Exchange Rate Exposure and The Use Of Foreign Currency Derivatives in the Australian Resources Sector

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Abstract

In this paper, we provide a re-examination of the exchange rate exposure and foreign currency derivative use by Australian resources firms in the 2006-2009 period which is characterized by increased volatility caused by the global financial crisis. In particular, we consider the interaction of a resources firm's exchange rate risk exposures, currency derivative use and the global financial crisis simultaneously. Conforming to expectations, our results indicate that more companies are significantly exposed to exchange rate risk since the onset of the financial crisis. However, there is a lack of evidence that the use of foreign currency derivative is more effective in alleviating exchange rate exposures during the crisis as opposed to the pre-crisis period.

Keywords: Exchange rate exposure; foreign currency derivatives; Australian resources firms; global financial crisis

JEL Classification: G32

1. Introduction

Exchange rate fluctuation has become a major source of risk to multinational corporations around the world since the collapse of the Bretton Woods system in the early 1970s. However, continuous innovations in financial markets and products have equipped corporations with a variety of tools to effectively manage their exchange rate exposures. As a matter of fact, exchange rate risk is one of the most widely hedged corporate risks. The popularity of foreign currency derivatives (FCD) as a hedging device provides an interesting reason for research that explores the relationship between FCD and foreign exchange exposure. Accordingly, in this paper, we aim to re-examine the relationship between corporate hedging through the use of FCD and its resultant impact on exchange rate exposures using a sample of Australian resources firms. In addition, we investigate whether the global financial crisis (GFC) had any impact on the dynamic of this relationship.

As highlighted above, we choose to re-examine this important empirical relationship by focusing on a sample of Australian resources firms during a period that encompasses the global financial crisis. Our sampling choice is based on a number of important considerations. First, the resources sector is the backbone of the Australian economy that accounts for substantial export revenues.[1] In fact, the Australia's resources sector is the country's largest single export sector and it is recognized as a high quality resources supplier in the world. Second, and more importantly, resources firms tend to have better defined FX exposures than industrial firms. The reason for this is two-fold: resources firms are heavily export oriented with Australia being the world leading provider of many mining and metal products. In addition, commodities prices are

[1] According to the Australia Export Fact sheet provided by the Department of Innovation, Industry, Science and Research, the mining sector was the top export sector by revenue in 2009. For more information, see http://www.innovation.gov.au/

often denominated in USD. As a result, resources companies commonly have exposure to fluctuations in the AUD/USD exchange rate. On the contrary, industrial firms are significantly more diverse in their operations and revenue structures and accordingly are less likely to have a relatively uniform set of exposures. The prevalence of FX exposure in the resources sector helps ensure that foreign currency derivatives FCD are generally used for hedging purposes as opposed to speculative reasons, a practice that can potentially cloud the relationship between exchange rate exposure and corporate use of FCD. Our sampling choice, hence, enables us to document a more robust empirical relationship between FCD and exposure.

Another contribution of our paper lies in the sampling period of 2006-2009 which covers the GFC. The GFC was responsible for a dramatic decline in the value of the AUD.[2] Factors contributing to this decline include interest rate cuts, a temporary weakening of commodity demand from China and the abandonment of the AUD by panicking investors. We hypothesize that such a large and sudden decline in the exchange rate would have a significant impact on the revenues and hence stock returns of resources firms. In particular, we predict that our sample firms would be more exposed to exchange rate fluctuations during the GFC.

Our results show that the majority of resources firms are significantly exposed to FX risk. More interestingly, the number of firms suffering from significant FX exposures increased from 14.43% to 45.36% during the financial crisis. We also find evidence that in response to the increased exposure, FCD users intensified the extent of FCD usage although there is no substantial increase in the proportion of firms that make use of the instruments. We also find some weak evidence that the use of FCD is associated with a lower level of exposures although

[2] Before the GFC hit the AUD was trading at approximately 94 US cents. In the midst of the GFC, the AUD bottomed at 63 US cents in late 2008.

conclusion cannot be drawn on whether the use of such instrument in alleviating exchange rate risk is more effective in one period compared to another. Another noteworthy finding of this paper is the "firm size effect" where larger firms appear to have much less exposure, a result that is plausibly an indication of how larger resources firms are better positioned to manage their exchange rate risk.

The remainder of this paper is structured as follows: in the next section, a review of the current literature on FX exposure and FCD usage is provided. Section 3 describes the sample selection and dataset followed by the econometric framework. Section 4 presents and discusses the results. Section 5 concludes.

2. Literature review

Exchange rate exposure identification and corporate FX risk management strategies have been the topic of a well established body of literature. Pioneer work in the area such as Jorion (1990), Bodnar and Gentry (1993) and Allayannis and Ofek (2001) highlighted the potential impact of exchange rate fluctuations on the firm stock return. In addition, although firms tend to use a combination of internal and external hedging instruments, FCD by far has been the most popular hedging device for short term exchange rate exposure.

Nevertheless, empirical studies that examined the effectiveness of FCD in managing FX risk produced mixed results. Bali et al. (2007), Copeland and Joshi (1996) and Hentschel and Kothari (2001) contend that FCD use does not appear to be associated with a lower level of FX exposure. A number of explanations have been advanced to account for this lack of relationship. First, firms use other forms of risk management such as operational hedging from global diversification or production management. Second, firms do not usually fully hedge the extent of

exchange rate movements. Third, interest rate, exchange rate, and commodity risks are economically insignificant relative to the firm's return. Fourth, firms do not have an economic justification for derivatives hedging if they are large, diversified and of good credit quality, except in special cases. Guay and Kothari (2003) further show that corporate derivative use appears to be a small piece of non-financial firms' overall risk profile as the amount of their derivatives holding is economically small in relation to their entity-level risk exposures. On the contrary, Nguyen and Faff (2003), Hagelin and Pramborg, (2004) and Chaing and Lin (2005) report that the use of FCD is associated with lower exposures. In addition, Allayannis and Ofek (2001) further demonstrate that the use of FCD can enhance firm value. In particular, firms that use FCD enjoy a substantial hedging premium.

Some existing literature also proposed that FX exposure might be an industry specific phenomenon. Bodnar and Gentry (1993) argued that exchange rate fluctuations affect some industries differently than others because some are more export or import dependent than others. The results were confirmed by Shin and Soenen (1999) and He and Ng (1998) who studied a set of different industrial sectors. Nguyen and Faff (2003) proposed the industry effect on exchange rate exposure. They found that the Australian sample firms from resources sector achieved a greater degree of monthly exposure reduction than the industrial sector with the use of FCD. Different sectors may also engage in different hedging practices. For example, resource/mining companies are believed to hedge more extensively.

In late 2008, global markets were blown apart by a sharp and sudden spike in volatility. The GFC caused many companies to revisit or establish new foreign exchange risk strategies. Kirschner (2009) mentioned that the use of FCD was being reassessed by firms attempting to effectively manage the dramatic increase in currency risk accompanying the GFC. Undoubtedly,

a financial turmoil the magnitude of the GFC provided an imperative for multinational corporations to review their risk management practices. Even in the absence of a financial shakeup like the GFC, Dominguez and Tesar (2006) demonstrated that firm exposures to FX movements are time-varying and likely to be an indication that firms actively adjust their behavior in response to FX risk.

3. Data and Empirical framework

3.1 Sample selection and dataset

In light of hedging theory, firms using derivatives are usually bigger in size compared to those that do not use derivatives. The economic explanation for this is only larger firms would have sufficient financial and human resources to establish and manage a hedging program (Nance et al., 1993). In addition, firms in exploration stages are generally small and more importantly they do not generate any profits and hence are unlikely to have revenue-based exchange rate exposure. Derivative usage also appears to be an uncommon practice among small firms in general and resources firms in particular. As a result, we focus on the top 200 Australian listed resource firms based on market capitalization. To enable the collection of FCD data, the firms are required to have financial statements available from 2006 to 2009. Firms are then screened according to the following criteria:

- They have thorough disclosure of the management of foreign exchange risk exposure in the financial statements
- Firms in exploration stage are excluded for reasons that were explained above.

Following this filtering process, a final sample of 97 firms is obtained. FCD data is collected manually from firms' annual financial statements. A firm is classified as a 'currency derivative user' if it uses any of the following derivative instruments to hedge the foreign exchange rate risk – swaps, futures/forwards and options. Accordingly, data on year-end notional value of FCD contracts were obtained from the notes to the financial statements of each individual firm. Monthly AUD/USD exchange rate was extracted from Bloomberg while monthly stock return data was gathered from Finanalysis. Foreign sales variable was attained from individual firm annual report. Further data relating to the control variables were obtained from Bloomberg.

In defining the onset of the (GFC), a number of opinions exist. However, for the purpose of this study, the pre-crisis period is defined as January 2006 – December 2007 and the crisis period is January 2008 – December 2009. This arbitrary definition is largely due to the fact that the variables used in the regressions are on annual basis. Hence both the pre-crisis and crisis periods have to contain full years.[3]

3.2 Research Methods

3.2.1 Measuring exchange rate exposure

Following the literature, we employ a two-stage market model to investigate the relationship between the use of FCD, and FX exposure. In the first stage, Jorion's (1991) model is used to estimate the FX exposure coefficients for the individual firms. The model is specified as follows:

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + \beta_{2i}R_{xt} + \varepsilon_{it} \quad (1)$$

[3] For example, FCD data are collected from annual financial reports. As a result, they are not available in higher time frequency.

where R_{it} is the monthly continuously stock return of firm i from January 2000 – July 2010; R_{mt} is the monthly return on the ASX All Ordinaries Index from January 2000 – July 2010; R_{xt} is the monthly change in the AUD/USD exchange rate. Monthly data will be used instead of daily or weekly, since daily and weekly exchange rate indices are noisier and usually suffer from nonsynchroneity problems which is the nonalignment of stock-return and exchange-rate series (Allayannis and Ofek, 2001). R_{it},R_{mt}, and $R_{xt}$are raw unadjusted measures of return.

To enable a comparison between the degrees of FX exposure pre- and during-crisis, pre-crisis exposure and during-crisis exposure are measured using the following regression:

$$R_{it} = \beta_{0i} + \beta_{1i}D_{Bt}R_{mt} + \beta_{2i}D_{At}R_{mt} + \beta_{3i}D_{Bt}R_{xt} + \beta_{4i}D_{At}R_{xt} + \omega_i \quad (2)$$

where D_{Bt} (D_{At}) is a dummy variable set equal to unity if an observation is made before (during) the GFC in Dec 2007 and zero otherwise. The definition of other variables remains the same as above.

3.2.2 Cross-sectional regression

The changing pattern, if any, of the association between FCD usage/intensity and FX exposure pre- and during-crisis is determined by second stage regressions using the FX exposures estimated in Equation (1) as the dependent variable. The regressions are specified as follows:

$$EXP_i = \gamma_0 + \gamma_1 USE_i + \varepsilon_i \quad (3)$$

$$EXP_i = \gamma_0 + \gamma_1 USE_i * D_{Bt} + \gamma_2 USE_i * D_{At} + \theta_i \quad (4)$$

$$EXP_i = \tau_0 + \tau_1 EXTENT_i + \alpha_i \quad (5)$$

$$EXP_i = \tau_0 + \tau_1 EXTENT_i * D_{Bt} + \tau_2 EXTENT_i * D_{At} + \rho_i \quad (6)$$

EXP_i is the exchange rate coefficient estimated from Equation (1). USE_i is a dummy variable taking a value of unity if a firm uses FCD in a financial year and zero otherwise. $EXTENT_i$ is

the extent of FCD usage which is measured as (1) the notional amount of FCD contracts scaled by total assets and (2) the notional amount of FCD contracts scaled by foreign sales.

Equations (3) to (6) incorporate the risk management activities proxied by USE and EXTENT, factors that are believed to determine the level of FX exposure. If firms use FCDs to hedge FX risk and FCDs are efficient in reducing the level of exposure, it is predicted that the more FCDs a firm uses, the less it is exposed to FX risk.

Finally, an extended cross-sectional analysis of FX exposure is performed by running the following regressions:

$$EXP_i = \delta_0 + \delta_1 USE_i + \sum_{j=1}^{n} \delta_{Bj} X_{ij} + \rho_i \quad (7)$$

$$EXP_i = \delta_0 + \delta_1 USE_i * D_{Bt} + \delta_2 USE_i * D_{At} + \sum_{j=1}^{n} \delta_{Bj} X_{ij} * D_{Bt} + \sum_{j=1}^{n} \delta_{Aj} X_{ij} * D_{At} + \gamma_i \quad (8)$$

$$EXP_i = \varphi_0 + \varphi_1 EXTENT_i + \sum_{j=4}^{n} \varphi_{Bj} X_{ij} + \mu_i \quad (9)$$

$$EXP_i = \varphi_0 + \varphi_1 EXTENT_i * D_{Bt} + \varphi_2 EXTENT_i * D_{At} + \sum_{j=1}^{n} \varphi_{Bj} X_{ij} * D_{Bt} + \sum_{j=1}^{n} \varphi_{Aj} X_{ij} * D_{At} + \varepsilon_i \quad (10)$$

The above equations followed the approach adopted by Chow and Chen (1998) who extended the cross-sectional analyses by including the additional independent variables(X_{ij}) to control for firms incentives to hedge. These variables comprise: LEV (gearing ratio) measured as the ratio of total debt to total equity, SIZE (firm size) measured as total assets, LIQ (liquidity) measured as ratio of cash flow to total assets and PE (price earnings) measured as ratio of price per share to earnings per share. The choice of these control variables is consistent with the literature. A number of previous studies reported a number of factors underlying a hedging policy. For example, firm's use of FCD is positively related to the amount of R&D expenditure to reduce underinvestment (Froot et al., 1993). Larger firms hedge more since they can achieve economies of scale. Thus, the use of FCD generally rises proportionately with the size of the firm.

Liquidity is argued to be a substitute for hedging. There is less intention to liquid firms to use derivatives to smooth earnings. Thus, less liquid firms would be more likely to use derivatives. Finally, firms with growth options are more likely to hedge so that they have adequate funds to undertake all positive NPV projects (Nguyen and Faff, 2002).

4. Results

4.1 Exchange rate exposure of Australian resource firms pre and during the GFC

FX exposure, as estimated using Equations (1) and (2), are reported in Panel A of Table 1. Our results show that 56.7% of all sample firms have statistically significant exchange rate exposure. The proportion of firms that have significant exposure is quite substantial compared to what had been reported in the literature.[4] Nevertheless, a closer examination reveals that the GFC was plausibly the underlying reason for the prevalence of significant FX exposure. In particular, only 13% of firms were exposed to FX exposure before the crisis. This figure increased substantially to 45.36% at the onset of the GFC. The results also indicate that Australian resources firms are overwhelmingly positively exposed to fluctuations in the AUD/USD exchange rate. In other words, firms appear to on average gain from an appreciation of the AUD, a result consistent with cost-based exposures as opposed to revenue-based exposures. There are two possible explanations for this result. First, 39% of the sample firms do not have any foreign sales.[5] Generally speaking, only firms with revenue exposure are expected to be hurt by an increase in

[4] The existing literature has documented relatively lower significant exposures. Bodnar and Gentry (1993) for example showed that 23%, 21%, and 25% of the portfolios were significantly exposed to FX risk for the United States, Canada and Japan, respectively. Nguyen and Faff (2003) and (2006) reported significant FX exposure for 10.34% and 30.3% of their samples of Australian and French firms respectively.

[5] Although 39% of the sample firms do not have any foreign sales, they still have foreign exchange rate exposure as their foreign exchange risk arises when future commercial transactions and recognized financial assets and financial liabilities are denominated in a currency that is not the entity's functional currency. Dominguez and Tesar (2006) mentioned that firms with no international business could also be affected by the exchange rate movement through competition with foreign firms.

the value of the local currency. Second, the revenue based exposures could be significantly reduced by corporate practices of setting up natural hedges where foreign denominated revenues are offset by foreign denominated expenses. As an example, of those firms that do not make use of FCD, 21% actually engage in one or more forms of natural hedges.

Partitioning the sample into pre-crisis and during-crisis periods further reveals that not only does the number of firms that have significant FX exposures increase during the crisis but in terms of economic significance, firm stock returns are more severely impacted upon by a certain change in the exchange rate. For example, before the crisis, a 1% increase in the exchange rate results in a 0.95% change in the individual stock return. This figure increased to 1.03% during the crisis.

Panel B of Table 1 reports the results for a test of difference in exposure between FCD users and non-users. As expected, non-users show a consistently higher mean exposure comparing to FCD users in both pre and during crisis periods. Overall, our preliminary results suggest that FCD users are not as exposed to FX exposures as their non FCD-using counterparts. Another noteworthy finding from Panel B of Table 2 is the fact that FCD users appear to have been more strongly impacted by the GFC than non-FCD users. FCD users, on average, experienced a higher level of exposure during the crisis while the absolute level of exposure for non-users stays relatively stable throughout the sampling period.

4.2 Descriptive statistics

Table 2 further provides descriptive statistics on the pattern of FCD usage and financial characteristics of our sample firms. As is shown in Table A, the number of firms that employ FCD does not appear to be impacted upon by the exchange rate fluctuation in 2008. Nonetheless,

there was a sharp increase in the intensity with which these instruments are used.. The mean extent of usage as measured by the contract value of FCD scaled by total assets, has amplified from 3.36% in 2007 to 8.60% in 2008. The median extent of usage increased from 1.08% to 1.83%. The other measure of the extent of FCD usage where FCD is scaled foreign sales produces very similar result.

FCD usage was then observed to decline in 2009 by 2.8% and 9.83% as measured by FCD/TA and FCD/FS respectively. This result is largely consistent with Melvin and Taylor's (2009) observation that after the onset of the GFC many firms choose to reduce the amount of hedging or leave the entire position unhedged due to the increased cost of hedging and more importantly increased counterparty risk. The bid-ask spread of currency derivatives contracts was noted by Melvin and Taylor (2009) to increase by at least 400% after the onset of the crisis. In addition, derivative contract providers, notably financial institutions, suffered from a number of credit issues which further undermined corporate desire to take out new over the counter contracts. [6] In the case of resource firms, if they had derivative dealings with a financial institution that might go bankrupt, there is a chance that the contract would not be honoured. The fact that both individual investors and institutional investors have lost confidence in financial institutions due to the crisis coupled with the increased hedging cost is responsible for a decline in the extent of FCD usage.

Financial characteristics of sample firms before and during the crisis are further presented in Panel B. For the whole sampling period, users of FCD and non-users are statistically discernible from each other with respect to total asset, total sales, foreign sales and PE ratio. FCD users, on average, are found to be larger with higher growth opportunities. The results

[6] Most of the FCD users in the sample use forward contract rather than futures contract to hedge their FX risk. As a result, counterparty risk is a relevant source of risk of our sample firms.

provide support to the contention that the cost of commencing and maintaining a derivatives program is not minor and as such larger firms are more likely to hedge. On the other hand, smaller firms may not make extensive use of FCD due to their limited exposure needs. With further partitioning of the sampling period, the hedgers and non-hedgers are statistically different from one another in relation to the PE ratio before the crisis but not during the crisis. On the contrary, leverage appears to be the factor that distinguishes hedgers and non-hedgers prior to the crisis but no longer so during the crisis. However, the findings in relation to both variables are consistent with the literature reviews that firms with higher leverage and more growth opportunities are more likely to use derivatives. A finding worthy of note is the fact that the mean PE ratio for non-FCD users is negative. By convention, companies that are not currently profitable (negative earnings) are treated as having negative PE ratio. This means some of the sample firms are suffering loss during the sampling period. Since some of the sample firms are newly established, it is not unusual that they do not generate any profit. This result is also consistent with our earlier finding that the sample firms on average have cost exposures rather than revenue exposures.

4.3 Exchange rate exposure and the use of foreign currency derivatives

This section explores the use of FCD in reducing FX exposure and whether this has been influenced by the GFC. Regression results of Equations (3) to (6) are reported in Table 3. In Panel A, the raw FX exposure as estimated in Equation (1) is used as the dependant variable. The absolute value of FX exposure coefficient was used in a number of previous studies to address the issue of 'sign confusion'.[7] Nevertheless, this exercise might be redundant in this case due to

[7] The 'sign confusion' effect refers to the multi dimensional interpretation that can be assigned to the coefficient. For example, a positive FCD coefficient can be interpreted as 'having a positive impact on FX exposure' in the case of a

the overwhelmingly positivity of the exposures.[8] With the fact that the majority of sample firms exhibit positive exposure, a negative coefficient on the FCD variable indicates that there is a negative relationship between the use/extent of FCD and the FX exposure. In other words, the use of FCD can reduce the level of FX exposure. As is obvious from Panel A, the use of FCD in both periods is associated with lower FX exposure. The incidence of FCD usage prior to the crisis is associated with a reduction of 0.5598 in the FX exposure while the reduction is of a magnitude of 0.3205 during the crisis. The results are significant at 1% level and 10% level respectively.

Unlike the substantial explanatory power of FCD use, the extent to which FCD are used appears to have little impact on exposure. Both the FCD/TA and FCD/FS are not significant in the whole period. However, there is some evidence that the extent of usage as measured by FCD/FS (Panel C) is a significant explanatory variable for FX exposure before the crisis which is consistent with the result in Allayannis and Ofek (2001). The FCD/TA variable, however, does not appear to have any power in explaining FX exposures. This lack of significant relationship is depicted in Panel B of Table 3. Although the intensity with which firms use FCD reveals a relationship to FX exposure that lacks consistency, the results in Panel A indicate that firms' FX exposure is mitigated through the use of FCD, a result that is in accordance with Allanyannis and Ofek (2001) and Chaing and Lin (2005). This supports the hypothesis that the use of FCD is for hedging purposes and that FCD is effective in alleviating exchange rate exposure.

In Table 4, a set of controlling variables were introduced that are proxies for other incentives for hedging, namely: firm size, leverage, liquidity and growth opportunities as

firm with positive exposure but a totally opposite meaning in the case of a firm with negative exposure. For more detail, see Nguyen and Faff (2006) and Allayannis and Ofek (2001).

[8] Absolute exposure was used as a robustness check but the exercise does not change the essence of the results.

measured by the PE ratio together with FCD, FCD/TA and FCD/FS. In the presence of the control variables, the results appear to be contradictory to previous studies. As is detailed in Panel A of Table 4, the explanatory powers of FCD usage disappear while firm size and leverage seem to be more powerful in explaining the level of FX exposure especially firm size. The coefficient of firm size in relation to the firm FX exposure is significant at 1% level as in whole period. It is also significant at 1% and 5% level before and during the crisis. The negative relationship between firm size and FX exposure is predictable as big firms are more effective in hedging risk.[9] Generally speaking, larger firms are more exposed to exchange rate fluctuation. In order to reduce their FX exposure, not only can they use FCD but also the other risk-management substitution techniques like foreign denominated debt, exposure netting,[10] funds adjustment[11] and other multiple methods.

On the other hand, leverage also has an effect on the FX exposure but only before the crisis. Contrary to the prediction that firms with higher leverage are more likely to use derivatives and so the level of FX exposure is mitigated, the finding shows that the leverage coefficient is positive. This connotes that higher leverage firms would have higher FX exposure before the crisis. Notwithstanding the fact that the explanatory powers of FCD usage disappear after the presence of control variables, results in Panel C suggest that the reduction in FX exposure is associated with the act of FCD usage. However, this relationship only holds in the pre-crisis period.

[9] It is worth noting that if derivatives are used by larger firms to hedge exposures, we should expect a negative relationship between larger firms (derivative use) and positive exposure.
[10] Exposure netting involves offsetting exposures in one currency with exposures in the same or another currency, where exchange rates are expected to move in a way such that losses (gains) on the first exposed position will be offset by gains (losses) on the second currency exposure.
[11] Funds adjustment involves altering either the amounts or the currencies (or both) of the planned cash flows of the parent or its subsidiaries to reduce the firms local currency accounting exposure.

4.4 Robustness checks

A number of robustness checks were performed to ensure the robustness of the results. Although the 97 sample firms are selected from a list of top 200 resource firms, there exists a wide gap in firm size as the total asset of the biggest firm is $78,770m while the smallest firm is worth $101.2m. In addition, as firm size appears to have significant impacts on the level of exposures for resources firms both economically and statistically, it is necessary to perform robustness checks to further re-estimate the exposure. Accordingly, the sample was separated into two portfolios in terms of market capitalization. The first portfolio contains the largest 49 sample firms while the second portfolio contains the remaining 48 sample firms.

Descriptive statistics in relation to the use of FCD for the two portfolios are presented in Table 5. As is shown in Panel A of Table 5, despite the fact that large resources firms use FCD more intensively during the financial crisis, the FX exposure for them during the crisis is higher than prior to the crisis. The results in this table further confirm the results reported in Table 1 that the GFC creates a substantially high level of exposure for sample firms. Table 5 further shows that despite using FCD more intensively during the crisis, firms still have a higher level of residual exposure.

The results of the robustness check are presented in Table 6.[12] Consistent with the previous estimation, the control variables were also included to proxy for factors other than hedging that can potentially influence the level of FX risk. In Panels A and D of Table 6, in the presence of control variables, the most important determinant of FX exposure appears to be firm size. In Panels E and F, the extent of usage as measured by both FCD/FS and FCD/TA is significant which is consistent with prior results. Guay (1999) examined new derivatives users

[12] Results relating to the control variables are not reported to conserve space.

and the time-series relation between changes in derivatives use and changes in firm risk. The result showed that new users of derivatives experienced significant FX risk reduction in the period following the initiation of a derivatives program. With the partitioning of the sample in the robustness checks, despite the comparatively lesser number of FCD users in the second portfolio, the extent of FCD usage of smaller firms is effective in reducing the level of FX exposure. Unlike the bigger firms in the first portfolio who are already well established, some of the sample firms in the second portfolio have only been established for a few years. These firms are still very new in using FCD. In that case, although only a small number of them use FCD, the extent of FCD usage is material. For bigger firms, since they have already been using FCD for a long time, the act of FCD use is meaningful to them but the intensity of FCD usage is comparatively marginal.

The findings of the robustness check provide strong evidence that the level of FX exposure for Australian resources firms is predominantly determined by firm size. This finding is indicative of the fact that larger firms are much better positioned to manage their risk exposure profiles using a variety of risk management techniques of which FCD is one. This result in relation to firm size might be a function of the way in which the sample is selected. In particular, the 97 sample firms are filtered from the top 200 resource firms in Australia which may create a bias towards larger firms. However, this filtering process is important to ensure that sample firms have revenue or cost-based foreign exchange exposures. In addition, small resource firms, more often than not, do not tend to employ FCD.[13] Bodnar and Gentry (1993) highlighted the importance of sample selection by arguing that the failure of a number of studies in documenting

[13] The sample initially comprised of the top 200 resources firms. However, the final sample is reduced to 97 due to the fact that most firms in the bottom 100 firms do not make use of FCD. More importantly, most of them are in exploration stages and as such do not have exchange rate exposures.

firm significant exchange rate exposures is due to poor sample selection practice whereby firms with no exchange rate exposures are included in the sample. The sample in Nguyen and Faff (2003) is also chosen based on a certain percentage of foreign sales of the firms.[14]

The finding in relation to firm size is in accordance with empirical findings reported by a plethora of studies. Berkman et al. (2002) found that firm size and leverage are the main explanatory variables underlying the use of financial derivatives in Australian industrial and mining firms. Similarly, Bali et al. (2007) showed that larger firms are more likely to be exposed to exchange-rate movements than firms with smaller involvement in international transactions. Many previous studies provided empirical evidence that level of risk exposure is associated with an increase in firm size, hence larger firms hedge more to reduce the exposure.[15]

5. Conclusion

Recent studies showed that FX exposures of non-financial companies could be managed through the use of FCD. Building on such research, the main contribution of this study is to further confirm the relationship between derivative usage and exposure to currency risk of a sample of large Australian resource firms. Our findings suggest that the number of firms that have significant FX exposure and the intensity of exposure increased during the crisis. In the presence of the increasing level of exposure, firms responded by using more FCD although the number of FCD users appears to reduce slightly during the crisis.

Consistent with the notion that the use of FCD is primarily for hedging purposes, there are some partial evidence that the use of FCD is associated with a reduction in firm FX risk

[14] Some previous studies pointed out the importance of foreign sales in influencing the foreign exchange exposure. They set a certain percentage of foreign sales as the necessary criterion to document FX exposures. See (Allayannis and Ofek , 2001; Chiang and Lin, 2005; Nguyen and Faff, 2006) for detail.
[15] See (Nance et al., 1993; Berkman and Bradbury, 1996; Nguyen and Faff , 2002) for detail.

despite the economic significance of the exposure reducing property of FCD during the crisis is relatively lower than before the crisis. To the extent that corporations monitor the effectiveness of their hedging strategy, it is expected that firms with significant FX exposure have changed their level use of FCD accordingly during the financial crisis. Nevertheless, there is not sufficient evidence to conclude that an increased level of FCD use results in lower FX exposure during the crisis.

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Table 1: Exchange rate exposure of Australian resource firms

Panel A reports the firm exposure to FX risk. FX exposure of all firms is estimated using the following regression:

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + \beta_{2i}R_{xt} + \varepsilon_{it} \quad (1)$$

Pre-crisis and during crisis exposure is estimated using the following regression:

$$R_{it} = \beta_{0i} + \beta_{1i}D_{Bt}R_{mt} + \beta_{2i}D_{At}R_{mt} + \beta_{3i}D_{Bt}R_{xt} + \beta_{4i}D_{At}R_{xt} + \omega_i \quad (2)$$

where R_{it} is the monthly continuously stock returns of firm i; R_{mt} is the monthly return on the ASX All Ordinaries Index. R_{xt} is the monthly fluctuation of the exchange rate of AUD/USD. D_{Bt} (D_{At}) is a dummy variable set equal to unity if an observation is made before (during) the global financial crisis in Dec 2007 and zero otherwise. Data used in the estimations cover the period Jan 2006- Dec 2009. Panel B reports the results for a test of difference in mean exposure between FCD users and non-users.

Panel A: Descriptive statistics of exchange rate exposure

	Whole period Jan 06 - Dec 09	**Before crisis Jan 06 - Dec 07**	**During crisis Jan 08 - Dec 09**
Mean	1.0095	0.9521	1.0342
Median	1.0302	0.8402	0.9775
SD	0.8133	1.1639	0.8748
Max	2.8682	4.3430	3.3273
Min	-0.9614	-1.3571	-1.0828
No of positive cases	89	75	85
No of significant cases	53	14	43
No of negative cases	8	22	12
No of significant cases	2	0	1
Total no of significant cases	55	14	44
% of significant cases	56.70%	14.43%	45.36%

Panel B: Mean exposure between FCD users and non-users

Whole period	FCD users (n=71)	Non-users (n=123)	p-value
Mean exposure	0.7131	1.1548	0.0037
Before crisis	FCD users (n=36)	Non-users (n=61)	p-value
Mean exposure	0.5950	1.1628	0.0912
During crisis	FCD users (n=35)	Non-users (n=62)	p-value
Mean exposure	0.8345	1.1470	0.0470

Table 2: Descriptive statistics of sample firms

Table 2 presents descriptive statistics for our sample firms in a pre-crisis and a during crisis period. FCD stands for foreign currency derivatives. FCD/TA is the notional amount of foreign currency derivative contracts scaled by total assets. FCD/FS is the notional amount of foreign currency derivative contracts scaled by foreign sales. TOTA is total assets. SALES is total sales. LEV is leverage: the ratio of total debt to total equity. LIQ is the liquidity: the ratio of cash flow to total assets. PE is price per earnings ratio. FORS is total foreign sales.

Panel A: Foreign currency derivatives usage in each individual year

	2006	**2007**	**2008**	**2009**
Number of FCD users	25	32	32	28
Number of FCD non-users	72	65	65	69
FCD/TA - Mean	3.14%	3.36%	8.60%	5.80%
FCD/TA - Median	0.46%	1.08%	1.83%	1.37%
FCD/FS - Mean	1.87%	2.14%	13.80%	3.97%
FCD/FS - Median	0.05%	0.03%	0.15%	0.02%

Panel B: Financial characteristics of sample firms

	User of FCD		**Non-user of FCD**		**p-value**
	Mean	**SD**	**Mean**	**SD**	
Whole period (06-09)					
lNTOTA (log total asset)	6.9777	1.7834	4.5381	1.9490	0.0000
lNSALES (log total sales)	6.0692	2.7143	2.0268	3.4409	0.0000
LEV (gearing ratio)	0.5379	0.6221	0.2283	3.2627	0.3093
LIQ (liquidity ratio)	0.1903	0.6504	0.6158	4.7000	0.3305
PE (PE ratio)	21.3306	100.4439	-18.4676	88.8793	0.0047
lNFORS (log foreign sales)	5.5525	2.9418	1.8871	3.2707	0.0000
Pre-crisis (06-07)					
lNTOTA (log total asset)	6.8220	1.7589	4.0824	2.0256	0.0000
lNSALES (log total sales)	5.8282	2.9956	1.8087	3.3892	0.0000
LEV (gearing ratio)	0.6472	0.7644	0.5176	2.3889	0.6892
LIQ (liquidity ratio)	0.1733	0.4166	0.8971	6.5006	0.4027
PE (PE ratio)	10.2193	56.4631	-37.3152	88.4367	0.0047
lNFORS (log foreign sales)	3.4410	3.6562	0.5620	2.6466	0.0135
During crisis (08-09)					
lNTOTA (log total asset)	7.1257	1.8086	5.0041	1.7559	0.0000
lNSALES (log total sales)	6.2981	2.4203	2.2498	3.4914	0.0000
LEV (gearing ratio)	0.4342	0.4288	0.2818	0.5925	0.0752
LIQ (liquidity ratio)	0.2065	0.8163	0.3282	1.2121	0.4798
PE (PE ratio)	32.7593	131.2418	0.0761	86.0318	0.1423
lNFORS (log foreign sales)	3.6795	3.7950	0.6712	3.1227	0.0001

Table 3: The use of foreign currency derivatives in reducing exchange rate exposure

This table presents the results of the following equations:

$$EXP_i = \gamma_0 + \gamma_1 USE_i + \varepsilon_i \quad (3)$$

$$EXP_i = \gamma_0 + \gamma_1 USE_i * D_{Bt} + \gamma_2 USE_i * D_{At} + \theta_i \quad (4)$$

$$EXP_i = \tau_0 + \tau_1 EXTENT_i + \alpha_i \quad (5)$$

$$EXP_i = \tau_0 + \tau_1 EXTENT_i * D_{Bt} + \tau_2 EXTENT_i * D_{At} + \rho_i \quad (6)$$

where EXP_i is the raw exchange rate coefficient estimated from equation (1), USE is the dummy variable taking a value of unity if a firm uses FCD in a financial year and zero otherwise. D_{Bt} (D_{At}) is a dummy variable set equal to unity if an observation is made before (during) the global financial crisis in Dec 2007 and zero otherwise. EXTENT is the total notional amount of foreign currency derivatives contracts scaled by total assets and foreign sales. Equation (3) and (5) estimate the exchange rate exposure and the use and extent of FCD as in whole period without any year dummy. Panel A reports the exchange rate exposure and the use of FCD. Panel B and C reports the exchange rate exposure and the extent of FCD usage. T-statistics are shown in parentheses.

	Whole period	**Pre and during crisis**
Panel A: Exchange rate exposure and the use of FCD		
Constant	1.1548[a]	1.1548[a]
	(12.7066)	(12.7067)
USE (FCD)	-0.4418[a]	
	(-2.9405)	
FCD (pre crisis)		-0.5598[a]
		(-2.9310)
FCD (during crisis)		-0.3203[c]
		(-1.6589)
R-squared	0.0431	0.0481
Panel B: Exchange rate exposure and the extent of FCD as measured by FCD/TA		
Constant	0.9928[a]	1.0140[a]
	(12.8369)	(12.9562)
Extent (FCD/TA)	0.0222	
	(0.0158)	
FCD/TA (pre crisis)		-5.9270
		(-1.4510)
FCD/TA (during crisis)		0.6692
		(0.4587)
R-squared	0.0000	0.0124
Panel C: Exchange rate exposure and the extent of FCD as measured by FCD/FS		
Constant	0.9973[a]	1.0395[a]
	(13.2378)	(13.7993)
Extent (FCD/FS)	-0.4839	
	(-0.6306)	
FCD/FS (pre crisis)		-16.0173[a]
		(-2.9641)
FCD/FS (during crisis)		-0.2484
		(-0.3280)
R-squared	0.0021	0.0445

a, b and c denoted significance at the 1, 5 and 10% levels, respectively.

Table 4: Cross-sectional analysis of exchange rate exposure

This table reports the results of the following regressions:

$$EXP_i = \delta_0 + \delta_1 USE_i + \sum_{j=4}^{n} \delta_{Bj} X_{ij} + \rho_i \quad (7)$$

$$EXP_i = \delta_0 + \delta_1 USE_i{*}D_{Bt} + \delta_2 USE_i{*}D_{At} + \sum_{j=4}^{n} \delta_{Bj} X_{ij}{*}D_{Bt} + \sum_{j=4}^{n} \delta_{Aj} X_{ij}{*}D_{At} + \gamma_i \quad (8)$$

$$EXP_i = \varphi_0 + \varphi_1 EXTENT_i + \sum_{j=4}^{n} \varphi_{Bj} X_{ij} + \mu_i \quad (9)$$

$$EXP_i = \varphi_0 + \varphi_1 EXTENT_i{*}D_{Bt} + \varphi_2 EXTENT_i{*}D_{At} + \sum_{j=4}^{n} \varphi_{Bj} X_{ij}{*}D_{Bt} + \sum_{j=4}^{n} \varphi_{Aj} X_{ij}{*}D_{At} + \varepsilon_i \quad (10)$$

where EXP_i is the raw exchange rate coefficient estimated from equation (1), USE_i is the dummy variable taking a value of unity if a firm uses FCD in a financial year and zero otherwise. D_{Bt} (D_{At}) is a dummy variable set equal to unity if an observation is made before (during) the global financial crisis in Dec 2007 and zero otherwise. EXTENT is the total notional amount of foreign currency derivatives contracts scaled by total assets and foreign sales. X_{ij} is a vector of the independent variables. These variables comprise: lnsize, lev, liq and pe. Insize is total assets. Lev is leverage: the ratio of total debt to total equity. Liq is the liquidity: the ratio of cash flow to total assets. Pe is price per earnings ratio. Equations (7) and (9) estimate the exchange rate exposure and the use and extent of FCD as in whole period without any year dummy. Panel A reports the exchange rate exposure and the use of FCD. Panel B and C reports the exchange rate exposure and the extent of FCD usage. T-statistics are shown in parentheses.

Panel A: Exchange rate exposure and the use of FCD

	Whole period	**Pre and during crisis**
Constant	1.6595[a]	1.7228[a]
	(8.1261)	(8.1740)
USE (FCD)	-0.2184	
	(-1.2610)	
FCD (pre crisis)		-0.1990
		(-0.7767)
FCD (during crisis)		-0.1291
		(-0.5422)
LNSIZE	-0.1161[a]	
	(-2.8553)	
LNSIZE (pre crisis)		-0.1548[a]
		(-3.1528)
LNSIZE (during crisis)		-0.1001[b]
		(-2.2136)
LEV	0.0948	
	(1.4633)	
LEV (pre crisis)		0.1298[c]
		(1.8742)
LEV (during crisis)		-0.0638
		(-0.3146)
LIQ	-0.0316	
	(-1.2186)	
LIQ (pre crisis)		-0.0283
		(-1.0806)
LIQ (during crisis)		-0.2017
		(-1.5624)

a, b and c denoted significance at the 1, 5 and 10% levels, respectively.

Table 4 - Continued

Panel A: Exchange rate exposure and the use of FCD		
	Whole period	**Pre and during crisis**
PE	0.0002	
	(0.2283)	
PE (pre crisis)		-0.0005
		(-0.3532)
PE (during crisis)		0.0002
		(0.1912)
R-squared	0.0870	0.1127

Panel B: Exchange rate exposure and the extent of FCD as measured by FCD/TA		
	Whole period	**Pre and during crisis**
Constant	1.7053[a]	1.7601[a]
	(8.4661)	(8.4888)
Extent (FCD/TA)	0.7998	
	(0.5779)	
FCD/TA (pre crisis)		-1.6936
		(-0.3926)
FCD/TA (during crisis)		1.2094
		(0.8122)
LNSIZE	-0.1429[a]	
	(-3.9608)	
LNSIZE (pre crisis)		-0.1749[a]
		(-4.1702)
LNSIZE (during crisis)		-0.1194[a]
		(-2.9349)
LEV	0.1022	
	(1.5723)	
LEV (pre crisis)		0.1345[c]
		(1.9493)
LEV (during crisis)		-0.0482
		(-0.2369)
LIQ	-0.0341	
	(-1.3136)	
LIQ (pre crisis)		-0.0297
		(-1.1361)
LIQ (during crisis)		-0.2252[c]
		(-1.7137)
PE	0.0000	
	(-0.0171)	
PE (pre crisis)		-0.0006
		(-0.4832)
PE (during crisis)		0.0001
		(0.0578)
R-squared	0.0809	0.1123

a, b and c denoted significance at the 1, 5 and 10% levels, respectively.

Table 4 – Continued

Panel C: Exchange rate exposure and the extent of FCD as measured by FCD/FS		
	Whole period	**Pre and during crisis**
Constant	1.7030[a]	1.7159[a]
	(8.4158)	(8.2584)
Extent (FCD/FS)	-0.0479	
	(-0.0635)	
FCD/FS (pre crisis)		-10.4258[c]
		(-1.7349)
FCD/FS (during crisis)		-0.0909
		(-0.1199)
LNSIZE	-0.1401[a]	
	(-3.8558)	
LNSIZE (pre crisis)		-0.1545[a]
		(-3.6152)
LNSIZE (during crisis)		-0.1068[a]
		(-2.6262)
LEV	0.0959	
	(1.4688)	
LEV (pre crisis)		0.1281[c]
		(1.8643)
LEV (during crisis)		-0.0722
		(-0.3568)
LIQ	-0.0334	
	(-1.2836)	
LIQ (pre crisis)		-0.0281
		(-1.0786)
LIQ (during crisis)		-0.1992
		(-1.5499)
PE	0.0001	
	(0.1008)	
PE (pre crisis)		0.0000
		(0.0310)
PE (during crisis)		0.0001
		(0.1298)
R-squared	0.0786	0.1225

a, b and c denoted significance at the 1, 5 and 10% levels, respectively.

Table 5: Descriptive statistics of 1st portfolio and 2nd portfolio firms

Table 5 presents descriptive statistics for the first top half 49 sample firms (1st portfolio) and the second half 48 sample firms (2nd portfolio) in terms of their market capitalization pre-crisis and during crisis. FCD stands for foreign currency derivatives. FCD/TA is the notional amount of foreign currency derivative contracts scaled by total assets. FCD/FS is the notional amount of foreign currency derivative contracts scaled by foreign sales. EXP stands for foreign exchange rate exposure.

Panel A: Foreign currency derivatives usage of 1st portfolio			
	Whole period 06-09	**Before crisis 06-07**	**During crisis 08-09**
Number of FCD users	53	28	25
Number of FCD non-users	45	21	24
FCD/TA - Mean	4.56%	2.74%	6.59%
FCD/FS - Mean	5.60%	1.53%	9.99%
EXP - Mean	0.90	0.81	0.99

Panel B: Foreign currency derivatives usage of 2nd portfolio			
	Whole period 06-09	**Before crisis 06-07**	**During crisis 08-09**
Number of FCD users	18	8	10
Number of FCD non-users	78	40	38
FCD/TA - Mean	3.90%	2.01%	5.42%
FCD/FS - Mean	2.31%	1.92%	2.63%
EXP - Mean	1.09	1.10	1.08

Table 6: Extended Cross-sectional analysis of exchange rate exposure by firm market capitalization

Table 6 presents the results of the first top half 49 sample firms (1st portfolio) and the second half 48 sample firms (2nd portfolio) according to their market capitalization.

This table reports the results of the following regressions:

$$EXP_i = \delta_0 + \delta_1 USE_i + \sum_{j=4}^{n} \delta_{Bj} X_{ij} + \rho_i \quad (7)$$

$$EXP_i = \delta_0 + \delta_1 USE_i{*}D_{Bt} + \delta_2 USE_i{*}D_{At} + \sum_{j=4}^{n} \delta_{Bj} X_{ij}{*}D_{Bt} + \sum_{j=4}^{n} \delta_{Aj} X_{ij}{*}D_{At} + \gamma_i \quad (8)$$

$$EXP_i = \varphi_0 + \varphi_1 EXTENT_i + \sum_{j=4}^{n} \varphi_{Bj} X_{ij} + \mu_i \quad (9)$$

$$EXP_i = \varphi_0 + \varphi_1 EXTENT_i{*}D_{Bt} + \varphi_2 EXTENT_i{*}D_{At} + \sum_{j=4}^{n} \varphi_{Bj} X_{ij}{*}D_{Bt} + \sum_{j=4}^{n} \varphi_{Aj} X_{ij}{*}D_{At} + \varepsilon_i \quad (10)$$

where EXP_i is the raw exchange rate coefficient estimated from equation (1), USE_i is the dummy variable taking a value of unity if a firm uses FCD in a financial year and zero otherwise. D_{Bt} (D_{At}) is a dummy variable set equal to unity if an observation is made before (during) the global financial crisis in Dec 2007 and zero otherwise. EXTENT is the total notional amount of foreign currency derivatives contracts scaled by total assets and foreign sales. X_{ij} is a vector of the independent variables. These variables comprise: lnsize, lev, liq and pe. Insize is total assets. Lev is leverage: the ratio of total debt to total equity. Liq is the liquidity: the ratio of cash flow to total assets. Pe is price per earnings ratio. Equations (7) and (9) estimate the exchange rate exposure and the use and extent of FCD as in whole period without any year dummy. Panel A and D reports the exchange rate exposure and the use of FCD of 1st and 2nd portfolio. Panel B and C; E and F reports the exchange rate exposure and the extent of FCD of 1st and 2nd portfolio, respectively. T-statistics are shown in parentheses.

Panel A: Cross-sectional analysis of 1st portfolio		
	Whole period	**Pre and during crisis**
Constant	1.9336[a]	2.1055[a]
	(4.0799)	(4.1815)
USE (FCD)	-0.2780	
	(-1.3046)	
FCD (pre crisis)		-0.1944
		(-0.6238)
FCD (during crisis)		-0.2333
		(-0.7771)
R-squared	0.1366	0.1906
Panel B: Cross-sectional analysis of 1st portfolio measured by FCD/TA		
Constant	1.9578[a]	2.1050[a]
	(4.1452)	(4.2002)
Extent (FCD/TA)	2.1675	
	(1.3669)	
FCD/TA (pre crisis)		-0.5142
		(-0.1105)
FCD/TA (during crisis)		2.0237
		(1.1903)
R-squared	0.1382	0.1946

a, b and c denoted significance at the 1, 5 and 10% levels, respectively.[16]

[16] The coefficients and the t-statistics of the control variables are not reported in Table 6 to conserve space.

Table 6 – Continued

	Whole period	Pre and during crisis
Panel C: Cross-sectional analysis of 1st portfolio measured by FCD/FS		
Constant	1.9636[a]	2.1056[a]
	-4.093	-4.0444
Extent (FCD/FS)	0.2364	
	-0.3148	
FCD/FS (pre crisis)		-1.5709
		(-0.1813)
FCD/FS (during crisis)		-0.0475
		(-0.0626)
R-squared	0.1173	0.1774
Panel D: Cross-sectional analysis of 2nd portfolio		
Constant	1.5709[a]	1.6464[a]
	-4.6724	-4.6538
USE (FCD)	-0.2675	
	(-0.8578)	
FCD (pre crisis)		-0.3667
		(-0.7304)
FCD (during crisis)		-0.1906
		(-0.4276)
R-squared	0.0581	0.0757
Panel E: Cross-sectional analysis of 2nd portfolio measured by FCD/TA		
Constant	1.6428[a]	1.6927[a]
	-5.0287	-4.9581
Extent (FCD/TA)	-3.8402	
	(-1.3812)	
FCD/TA (pre crisis)		-23.6061[c]
		(-1.7334)
FCD/TA (during crisis)		-2.0903
		(-0.6741)
R-squared	0.0701	0.1045
Panel F: Cross-sectional analysis of 2nd portfolio measured by FCD/FS		
Constant	1.5967[a]	1.7050[a]
	-5.0246	-5.1084
Extent (FCD/FS)	-13.3067	
	(-2.6881)	
FCD/FS (pre crisis)		-18.9076[b]
		(-2.0431)
FCD/FS (during crisis)		-11.6100[c]
		(-1.8539)
R-squared	0.1209	0.1447

a, b and c denoted significance at the 1, 5 and 10% levels, respectively.