic Industries, Diversified Industries, General Industries); the resource sector (Mining, Oil and Gas, Resources and Steel and Other Metals) and the construction industry (Construction & Building and Other Construction) are only significantly correlated to the AUDJPY. The portfolio Non Cyclical Consumption Goods is also only correlated to the AUDJPY. Again, as in the AUDUSD analysis, the negative correlation reported in Panel A of Table 6 is reflected in Panel B of the table that reports the summary statistics of the correlation between the AUDJPY and the AOI ($\rho_{C,M}$).

Panel A of Table 6 also reports time-varying conditional correlation results θ_1 and θ_2 and the results are similar to the AUDUSD analysis. For example, we observe that twenty-eight of the θ_1 estimates are positive, highly significant and close to one, suggesting (as in the results of the AUDUSD analysis) a strong persistence in conditional correlation.[9]

[9] The results reported in Panel B of Table 6, mirror their counterparts in Table 3. As such, discussion is suppressed to conserve space.

[Insert Table 6 about here]

Table 7 reports the descriptive statistics for the currency betas of the AUDJPY exchange rate. Consistent with the results reported thus far, the exchange rate exposure observed across the thirty-two industry portfolios is strongly negative. As reported in the findings of the AUDUSD analysis, strong negative cases are found in the resource sector (Gold Mining, Mining, and Oil and Gas). However, in this case the industrial sector (Basic Industrials, Diversified Industries and General Industrials) is also noted to have a significant number of negative currency betas, with Diversified Industries and General Industrials reporting 100% negative values. These results are consistent with the sign predictions detailed for these portfolios in Table 2. However, in other cases, such as Other Construction and Oil & Gas that report a very high incidence of negative values, our sign prediction in Table 2 is contradicted.[10]

[Insert Table 7 about here]

5. Conclusion

This investigation examines the time-varying foreign exchange rate risk exposure of the Australian stock market. Implementing the varying correlation GARCH (1,1) Tse and Tsui (2002) model, we analyse thirty-two industry portfolios using daily data for the period June 1992 to August 2005. Specifically, we apply this model to a trivarite setting between portfolio stock returns, the market return and the exchange rate. In addition, we accommodate a potential asymmetric response in variance to fluctuations in the exchange rate by using the GJR specification model.

[10] Results for descriptive statistics of the market betas when using AUDJPY, mirror their counterparts in Table 5. As such, tabulated results and discussion is suppressed to conserve space.

In general our findings indicate that the Australian stock market experiences an asymmetric response to exchange rate movements. While most of the sample industry portfolios exhibit a statistically significant volatility response to positive shocks, approximately 40% of the portfolios record an (additional) statistically significant volatility response to negative shocks. This asymmetric response is consistent in the analysis of both exchange rates and evident in the construction, finance, industrial and resource sectors.

In our investigation of the correlation between the portfolio returns and the exchange rate returns, we find statistically significant negative correlation in about 25% (50%) of cases in the AUDUSD (AUDPY) analysis. Thus, interestingly we find that twice as many industries are statistically significantly correlated with the AUDJPY than are correlated with the AUDUSD. We find that this is particularly evident in the industrial and resource sectors. In addition, the time-varying conditional correlation results suggest a strong persistence in correlation in the Australian stock market with statistically significant estimates in 90% of cases. This finding is consistent across the two exchange rates.

Further, consistent with the results reported in the current literature in this research area, we find 'sign switching' in the currency betas through time for given industry portfolios. Although the incidence of negative currency betas far outweighs the number of positive currency betas in our analysis of both exchange rates, we observe considerable evidence of sign switching during the sample period. Possible explanations for this finding could include changes in firm-specific characteristics (such as hedging policies) and/or changes in macroeconomic variables.

Finally, when considering predictions attained through an analysis of the import/export activity of the industry groups analysed in this investigation, we find that although we predicted a negative sign for about 50% (albeit weak in some instances), the results of our empirical analysis provide evidence of overwhelming negative exchange rate

exposure. This may be due to a possible averaging effect within the industry portfolio returns. Hence, a possible extension of this research is the investigation of individual stock data in a bid to provide greater insight into the foreign exchange exposure of the Australian market.

References

Adler, M., Dumas, B., 1984. Exposure to currency risk: Definition and measurement. *Financial Management,* 13, 41-50.

Allayannis,G., 1995. Time-variation of the exchange rate exposure: An industry analysis. Working Paper, New York University.

Allayannis,G., Ihrig, J., 2001. Exposure and markups. *Review of Financial Studies*, 14, 805-835.

Amihud, Y. Exchange rates and the valuation of equity shares. In: Y. Amihud and R.M. Levich, Editors, *Exchange rates and corporate performance*. Irwin, New York 1994. 49–59.

Australian Bureau of Statistics, Australian National Accounts Input-Output Tables, 1998-1999.

Australian Bureau of Statistics: International Merchandise Trade Cat. No. 5422.

Australian Industry Group PricewaterhouseCoopers *Quarterly Survey of Australian Manufacturing*, December quarter, 2003.

Baba, N., Fukao, K., 2000. Currency risk exposure of Japanese firms with overseas production bases: theory and evidence. IMES Discussion Paper Sereis, No 2000-E-1.

Bartov, E., Bodnar, G.M., 1994. Firm valuation, earnings expectations, and the exchange rate exposure effect. *Journal of Finance, 49*, 1755-85.

Black, F., 1976. Studies of stock price volatility changes. Proceedings of the American Statistical Association, Business and Economics Statistics Section, 177-181.

Bodnar, G. M., Gentry, W.M., 1993. Exchange Rate Exposure and Industry Characteristics: evidence from Canada, Japan and the USA. *Journal of International Money and Finance,* 12, 29-45.

Bodnar, G. M, Gentry W.M., 1994. Firm Valuation, Earnings Expectations, and the Exchange-Rate Exposure Effect. *Journal Finance*, 49, 1755-1785.

Bollerslev, T., 1990. Modelling the coherence in short run nominal exchange rates: A multivariate Generalised ARCH model. *The Review of Economics and Statistics*, 72, 498-505.

Booth, L., 1996. On the nature of foreign exchange exposure. *Journal of Multinational Financial Management*, 6, 1-24.

Business Week, May 16, 2003. p 157.

Chamberlain, S., Howe, J.S., Popper, H. 1997. The exchange rate exposure of U.S. and Japanese banking institutions. *Journal of Banking and Finance,* 21, 871-892.

Choi, J.J., Prasad, A.M. 1995. Exchange rate sensitivity and its determinants. *Financial Management,* 24, 77-88.

Chow, E., Lee, W., Solt, M., 1997a. The economic exposure of US multinational firms. *Journal of Finance Research*, 20, 191 - 210.

Chow, E., Lee, W., Solt, M., 1997b. The exchange rate exposure of US multinational firms. *Journal of Business,* 70, 105-123.

Chow, E.H., Chen, H.L., 1998. The determinants of foreign exchange rate exposure: Evidence on Japanese firms. *Pacific-Basin Finance Journal,* 6, 153-174.

DeSantis, G., Bruno, G., Hillion, P., 2003. The relevance of currency risk in the EMU. *Journal of Economics and Business*, 55, 427-462.

Di Iorio, A., Faff, R., 2000. An analysis of asymmetry in foreign currency exposure of the Australian equities market. *Journal of Multinational Financial Management,* 10(2), 133-159.

Di Iorio, A., Faff, R., 2001. The effect of intervaling on the foreign exchange exposure of Australian stock returns. *Multinational Finance Journal,* 5(1), 1-33.

Entorf, H., Jamin, G., 2004. German exchange rate exposure at DAX and aggregate level, international trade, and the role of exchange rate adjustment costs. Working Paper, Darmstadt University of Technology.

Flood, E., Lessard, D.R., 1986. Spring. On the measurement of operating exposure to exchange rates: a conceptual approach. *Financial Management*, 25-37.

Gao, T., 2000. Exchange rate movements and the profitability of US multinationals. *Journal of International Money and Finance*, 19, 117-134.

Glaum, M., Brunner, M., Holger, H., 2000. The DAX and the dollar: The economic exchange rate exposure of German corporations. *Journal of International Business Studies*, 31, 715-724.

Glosten, L., Jaganathan, R., Runkle, D., 1993. The relationship between expected value and the volatility of the nominal excess return on stocks. *Journal of Finance*, 48, 1779-1801.

He, J., Ng L., 1998. The foreign exchange exposure of Japanese multinational corporations. *Journal of Finance,* 53, 733-753.

Hekman, C.R., 1985. A financial model of foreign exchange exposure. *Journal of International Business Studies,* 41, 83-99.

Hodder, J.E., 1982. Exposure to exchange rate movements. *Journal of International Economics*, 13, 375-386.

Hung, H., 1992. Assessing the exchange rate's impact on US manufacturing profits. Quarterly Review, Federal Reserve Bank of New York.

Jorion, P., 1990. The exchange rate exposure of multinationals. *Journal of Business*, 63**,** 331-342.

Jorion, P., 1991. The pricing of exchange rate risk in the stock market. *Journal of Financial and Quantitative Analysis,* 26, 363-376.

Khoo, A., 1994. Estimation of foreign exchange exposure - an application to mining companies in Australia. *Journal of International Money and Finance*, 13, 342-363.

Kiymaz, H., 2003. Estimation of foreign exchange exposure: An emerging market application. *Journal of Multinational Financial Management,* 13, 71–84.

Koutmos, G., Martin, A.D. 2003. Asymmetric exchange rate exposure: Theory and evidence. *Journal of International Money and Finance*, 14, 747-62.

Lawrence, C., Tits, A., 2001. A Computationally Efficient Feasible Sequential Quadratic Programming Algorithm. *SIAM Journal on Optimisation*, 11, 1092-1118.

Levi, M.D., 1983. International finance: financial management and international economy. McGraw-Hill International Book Company, London, 317-319.

Levi, M.D., 1994. Exchange rates and the valuation of firms. In: Amihud, Y., Levich, R.M. (Eds), Exchange Rates and Corporate Performance. Irwin, New York, pp. 37-48.

Ling, S., McAleer, M., 2002. Stationarity and the existence of moments of a family of GARCH processes, *Journal of Econometrics,* 106, 109-117.

Loudon, G., 1993a. The foreign exchange operating exposure of Australian stocks. *Accounting & Finance*, 32, 19-32.

Loudon, G., 1993b. Foreign exchange exposure and the pricing of currency risk in equity returns. *Pacific-Basin Finance Journal,* 1, 335-354.

Marston, R.C., 2001. The effects of industry structure on economic exposure. *Journal of International Money and Finance*, 20, 149-164.

Pagan, A., 1996. The Econometrics of Financial Markets. *Journal of Empirical Finance*, 3, 15-102.

Patro, D.K. Wald J.K., Yangru, W., 2002. Explaining exchange rate risk in world stock markets: A panel approach. *Journal of Banking & Finance,* 26 (10), 1951-1972

Rosenberg, M., 2003. Exchange-rate determination, McGraw Hill.

Shapiro, A.C., 1975. Exchange rate changes, inflation and the value of multinational corporations. *Journal of Finance*, 30, 485-502.

Survey of Australian Manufacturing, December quarter, 2003.

Tai, C.S., 1999. Time-varying risk premia in foreign exchange and equity markets: evidence from Asia-Pacific countries. *Journal of Multinational Financial Management*, 9(3-4), 291-316.

Tai, C.S., 2000. Time-varying market, interest rate and exchange rate risk premia in the US commercial bank stock returns. *Journal of Multinational Financial Management*, 9, 397-420.

Tse, Y., Tsui, A., 2002. A multivariate generalised autoregressive conditional heteroscedasticity model with time-varying correlations. *Journal of Business and Economic Statistics*, 20, 351-362.

Williamson, R.G., 2001. Exchange rate exposure and competition: Evidence from the automotive industry. *Journal of Financial Economics,* 59, 441-475.

Table 1: Input-Output Coefficients of Relative Export and Import Importance across Australian Industry Classifications

		Panel A: Exports		Panel B: Imports		
	ABS Industry Classification	Input-Output Co-efficient [a]	Relative Co-efficient [b]	Input-Output Co-efficient [a]	Relative Co-efficient [b]	Datastream Industry Classification
1	Agriculture; hunting and trapping	0.59751	2.36849	0.04971	0.52015	Diversified Industrials, General industrials
2	Forestry and fishing	0.27561	1.09250	0.14384	1.50506	Basic Industries
3	Mining	0.92462	3.66511	0.05355	0.56031	Mining, Gold Mining, Steel and Other Metals
4	Meat and dairy products	0.48055	1.90486	0.02469	0.25831	General Industrials, Diversified Industrials
5	Other food products	0.27567	1.09274	0.05983	0.62599	Food Processing
6	Beverages and tobacco products	0.12832	0.50863	0.03901	0.40821	Beverages, Non Cyclical Consumption Goods
7	Textiles	0.45958	1.82172	0.10922	1.14274	
8	Clothing and footwear	0.23617	0.93615	0.21140	2.21192	Cyclical Services, Retail
9	Wood and wood products	0.75301	2.98486	0.11966	1.25201	Basic Industries
10	Paper, printing and publishing	0.12988	0.51485	0.14093	1.47462	Publishing and Printing
11	Petroleum and coal products	0.21768	0.86287	0.45513	4.76211	Oil and Gas
12	Chemicals	0.36648	1.45268	0.19461	2.03628	Chemicals
13	Rubber and plastic products	0.27080	1.07342	0.18231	1.90754	Diversified Industrials, General industrials
14	Non-metallic mineral products	0.37625	1.49142	0.05683	0.59464	Resources
15	Basic metals and products	0.95106	3.76992	0.14362	1.50276	Steel and Other Metals
16	Fabricated metal products	0.28176	1.11688	0.08871	0.92823	Basic Industries
17	Transport equipment	0.19364	0.76756	0.24513	2.56486	
18	Other machinery and equipment	0.39675	1.57267	0.21556	2.25543	
19	Miscellaneous manufacturing	0.18545	0.73511	0.12390	1.29634	Basic Industries
20	Electricity, gas and water	0.00363	0.01439	0.03696	0.38675	Oil and Gas, Gas Distribution, Utilities, Other Utilities
21	Construction	0.00089	0.00354	0.05961	0.62369	Construction & Building, Basic Industries, Other Construction
22	Wholesale trade	0.20167	0.79939	0.03099	0.32427	
23	Retail trade	0.03316	0.13145	0.02996	0.31345	Cyclical Services, Retail
24	Repairs	0.03911	0.15505	0.08133	0.85103	
25	Accommodation, cafes & restaurants	0.12325	0.48856	0.04572	0.47837	Leisure and Hotels
26	Transport and storage	0.47477	1.88196	0.04212	0.44074	Transport
27	Communication services	0.11014	0.43660	0.06146	0.64308	Media and Entertainment, Cyclical Services,
28	Finance and insurance	0.06348	0.25162	0.01140	0.11923	Banks, Financials, Insurance, SPC & Finance
29	Ownership of dwellings	0.00390	0.01546	0.00635	0.06646	
30	Property and business services	0.16617	0.65868	0.04925	0.51534	Real Estate, Investment Companies
31	Government administration	0.00394	0.01562	0.05791	0.60588	
32	Education	0.05741	0.22756	0.02612	0.27329	Support Services
33	Health and community services	0.00654	0.02593	0.03332	0.34866	Health, Non Cyclical Consumption Goods, Pharmaceuticals
34	Cultural and recreational services	0.03615	0.14329	0.06605	0.69105	Cyclical Services, Leisure and Hotels
35	Personal and other services	0.00466	0.01846	0.048859	0.511221	Support Services

[a] Export (import) Input-Output coefficient for each industry is calculated as the ratio of exports (imports) as a proportion of Final Demand (Production) i.e. ($Exports)/($Final Demand) and ($Imports)/($Aust. Production).

[b] Relative coefficient for each industry is calculated as the ratio (Input-Output Coefficient) / (Industry Average Input-Output Coefficient).

Table 2: Summary of Sign Predictions of Foreign Exchange Exposure

	Datastream Industry Classification	Exports Relative Coefficient	Imports Relative Coefficient	Prediction with an appreciation of the AUD
1	Banks	0.25162	0.11923	- / negligible
2	Basic Industries	1.18659	1.12106	- / negligible
3	Beverages	0.50863	0.40821	- / negligible
4	Chemicals	1.45268	2.03628	++
5	Construction & Building	0.79939	0.32427	-
6	Cyclical Services	0.41187	0.96488	+
7	Diversified Industrials	1.78226	0.89533	--
8	Financials	0.25162	0.11923	- / negligible
9	Food Processing	1.09274	0.62599	-
10	Gas Distribution	0.01439	0.38675	+
11	General Industrials	1.78226	0.89533	--
12	Gold Mining	3.66511	0.56031	--
13	Health	0.02593	0.34866	+
14	Insurance	0.25162	0.11923	- / negligible
15	Investment Companies	0.65868	0.51534	- / negligible
16	Leisure and Hotels	0.31592	0.58471	+
17	Media & Entertainment	0.43660	0.64308	+
18	Mining	3.66511	0.56031	--
19	Non Cyclical Consumption Goods	0.26728	0.37843	+ / negligible
20	Oil and Gas	0.43863	2.57443	++
21	Other Construction	0.00354	0.62369	++
22	Other Utilities	0.01439	0.38675	+
23	Pharmaceuticals	0.02593	0.34866	+
24	Publishing and Printing	0.51485	1.47462	++
25	Real Estate	0.65868	0.51534	- / negligible
26	Resources	1.49142	0.59464	- -
27	Retail	0.5338	1.26269	+ +
28	SPC & Finance	0.25162	0.11923	- / negligible
29	Steel & Other Metals	3.71751	1.03153	--
30	Support Services	0.12301	0.39225	+
31	Transport	1.88196	0.44074	--
32	Utilities	0.01439	0.38675	++

* Note: -- strongly negative; - negative; ++ strongly positive; + positive;

Table 3: Multivariate GJR-GARCH Model Summary – AUDUSD Analysis

Panel A: Australian Industry Portfolio GJR-GARCH Model Summary

	Industry	GARCH Parameters			GJR Parameter	Correlation Equation Coefficients			
		μ	α	β	δ_1	$\rho_{A,C}$	$\rho_{A,M}$	θ_1	θ_2
1	Banks	0.0616**	0.0868**	0.8373**	0.0153	-0.0683**	0.7934**	0.9768**	0.0100**
		(3.6466)	(5.1405)	(27.2540)	(0.8206)	(-2.0804)	(41.9740)	(106.8300)	(3.2117)
2	Basic Industries	0.0256**	0.0174*	0.9200**	0.0560**	-0.1159	0.9212**	0.9871**	0.0099**
		(2.9363)	(1.7153)	(44.2090)	(3.9987)	(-1.5500)	(31.7020)	(436.9000)	(5.7237)
3	Beverages	0.0092	0.0254**	0.9611**	0.0158	-0.0439	0.5343**	0.9818**	0.0085**
		(0.9942)	(2.2697)	(40.8400)	(0.7806)	(-1.2949)	(16.7060)	(90.7560)	(2.3268)
4	Chemicals	0.1358*	0.0976**	0.8024**	0.0096	-0.0380**	0.4037**	0.0001	0.0442
		(1.7441)	(2.5866)	(9.8056)	(0.3345)	(-1.9865)	(17.6970)	(0.0000)	(0.4465)
5	Construction & Building	0.0374**	0.0264*	0.9048**	0.0559**	-0.0761	0.8261**	0.9868**	0.0096**
		(2.4599)	(1.8331)	(31.1640)	(3.1815)	(-1.1775)	(13.7500)	(265.3200)	(4.3690)
6	Cyclical Services	0.0161*	0.0513**	0.9311**	0.0142	-0.0521**	0.8208**	0.9312**	0.0169**
		(1.7447)	(2.7511)	(35.1440)	(0.8511)	(-2.1171)	(68.8810)	(22.8950)	(2.2610)
7	Diversified Industrials	0.0807**	0.0369*	0.8707**	0.0518**	-0.0808	0.8055**	0.9933**	0.0057**
		(2.1971)	(1.9119)	(18.7030)	(2.3546)	(-0.8113)	(17.7260)	(473.1300)	(3.4542)
8	Financials	0.0270**	0.0651**	0.8811**	0.0171	-0.0642**	0.8658**	0.9652**	0.0129**
		(2.9334)	(4.4640)	(31.8750)	(1.1433)	(-2.1985)	(65.7720)	(83.1510)	(3.8681)
9	Food Processing	0.1942**	0.0612**	0.6969**	0.0332	-0.0549	0.7011**	0.9956**	0.0040**
		(2.7334)	(1.9817)	(8.2890)	(0.9751)	(-0.4964)	(11.8320)	(789.4300)	(4.0359)
10	Gas Distribution	0.0010	0.0218**	0.9853**	-0.0158**	-0.0464	0.3632**	0.9928**	0.0042**
		(0.6253)	(2.0036)	(85.462)	-(2.7396)	(-1.0069)	(9.2539)	(518.1500)	(3.4166)
11	General Industrials	0.0634**	0.0360*	0.8781**	0.0514**	-0.0938	0.8180**	0.9927**	0.0057**
		(2.2525)	(1.8713)	(20.338)	(2.4412)	(-1.2425)	(20.8130)	(305.3600)	(2.4377)
12	Gold Mining	0.2152**	0.1206**	0.8297**	-0.0220	-0.1529*	0.3981**	0.9931**	0.0058**
		(2.2276)	(3.4861)	(16.0200)	(-0.8382)	(-1.8429)	(4.8583)	(652.5700)	(5.3512)
13	Health	0.1247	0.1195	0.8055**	0.0222	-0.0369	0.4358**	0.9931**	0.0049**
		(0.3822)	(0.5394)	(2.2720)	(0.2879)	(-0.6876)	(8.6070)	(724.9200)	(4.9608)
14	Insurance	0.1443**	0.0594**	0.7726**	0.1380**	-0.0345*	0.5472**	0.0001	0.0579*
		(2.9277)	(2.0814)	(12.2910)	(2.2101)	(-1.7987)	(33.0270)	(0.0002)	(1.9711)
15	Investment Companies	0.0014*	0.0314**	0.9659**	0.0048	-0.0379	0.4804**	0.9922**	0.0030*
		(1.7483)	(93.9095)	(124.1500)	(0.5092)	(-1.3158)	(12.2960)	(174.8800)	(1.6972)
16	Leisure and Hotels	0.0865	0.0437	0.8251**	0.0476**	-0.0474	0.6073**	0.9855**	0.0083**
		(1.2653)	(1.0306)	(6.8191)	(2.2392)	(-1.1390)	(16.7910)	(221.8200)	(3.6374)

Table 3 (cont)

	Industry	GARCH Parameters			GJR Parameter	Correlation Equation Coefficients			
		μ	α	β	δ_1	$\rho_{A,C}$	$\rho_{A,M}$	θ_1	θ_2
17	Media & Entertainment	0.0129	0.0383**	0.9559**	0.0050	-0.0437	0.7241**	0.9866**	0.0065**
		(0.9853)	(2.6171)	(44.8610)	(0.2829)	(-1.2610)	(29.3440)	(218.4000)	(3.3124)
18	Mining	0.0317**	0.0577**	0.9100**	0.0231*	-0.2007	0.9751**	0.9909**	0.0084**
		(2.3375)	(4.1547)	(41.134)	(1.6571)	(-1.2784)	(95.3450)	(598.6900)	(5.7797)
19	Non CYC Cons Goods	0.0119**	0.02102**	0.9455**	0.0318**	-0.0501	0.7338**	0.9811**	0.0079
		(1.9966)	(2.5538)	(57.7540)	(2.5074)	(-1.4092)	(19.3690)	(43.1150)	(1.1342)
20	Oil and Gas	0.0661	0.0583	0.8831**	0.0188	-0.1236	0.7136**	0.9941**	0.0051**
		(0.8323)	(1.1485)	(8.5494)	(0.9737)	(-1.0683)	(10.3560)	(740.4700)	(4.2839)
21	Other Construction	0.1206	0.0430	0.8551**	0.0699*	-0.0258	0.4336**	0.9901**	0.0058**
		(0.6913)	(1.1029)	(5.8032)	(1.7407)	(-0.6371)	(10.1910)	(472.6200)	(4.1460)
22	Other Utilities	0.0010	0.0218**	0.9853**	-0.0158**	-0.0464	0.3632**	0.9928**	0.0042**
		(0.6254)	(2.0042)	(85.489)	(-2.7396)	(-1.0068)	(9.2534)	(518.0000)	(3.4167)
23	Pharmaceuticals	0.1555	0.0645	0.8618**	0.0864**	0.0044	0.3531**	0.9871**	0.0057**
		(1.2424)	(1.2614)	(10.8500)	(2.0512)	(0.1428)	(8.6555)	(286.6300)	(2.6761)
24	Publishing and Printing	0.0299	0.0579**	0.9095**	0.0044	-0.0734*	0.6221**	0.9923**	0.0044**
		(1.1366)	(1.9698)	(16.0540)	(0.2706)	(-1.7129)	(12.5030)	(476.0200)	(3.3767)
25	Real Estate	0.0168**	0.0405**	0.9155**	0.0232	-0.0124	0.6825**	0.9851**	0.0078**
		(2.6549)	(3.7061)	(42.3580)	(1.6075)	(-0.3386)	(19.1550)	(149.8500)	(3.0198)
26	Resources	0.0270**	0.0515**	0.9163**	0.0214*	-0.1877	0.9829**	0.9898**	0.0091**
		(2.3308)	(4.0850)	(44.3830)	(1.6796)	(-1.3437)	(143.7600)	(567.2100)	(6.0601)
27	Retail	0.1431*	0.1210**	0.7610**	0.0374	-0.0453**	0.4986**	0.1956	0.0467
		(1.6577)	(3.0793)	(7.4883)	(0.6267)	(-2.3180)	(27.9260)	(0.2728)	(1.5785)
28	SPC & Finance	0.1120**	0.0567**	0.7646**	0.0692**	-0.0882**	0.5316**	0.9884**	0.0055**
		(3.3291)	(2.4308)	(14.318)	(2.2817)	(-2.1885)	(12.6420)	(137.5700)	(2.2277)
29	Steel & Other Metals	0.1572*	0.0714*	0.8780**	0.0153	-0.0528	0.4911**	0.9899**	0.0056**
		(1.7831)	(1.7300)	(17.9260)	(0.5173)	(-1.2805)	(10.2580)	(392.5900)	(4.1302)
30	Support Services	0.0260	0.0270	0.9537**	0.0108	-0.0672	0.4297**	0.9915**	0.0068**
		(0.5038)	(1.0817)	(15.7470)	(0.4516)	(-0.8227)	(4.4278)	(334.5600)	(2.8152)
31	Transport	0.0233	0.0481	0.9266**	0.0105	-0.0777	0.7674**	0.9935**	0.0052**
		(0.3361)	(0.6678)	(6.6933)	(0.5589)	(-0.9936)	(11.1080)	(620.3700)	(3.9360)
32	Utilities	0.0010	0.0206	0.9846**	-0.0121**	-0.0389	0.3859**	0.9912**	0.0041**
		(0.6216)	(1.5487)	(68.942)	(-2.1974)	(-1.0920)	(11.8880)	(331.3500)	(2.7987)

* Statistic is significantly different from zero at the 10% level; ** Statistic is significantly different from zero at the 5% level; Note: t-statistics in parentheses.

Table 3 (cont)

Panel B: Exchange Rate and Market GJR-GARCH Model Summary									
	Exchange Rate			Market			GJR Parameters		Correlation Coefficient
	μ	α	β	μ	α	β	δ_2	δ_3	$\rho_{C,M}$
Mean	0.0022	0.0300	0.9700	0.0115	0.0248	0.9187	-0.0105	0.0732	-0.1128
Median	0.0022	0.0299	0.9700	0.0110	0.0230	0.9195	-0.0104	0.0770	-0.0986
Std Dev	0.0000	0.0003	0.0003	0.0027	0.0061	0.0092	0.0003	0.0124	0.03103
Min	0.0021	0.0293	0.9696	0.0091	0.0190	0.8867	-0.0111	0.0413	-0.2073
Max	0.0022	0.0307	0.9707	0.0187	0.0435	0.9333	-0.0097	0.0898	-0.0841
No. of positive	32	32	32	32	32	32	0	32	0
- Sign at 5%	0	3	32	31	32	32	0	32	0
- Sign at 10%	0	32	32	32	32	32	0	32	0
No. of negative	0	0	0	0	0	0	32	0	32
- Sign at 5%	0	0	0	0	0	0	0	0	20
- Sign at 10%	0	0	0	0	0	0	0	0	25

Table 4: Descriptive Statistics of Currency Betas – AUDUSD Analysis

	Industry	Sign Prediction	Mean	Median	Variance	Kurtosis	Skewness	Min	Max	Positive Cases %	Negative Cases %
1	Banks	- / negligible	-0.0873	-0.0865	0.0043	1.4286	0.0507	-0.3680	0.1816	7	93
2	Basic Industries	- / negligible	-0.0890	-0.0909	0.0073	1.0919	-0.2748	-0.4612	0.1712	13	87
3	Beverages	- / negligible	-0.0701	-0.0684	0.0087	1.7228	0.2599	-0.3518	0.3720	18	82
4	Chemicals	++	-0.0712	-0.0672	0.0030	0.1851	-0.5750	-0.4056	0.0251	9	91
5	Construction & Building	-	-0.0860	-0.0839	0.0091	58.7707	-3.4073	-2.0890	0.2108	14	86
6	Cyclical Services	+	-0.0932	-0.0807	0.0084	1.5283	-0.8025	-0.5725	0.1410	13	87
7	Diversified Industrials	--	-0.0981	-0.0873	0.0130	-0.3552	-0.3558	-0.4551	0.1989	23	77
8	Financials	- / negligible	-0.0698	-0.0669	0.0036	0.9723	0.0103	-0.3067	0.1625	10	90
9	Food Processing	-	-0.0034	-0.0050	0.0036	-0.3109	0.2521	-0.2170	0.1690	48	52
10	Gas Distribution	+	-0.0299	-0.0322	0.0033	0.9470	-0.0560	-0.2666	0.1514	26	74
11	General Industrials	--	-0.1071	-0.0954	0.0089	-0.3896	-0.3889	-0.4463	0.1068	14	86
12	Gold Mining	--	-0.2734	-0.2505	0.0265	2.8519	-0.9838	-1.3040	0.0716	2	98
13	Health	+	-0.0211	-0.0335	0.0071	4.9150	1.6030	-0.2390	0.4973	29	71
14	Insurance	- / negligible	-0.0641	-0.0597	0.0057	25.1219	-2.4182	-1.1685	0.0772	22	78
15	Investment Companies	- / negligible	-0.0418	-0.0394	0.0010	1.7562	-0.2393	-0.1571	0.0707	6	94
16	Leisure and Hotels	+	-0.0385	-0.0416	0.0035	-0.1590	0.1195	-0.2362	0.1251	25	75
17	Media & Entertainment	+	-0.1141	-0.0905	0.0188	0.5288	-0.8714	-0.5544	0.1734	19	81
18	Mining	--	-0.1848	-0.1795	0.0147	0.5257	-0.5309	-0.6943	0.1435	3	97
19	Non Cyclical Consumption Goods	+ / negligible	-0.0478	-0.0486	0.0030	0.4647	0.1512	-0.2409	0.1550	18	82
20	Oil and Gas	++	-0.1163	-0.1071	0.0083	0.6234	-0.1817	-0.4226	0.1420	8	92
21	Other Construction	++	-0.0740	-0.0733	0.0065	0.7841	0.2571	-0.3533	0.2611	16	84
22	Other Utilities	+	-0.0299	-0.0322	0.0033	0.9472	-0.0560	-0.2666	0.1514	26	74
23	Pharmaceuticals	+	0.0074	0.0142	0.0128	0.6756	-0.3443	-0.5268	0.3791	55	45
24	Publishing and Printing	++	-0.0933	-0.0915	0.0022	-0.0030	-0.1548	-0.2404	0.0366	3	97
25	Real Estate	- / negligible	-0.0100	-0.0141	0.0029	0.9018	0.6416	-0.1323	0.2224	39	61
26	Resources	- -	-0.1689	-0.1628	0.0141	0.6916	-0.4962	-0.6490	0.1850	8	92
27	Retail	+ +	-0.0825	-0.0772	0.0040	0.3762	-0.6446	-0.4305	0.0491	4	96
28	SPC & Finance	- / negligible	-0.0748	-0.0666	0.0026	2.2216	-1.0173	-0.3340	0.0695	19	81
29	Steel & Other Metals	--	-0.1098	-0.1181	0.0157	0.0517	0.1980	-0.5998	0.2750	24	76
30	Support Services	+	-0.0780	-0.0704	0.0111	0.1932	-0.4782	-0.4742	0.1551	13	87
31	Transport	--	-0.0863	-0.0842	0.0051	-0.3668	-0.0275	-0.3385	0.1239	22	78
32	Utilities	++	-0.0333	-0.0326	0.0025	1.0799	-0.2497	-0.2461	0.1147	7	93

Table 5: Descriptive Statistics of Market Betas – AUDUSD Analysis

	Industry	Mean	Median	Variance	Kurtosis	Skewness	Min	Max
1	Banks	0.9693	0.9661	0.0234	1.4183	0.3389	0.3718	1.7111
2	Basic Industries	0.8374	0.8622	0.0334	0.2343	-0.4483	0.1905	1.4214
3	Beverages	0.8449	0.8196	0.0503	-0.0219	0.5052	0.2974	1.5768
4	Chemicals	0.6699	0.6483	0.0378	2.4168	0.9530	0.2076	1.8217
5	Construction & Building	0.8506	0.8718	0.0331	0.2184	-0.2665	0.2104	1.4668
6	Cyclical Services	1.2404	1.1534	0.0947	1.8140	1.3312	0.7123	2.6392
7	Diversified Industrials	0.8338	0.8341	0.0388	1.6624	0.2842	0.2197	2.1279
8	Financials	0.8669	0.8723	0.0125	1.4473	-0.2131	0.3390	1.2898
9	Food Processing	0.5372	0.5410	0.0315	-0.1542	0.3246	0.1422	1.2659
10	Gas Distribution	0.5638	0.5691	0.0368	-0.3798	0.1798	0.1503	1.2073
11	General Industrials	0.8423	0.8389	0.0282	2.6826	0.5268	0.3932	2.0877
12	Gold Mining	0.7198	0.7452	0.1586	0.1431	-0.2967	-0.2871	2.1294
13	Health	0.6173	0.5888	0.0402	0.5672	0.7075	0.2122	1.6111
14	Insurance	0.8859	0.8496	0.0659	10.5234	1.9772	0.2535	3.3243
15	Investment Companies	0.6235	0.5982	0.0492	-0.2752	0.4949	0.2194	1.3468
16	Leisure and Hotels	0.6466	0.6558	0.0227	0.1657	0.2432	0.3011	1.5437
17	Media & Entertainment	1.5846	1.4228	0.3114	0.1268	0.9208	0.5926	3.3422
18	Mining	1.1723	1.1813	0.0897	1.1891	0.4386	0.3315	2.4200
19	Non Cyclical Consumption Goods	0.7672	0.7635	0.0109	0.7546	0.3876	0.4325	1.2129
20	Oil and Gas	0.8120	0.8087	0.0402	0.0770	0.1156	0.2049	1.5155
21	Other Construction	0.6939	0.6744	0.0391	11.8175	2.0020	0.2260	2.7549
22	Other Utilities	0.5638	0.5691	0.0368	-0.3797	0.1798	0.1503	1.2073
23	Pharmaceuticals	0.8730	0.8191	0.0918	4.1390	1.5475	0.2734	2.7251
24	Publishing and Printing	0.7274	0.7275	0.0161	0.6484	0.3239	0.3751	1.2909
25	Real Estate	0.6022	0.5946	0.0173	0.1323	0.2381	0.1635	1.1558
26	Retail	0.7900	0.7722	0.0452	28.3149	3.2358	0.3023	3.7159
27	SPC & Finance	0.6018	0.5675	0.0375	2.5094	1.0439	0.2288	2.0608
28	Steel & Other Metals	1.0793	1.0823	0.0827	0.5414	0.2439	0.2079	2.6193
29	Support Services	0.6505	0.6172	0.0799	0.1122	0.5059	0.1041	1.9098
30	Transport	0.8012	0.7798	0.0262	0.7394	0.6766	0.4094	1.5272
31	Utilities	0.6018	0.6072	0.0346	-0.2676	0.1637	0.1783	1.2130

Table 6: Multivariate GJR-GARCH Model Summary – AUDJPY Analysis

Panel A: Australian Industry Portfolio GJR-GARCH Model Summary

	Industry	GARCH Parameters			GJR Parameter	Correlation Equation Coefficients			
		μ	α	β	$\delta 1$	$\rho_{A,C}$	$\rho_{A,M}$	θ_1	θ_2
1	Banks	0.0630**	0.0877**	0.8350**	0.0158	-0.0520*	0.7903**	0.9678**	0.0130**
		(3.6957)	(5.1721)	(27.2220)	(0.8383)	(-1.7366)	(43.3620)	(66.8500)	(2.9266)
2	Basic Industries	0.0253**	0.0176*	0.9209**	0.0552**	-0.1444**	0.9155**	0.9849**	0.0114**
		(2.9766)	(1.7431)	(45.7660)	(4.0696)	(-2.0019)	(24.5540)	(313.9700)	(5.1528)
3	Beverages	0.0096	0.0259**	0.9603**	0.0159	-0.0416	0.5319**	0.9830**	0.0078**
		(0.9821)	(2.2109)	(39.1890)	(0.7751)	(-1.3216)	(16.5910)	(97.4850)	(2.3429)
4	Chemicals	0.1356*	0.0975**	0.8028**	0.0090	-0.0542**	0.4053**	0.0001	0.0701**
		(1.8344)	(2.6756)	(10.3290)	(0.3144)	(-2.9646)	(19.0680)	(0.0004)	(2.6209)
5	Construction & Building	0.0379**	0.0275*	0.9037**	0.0550**	-0.1057*	0.7852**	0.9773**	0.0146**
		(2.4542)	(1.9017)	(30.9830)	(3.1623)	(-1.8406)	(14.3580)	(139.6500)	(4.5710)
6	Cyclical Services	0.0166*	0.0525**	0.9295**	0.0145	-0.0308	0.8242**	0.9460**	0.0155**
		(1.7434)	(2.7036)	(33.9880)	(0.8589)	(-1.2067)	(66.1720)	(34.5620)	(2.5052)
7	Diversified Industrials	0.0894**	0.0401*	0.8604**	0.0509**	-0.0833**	0.5486**	0.0001	0.0393
		(2.2608)	(1.9068)	(17.6420)	(2.2506)	(-4.4358)	(33.8430)	(0.0000)	(0.6430)
8	Financials	0.0278**	0.0661**	0.8788**	0.0174	-0.0551*	0.8664**	0.9636**	0.0136**
		(2.9872)	(4.5415)	(31.8530)	(1.1509)	(-1.9141)	(66.9070)	(100.5400)	(4.7089)
9	Food Processing	0.1957**	0.0624**	0.6938**	0.0336	-0.1073	0.6897**	0.9965**	0.0033**
		(2.7894)	(2.0232)	(8.3927)	(0.9773)	(-1.1121)	(12.8580)	(747.1800)	(3.0957)
10	Gas Distribution	0.0010	0.0219**	0.9852**	-0.0159**	-0.0105	0.3567**	0.9915**	0.0043**
		(0.6566)	(2.0421)	(87.6600)	(-2.7645)	(-0.3014)	(10.0960)	(315.7200)	(2.6913)
11	General Industrials	0.0638**	0.0365*	0.8773**	0.0509**	-0.1736*	0.8223**	0.9933**	0.0053*
		(2.2555)	(1.9072)	(20.2990)	(2.4441)	(-1.9097)	(21.2920)	(224.8900)	(1.6419)
12	Gold Mining	0.2051**	0.1164**	0.8365**	-0.0213	-0.1590**	0.3777**	0.9843**	0.0108*
		(2.2719)	(3.6038)	(17.3360)	-(0.8469)	(-2.7945)	(6.2884)	(85.9450)	(1.8391)
13	Health	0.1185	0.1169	0.8117**	0.0222	-0.0208	0.4332**	0.9932**	0.0047**
		(0.3804)	(0.5390)	(2.3727)	(0.2941)	(-0.3939)	(8.8134)	(589.7200)	(4.2039)
14	Insurance	0.1436**	0.0592**	0.7732**	0.1390**	-0.0398**	0.5489**	0.0632	0.0641**
		(2.8994)	(2.0711)	(12.2040)	(2.2121)	(-2.1815)	(33.1080)	(0.2908)	(3.3160)
15	Investment Companies	0.0015*	0.0317**	0.9655**	0.0047	-0.0154	0.4587**	0.9775**	0.0049
		(1.8402)	(3.9045)	(122.2500)	(0.4925)	(-0.6544)	(17.2750)	(45.1820)	(1.4961)
16	Leisure and Hotels	0.0853	0.0442	0.8265**	0.0474**	-0.0497	0.6178**	0.9829**	0.0101**
		(1.2569)	(1.0188)	(6.8376)	(2.2438)	(-1.1774)	(16.0580)	(209.1800)	(4.1263)

Table 6 (cont)

	Industry	GARCH Parameters			GJR Parameter	Correlation Equation Coefficients			
		μ	α	β	$\delta 1$	$\rho_{A,C}$	$\rho_{A,M}$	θ_1	θ_2
17	Media & Entertainment	0.0141	0.0387**	0.9548**	0.0057	-0.0204	0.7210**	0.9840**	0.0069**
		(0.9903)	(2.5520)	(42.0690)	(0.3133)	(-0.6327)	(31.2210)	(140.6200)	(3.0259)
18	Mining	0.0327**	0.0579**	0.9089**	0.0236*	-0.2880*	0.9778**	0.9892**	0.0098**
		(2.3456)	(4.1540)	(40.4530)	(1.6701)	(-1.8608)	(95.7530)	(388.8400)	(4.4576)
19	Non CYC Cons Goods	0.0122**	0.0208**	0.9451**	0.0321**	-0.0555*	0.7298**	0.9822**	0.0072
		(2.0685)	(2.5405)	(58.7870)	(2.6123)	(-1.8248)	(20.9810)	(51.1290)	(1.2461)
20	Oil and Gas	0.1024	0.0747	0.8407**	0.0170	-0.0934**	0.5217**	0.5839**	0.0484**
		(0.8039)	(1.1368)	(5.5941)	(0.6698)	(-4.8125)	(32.2130)	(4.2667)	(3.3702)
21	Other Construction	0.1316	0.0484	0.8444**	0.0700	-0.0628**	0.3765**	0.0001	0.0317
		(0.4080)	(0.7270)	(3.1638)	(1.3659)	(-3.5033)	(19.0990)	(0.0001)	(0.6567)
22	Other Utilities	0.0010	0.0219**	0.9852**	-0.0159**	-0.0105	0.3567**	0.9915**	0.0043**
		(0.6566)	(2.0423)	(87.6700)	(-2.7644)	(-0.3014)	(10.0950)	(315.6600)	(2.6913)
23	Pharmaceuticals	0.1476	0.0639	0.8656**	0.0843**	-0.0192	0.3364**	0.5530**	0.0398**
		(1.1627)	(1.2100)	(10.5530)	(2.0226)	(-1.0438)	(14.3840)	(2.4895)	(2.0207)
24	Publishing and Printing	0.0315	0.0623**	0.9039**	0.0040	-0.0428**	0.5424**	0.5583**	0.0344**
		(1.2621)	(2.1309)	(16.7270)	(0.2441)	(-2.2835)	(35.3530)	(2.3500)	(2.2825)
25	Real Estate	0.0175**	0.0415**	0.9132**	0.0238	-0.0497	0.6810**	0.9831**	0.0085**
		(2.5204)	(3.5901)	(38.7210)	(1.6057)	(-1.3347)	(19.2990)	(115.0600)	(2.7020)
26	Resources	0.0282**	0.0516**	0.9148**	0.0226*	-0.2641*	0.9843**	0.9885**	0.0103**
		(2.3478)	(4.0611)	(43.3490)	(1.7489)	(-1.8911)	(157.7000)	(409.4400)	(5.0240)
27	Retail	0.1415	0.1151**	0.7651**	0.0435	-0.0567**	0.5190**	0.9691**	0.0108**
		(1.5430)	(2.9435)	(7.1583)	(0.7231)	(-2.0762)	(20.1340)	(120.0100)	(3.2703)
28	SPC & Finance	0.1096**	0.0580**	0.7671**	0.0688**	-0.0452	0.5359**	0.9827**	0.0083**
		(3.3329)	(2.4760)	(14.4530)	(2.2679)	(-1.3310)	(12.6380)	(85.2330)	(2.0423)
29	Steel & Other Metals	0.1536*	0.0707*	0.8801**	0.0148	-0.0760*	0.4889**	0.9869**	0.0071**
		(1.7484)	(1.6920)	(17.8340)	(0.5012)	(-1.9449)	(8.8402)	(124.0400)	(2.3804)
30	Support Services	0.0259	0.0269	0.9538**	0.0107	-0.0208	0.4237**	0.9920**	0.0064**
		(0.5032)	(1.0884)	(15.8210)	(0.4530)	(-0.2888)	(4.3266)	(287.7700)	(2.4461)
31	Transport	0.0222	0.0468	0.9291**	0.0103	-0.1227	0.7800**	0.9923**	0.0062**
		(0.3773)	(0.7521)	(7.8317)	(0.5730)	(-1.4660)	(10.1960)	(382.9900)	(3.0353)
32	Utilities	0.0010	0.0207	0.9846**	-0.0123**	-0.0141	0.3756**	0.9895**	0.0038**
		(0.6524)	(1.5738)	(70.3870)	(-2.2249)	(-0.4990)	(13.0760)	(206.1600)	(2.0781)

* Statistic is significantly different from zero at the 10% level; ** Statistic is significantly different from zero at the 5% level; Note: t-statistics in parentheses.

Table 6 (cont)

Panel B: Exchange Rate and Market GJR-GARCH Model Summary									
	Exchange Rate			Market			GJR Parameters		Correlation Coefficient
	μ	α	β	μ	α	β	δ_2	δ_3	$\rho_{C,M}$
Mean	0.0210	0.0613	0.9260	0.0119	0.0243	0.9172	-0.0291	0.0755	-0.1128
Median	0.0210	0.0612	0.9259	0.0113	0.0224	0.9181	-0.0290	0.0789	-0.0910
Std Dev	0.0007	0.0012	0.0016	0.0027	0.0062	0.0090	0.0010	0.0129	0.0508
Min	0.0198	0.0594	0.9227	0.0094	0.0184	0.8870	-0.0311	0.0425	-0.2843
Max	0.0226	0.0638	0.9290	0.0219	0.0428	0.9322	-0.0272	0.0921	-0.0778
No. of positive	32	32	32	32	32	32	0	32	0
- Sign at 5%	0	3	32	31	32	32	0	32	0
- Sign at 10%	0	32	32	32	32	32	0	32	0
No. of negative	0	0	0	0	0	0	32	0	32
- Sign at 5%	0	0	0	0	0	0	0	0	21
- Sign at 10%	0	0	0	0	0	0	0	0	26

Table 7: Descriptive Statistics of Currency Betas – AUDJPY analysis

	Industry	Sign Prediction	Mean	Median	Variance	Kurtosis	Skewness	Min	Max	Positive Cases %	Negative Cases %
1	Banks	- / negligible	-0.0492	-0.0448	0.0038	0.2502	-0.0314	-0.2675	0.1987	20	80
2	Basic Industries	- / negligible	-0.0933	-0.0860	0.0056	0.8515	-0.4545	-0.4510	0.1290	9	91
3	Beverages	- / negligible	-0.0424	-0.0357	0.0045	0.7125	-0.4866	-0.3049	0.1498	24	76
4	Chemicals	++	-0.0721	-0.0693	0.0038	-0.5322	-0.3356	-0.2958	0.0765	14	86
5	Construction & Building	-	-0.0830	-0.0748	0.0071	0.7814	-0.2532	-0.4527	0.1631	12	88
6	Cyclical Services	+	-0.0344	-0.0289	0.0051	2.2086	-0.7734	-0.3689	0.1899	31	69
7	Diversified Industrials	--	-0.1052	-0.1017	0.0015	3.1091	-0.9400	-0.3867	-0.0324	0	100
8	Financials	- / negligible	-0.0450	-0.0416	0.0023	0.0246	0.02614	-0.1983	0.1445	16	84
9	Food Processing	-	-0.0305	-0.0280	0.0013	1.2463	-0.8426	-0.1814	0.0541	17	83
10	Gas Distribution	+	-0.0251	-0.0178	0.0021	0.0847	-0.57712	-0.1798	0.0895	33	67
11	General Industrials	--	-0.1203	-0.1147	0.0029	6.6317	-1.1953	-0.6277	-0.0047	0	100
12	Gold Mining	--	-0.2716	-0.2503	0.0327	1.9560	-0.9613	-1.3183	0.0863	4	96
13	Health	+	-0.0017	-0.0003	0.0051	0.3873	0.0689	-0.3200	0.2550	50	50
14	Insurance	- / negligible	-0.0544	-0.0525	0.0039	34.72145	-2.6709	-1.1779	0.1050	20	80
15	Investment Companies	- / negligible	-0.0215	-0.0168	0.0010	0.9263	-0.6679	-0.1616	0.0691	23	77
16	Leisure and Hotels	+	-0.0431	-0.0438	0.0033	0.4066	-0.0891	-0.3250	0.1402	22	78
17	Media & Entertainment	+	-0.0184	-0.0145	0.0076	4.3277	-1.1476	-0.4586	0.2144	41	59
18	Mining	--	-0.1375	-0.1336	0.0145	1.1089	0.3492	-0.5092	0.3120	8	92
19	Non Cyclical Consumption Goods	+ / negligible	-0.0442	-0.0395	0.0014	0.0610	-0.5249	-0.1944	0.0457	12	88
20	Oil and Gas	++	-0.1229	-0.1192	0.0051	-0.1689	-0.3239	-0.3971	0.0371	3	97
21	Other Construction	++	-0.0964	-0.0914	0.0017	5.2376	-1.4834	-0.3991	-0.0210	0	100
22	Other Utilities	+	-0.0251	-0.0178	0.0021	0.0846	-0.5771	-0.1798	0.0896	33	67
23	Pharmaceuticals	+	-0.0394	-0.0374	0.0082	0.4229	-0.3184	-0.4380	0.2626	35	65
24	Publishing and Printing	++	-0.0484	-0.0470	0.0017	0.1053	-0.3472	-0.2458	0.0575	12	88
25	Real Estate	- / negligible	-0.0321	-0.0326	0.0015	0.2268	0.0767	-0.1520	0.0982	20	80
26	Resources	- -	-0.1358	-0.1305	0.0116	0.7249	0.1864	-0.5011	0.2401	13	87
27	Retail	+ +	-0.0629	-0.0604	0.0032	0.0741	-0.3074	-0.2752	0.0894	25	75
28	SPC & Finance	- / negligible	-0.0323	-0.0276	0.0023	1.8750	-0.8523	-0.2916	0.1019	4	96
29	Steel & Other Metals	--	-0.1568	-0.1513	0.0102	1.4477	-0.6076	-0.6081	0.1350	45	55
30	Support Services	+	-0.0114	-0.0071	0.0059	3.0400	-0.9763	-0.4820	0.1732	8	92
31	Transport	--	-0.0897	-0.0864	0.0048	0.4966	-0.0352	-0.3251	0.1074	26	74
32	Utilities	++	-0.0265	-0.0210	0.0014	0.2003	-0.6049	-0.1659	0.0678	20	80

Figure 1: Selected Plots of Time-varying Currency Betas – AUDUSD