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An analysis of asymmetry in foreign currency exposure of the Australian equities market

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Abstract

Using both daily and monthly data, the authors: (a) analyse the extra-market component of foreign exchange exposure of the Australian equities market using the Australian/US exchange rate factor return in an augmented market model; and (b) use a dummy variable specification to model the potential asymmetric effect induced by non-linear hedging strategies, such as using currency options, for the period 1988–1996. Overall, the results are mixed. The following are found: (i) stronger evidence of foreign exchange exposure in the analysis employing daily data; (ii) when using daily data, a stronger lagged response than a contemporaneous response is observed; (iii) some evidence of asymmetry; and (iv) evidence of significant exchange rate exposures of the predicted sign in several industries. Further, the findings using monthly data are less significant than those using daily data.

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1. Introduction

Exposure to foreign currency risk has become an increasingly important issue to investors and financial managers alike with the globalisation of markets, and

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particularly in the wake of the events that occurred in the Asian financial markets in 1997. Although direct exposure (i.e. transaction and translation exposure) can be effectively managed by well structured hedging strategies, indirect, or economic, exposure provides significant variability in cash flows for most companies worldwide.

The impact of foreign currency exposure on the value of the firm has been the subject of analytical literature for several decades (see, e.g. Adler and Dumas, 1984). In recent times some empirical literature has also emerged. For example, Booth and Rotenberg (1990) analyse a sample of Canadian firms for exposure to changes in the Canadian dollar/US dollar exchange rate, while Jorion (1990) investigates the sensitivity of US multinationals to changes in a trade weighted exchange rate. Indeed, Jorion's analysis provided the impetus for several further studies. This group of studies is well represented by Loudon (1993); Bodnar and Gentry (1993); Levi (1994); Khoo (1994); Chow et al. (1997a,b); Chamberlain et al. (1997); He and Ng (1998); and Chow and Chen (1998). Specifically, the Australian equities market is analysed in Loudon (1993) and Khoo (1994). Both, however, fail to establish a significant statistically sensitive relationship between the stock returns and changes in the exchange rate. These results are consistent with those of many other studies which report, at best, weak evidence of exchange rate exposure (see, e.g. Jorion, 1990; Amihud, 1994; Bartov and Bodnar, 1994).

The inability of many researchers to establish the extra-market foreign exchange rate sensitivity of stocks has been addressed by other financial economists, who attempt to determine the cause of these findings of insensitivity. Some investigate the possibility that the use of monthly data is not an adequate specification to capture the exposure of investors. For example, Chow et al. (1997a,b) specify longer than 1-month return horizons and find a statistically significant relationship between stock returns and foreign exchange exposure. In contrast, Chamberlain et al. (1997) report that daily data provides better results of sensitivity than monthly data. These contrary findings add to the interest that the issue of foreign exchange exposure has in finance research and it has resulted in further analysis.

Another issue addressed in previous literature is that of the asymmetric nature of foreign exchange exposure due to the hedging strategies implemented by companies. Indeed, while Levi (1994) and Booth (1996) suggest that good hedging ability may in fact be the cause of poor exposure coefficient estimates, Booth (1996) goes on to examine 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.

A specific issue of interest when analysing foreign exchange exposure is that of the predicted economic effect of the exchange rate movement. In examining the impact of directional fluctuations in the exchange rate on the returns of various industries, some insight can be obtained as to what the determinants of foreign

exchange exposure may be. 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.

Given the issues discussed above, the current study investigates the foreign exchange exposure of the Australian equities market, being one of the most established markets in the Asia-Pacific. More specifically, this study is conducted, using both daily and monthly data, in the traditional unconditional form as well as exploring the possibility that asymmetric effects exist. An augmented market model is implemented using a value weighted domestic market return and an exchange rate return factor is based on the Australian–US exchange rate. Further, this analysis attempts to redress the issue referred to by Ang (1991) that more research of the Asia-Pacific region is essential. This has become increasingly important as a consequence of the recent Southeast Asian financial crisis and the significant and abrupt devaluation on many Asian currencies (including the Australian dollar).[2]

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

2. Developing predictions of exchange rate exposure across industries

Exchange rates are financial variables and a fluctuation in exchange rates will affect the value of most firms whether or not they are directly involved in foreign operations. Notably, however, is the effect of exchange rate exposure on those firms that are involved in importing and/or exporting. Even though a firm may hedge its foreign exchange contracts, minimising its transaction and translation exposure, there is still another important element of foreign exchange exposure, that is, economic exposure. Economic exposure occurs because the future profits from operating as 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 in the estimation of the extent of economic exposure, that is, the effect of fluctuations of the exchange rate will have on the cash flows of the firms. These factors include: (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

[2] Over the period June–November 1997, the Australian dollar devalued approximately 16% against the US dollar and 20% against the UK pound.

operating income; (iv) whether payment for goods lags the sales/buying agreement; and (v) whether a sales agreement has been offset by hedging strategies.[3]

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.

In order to investigate the potential effects of a currency appreciation, and conversely, a currency devaluation across Australian industries, industry level data was obtained from the Australian Bureau of Statistics (ABS) Input–Output Tables for 1993–1994. Matching ABS classifications with the Australian Stock Exchange (ASX) classifications [see Australia Stock Exchange Industry Classification Report, January 1997], measures of both import and export activity were derived by estimating an input–output coefficient (IOC) for both types of activities for each industry.[4] The import IOC was derived as the percentage of total imports for each industry to total Australian production, while the export IOC was calculated as the percentage of total exports to final demand. Further, *relative* input–output measures for both imports and exports were estimated to provide an indication of the possible effect of movements in the exchange rate on Australian industries. The *relative* input–output measure was calculated as the ratio of a particular industry's coefficient to the average input–output coefficient across all industries. Economic theory suggests that industries with a high *relative* input–output export measure, all other things being equal, would experience negative exchange rate exposure *relative* to an appreciation of the exchange rate factor, while industries with a high relative input–output import measure would experience positive exchange rate exposure. Table 1 summarises the relative IOCs for both imports and exports in columns 3 and 4.[5] Based on a comparative analysis of the two columns, the authors endeavour to predict the directional movement of each industry as a consequence of an appreciation in the AUD. It should be noted that there are some industries in which it is believed the movement would be negligible due to the offsetting effects of both the export activities and the imported inputs utilised in the production of the goods and services.

In short then, what are the predictions? It would seem from Table 1 that while a strong positive exposure could be predicted for the ASX industry classifications of solid fuels (3), oil and gas (4) and retail (13) (relying significantly on imported inputs), export commodities such as metals, minerals and some agricultural prod-

[3] Levi (1983) (pp. 317–319).

[4] It should be noted that the ASX partitions the stock market into 24 industry categories and the ABS classifies Australian industries into 35 different sectors. Consequently, the ASX industry classifications and the ABS industry classifications are not completely compatible.

[5] Further details of this analysis are available from the authors upon request.

Table 1
Summary of sign predictions of the extra market sensitivity to foreign exchange movements across Australian industry classifications[a]

	ABS industry classification	ASX industry (ies) (ASX industry number)	Exports relative Coefficient	Imports relative coefficient	Prediction with an appreciation of the AUD
1	Agriculture; hunting	Miscellaneous industrials (22)	2.51606	0.47122	− −
2	Forestry and fishing	Paper and packaging (12)	0.75176	0.88975	Negligible
3	Mining	Gold (1), other metals (2)	4.07146	0.61691	−
4	Meat and dairy products	Miscellaneous industrials (22)	1.79722	0.15247	−
5	Other food products	Food and household (9)	1.13878	0.65247	−
6	Beverages and tobacco products	Alcohol and tobacco (8); entrepreneurial investors (18)	0.31713	0.65854	+
7	Textiles	Miscellaneous industrials (22)	2.07841	1.59515	−
8	Clothing and footwear	Retail (13)	0.47500	2.51891	+ +
9	Wood and wool products	Building materials (7); diversified industrial (23)	3.27971	1.07136	− −
10	Paper, printing and publishing	Paper and packaging (12); media (15)	0.67455	1.59229	+
11	Petroleum and coal products	Solid fuels (3); oil and gas (4)	1.02993	4.23906	+ +
12	Chemicals	Chemicals (10)	1.60483	2.17983	+
13	Rubber and plastic products	Paper and packaging (12)	0.85439	1.90557	+
14	Non-metallic mineral products	Diversified resources (5)	2.62967	0.75143	− −
15	Basic metals and products	Other metals (2)	4.05651	1.32517	− −
16	Fabricated metal products	Miscellaneous industrials (22)	0.80227	0.94850	Negligible
17	Transport equipment		0.85708	2.53047	+ +
18	Other machinery and equipment	Engineering (11)	1.22017	2.07969	+

Table 1 (*Continued*)

	ABS industry classification	ASX industry (ies) (ASX industry number)	Exports relative Coefficient	Imports relative coefficient	Prediction with an appreciation of the AUD
19	Miscellaneous manufacturing	Engineering (11), retail (13)	0.49900	1.50381	+
20	Electricity, gas and water		0.00027	0.21598	Negligible
21	Construction	Developers and contractors (6)	0.00007	0.63285	+
22	Wholesale trade		0.85526	0.31577	Negligible
23	Retail trade	Retail (13)	0.00000	0.25226	Negligible
24	Repairs		0.00015	0.98751	+
25	Accommodation, cafes and restaurants	Tourism and leisure (24)	0.00000	0.41532	Negligible
26	Transport and storage	Transport (14)	1.71640	0.67186	−
27	Communication services	Media (15)	0.63733	0.57529	Negligible
28	Finance and insurance	Banks and finance (16); insurance (17)	0.18568	0.17257	Negligible
29	Ownership of dwellings		0.00000	0.01094	Negligible
30	Property and business services	Property trusts (20)	0.78703	0.38000	−
31	Government administration		0.00018	0.73656	+
32	Education		0.15422	0.17495	Negligible
33	Health and community services	Miscellaneous services (21)	0.00002	0.48216	+
34	Cultural and recreational services	Tourism and leisure (24)	0.00028	0.85074	+
35	Personal and other services	Miscellaneous services (21)	0.00002	0.55233	+

[a] Note: − −, strongly negative; −, negative; + +, strongly positive; +, positive.

ucts such as wool, would demonstrate an inverse relationship. Accordingly, industries such as gold (1), other metals (2), diversified resources (5), diversified industrials (23), miscellaneous industrials (22) and to some extent building materials (7) are predicted to react negatively to an appreciation of the Australian dollar. However, clear cut predictions cannot be made for approximately one-third of the ABS industry classifications.

3. Methodology and data

3.1. Basic augmented market model

Consider a two-factor augmented market model of the form

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i XR_t + e_{it} \quad (1)$$

where R_{it} is the return on the ith asset or portfolio in period t, R_{mt} is the return on the market index in period t and XR_t is the return on the exchange rate factor in period t expressed in Australian dollars. That is, an appreciation (depreciation) of the Australian dollar will produce a positive (negative) value for XR_t. Following Jorion (1990) and others, the inclusion of the return on the market minimises omitted variable bias.[6] The model is also augmented with a lagged exchange rate variable.[7]

3.2. Potential asymmetric effect in exchange rate exposure

An issue with the above model is the possible asymmetry of the exchange rate effect. Bartov and Bodnar (1994) (p. 1761) briefly allude to this issue as one of the complexities facing investors that may lead them to make systematic errors in assessing the relationship between firm's value and exchange rate changes.

Booth (1996), by developing an economic model of firm exposure that attempts to capture its asymmetric nature, shows that exposure should be non-linear in the exchange rate. He argues that exposure changes over time with the level of the exchange rate and varies dramatically at 'trigger points', where the nature of the market structure changes and with it the nature of the firm's exposure. It may be

[6] Examples of papers using the augmented market model approach are Jorion (1990); Loudon (1993); Chamberlain et al. (1997); and He and Ng (1998). An alternate specification is one which omits the return on the market, [see, for example, Chow et al., 1997a,bChow and Chen, 1998]. Further, the robustness of Jorion (1990) and Levi (1994) original findings are not affected by the inclusion of the market index into the model.

[7] Given that the current analysis will primarily employ daily data, the specification of Eq. (1) may not be adequate to capture the full effect of any extra-market exchange rate exposure of equities. In one sense the argument is analogous to the thin trading issue in the beta estimation literature. In a similar context to this, Bodnar and Gentry (1993) (pp. 1761) outline a 'lagged response hypothesis' in which they argue that a detectable response to exchange rate movements may not occur contemporaneously.

at these points that governments intervene to assist industries that are suffering from increased imports or an erosion of export markets and thus, it is at these points that Booth (1996) suggests hedging instruments with asymmetric payoffs, such as currency options, appear to be most useful.[8]

In this vein, an asymmetry hypothesis in this model can be argued from the point of view that companies may take hedging strategies to control foreign exchange (and other) exposures. Although forward and futures may protect the holder against the potential financial loss due to foreign exchange exposure, they also eliminate the possibility of a financial gain if the exchange rate moves favourably. In contrast, currency options provide the downside protection, while allowing the upside potential. It is this very asymmetric nature that would lead one to hypothesise that evidence of exchange rate exposure may display an asymmetric behaviour.[9] Interestingly, the findings reported in Kanas (1997) provide strong empirical support for the asymmetry model of Ware and Winter (1988), so much so that "…hedging against economic exposure may be an area in which currency options have a practical application" (Kanas, 1997, p. 40).

3.3. Augmented market model incorporating asymmetric foreign exchange exposure effect

From a methodological point-of-view, the type of empirical investigation proposed in the current paper can be compared to that of adjusting beta for other market conditions, such as bull and bear market changes (Fabozzi and Francis, 1977, 1979; Bhardwaj and Brooks, 1993; Clinebell et al., 1993). Following the approach of Fabozzi and Francis (1977, 1979), a technique similar to their 'substantial up and down' (SUD) months' analysis is used, applying it to the foreign exchange exposure coefficient. Specifically, this asymmetry hypothesis is accommodated in the empirical analysis in the form of a dummy variable regression whereby the time series sample is partitioned according to the sign of exchange rate movement. Accordingly, one proceeds by defining three dummy variables:

$D_{\text{pos},x}$ is a dummy variable that takes a value of unity in period t if the exchange rate has appreciated by more than x percent in that period and a value of zero otherwise;

[8] Recently, Kanas (1997) in a slightly different setting, confronts the issue of asymmetry in exchange rate exposure. Kanas (1997) identifies a literature, including Ware and Winter (1988); Froot and Klemperer (1989) and Marston (1990); that has developed models which predict an asymmetric economic exposure to exchange rate appreciations and depreciations.

[9] The argument used here is analogous to that used in the mutual fund performance evaluation literature with regard to the possibility of superior market timing ability. Jagannathan and Korajczyk (1986) argued that equity in levered firms may be viewed as options on the firms assets, thereby inducing a non-linear payoff structure. Further, Sinclair (1990) (p. 55) points out that "[a] related source of non-linearity … arises from the direct investment in derivative securities such as options… To the extent that the 'insurance' feature of these securities is reflected in the returns on the fund then non-linearities [in the market model] are also likely." This is also very similar to the argument used by Chen and Chan (1989) to investigate for potential asymmetry of interest rate sensitivity of financial institutions around interest rate cycles.

$D_{\text{neg},x}$ is a dummy variable that takes a value of unity in peered t if the exchange rate has depreciated by more than x percent in that period and a value of zero otherwise;

$D_{\text{neut},x}$ is a dummy variable that takes a value of unity when both $D_{\text{pos},x}$ and $D_{\text{neg},x}$ are zero and a value of zero otherwise.

To accommodate this analysis the main model of (1) is re-specified utilising the appropriately defined dummy variables as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_{\text{pos}} D_{\text{pos},x} XR_t + \gamma_{\text{neg}} D_{\text{neg},x} XR_t + \gamma_{\text{neut}} D_{\text{neut},x} XR_t + e_{it} \quad (2)$$

Again, the specification is adjusted to accommodate lagged values of the asymmetric effects as follows.

$$\begin{aligned} R_{it} = {} & \alpha_i + \beta_i R_{mt} + \gamma_{1i,\text{pos}} D_{\text{pos},x} XR_t + \gamma_{1i,\text{neg}} D_{\text{neg},x} XR_t + \gamma_{1i,\text{neut}} D_{\text{neut},x} XR_t \\ & + \gamma_{2i,\text{pos}} D_{\text{pos},x,t-1} XR_{t-1} + \gamma_{2i,\text{neg}} D_{\text{neg},x,t-1} XR_{t-1} \\ & + \gamma_{2i,\text{neut}} D_{\text{neut},x,t-1} XR_{t-1} + e_{it} \end{aligned} \quad (3)$$

Model (3) is tested for three different ranges or 'filter' parameters for both daily data and monthly data. More specifically, for daily data the 'filter' parameters 0.001 (or 0.1%), 0.005 (or 0.5%) and 0.01 (or 1%) are used and for monthly data the 'filter' parameters 0.01 (or 1%), 0.02 (or 2%) and 0.03 (or 3%) are used.

3.4. Data

The data employed are continuously compounded daily and monthly returns on 24 Australian industry indices, obtained from Datastream. The period of the analysis involves 2280 (108) daily (monthly) observations from January 1988 to December 1996. Data has been completed over this sample period for 19 industries. Data used for the remaining five industries are as follows: (a) 4 January 1988 to 29 October 1996: ASX 3: solid fuels; ASX 4: oil and gas; and ASX 18: entrepreneurial investors; (b) 3 January 1991 to 31 December 1996: ASX 22: miscellaneous industries; and (c) 8 August 1994 to 31 December 1996: ASX 24: tourism and leisure. The proxy for the market portfolio used is the all ordinaries accumulation index and the exchange rate factor return is based on Australian dollar/US dollar exchange rate (AUDUSD) obtained from Datastream. The choice of the AUDUSD is supported by the fact that the US is one of Australia's two most important trading partners. Table 2 reports the bilateral trade of Australia's ten most important trading partners as a percentage of its total trade for the period 1988 to 1997, the sample period for the analysis.[10]

Even though Japan has been Australia's most important trade partner over the past 10 years (averaging almost 21% of the total trade over this period), it is closely followed by the US, which has averaged 15.5%. It should also be noted that an independent survey of Australian businesses indicates that 55% of all export

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

contracts are written against the US dollar, including the majority of commodity contracts.[11]

The period from 1988 to 1996 represents a turbulent time for Australia's economy. In the shadow of the October 1987 'crash', the Government of the day loosened both monetary policy and fiscal policy, which led to increased asset prices throughout the country. As a result, the Australian economy grew. However, with an expanding economy developed growing Current Account deficit concerns, resulting in the Government reversing its original fiscal and monetary policies, leading the country into the 1989–1991 recession. A slump in commodity prices saw downward pressure on the AUDUSD, which persisted until 1994. A gradual appreciation of the exchange rate was then observed until the recent devaluation due to the Southeast Asia currency crisis. Over the full sample period, the AUDUSD exchange rate varied from a low of $0.654 in September 1993, to a high of $0.895 in February 1989. For the same period, however, the Australian stock market has trended upwards. In an environment of low interest rates, the All Ordinaries Index has increased steadily from a low point of 3276.9 in February 1988, to a high point of 10065.20 in December 1996.

As discussed in Section 3.2 above, model (2) is tested for three 'filter' parameters for both the daily and the monthly data. These are outlined in Table 3, together with the number of observations for each case of $D_{\text{pos},x}$, $D_{\text{neg},x}$ and $D_{\text{neut},x}$ for a given 'filter' parameter.

Table 2
Relative trade statistics for Australia's major trading partners over the period 1988–1997[a]

Country	Mean	Median	Maximum	Minimum	S.D.
Japan	0.2097	0.2166	0.2530	0.1515	0.0267
US	0.1555	0.1516	0.1998	0.1321	0.0145
New Zealand	0.0528	0.0519	0.0926	0.0359	0.0076
UK	0.0499	0.0493	0.0682	0.0393	0.0051
Korea	0.0481	0.0466	0.0769	0.0312	0.0094
Germany	0.0403	0.0395	0.0528	0.0300	0.0052
Taiwan	0.0392	0.0391	0.0463	0.0307	0.0029
China	0.0380	0.0390	0.0601	0.0180	0.0114
Singapore	0.0377	0.0384	0.0552	0.0219	0.0067
Hong Kong	0.0263	0.0263	0.0508	0.0149	0.0053

[a] Source: Australian Bureau of Statistics: International Merchandise Trade Cat. No. 5422. $[(\text{Imports}_x + \text{Exports})_x / (\text{Imports}_{\text{AUST.}} + \text{Exports}_{\text{AUST.}})]$.

[11] Australian Society of Corporate Treasurers (1995) Independent Survey of the Australian Financial Review newspaper.

Table 3
Asymmetry model filter parameter: summary information

Asymmetry filter value	No. observations		
	D_{pos}[a]	D_{neg}[b]	D_{neut}[c]
Panel A: daily data			
0.001	1030	892	357
0.005	366	349	1564
0.01	78	103	2098
Panel B: monthly data			
0.01	36	36	35
0.02	23	18	66
0.03	14	8	85

[a] $D_{pos,x}$ is a dummy variable that takes a value of unity in period t if the exchange rate has appreciated by more than x percent in that period and a value of zero otherwise.

[b] $D_{neg,x}$ is a dummy variable that takes a value of unity in period t if the exchange rate has depreciated by more than x percent in that period and a value of zero otherwise.

[c] $D_{neut,x}$ is a dummy variable that takes a value of unity when both D_{posx} and $D_{neg,x}$ are zero and a value of zero otherwise.

4. Results

In Table 4 the results of the two-factor model outlined in Eq. (1) are reported (augmented by a lagged foreign exchange rate factor) for the period January 1988 to December 1996. Specifically, the gamma coefficients when employing daily data and monthly data, respectively, are reported.[12] Firstly, in the analysis implementing daily data, little evidence of a contemporaneous relationship is found between the industry returns and the exchange rate factor return. Of the 24 industries, only two industries (gold and alcohol and tobacco) have a statistically significant positive sensitivity to fluctuations of the AUDUSD exchange rate. While this relationship is of the predicted sign for alcohol and tobacco (Table 1), it is contrary to the prediction for the gold industry.

By way of contrast, the results for the lagged exchange rate factor indicate some evidence of a significant effect in five (eight) cases at the 5% (10%) level. Specifically, a significantly positive estimate is found for gold; other metals; oil and gas; diversified resources; engineering; and banks at the 10% level. These outcomes are consistent with the Table 1 predictions in the case of oil and gas; and engineering. However, gold; other metals; and diversified resources; all belonging to the resources sector, provide results contrary to the prediction. The negative coefficient for media compares to a negligible prediction, while the negative coefficient for miscellaneous services opposes the prediction for this industry.

[12] An issue regarding the application of our augmented market model is that of multicollinearity. In response to this we calculated the correlation between the market return and the exchange rate return over our full sample period and found the values of 0.08 and 0.22 for daily and monthly data, respectively. As a result one dismisses the issue of multicollinearity.

Table 4
Estimation of an exchange rate factor augmented market model (1988–1996) (see Eq. (1))

ASX industry	Daily data		Monthly data	
	γ_{1i}	γ_{2i}	γ_{1i}	γ_{2i}
1. Gold	0.1089**	0.1651**	0.1031	0.0552
	(2.24)	(3.41)	(0.39)	(0.21)
2. Other metals	0.0359	0.0797**	0.3227**	0.1475
	(1.17)	(2.59)	(2.34)	(1.09)
3. Solid fuels	0.0493	0.0509	0.0785	−0.1005
	(0.98)	(1.02)	(0.43)	(−0.56)
4. Oil and gas	−0.0101	0.0804*	0.0007	0.0970
	(−0.24)	(1.95)	(0.00)	(0.66)
5. Diversified resources	0.0138	0.0658*	0.0763	0.0229
	(0.37)	(1.80)	(0.45)	(0.14)
6. Developers and contractors	−0.0260	−0.0073	−0.0293	0.0303
	(−0.88)	(−0.25)	(−0.24)	(0.26)
7. Building materials	−0.0075	−0.0175	−0.0379	0.1339
	(−0.30)	(−0.72)	(−0.40)	(1.45)
8. Alcohol and tobacco	0.0917**	0.0645	−0.1074	0.0151
	(2.22)	(1.57)	(−0.74)	(0.11)
9. Food and household goods	−0.0234	0.0093	−0.2997*	−0.0451
	(−0.70)	(0.28)	(−1.76)	(−0.27)
10. Chemicals	−0.0316	0.0441	0.0731	0.1239
	(−0.80)	(1.12)	(0.45)	(0.77)
11. Engineering	−0.0129	0.0907**	0.2525*	0.0308
	(−0.36)	(2.54)	(1.83)	(0.23)
12. Paper and packaging	−0.0566	−0.0222	−0.4109**	−0.0712
	(−1.57)	(−0.62)	(−3.37)	(−0.60)
13. Retail	−0.0577	0.0414	0.0706	0.1742
	(−1.60)	(1.15)	(0.47)	(1.18)
14. Transport	0.0103	0.0412	0.0615	0.0482
	(0.29)	(1.18)	(0.39)	(0.31)
15. Media	0.0309	−0.1127*	−0.6493*	−0.5952*
	(0.51)	(−1.87)	(−1.95)	(−1.82)
16. Banks	−0.0194	0.1073**	0.0351	0.0787
	(−0.56)	(3.13)	(0.26)	(0.60)
17. Insurance	0.0608	0.0742	−0.0184	−0.3489*
	(1.32)	(1.62)	(−0.10)	(−1.85)
18. Entrepreneurial investors	−0.0203	−0.0522	−0.2940	0.0907
	(−0.34)	(−0.89)	(−1.13)	(0.35)
19. Investment and financial services	0.0136	0.0145	0.1276	0.1181
	(0.60)	(0.64)	(1.31)	(1.24)
20. Property trusts	−0.0144	−0.0043	−0.0564	0.0432
	(−0.63)	(−0.19)	(−0.65)	(0.51)
21. Miscellaneous services	−0.0113	−0.1000**	−0.3667**	−0.1812
	(−0.38)	(−3.38)	(−3.01)	(−1.52)
22. Miscellaneous industrials	0.0037	−0.0612	0.4057	0.0962
	(0.07)	(−1.20)	(1.66)	(0.40)
23. Diversified industrials	0.0365	0.0440	0.0072	−0.0544
	(1.03)	(1.24)	(0.07)	(−0.54)
24. Tourism and leisure	−0.0455	0.0323	−0.0148	0.5419
	(−0.78)	(0.56)	(−0.05)	(1.63)

* Statistic is significantly different from zero at the 10% level.
** Statistic is significantly different from zero at the 5% level.

In the analysis based on monthly data, evidence of a contemporaneous response to fluctuations in the exchange rate factor return in three (six) cases is found at the 5% (10%). The industries that have statistically significant coefficients are other metals; food and household goods; engineering; paper and packaging; media; and miscellaneous services. However, only two lagged monthly coefficients (media and insurance) are found to be statistically significant, both at the 10% level. These results are not surprising given that the monthly response subsumes both the contemporaneous and the lagged daily response.

In terms of the Table 1 predictions, of the seven industries which reported a statistically significant response, both engineering and food and household goods were confirmed. Media, which recorded both a negative contemporaneous and a negative lagged monthly response, was predicted to have a positive response. Further, Insurance, for which one was unable to make a definite sign prediction, records a significant negative lagged coefficient.

Tables 5–7 report the findings of the asymmetry exchange factor augmented market model (Eq. (3)) employing daily data and using 1, 0.5 and 0.1% 'filter' parameters. More specifically, Table 5 reports the findings of the 1% 'filter'. It is apparent from the findings that there remains relatively little evidence of statistically significant contemporaneous sensitivity to the exchange rate factor return when taking into account the possible asymmetry. This is particularly so in the case of the positive and negative coefficients where only one and two industries are significant (10% level), respectively. Of some note here is the significantly negative sign for the food and household goods estimate, as predicted (Table 1). In the case of the neutral contemporaneous coefficient, however, four (five) industries reveal a significant exchange rate coefficient at the 5% (10%) level, with all but one positive. The significant estimates found for both Solid Fuels and Alcohol and Tobacco have the predicted signs.

Similar to the general findings reported in the previous table, there is more evidence of asymmetric effects in the lagged terms (as opposed to the contemporaneous terms) for the 1% filter reported in Table 5. Specifically, five (seven) are significant for the positive case; four (four) are significant for the negative case; and four (five) are significant for the neutral case at the 5 and 10% levels, respectively. In summary, some significant positive estimates as predicted for engineering; retail; and oil and gas; and a negative estimate (as predicted) for the building materials industry were found. In contrast, significant estimates that are contrary to predictions are found for gold; other metals; diversified resources; transport; media; miscellaneous services and diversified industrials. Finally, some significant estimates were also found for banks; insurance; and investment and financial services; despite the lack of a strong prediction (Table 1).

Table 6 reports a tighter 'filter' parameter than that reported in Table 5, namely 0.5%. As was apparent for the 1% filter results, there remains relatively little evidence of statistically significant contemporaneous sensitivity to the exchange rate factor return when taking into account the possible asymmetry. Indeed, the general nature of these results is very similar to the 1% 'filter' case and hence warrants no additional comment. Turning to the asymmetric estimates for the lagged exchange

Table 5
Estimation of an asymmetric exchange rate factor augmented market model with a filter parameter of 0.01 using daily data (1988–1996) (see Eq. (3))

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
1. Gold	−0.0632	0.0242	0.1668**	0.0455	0.0401	0.2312**
	(−0.41)	(0.23)	(2.80)	(0.30)	(0.39)	(3.89)
2. Other metals	0.0570	0.1242*	0.0019	0.0683	−0.0554	0.1224**
	(0.58)	(1.91)	(0.05)	(0.71)	(−0.84)	(3.24)
3. Solid fuels	−0.0566	−0.1646	0.1355**	0.0520	0.0035	0.0818
	(−0.35)	(−1.49)	(2.21)	(0.33)	(0.03)	(1.34)
4. Oil and gas	−0.2804**	−0.0975	0.0618	0.1466	0.1912**	0.0359
	(−2.15)	(−1.09)	(1.23)	(1.14)	(2.11)	(0.72)
5. Diversified resources	−0.1552	0.0872	0.0169	−0.0412	0.0575	0.0785*
	(−1.34)	(1.11)	(0.37)	(−0.36)	(0.73)	(1.75)
6. Developers and contractors	−0.0858	0.0211	−0.0344	0.0861	0.0464	−0.0458
	(−0.91)	(0.33)	(−0.95)	(0.93)	(0.73)	(−1.26)
7. Building materials	0.0444	−0.0131	−0.0154	0.1001	−0.1243**	0.0029
	(0.57)	(−0.25)	(−0.51)	(1.31)	(−2.36)	(0.10)
8. Alcohol and tobacco	0.0236	0.0771	0.1088**	−0.0294	0.1102	0.0631
	(0.18)	(0.87)	(2.15)	(−0.23)	(1.24)	(1.25)
9. Food and household goods	−0.0261	−0.1244*	0.0135	−0.0867	0.0465	0.0191
	(−0.25)	(−1.74)	(0.33)	(−0.83)	(0.65)	(0.47)
10. Chemicals	−0.1082	0.0115	−0.0356	0.0988	−0.0352	0.0590
	(−0.86)	(0.14)	(−0.73)	(0.80)	(−0.42)	(1.22)
11. Engineering	−0.0044	−0.0526	−0.0034	0.2702**	0.0971	0.0636
	(−0.04)	(−0.68)	(−0.08)	(2.41)	(1.26)	(1.45)

Table 5 (*Continued*)

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
12. Paper and packaging	0.0348	−0.0563	−0.0723	0.0267	0.0837	−0.0668
	(0.30)	(−0.73)	(−1.64)	(0.24)	(1.08)	(−1.51)
13. Retail	−0.0125	−0.0150	−0.0830*	0.2490**	0.0822	−0.0086
	(−0.11)	(−0.19)	(−1.88)	(2.21)	(1.06)	(−0.20)
14. Transport	0.0498	−0.0597	0.0303	0.1857*	0.0794	0.0112
	(0.45)	(−0.80)	(0.70)	(1.70)	(1.06)	(0.26)
15. Media	−0.1873	0.1578	0.0178	0.0659	−0.1073	−0.1544**
	(−0.98)	(1.22)	(0.24)	(0.35)	(−0.83)	(−2.09)
16. Banks	0.0466	0.0497	−0.0585	0.4028**	0.1147	0.0537
	(0.43)	(0.68)	(−1.39)	(3.75)	(1.55)	(1.28)
17. Insurance	0.0100	−0.1015	0.1271**	−0.0979	0.2795**	0.0404
	(0.07)	(−1.03)	(2.25)	(−0.68)	(2.84)	(0.72)
18. Entrepreneurial investors	−0.0197	−0.1434	0.0180	0.0583	−0.0554	−0.0583
	(−0.11)	(−1.11)	(0.25)	(0.32)	(−0.43)	(−0.82)
19. Investment and financial services	0.0028	0.0734	−0.0029	−0.1373*	0.0561	0.0187
	(0.04)	(1.51)	(−0.10)	(−1.94)	(1.15)	(0.67)
20. Property trusts	−0.0807	0.0051	−0.0102	−0.0263	−0.0115	−0.0009
	(−1.11)	(0.10)	(−0.36)	(−0.37)	(−0.23)	(−0.03)
21. Miscellaneous services	0.0393	0.1013	−0.0563	−0.2253**	−0.1269**	−0.0789**
	(0.42)	(1.59)	(−1.54)	(−2.43)	(−1.98)	(−2.17)
22. Miscellaneous industrials	−0.2026	0.0506	0.0082	−0.0593	−0.0098	−0.0678
	(−0.89)	(0.39)	(0.14)	(−0.26)	(−0.07)	(−1.18)
23. Diversified industrials	−0.0626	0.0464	0.0452	0.2687**	0.0620	−0.0000
	(−0.55)	(0.61)	(1.04)	(2.42)	(0.81)	(−0.00)
24. Tourism and leisure	−0.2192	−0.0245	−0.0214	−0.0033	0.0726	0.0310
	(−1.25)	(−0.22)	(−0.29)	(−0.02)	(0.64)	(0.42)

* Statistic is significantly different from zero at the 10% level.

** Statistic is significantly different from zero at the 5% level. Note: t-statistics are in parenthesis.

Table 6
Estimation of an asymmetric exchange rate factor augmented market model with a filter parameter of 0.005 using daily data (1988–1996) (see Eq. (3))

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
1. Gold	0.2310**	0.0496	0.0941	0.0737	0.1691**	0.2352**
	(2.26)	(0.60)	(1.20)	(0.73)	(2.05)	(2.99)
2. Other metals	0.0735	0.1009*	−0.0508	0.0868	0.0101	0.1392**
	(1.13)	(1.95)	(−1.02)	(1.36)	(0.19)	(2.80)
3. Solid fuels	−0.0554	−0.0754	0.2326**	0.0918	0.0158	0.0646
	(−0.52)	(−0.87)	(2.89)	(0.88)	(0.18)	(0.80)
4. Oil and gas	0.0865	−0.1169*	0.0377	−0.0087	0.1265*	0.1119*
	(1.00)	(−1.66)	(0.57)	(−0.10)	(1.78)	(1.69)
5. Diversified resources	−0.0452	0.0442	0.0253	−0.0284	0.0979	0.0881
	(−0.59)	(0.71)	(0.43)	(−0.37)	(1.57)	(1.48)
6. Developers and contractors	−0.0667	−0.0014	−0.0248	0.0019	0.0195	−0.0456
	(−1.07)	(−0.03)	(−0.52)	(0.03)	(0.39)	(−0.95)
7. Building materials	0.0139	0.0055	−0.0343	0.0599	−0.1143**	0.0289
	(0.27)	(0.13)	(−0.87)	(1.18)	(−2.74)	(0.73)
8. Alcohol and tobacco	0.0423	0.0719	0.1436**	0.0553	0.0458	0.0873
	(0.48)	(1.02)	(2.15)	(0.64)	(0.65)	(1.31)
9. Food and household goods	0.0468	−0.0986*	0.0069	−0.0317	0.0117	0.0463
	(0.67)	(−1.74)	(0.13)	(−0.46)	(0.21)	(0.86)
10. Chemicals	−0.0276	−0.0725	0.0066	0.0923	−0.0460	0.1067*
	(−0.33)	(−1.09)	(0.10)	(1.12)	(−0.68)	(1.67)
11. Engineering	−0.0070	−0.0662	0.0328	0.1579**	0.0885	0.0567
	(−0.09)	(−1.09)	(0.57)	(2.11)	(1.44)	(0.98)

Table 6 (*Continued*)

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
12. Paper and packaging	−0.0899	−0.0900	−0.0064	0.0337	0.0566	−0.1354**
	(−1.18)	(−1.47)	(−0.11)	(0.45)	(0.92)	(−2.33)
13. Retail	−0.0590	−0.0587	−0.0588	0.1329*	0.0192	0.0053
	(−0.77)	(−0.96)	(−1.01)	(1.77)	(0.31)	(0.09)
14. Transport	0.0466	−0.0496	0.0465	0.0397	0.0376	0.0550
	(0.63)	(−0.84)	(0.82)	(0.54)	(0.63)	(0.97)
15. Media	−0.1097	0.1395	0.0162	−0.1366	−0.1216	−0.1097
	(−0.86)	(1.36)	(0.17)	(−1.09)	(−1.18)	(−1.12)
16. Banks	−0.0969	0.0023	0.0021	0.3284**	0.0683	−0.0023
	(−1.33)	(0.04)	(0.04)	(4.59)	(1.16)	(−0.04)
17. Insurance	0.0672	−0.0168	0.1333*	−0.0370	0.2083**	0.0214
	(0.69)	(−0.21)	(1.79)	(−0.39)	(2.66)	(0.29)
18. Entrepreneurial investors	−0.1079	−0.1512	0.1571*	0.0226	−0.1036	−0.0421
	(−0.87)	(−1.50)	(1.67)	(0.19)	(−1.02)	(−0.45)
19. Investment and financial services	0.0240	0.0625	−0.0401	−0.0030	0.0198	0.0158
	(0.50)	(1.62)	(−1.09)	(−0.06)	(0.51)	(0.43)
20. Property trusts	−0.0354	−0.0294	0.0155	−0.0636	0.0220	0.0069
	(−0.73)	(−0.76)	(0.42)	(−1.33)	(0.56)	(0.19)
21. Miscellaneous services	−0.0188	0.0072	−0.0239	−0.1314**	−0.0838*	−0.0993**
	(−0.30)	(0.14)	(−0.50)	(−2.12)	(−1.65)	(−2.07)
22. Miscellaneous industrials	−0.1015	−0.0059	0.0591	−0.1166	−0.0552	−0.0392
	(−0.89)	(−0.06)	(0.78)	(−1.03)	(−0.60)	(−0.52)
23. Diversified industrials	0.0034	0.0294	0.0634	0.1011	0.0134	0.0365
	(0.05)	(0.49)	(1.10)	(1.37)	(0.22)	(0.63)
24. Tourism and leisure	−0.0759	−0.0167	−0.0586	−0.0222	0.0165	0.1739
	(−0.72)	(−0.19)	(−0.43)	(−0.21)	(0.18)	(1.28)

* Statistic is significantly different from zero at the 10% level.

** Statistic is significantly different from zero at the 5% level. Note: t-statistics are in parenthesis.

Table 7
Estimation of an asymmetric exchange rate factor augmented market model with a filter parameter of 0.001 using daily data (1988–1996) (see Eq. (3))

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
1. Gold	0.2395**	0.0326	−0.1109	0.1421*	0.2181**	−0.0484
	(3.01)	(0.46)	(−0.57)	(1.80)	(3.11)	(−0.25)
2. Other metals	−0.0308	0.0792*	0.1114	0.0917*	0.0652	0.0734
	(−0.61)	(1.79)	(0.90)	(1.83)	(1.46)	(0.59)
3. Solid fuels	0.1358*	−0.0513	0.2984	0.0264	0.0847	0.0098
	(1.65)	(−0.70)	(1.50)	(0.32)	(1.15)	(0.05)
4. Oil and gas	0.0635	−0.0268	−0.3234**	0.0854	0.0864	0.0404
	(0.95)	(−0.45)	(−1.98)	(1.28)	(1.44)	(0.25)
5. Diversified resources	0.0197	0.0361	−0.1967	−0.0764	0.1788**	0.0547
	(0.33)	(0.68)	(−1.34)	(−1.28)	(3.38)	(0.37)
6. Developers and contractors	−0.0137	−0.0367	−0.0150	−0.0412	0.0150	0.0375
	(−0.28)	(−0.86)	(−0.13)	(−0.85)	(0.35)	(0.32)
7. Building materials	−0.0055	−0.0111	0.0066	0.0250	−0.0456	−0.0597
	(−0.14)	(−0.31)	(0.07)	(0.63)	(−1.28)	(−0.61)
8. Alcohol and tobacco	0.0724	0.0989*	0.1626	−0.0108	0.0978	0.2661
	(1.07)	(1.65)	(0.98)	(−0.16)	(1.63)	(1.61)
9. Food and household goods	0.0033	−0.0923*	0.3908**	−0.0288	0.0707	−0.2198*
	(0.06)	(−1.92)	(2.93)	(−0.53)	(1.47)	(−1.65)
10. Chemicals	−0.0605	−0.0246	0.0919	0.1051	−0.0142	0.1161
	(−0.93)	(−0.43)	(0.58)	(1.63)	(−0.25)	(0.73)
11. Engineering	0.0351	−0.0554	0.0214	0.0873	0.0890*	0.1675
	(0.59)	(−1.07)	(0.15)	(1.49)	(1.71)	(1.17)

Table 7 (*Continued*)

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
12. Paper and packaging	−0.0164	−0.1011*	0.0663	−0.1467**	0.0777	−0.0207
	(−0.28)	(−1.94)	(0.46)	(−2.50)	(1.49)	(−0.14)
13. Retail	−0.0660	−0.0817	0.2025	0.0699	0.0402	−0.1375
	(−1.11)	(−1.57)	(1.40)	(1.19)	(0.77)	(−0.95)
14. Transport	0.0378	−0.0119	0.0233	−0.0008	0.0873*	−0.0495
	(0.66)	(−0.24)	(0.17)	(−0.01)	(1.72)	(−0.35)
15. Media	−0.0505	0.1201	−0.1510	−0.1434	−0.0322	−0.6609**
	(−0.51)	(1.38)	(−0.62)	(−1.46)	(−0.37)	(−2.73)
16. Banks	−0.0183	−0.0362	0.1074	0.1547** (2.76)	0.0724	0.0975
	(−0.32)	(−0.73)	(0.78)		(1.45)	(0.71)
17. Insurance	0.1143	0.0072	0.1716	−0.0466	0.1815**	0.0065
	(1.51)	(0.11)	(0.93)	(−0.62)	(2.73)	(0.03)
18. Entrepreneurial investors	0.1273	−0.1614*	0.1476	−0.0322	−0.0629	0.0316
	(1.33)	(−1.89)	(0.64)	(−0.34)	(−0.74)	(0.14)
19. Investment and financial services	0.0134	0.0078	0.0697	0.0009	0.0373	−0.0883
	(0.36)	(0.24)	(0.76)	(0.02)	(1.13)	(−0.97)
20. Property trusts	−0.0112	−0.0329	0.1314	−0.0480	0.0485	−0.1612*
	(−0.30)	(−0.99)	(1.43)	(−1.29)	(1.46)	(−1.76)
21. Miscellaneous services	−0.0172	−0.0050	−0.0211	−0.1289**	−0.0784*	−0.1015
	(−0.35)	(−0.12)	(−0.18)	(−2.65)	(−1.81)	(−0.85)
22. Miscellaneous industrials	−0.0081	0.0210	−0.0448	−0.1027	−0.0087	−0.1768
	(−0.10)	(0.28)	(−0.26)	(−1.22)	(−0.12)	(−1.03)
23. Diversified industrials	0.0258	0.0290	0.1728	0.0679	0.0395	−0.0796
	(0.44)	(0.56)	(1.21)	(1.17)	(0.77)	(−0.56)
24. Tourism and leisure[a]	–	–	–	–	–	–

[a] Estimation did not converge for this industry.

* Statistic is significantly different from zero at the 10% level.

** Statistic is significantly different from zero at the 5% level. Note: t-statistics are in parenthesis.

returns, stronger evidence is again observed — although it is somewhat mixed relative to the predictions. Specifically, oil and gas (positive sign); building materials (negative sign); chemicals (positive sign); engineering (positive sign); and retail (positive sign); produce some significant estimates of the predicted signs; while gold; other metals; paper and packaging; and miscellaneous services produce some significant estimates of the 'incorrect' sign.

The results reported in Table 7 are those for the analysis using the 'filter' parameter of 0.1%. In general, these results reflect those for the other filter values and so will not be discussed in detail. As was the case for the 1 and 0.5% filters, there remains relatively little evidence of statistically significant contemporaneous sensitivity to the exchange rate factor return when taking into account the possible asymmetry. Turning to the asymmetric estimates for the lagged exchange returns, once again stronger (albeit mixed) evidence was observed. Specifically, while food and household goods (negative sign); engineering (positive sign); and property trusts (negative sign); produce some significant estimates of the predicted signs; gold; other metals; diversified resources; paper and packaging; transport; and miscellaneous services produce some significant estimates of the 'incorrect' sign.

As reported in Table 3, three monthly 'filter' parameters were also employed, namely 0.01, 0.02 and 0.03. The results obtained for the 0.02 'filter' parameter represent a common base for a comparative analysis to be made with the daily data results. Indeed, assuming 20 trading days in a month, of the three 'filter' parameters employed for each data set, respectively, the two sets of results which are most comparable are those for the 0.001 'filter' (daily data) and the 0.02 'filter' (monthly data). Accordingly, Table 8 reports the results of the monthly data analysis using the 0.02 'filter' parameter.[13] From the table it was observed that there is evidence of some asymmetric response in 12 of the 24 industries, namely, other metals; oil and gas; diversified resources; food and household goods; paper and packaging; retail; insurance; investment and financial services; property trusts; miscellaneous services; miscellaneous industrials; and diversified industrials. A contemporaneous response is observed in nine of these industries, while four industries record a lagged response. The only industry to record significant contemporaneous and lagged coefficients is miscellaneous services. However, the evidence of asymmetry is weak. Of the significant contemporaneous coefficients, three positive coefficients are significant at the 5% level, one (three) negative coefficients are significant at the 5% (10%) level, and one (four) neutral coefficients are significant at the 5% (10%) level. Other metals has both a contemporaneous positive and negative coefficient, while paper and packaging has a contemporaneous positive and neutral coefficient. Of the significant lagged coefficients, one (two) positive coefficients is (are) significant at the 5% (10%) level, one (two) negative coefficients is (are) are significant at the 5% (10%) level, one (two) neutral coefficients is (are) significant at the 5% (10%) level. Further, the sign predictions reported in Table 1 are accurate for four industries, namely, oil and gas (positive); retail (positive); food and household goods (negative); and property trusts (negative).

[13] In order to conserve space, the results of the 0.01 and 0.03 'filter' parameters are not reported and are available from the authors on request.

Table 8
Estimation of an asymmetric exchange rate factor augmented market model with a filter parameter of 0.02 using monthly data (1988–1996) (see Eq. (3))

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
1. Gold	0.0689	0.1705	0.1863	−0.2508	0.2116	0.5939
	(0.15)	(0.39)	(0.24)	(−0.55)	(0.49)	(0.75)
2. Other metals	0.5023**	0.3703*	−0.5771	0.2045	0.2481	−0.0685
	(2.12)	(1.66)	(−1.43)	(0.87)	(1.12)	(−0.17)
3. Solid fuels	−0.2718	0.2982	0.3547	0.0940	−0.1907	−0.3458
	(−0.85)	(1.00)	(0.65)	(0.30)	(−0.64)	(−0.65)
4. Oil and gas	−0.2203	0.0326	0.7723*	0.2863	−0.1515	0.1320
	(−0.85)	(0.14)	(1.76)	(1.12)	(−0.63)	(0.31)
5. Diversified resources	0.1904	−0.1375	0.5262	0.5189*	−0.4692*	−0.1782
	(0.65)	(−0.50)	(1.06)	(1.79)	(−1.72)	(−0.37)
6. Developers and contractors	−0.0526	0.1260	−0.4230	−0.2051	0.2033	0.4678
	(−0.25)	(0.64)	(−1.19)	(−0.99)	(1.04)	(1.34)
7. Building materials	−0.0891	−0.1672	0.4476	0.2405	0.0679	−0.1553
	(−0.55)	(−1.10)	(1.60)	(1.50)	(0.45)	(−0.58)
8. Alcohol and tobacco	−0.1644	−0.3414	0.3859	−0.2318	0.1598	−0.2994
	(−0.64)	(−1.40)	(0.89)	(−0.92)	(0.67)	(−0.69)
9. Food and household goods	−0.1123	−0.5099*	−0.2306	−0.3782	0.2603	−0.2524
	(−0.38)	(−1.83)	(−0.45)	(−1.28)	(0.94)	(−0.51)
10. Chemicals	0.1943	0.1280	−0.7072	0.0464	0.2999	0.0532
	(0.68)	(0.48)	(−1.45)	(0.16)	(1.13)	(0.11)
11. Engineering	0.2957	0.1792	0.3759	0.1312	−0.0670	−0.0544
	(1.21)	(0.78)	(0.90)	(0.54)	(−0.29)	(−0.13)

Table 8 (*Continued*)

ASX industry	$\gamma_{1i,\text{pos}}$	$\gamma_{1i,\text{neg}}$	$\gamma_{1i,\text{neut}}$	$\gamma_{2i,\text{pos}}$	$\gamma_{2i,\text{neg}}$	$\gamma_{2i,\text{neut}}$
12. Paper and packaging	−0.4786**	−0.2197	−1.0039**	0.1498	−0.1700	−0.0865
	(−2.26)	(−1.11)	(−2.79)	(0.72)	(−0.86)	(−0.25)
13. Retail	−0.0638	0.1123	0.4175	0.2915	−0.1951	1.0812**
	(−0.25)	(0.46)	(0.95)	(1.14)	(−0.81)	(2.52)
14. Transport	0.1427	−0.1074	0.5257	−0.0334	0.0294	0.0916
	(0.51)	(−0.41)	(1.10)	(−0.12)	(0.11)	(0.20)
15. Media	−0.5069	−0.6798	−1.1301	−0.4431	−0.6651	−0.7112
	(−0.86)	(−1.23)	(−1.12)	(−0.76)	(−1.21)	(−0.72)
16. Banks	0.1249	−0.0487	0.2633	−0.0737	0.0746	0.4707
	(0.53)	(−0.22)	(0.66)	(−0.32)	(0.34)	(1.21)
17. Insurance	−0.3271	0.1667	0.4174	−0.6663**	−0.0935	−0.2140
	(−0.97)	(0.53)	(0.73)	(−2.00)	(−0.30)	(−0.38)
18. Entrepreneurial investors	−0.0227	−0.2486	−1.2291	−0.3076	0.3697	0.7931
	(−0.05)	(−0.58)	(−1.59)	(−0.68)	(0.87)	(1.05)
19. Investment and financial services	−0.0944	0.3358**	0.0609	0.0468	0.2355	0.1230
	(−0.56)	(2.12)	(0.21)	(0.28)	(1.50)	(0.44)
20. Property trusts	−0.0462	0.0180	−0.4586*	0.0192	0.1299	0.0061
	(−0.30)	(0.13)	(−1.78)	(0.13)	(0.92)	(0.02)
21. Miscellaneous services	−0.7480**	−0.0828	−0.0939	0.1327	−0.4401**	−0.1444
	(−3.59)	(−0.43)	(−0.26)	(0.64)	(−2.27)	(−0.42)
22. Miscellaneous industrials	0.1125	0.3395	1.1346* (1.98)	0.2643	−0.3127	0.2059
	(0.26)	(0.78)		(0.63)	(−0.71)	(0.36)
23. Diversified industrials	0.0993	−0.0400	−0.3989	0.2376	−0.1620	−0.5555*
	(0.57)	(−0.25)	(−1.36)	(1.39)	(−1.01)	(−1.94)
24. Tourism and leisure	−0.4571	0.4313	0.2666	0.1015	−0.2778	1.1156
	(−0.89)	(0.60)	(0.28)	(0.18)	(−0.33)	(1.19)

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

When comparing Tables 7 and 8, (i) significant contemporaneous negative coefficients are observed in other metals; and food and household goods; (ii) significant contemporaneous neutral coefficients are observed in oil and gas; and (iii) significant lagged negative coefficients are observed in diversified resources and miscellaneous services. of these, two coefficients report a different sign (the oil and gas contemporaneous neutral coefficient and the negative lagged coefficient for diversified resources). In summary, the evidence of asymmetry is stronger in the analysis employing daily data. Further (and not surprisingly given that the fact the monthly data response subsumes the daily data response), where a contemporaneous response is more obvious in the analysis using monthly data, a lagged response is evident when using daily data.

Weak evidence of asymmetry is also observed in the results obtained when implementing the monthly 'filter' parameters 0.01 and 0.03. Indeed, many of the significant coefficients reported in Table 8 are mirrored in the results observed when using the other two 'filters' in the monthly analysis.

4.1. General discussion

Overall, the results are quite mixed. When comparing the results obtained from the monthly data analysis with the results reported from the analysis employing daily data, it is quite apparent that the asymmetric response is strongest in the latter case. Generally, the finding in favour of daily data (over monthly) supports the analysis of Chamberlain et al. (1997). Regardless of the 'filter' parameter implemented, between 16 and 17 industries had at least one statistically significant coefficient when analysing the asymmetry of the exchange rate return using daily data, while only seven to 12 industries had at least one statistically significant coefficient in the analysis using monthly data. In addition, while a stronger lagged response is observed in the daily data analysis, a stronger contemporaneous effect is seen in the monthly analysis.

When considering the sign predictions made in Table 1, there is some evidence of significant exchange rate exposures of the predicted signs in nine industries, using daily data. Specifically, the six industries that produce some evidence of significant positive exchange rate exposures as predicted by theory are: oil and gas; solid fuels; alcohol and tobacco; chemicals; engineering; and retail. In addition, the three industries that produce some evidence of significant negative exchange rate exposures as predicted by theory are: food and household goods; and property trusts; and building materials. On the other hand, five industry categories are found in which considerable evidence was found against the predicted signs. These industries were: gold; other metals; diversified resources; transport; and miscellaneous services.

Interestingly, while all are not of the predicted sign, all five resources sector industries show signs of having extra-market exchange rate risk exposures in the sample. Of further interest, there are just three industries for which there is no evidence at all, across any of the daily analysis, of any exchange rate exposure — whether predicted by theory or not. These industries are: developers and contrac-

tors; miscellaneous industrials; and tourism and leisure. Perhaps, the most surprising of these is the tourism and leisure industry which, by its very nature, one would think should reveal some exposure.

The sign predictions are less accurate in the monthly data analysis. There is some evidence of the predicted sign in five industries, namely, food and household goods (which had the correct predicted sign across all 'filter' parameter results); oil and gas; retail; property trusts; and diversified resources. The results for these industries are generally consistent with those observed when using daily data. Also consistent are two of the industry categories in which considerable evidence is found against the predicted signs, namely, other metals; and miscellaneous services. Another industry where considerable evidence is found against the predicted sign is paper and packaging. There are several other industries for which there is no evidence of foreign exchange exposure when employing monthly data, namely, solid fuels; developers and contractors; building materials; chemicals; banks; entrepreneurial investors; and tourism and leisure.

Why are the results so mixed? One possible explanation could be that of empirical design, that is, the use of an exchange rate other than the AUDUSD as the exchange rate factor, is also worthy of further analysis. One interpretation of the results questions the relative importance of the US market from an Australian investor's point-of-view (a surprising finding) and certainly provides an area for future investigation. A further potential explanation of the mixed results is that the industry data is too aggregated and that as a result, the strength of the predictions is somewhat weakened.

5. Summary

Exposure to foreign currency risk has become an increasingly important issue with the globalisation of markets, and particularly in the wake of the events that occurred in the Asian financial markets in the latter part of 1997. Although the Australian economy is well established and relatively stable in comparison to several other Asian markets, it too has been adversely affected. The issue of foreign exchange risk has always been one that has concerned investors and financial managers alike, especially since one component of this type of exposure (operating exposure) is difficult to manage using hedging strategies.

The study attempts to analyse the foreign exchange exposure of the Australian equities market using the AUDUSD factor return in an augmented market model and implementing both daily data and monthly over the period 1988–1996. The Australian equities market is partitioned in accordance with the ASX industry classifications. Due to the potential asymmetric effects from hedging strategies such as using currency options, which limits the downside exposure whilst permitting the potential upside gains, analysis is extended by using a dummy variable specification in an attempt to model this asymmetry.

Overall, the results are quite mixed. When employing daily data, there is some evidence of significant exchange rate exposures of the predicted signs in nine

industries. Specifically, the six industries that produce some evidence of significant positive exchange rate exposures as predicted by theory are: oil and gas; solid fuels; alcohol and tobacco; chemicals; engineering; and retail. In addition, the three industries that produce some evidence of significant negative exchange rate exposures as predicted by theory are: food and household goods; and property trusts; and building materials. On the other hand, five industry categories are found for which considerable evidence was found against the predicted signs. These industries were: gold; other metals; diversified resources; transport; and miscellaneous services.

Interestingly, while all are not of the predicted sign, all five resources sector industries show signs of having extra-market exchange rate risk exposures in the sample. Of further interest, there are just three industries for which there is no evidence at all, across any of the daily analysis, of any exchange rate exposure — whether predicted by theory or not. These industries are: developers and contractors; miscellaneous industrials; and tourism and leisure. Perhaps, the most surprising of these is the Tourism and Leisure industry which, by its very nature, one would think should reveal some exposure. However, this result should be interpreted with caution given the restricted sample of data available for this industry.

The results are less encouraging when monthly data is employed. Evidence of (i) foreign exchange exposure; (ii) the asymmetric nature of the exposure; and (iii) significant coefficients of the predicted sign, is significantly weaker than that observed in the daily data findings. Generally, the findings of greater foreign exchange sensitivity using daily versus monthly data confirms the analysis of Chamberlain et al. (1997).

Finally, this analysis brings to the fore some empirical design issues that provide the foundation for further investigation. For example, future empirical research could investigate the use of longer than daily sampling intervals. Sampling periods could range from two days to greater than 1 month (that is, 2- and 6-month and 1-year intervals). Another possible direction of future analysis could involve the use of the Australian exchange rate relative to different Asian currencies.

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