Exchange Rate Exposure of Chinese Firms at the Industry and Firm level

Tang, Bo

Department of Economcis, University of Sheffield

December 2014

Exchange Rate Exposure of Chinese Firms at the Industry and Firm level

Bo Tang[*†]

Department of Economics, University of Sheffield

This version: December 2014

Abstract

This study investigates the exchange rate exposure of Chinese firms at the industry and firm level based on the conventional capital asset pricing model (CAPM) framework. At the industry level, the dynamic conditional correlation MGARCH (DCC MGARCH) estimates demonstrate that the market model and three-factor model are appropriate for exposure measurements, and industry returns are more likely to be exposed to unanticipated changes in the real exchange rate and the trade-weighted effective exchange rate, particularly for manufacturing industries. At the firm level, although the seemingly unrelated regression (SUR) estimates vary across markets, it is apparent that there is a relationship between firm size and exposure effects, which also show that lagged exchange rate changes have significant exposure effects on firm returns. This study finally suggests that non-financial firms should set up special commissions to hedge currency risks of their future cash flows.

JEL Codes: C58, F31, G12.

Keywords: exchange rate exposure, Chinese firms, industry and firm level, dynamic conditional correlation MGARCH (DCC MGARCH), seemingly unrelated regression (SUR).

[*]The author is grateful to Juan Carlos Cuestas, Karl Taylor and the participants of international conference on "Exchange Rate, Monetary Policy and Financial Stability in Emerging Markets and Developing Countries" in Leipzig (Germany) for their helpful comments. The usual disclaimer applies.

[†]Department of Economics, University of Sheffield, Sheffield, S1 4DT, United Kingdom. Email: bo.tang@hotmail.com. Tel: + 44 114 222 3421, Fax: + 44 114 222 3458.

1. Introduction

In the era of financial integration, exchange rate changes have considerable influences on firm values in the transaction and operation process. The classical definition of exchange rate exposure refers to the effects of unanticipated changes in exchange rates on firm values (Adler and Dumas, 1984; Jorion, 1990). Multinational firms are subject to the currency movements by virtue of their global operations. Generally, three types of typical risks caused by exchange rate changes affect firm values (Hakala and Wystup, 2002; Shapiro, 2008): transaction exposure, translation exposure and operating exposure. The empirical studies on the exchange rate exposure of firm returns have seen a dramatic increase in the past decade (Bodnar and Marston, 2002; Muller and Verschoor, 2006; Chue and Cook, 2008). Their objectives are to examine the significant exposure effects of exchange rate changes on firm values, and to further highlight the importance of hedging currency risks.

Since 2009, China has been the largest exporter and second largest importer in the world. More than 200 countries and regions have trade connections with China[1]. According to the reports of the China Securities Regulatory Commission (CSRC), more than 2500 Chinese listed firms are actively participating in the financial market and around 60% of them are exporting firms. With the further opening to outside world, an increasing number of Chinese exporting firms are seeking opportunities of doing businesses overseas. However, the studies on exchange rate exposure of Chinese firms are still scant due to its particular exchange rate policy. Since 1994, the Chinese government merged the dual currency system and launched the unified exchange rate policy. The daily floating range of RMB against USD was restricted at 0.3%. The managed floating exchange rate system was implemented in China in July 2005. The floating range was expanded to 0.5% in 2007 and further widened to 1% in 2012, and to 2% in March 2014 [2].

Motivated from the existing literature and the real situation in China, this study aims to answer the following questions: (1) Do Chinese firms suffer from exchange rate exposure under the managed floating exchange rate system? If yes, which kind of exchange rate has the most influence on Chinese firms? (2) Under the conventional exchange rate exposure measurement framework, which approaches fit with the industry and firm level exposure analyses? (3) Is there a correlation between firm size and the exposure effects? (4) Do lagged exchange rate changes have a significant impact on firm returns?

The exchange rate exposure of Chinese firms in this study is investigated from the following aspects. First, the capital market approach and the cash flow approach are applied to measure the exchange rate exposure of Chinese firms at the industry and firm level separately, which are estimated by the macroeconometric and microeconometric approaches, respectively. Second, the exposure effects from different exchange rates are investigated individually to observe which one has the most influence on firm returns. Third, three types of models based on the capital asset pricing model (CAPM) framework are separately carried out to identify the most suitable model for measuring exposure. Fourth, the firm level exposure is estimated by examining the size effects of different types of firms (large, medium and small firms) using the seemingly unrelated regression (SUR) approach, which is able to test the cross-sectional independence in the residuals. Last, since the daily floating range of the RMB exchange rate is restricted within a narrow band, therefore the effect from lagged exchange rate changes will also be examined in the study.

The remaining parts of this study are organised as follows. Section 2 reviews the approaches for measuring exchange rate exposure. Data and preliminary statistics are given in section 3. Theoretical models and econometric strategies are discussed in section 4. Section 5 details the empirical results and the last section concludes.

2. Exchange Rate Exposure Measurement

It is not easy to measure the exchange rate exposure in a simple way, at least relating to the translation and operating exposure (Holton, 2003; Papaioannou, 2006). The widely used approaches in the extant literature are the value-at-risk (VaR) (Jorion,1996; Berkowitz and O'Brien, 2002), the capital market approach and the cash flow approach. There are also some theoretical models designed by researchers based on different assumptions, which could be linear, nonlinear, symmetric or asymmetric models (Flood and Lessard, 1986; Dekle and Ryoo, 2007), but the optimum model for measuring exchange rate exposure should take different realities into consideration. In this study, the capital market approach and the cash flow approach fit with the industry and firm level exposure measurements, respectively.

Capital Market Approach

A considerable amount of studies measure the currency exposure under the framework of capital asset pricing model (CAMP)(Adler and Dumas, 1984; Jorion, 1990; Dominguez and Tesar, 2006; Chue and Cook, 2008; Du and Hu, 2012). The capital market approach for measuring exposure is to include the exchange rate variable on the right hand side of the conventional CAPM and test the the zero assumption of the exposure coefficients. The left hand side variable is the firm returns. It estimates the capital market exposures of firms to the movements in the bilateral or trade-weighted exchange rate. Some control variables can also be included, such as market returns. The augmented capital market approach takes the risk-free rate into account (Huffman et al., 2010; Du and Hu, 2012). It measures the excess returns of firm values and market portfolios, since investors's expected returns should be higher than the risk-free rate.

Cash Flow Approach

The Cash flow approach is an alternative for measuring exchange rate exposure. The major difference between the capital market approach and the cash flow approach is the left hand side variable. The former is firm returns while the latter is cash flows. Putting the model in a simple way, the exchange rate exposure of total (or net) cash flows and firm values (stock prices) are identical (Bodnar and Marston, 2002; Bartram, 2007), since the current value of firms's future cash flows are interpreted by stock prices. In the existing literature, the operating income is usually used as a proxy of cash inflow (Martin and Mauer, 2003b). Bartram (2007) represents that exchange rate exposure of US non-financial firms at longer horizons are particularly significant using the cash flow approach. Martin and Mauer (2003a) also indicate that the exposure at longer horizons are more prevalent than short horizons based on the evidence of US banks.

3. Data and Preliminary Statistics

Industry Level Data

Industry indices are obtained from the Chinese Dazhihui securities trading software. The final sample is constituted by 24 industries and 2 market indices, covering the period 2006:09-2014:04. Financial industries and non-exporting industries are excluded. The nominal exchange rate (NER) of USD/RMB is collected from the same data source as industry indexes. The US and China consumer price index (CPI) are collected from the Bureau of Labor Statistics of the USA and the China Statistic Database, respectively. The real exchange rate (RER) is defined as the NER adjusted for domestic and foreign price levels. The trade-weighted effective exchange rate (TWEER) is gathered from the Bank for International Settlements (BIS). To observe exposure effects on excess industry returns, this study applies the 7-day Treasury bills rate as the risk-free rate given it has good mobility, low risk, stable returns and active transactions.

Firm Level Data

The firm level data are obtained from the NetEase website. The sample covers the period 1991-2013. Since firm size has been widely used to examine exposure effects, total assets are used to differentiate firm sizes in this study. Those firms listed after 2010 are not included in the sample because of their small number of observations. Non-exporting firms and those firms labelled as special treatment stocks are excluded from the sample [3]. The final sample is constituted by 701 firms from the Shanghai A-share market, 44 firms from the Shanghai B-share market, 662 firms from the Shenzhen A-share market and 45 firms from the Shenzhen B-share market. The sample firms account for 55.71% of the total number of listed firms in the Chinese stock market. Apart from the firm data, the market level data consist of the Shanghai A-share Index (SHAI), Shanghai B-share Index (SHBI), Shenzhen A-share Index (SZAI), Shenzhen B-share Index (SZBI), Shanghai and Shenzhen stock market indexes.

Data Transformation and Preliminary Statistics

Industry returns are expressed as logarithmic returns, $R_t^j = log\frac{R_t^j}{R_{t-1}^j}$, where j denotes each individual industry and t represents time. The changes in exchange rates and market portfolios are calculated on the same basis. Market returns are defined as the average returns of the Shanghai and Shenzhen stock indices [4]: $RM_t = \frac{RM_t^{SHSE}+RM_t^{SZSE}}{2}$, where RM_t^{SHSE} and RM_t^{SZSE} denote the market return of the Shanghai and Shenzhen stock market respectively. Table 1 reports the stationary tests for the industry level series. All series are stationary at levels.

INSERT Table 1 Here.

For the firm level data, this study divides the sample into large, medium and small firms according to their average total assets. If the average total assets are greater than ¥6 billion, the firms are considered as large firms. Similarly, medium firms have an average total assets between ¥1 billion and ¥6 billion, while the average total assets of small firms are less than ¥1 billion. The unanticipated changes of firm values are expressed as the log returns of their operating incomes. $OPI_t^j = log\frac{OPI_t^j}{OPI_{t-1}^j}$, where OPI_t^j is the operating income of firm j at time t. The remaining firm level series also are expressed as logarithmic returns. Table 2 reports summary statistics of the firm level data.

INSERT Table 2 Here.

4. Theoretical Models and Econometric Strategies

Theoretical models and Assumptions

The conventional two-factor CAPM for measuring the sensitivity of firm values to exchange rate changes has been widely applied in previous studies (Adler and Dumas, 1984; Jorion, 1990; Bodnar and Wong, 2003). The exposure measurement is the regression of firm returns on the changes in exchange rate .

$$R_{j,t} = \beta_{0,j} + \beta_{1,j}ER_t + \varepsilon_{j,t} \tag{1}$$

Where $R_{j,t}$ is the return for firm j (or industry j), ER_t is the log return of exchange rate. If the changes in firm returns and exchange rates are unanticipated, then the two-factor model is appropriate (Jorion, 1990), and $\beta_{1,j}$ is called total exposure elasticity. The augmented three-factor model takes the returns of market portfolio into account (Dominguez and Tesar, 2001; Muller and Verschoor, 2006; Huffman et al., 2010).

$$R_{j,t} = \beta_{0,j} + \beta_{1,j}ER_t + \beta_{2,j}RM_t + \varepsilon_{j,t} \tag{2}$$

Where $\beta_{2,j}$ denotes the sensitivity of firm returns (or industry returns) to the changes in market portfolio RM_t. The excess returns of firm values are introduced to measure exchange rate exposure (Hsin et al., 2007; Huffman et al., 2010; Du and Hu, 2012).

$$(R_{j,t} - RF_t) = \beta_{0,j} + \beta_{1,j} ER_t + \beta_{3,j}(RM_t - RF_t) + \varepsilon_{j,t} \tag{3}$$

In equation (3), RF_t is the risk-free rate. $(R_{j,t} - RF_t)$ and $(RM_t - RF_t)$ represent the excess return of firm j (or industry j) and market portfolio, respectively.

This study assumes that the Chinese firms are exposed to different types of exchange rates. The effects from the changes in the NER, RER and TWEER should be examined separately. Exchange rate changes mainly affect returns of exporting industries. Non-exporting industries (which have been excluded) are assumed to be less sensitive to exchange rate changes. Further, there is no preference in choosing models (equations(1)–(3)) to measure exchange rate exposure and the best model should be determined by empirical results.

The three-factor model is inappropriate for the exposure measurement at the firm level owing to the very small number of observations for the risk-free rate. It is clear that large firms have more interactions with the global market while small firms mainly operate their businesses in the domestic market. In addition, the temporary exchange rate shock could be limited by the managed floating exchange rate policy, but the lagged exposure effect may appear if the shock continues. Therefore this paper has two assumptions for the exposure measurement at the firm level: (1) There is a relationship between firm size and the exchange rate exposure, and this kind of correlation varies between RMB ordinary shares and foreign capital shares; (2)Lagged exchange rate changes have significant influences on firm returns.

Dynamic Conditional Correlation Multivariate GARCH

The empirical strategy for estimating exposures is to calculate the average exposure coefficients, the percentages or the number of significant positive and negative exposure coefficients (Jorion, 1990; Dominguez and Tesar, 2001; Hsin et al., 2007). The CAPM for measuring exposure is implicitly assumed to have a constant variance, but the financial time series data usually do not hold this assumption and the homoscedasticity may be invalid under the OLS regression. This study estimate the CAPM in a dynamic conditional correlation multivariate generalized autoregressive conditionally heteroscedastic (DCC MGARCH) model (Engle, 2002; Fang et al., 2009). It models the conditional covariance matrix of the error terms in a nonlinear combination of GARCH(1,1) model with time-varying cross-equation weights. Equation (4) gives the basic framework of the DCC MGARCH model.

$$\begin{aligned} y_t &= Cx_t + \varepsilon_t \\ \varepsilon_t &= H_t^{\frac{1}{2}} v_t \\ H_t &= D_t^{\frac{1}{2}} R_t D_t^{\frac{1}{2}} \\ R_t &= diag(Q_t)^{-\frac{1}{2}} Q_t diag(Q_t)^{-\frac{1}{2}} \\ Q_t &= (1-\lambda_1-\lambda_2)R + \lambda_1 \widetilde{\varepsilon}_{t-1} \widetilde{\varepsilon}_{t-1}' + \lambda_2 Q_{t-1} \end{aligned} \tag{4}$$

Take the two-factor model as an example, y_t contains the dependent variable $R_{j,t}$, x_t is a $k \times 1$ vector of independent variables (ER_t). C is the parameter matrix. D_t contains a diagonal matrix of conditional variances[5]. $H_t^{\frac{1}{2}}$ is the time-varying conditional covariance matrix and v_t is normal *i.i.d* innovations. R_t is a matrix of conditional quasicorrelations. $\widetilde{\varepsilon}_t$ is the standardized residuals. λ_1 and λ_2 are positive and meet $0 \leq \lambda_1 + \lambda_2 \leq 1$. Before the application of the DCC MGARCH approach, the ARCH effect has been examined by testing residuals of the OLS regression. If it indicates the existence of ARCH effects, the lagged exchange rate change together with the GARCH (1,1) process will be included in the specification of the conditional covariance. No other constraints will be imposed. These parameters can be estimated by the maximum likelihood function.

Seemingly Unrelated Regression

The DCC MGARCH model is inappropriate for the exposure measurement at the firm level due to the very small number of observations. Following Williamson (2001), the seeming unrelated regression (SUR) approach is applied in the study to account for the cross-sectional dependence in the residuals. If the cross-sectional correlations do not exist, then the SUR is equivalent to the OLS estimation. Taking the market model as an example:

$$R_{j,t} = \beta_{0,j} + \sum_{k=0}^{2} \beta_{k,j} ER_t + \beta_{2,j} RM_t + \varepsilon_{j,t} \tag{5}$$

Where $\beta_{k,j}$ is the exposure coefficient (beta) of exchange rate, j denotes different types of firms (large, medium and small firms). k is the lag length. A maximum of 2 lags are initially included in the model, but the optimum lag length is selected by the general-to-specific (G2S) approach. If the cross-equation correlations in the residuals exist, the investigation of Hypothesis 4 is to test that whether the exposure coefficients jointly estimated by the SUR are equal to each other.

5. Exchange Rate Exposure of Chinese Firms at the Industry and Firm Level

Measuring Exposures at the Industry Level

Table 3 reports the exchange rate exposure at the industry level [6]. Some models include the lagged exchange rate variables, which help to improve the significance of exposure coefficients and the convergence of the DCC MGARCH model. This accords with the evidence that the one-period lagged exchange rate changes may affect firm returns (Fraser and Pantzalis, 2004).

INSERT Table 3 Here.

The two-factor model estimates suggest that Chinese firms are less likely to be exposed to the NER changes at the industry level. Among the 24 sample industries, only five industries (electronic information, machinery, tourism and hotel, traffic equipment and vehicles industries) have significant exposure betas in the test of the NER changes. However, the majority of the exposure coefficients are statistically significant at the 5% level in the exposure measurement to the changes in the RER and TWEER [7]. The reason for different exposure effects across industries could be the degree of their participation in the global market. The exposure betas are positive for RER changes but negative for TWEER changes. Since an increase in the bilateral RER means the depreciation of Chinese currency, it strengthens the competitiveness of exports and then further lifts industry returns, while the rise in the TWEER reduces the cost of one nation's imports but undermines the competitiveness of exports. For example, both the exposure coefficients are significant at the 5% level in the building construction industry. An upturn of the RER fluctuation (RMB depreciation) by 1% increase the return of the building construction industry by 2.46%, but an upturn of 1% in the TWEER fluctuation reduces the industry return by 1.85%.

In terms of the market model estimates, only the agriculture, forest, husbandry and fishing (AFHF) industry is significantly exposed to the NER change. Other industries are resilient to NER fluctuations. AFHF, coal and petroleum, electrical equipment, paper making and printing, wine and food industries have received significant shocks from RER changes. In testing the exposure to the TWEER fluctuation, only four industries are significantly exposed to the exposure effect, including building construction, coal and petroleum, commercial chains and nonferrous metals. The remaining industries do not suffer from TWEER changes. All Wald tests reject the null hypothesis that the coefficients of market portfolios are equal to zero. It is in accord with the conventional interpretation of the CAPM that changes in market returns should be systematically associated with firm returns (Dominguez and Tesar, 2006).

The three-factor model estimates the exposure of excess industry returns to exchange rate changes and excess market returns. The results are almost the same as market model estimates. AFHF, commercial chains, machinery, wine and food industries are significantly exposed to the NER change. The change in the RER has systematic shocks to electrical equipment, electronic information, foreign trade, steel, wine and food industries. When the TWEER is included in the three-factor model, nine industries are found to significantly suffer from exchange rate exposure, namely AFHF, coal and petroleum, commercial chains, construction materials, electrical equipment, machinery, non-ferrous metals, steel and vehicles. This reveals that Chinese firms are more likely to be exposed to TWEER changes.

INSERT Table 4 Here.

Table 4 reports summary statistics of exposure coefficients at the industry level. Results from the two-factor model suggest that 22 industries have suffered negative exposures from TWEER changes, which account for 91.67% of the total number of industries. The average exposure beta is –2.308. This indicates that the average industry return will decrease by 2.308% responding to a 1% upturn in the TWEER change. The significant positive exposures from RER changes account for 95.83% of the whole industries. Both types of exposure betas are much higher than the results represented by Jorion (1990) and Muller and Verschoor (2006). The average exposure coefficients are 0.019 and –0.195 for measuring exposures to RER and TWEER changes respectively, while there are eight industries (33.33% of total industries) significantly affected by the change in the TWEER from the three-factor model estimates. This is relatively higher than those negatively exposed to RER changes (8.33%). The average exposure coefficient is –0.346. It means that the average industry returns will decline by 0.346% when the TWEER changes increase by 1%. Compared with the two-factor model estimates, the market model and the three-factor model estimates are more likely to be accepted. This is supported by information criteria (not reported) and the empirical analysis.

Measuring Exposures at the Firm Level

Table 5 reports the exchange rate exposure of Chinese firms at the firm level. In the Shanghai stock market, the exposure betas for small firms in the RMB ordinary share market (SHA) is statistically significant. However, the Wald test ($F_{test_{SHA}}$) accepts the null hypothesis that the exposure betas are equal to each other. This means that there is no correlation between firm size and exposure effects. Although the F-tests suggest that the exposure betas vary across equations in the test of exposures to the RER changes, exposure coefficients are not statistically significant. Moreover, the evidence from the Shanghai B-share (SHB) market shows that large and medium firms suffer exposures from the changes in the NER and TWEER, but the cross-equation correlated residuals do not exist (indicated by the dagger symbol)(indicated by the diamond symbol in Table 5).

INSERT Table 5 Here.

In the Shenzhen stock market, the cross-equation correlation in the residuals exists in the two-factor model estimates when the TWEER is included. The exposure beta for large firms is significant in levels. When the lagged TWEER is incorporated, medium and small firms are significantly exposed to lagged exposure effects. In terms of the market model estimates, large firms have a strong relationship with the TWEER change, while medium firms are more likely to be exposed to the change in the RER. In the Shenzhen B-share (SHB) market, there is no correlation between firm size and exposure effects.

Exposure effects to Chinese listed firms from the aggregate Shanghai and Shenzhen stock markets have also been individually examined. The linkage between firm size and exposure effects does not exist in the Shanghai stock market. However, significant exposure betas and size effects are represented in the Shenzhen stock market in testing the exposure to TWEER changes. Large firms suffer significant negative exposures from the change in the TWEER, while medium and small firms receive relatively small shocks from lagged TWEER changes. As large firms have operations overseas, they are subject to the transaction and translation exposures. Medium and small firms mainly operate their businesses in the domestic market. Therefore they are less likely to suffer from exchange rate changes. The exposure effects are slightly different between the Shanghai and Shenzhen stock markets. A possible explanation is that the Shanghai stock market is the economic center of China. The authorities are gradually incorporating the Shenzhen stock exchange (SZSE) into the Shanghai stock exchange (SHSE) and much attention has been focused on the Shanghai main board market. The spillover effects also can be temporarily restricted by means of the managed floating exchange rate system. Although the Shenzhen market contains a proportion of main board shares, its main mission is to establish the multiple level capital market in China, which servers the development of the medium- and small-sized panel and the growth enterprise market (GEM). The SZSE is more vulnerable to changes in stock prices of these panels (medium- and small-sized panel, and the GEM). Moreover, foreign capital shares listed in the SZSE are traded in Hong Kong dollar (HKD), and the change in the USD exchange rate might directly affect the stock prices of Shenzhen B-shares, since the Hong Kong government adopts a linked currency system (The HKD is linked to the USD.)

Table 5 also reports the exposure of whole sample firms in the Chinese stock market. In estimating exposures from TWEER changes, Chinese firms are significantly exposed to lagged exchange rate changes, and the F-test confirms the existence of the correlation between firm size and exposure effects. This is consistent with previous exchange rate exposure studies (Fraser and Pantzalis, 2004). The exposure betas from the two-factor model and the market model estimates are not very different, thus both models are appropriate for estimating exchange rate exposure of Chinese firms at the firm level.

6. Concluding Remarks

This paper has investigated the exchange rate exposure of Chinese firms at the industry and firm level. At the industry level, several implications can be concluded. First, the market model and three-factor model are suitable for measuring the industry level exposure. Second, industry returns are more likely to be exposed to the changes in the RER and TWEER. The average exposure beta from the test of the exposure to TWEER changes is larger than those from RER changes in magnitude. Third, manufacturing industries are more likely to suffer from exchange rate changes. Fourth, if the ARCH effect exists in the linear regression test, the DCC MGARCH model is more efficient in estimating exchange rate exposure. At the firm level, exposure effects from the SUR estimates vary across markets owing to the market segmentation, but the whole sample estimates indicate the existence of the correlation between firm size and exposure effects in testing the exposure to the change in the TWEER. Moreover, lagged exchange rate changes have significant influences on firm returns, which also improve the convergence of the DCC MARCH model at the industry level.

In general, Chinese firms suffer exposure effects from RER and TWEER changes. The evidence shows that the connection between firm size and exchange rate exposure exists at the firm level. Also, lagged exposure effects on firm returns are found to be significant. Nevertheless, the Chinese authorities are faced with continuous pressures from trade partners, the RMB exchange rate may have to be adjusted to be more flexible and tradable in the future, which may strengthen the exposure effect to some extent. Currently, Chinese firms are expanding their operations overseas, but exchange rate exposures are usually ignored in practice owing to a lack of understanding on currency risks. To manage the exchange rate exposure, this study finally suggests that Chinese firms should set up special commissions to hedge currency risks of their future cash flows, in particular for those non-financial firms. The hedging strategy should not only focus on the change in the USD, but a basket of currencies, since changes in the TWEER have the largest influence on Chinese firms.

References

Adler, Michael and Dumas Bernard, "Exposure to currency risk: definition and measurement," *Financial management*(1984):41–50.

Bartram, Söhnke M., "Linear and nonlinear foreign exchange rate exposures of german nonfinancial corporations," *Journal of International Money and Finance* 23(2004):673–699.

———, "Corporate cash flow and stock price exposures to foreign exchange rate risk," *Journal of Corporate Finance* 13(2007):981–994.

Berkowitz, Jeremy and O'Brien James, "How accurate are value-at-risk models at commercial banks?" *The Journal of Finance* 57(2002):1093–1111.

Bodnar, Gordon M. and Marston Richard C., "Exchange rate exposure: A simple model," *International Finance Review* 3(2002):107–115.

Bodnar, Gordon M. and Wong M.H. Franco, "Estimating exchange rate exposures: issues in model structure," *Financial Management*(2003):35–67,.

Chue, Timothy K. and Cook David, "Emerging market exchange rate exposure," *Journal of Banking & Finance* 32(2008):1349–1362.

Crotty, James, "Structural causes of the global financial crisis: a critical assessment of the 'new financial architecture'," *Cambridge Journal of Economics* 33(2009):563–580.

Dekle, Robert and Ryoo Heajin H., "Exchange rate fluctuations, financing constraints, hedging, and exports: Evidence from firm level data," *Journal of International Financial Markets, Institutions and Money* 17(2007):437–451.

Dominguez, Kathryn M.E. and Tesar Linda L., "A reexamination of exchange-rate exposure," *American Economic Review*(2001):396–399.

———, " Exchange rate exposure," *Journal of International Economics* 68(2006):188–218.

Doukas, John A., Hall Patricia H., and Lang Larry H.P., "Exchange rate exposure at the firm and industry level," *Financial Markets, Institutions & Instruments* 12(2003):291–346.

Du, Ding and Hu Ou, "Exchange rate risk in the US stock market," *Journal of International Financial Markets, Institutions and Money* 22(2012):137–150.

Engle, Robert, "Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models," *Journal of Business & Economic Statistics* 20(2002):339–350.

Fang, WenShwo, Lai YiHao, and Miller Stephen M., "Does exchange rate risk affect exports asymmetrically? Asian evidence," *Journal of International Money and Finance* 28(2009): 215–239.

Flood Jr., Eugene and Lessard Donald R., "On the measurement of operating exposure to exchange rates: A conceptual approach," *Financial Management*(1986):25–36.

Fraser, Steve P. and Pantzalis Christos, "Foreign exchange rate exposure of US multinational corporations: a firm-specific approach," *Journal of Multinational Financial Management* 14 (2004):261–281.

Hakala, Jürgen and Wystup Uwe, *Foreign Exchange Risk; Models, Instruments and Strategies,* Risk Boots, 2002.

Hsin, Chin-Wen, Shiah-Hou Shin-Rong, and Chang Feng-Yi, "Stock return exposure to exchange rate risk: A perspective from delayed reactions and hedging effects," *Journal of Multinational Financial Management* 17(2007):384–400.

Huffman, Stephen P., Makar Stephen D,, and Beyer Scott B., "A three-factor model investigation of foreign exchange-rate exposure," *Global Finance Journal* 21(2010):1–12.

Jorion, Philippe, "The exchange-rate exposure of US multinationals," *Journal of Business*(1990):331–345.

———, "Risk2: Measuring the risk in value at risk," *Financial Analysts Journal*(1996): 47–56.

Martin, Anna D. and Mauer Laurence J., "Exchange rate exposures of US banks: A cash flow-based methodology," *Journal of banking & finance* 27(2003a):851–865.

———, "Transaction versus economic exposure: which has greater cash flow consequences?" *International Review of Economics & Finance* 12(2003b):437–449.

Muller, Aline and Verschoor, Willem F.C., "Asymmetric foreign exchange risk exposure: Evidence from US multinational firms," *Journal of Empirical Finance* 13(2006):495–518.

Papaioannou, Michael G., *Exchange rate risk measurement and management: issues and approaches for firms,* Number 2006-2255, International Monetary Fund, 2006.

Shapiro, Alan C., *Multinational financial management,* John Wiley & Sons, 2008.

Williamson, Rohan, "Exchange rate exposure and competition: evidence from the automotive industry," *Journal of financial Economics* 59(2001):441–475.

Notes

1. See the General Administration of Customs of the People's Republic of China and the Embassy of the People's Republic of China in the United States of America for details.

2. Mr Deng Xianhong, Vice Chairman of the State Administration of Foreign Exchange of China (SAFE), gave a keynote speech of the "Chinese Foreign Exchange Policies" on the international conference on "China After 35 Years of Economic Transition" (2014) in London.

3. Special treatment (ST) of stocks mean that those listed companies have problems in their financial conditions, such as continuing losses. Once a stock has been labelled as "ST", it implies the existence of potential risks and delisting.

4. This study assumes that equal weights should be given to each index.

5. D_t is a diagonal matrix of conditional variances, by default: $\sigma_{i,t}^2 = exp(\gamma_i, z_i, t) + \alpha_1 \varepsilon_{i,t}^2 + \alpha_2 \sigma_{i,t}^2$,, where γ_i is the dependent variable including a constant, α_1 is the ARCH parameter and α_2 is the GARCH parameter.

6. In Table 3, only the exposure coefficients are reported. The exposure betas for market returns and other covariances coefficients are not represented.

7. In testing exposures to RER changes, the exposure betas for electrical equipment and wine and food industries are not statistically significant at the 5% level. In the test of the exposure to the change in the TWEER, the exposure coefficients for agriculture, forestry, husbandry and fishing (AFHF), computer, medicine, textile and garment industries are not significant at the 5% level.

	ADF	KPSS		ADF	KPSS
AFHF	-9.455***	0.278	Paper-making and Printing	-9.512***	0.123
Building construction	-10.249***	0.233	Steel	-9.532***	0.307
Chemicals	-9.368***	0.170	Textile and Garment	-9.536***	0.189
Coal and petroleum	-9.130***	0.180	Tourism and Hotel	-8.621***	0.116
Commercial chains	-8.906***	0.187	Traffic Equipment	-9.141***	0.128
Communication	-10.664***	0.168	Transport & Logistics	-9.153***	0.206
Computer	-10.196***	0.137	Vehicles	-8.937***	0.120
Construction materials	-9.222***	0.213	Wine and Food	-9.230***	0.243
Electrical equipment	-8.387***	0.117	Other Industries	-10.202***	0.124
Electronic information	-9.941***	0.071	Market Return	-9.206***	0.179
Foreign trade	-9.484***	0.197	Risk-free Rate	-10.318***	0.206
Instruments and meters	-10.133***	0.235	NER	-4.219***	0.442
Machinery	-4.677***	0.182	RER	-11.282***	0.350
Medicine	-9.702***	0.151	Trade-weighted Rate	-6.127***	0.063
Non-ferrous metals	-8.942***	0.180			

Table 1. Stationary test of the industry level series

Notes: The sample industries cover the period 2006:09-2014:04. AFHF represents the industry of agriculture, forest, husbandry and fishing. NER, RER and TWEER represent the nominal real exchange rate, real exchange rate and trade-weighted effective exchange rate, respectively. Both the ADF and KPSS tests are conducted with the restriction of a constant only. The critical values for the ADF test with a constant restriction are -3.459, -2.875 and -2.573 at the 1%, 5% and 10% level, respectively. The critical values for the KPSS test with a constant restriction are 0.739, 0.463 and 0.347 at the 1%, 5% and 10% level, respectively. *** denotes significance at 1% level.

	Mean	Median	Maximum	Minimum	Std.Dev	Skewness	Kurtosis
SHA_{Large}	0.2423	0.2264	0.8910	0.0764	0.1568	3.1375	14.0851
SHA_{Medium}	0.1980	0.1831	0.5739	0.0131	0.1199	1.6211	6.1430
SHA_{Small}	0.1384	0.1138	0.3696	-0.0435	0.0886	0.4983	3.8642
SHB_{Large}	0.2190	0.2057	0.4251	-0.0121	0.1471	-0.0380	1.5381
SHB_{Medium}	0.1599	0.1255	0.6597	-0.1073	0.1819	1.0870	3.7942
SHB_{Small}	0.0143	0.0444	0.3358	-0.9538	0.2788	-1.9719	7.6567
SZA_{Large}	0.2997	0.2095	2.2025	-0.1073	0.4394	3.6937	16.7755
SZA_{Medium}	0.1719	0.1542	0.3708	-0.0484	0.0974	-0.1031	2.8595
SZA_{Small}	0.1487	0.1180	0.4585	-0.0060	0.1069	1.2006	4.4560
SZB_{Large}	0.1850	0.1517	0.5455	0.0192	0.1337	1.0560	3.7285
SZB_{Medium}	0.1387	0.1349	0.6470	-0.5800	0.2087	-1.1315	8.5054
SZB_{Small}	0.0517	0.0162	0.6823	-0.2254	0.2047	1.2377	4.9653
$SHSE_{Large}$	0.2426	0.2309	0.8389	0.0715	0.1475	2.8783	12.9083
$SHSE_{Medium}$	0.1956	0.1737	0.5840	0.0108	0.1225	1.5712	6.0279
$SHSE_{Small}$	0.1299	0.1151	0.2729	-0.0676	0.0834	-0.1542	3.1684
$SZSE_{Large}$	0.2631	0.2031	1.5050	-0.1073	0.3024	3.0828	13.6852
$SZSE_{Medium}$	0.1667	0.1510	0.4239	-0.1934	0.1202	-0.7012	5.2215
$SZSE_{Small}$	0.1364	0.1260	0.4099	-0.0280	0.1047	0.7378	3.5772
$SHSZ_{Large}$	0.2486	0.2351	0.7084	0.0662	0.1402	1.6287	6.3960
$SHSZ_{Medium}$	0.1850	0.1799	0.5146	0.0315	0.1092	1.3072	5.1990
$SHSZ_{Small}$	0.1426	0.1405	0.4147	0.0012	0.0838	1.3548	6.0751
SHAI	0.1241	0.0307	1.0249	-1.0606	0.4696	-0.0621	3.3073
SHBI	0.0639	0.0349	1.0340	-1.1936	0.5692	-0.1150	2.4929
SZAI	0.0622	-0.0656	1.2050	-0.9937	0.5314	0.4717	2.9672
SZBI	0.0600	0.1303	0.9208	-0.9762	0.5293	-0.0502	2.0746
SHCOMP	0.1221	0.0312	0.9805	-1.0611	0.4660	-0.0997	3.2931
SICOMP	0.0969	-0.0530	1.1809	-1.0040	0.5462	0.3474	2.6035
NER	0.0062	-0.0002	0.3716	-0.0677	0.0847	3.6585	16.5678
RER	0.0306	0.0288	0.3193	-0.0769	0.0801	1.9376	8.4605
TWEER	0.0066	0.0267	0.1079	-0.2438	0.0793	-1.4773	5.5190

Table 2. Summary statistics of the firm level data

Notes: The sample for the firm level data covers the period 1991-2013. Those variables with subscripts represent the mean returns of firms's operating incomes according to the division of firm size. The notations of capital letters indicate different markets. SHA: Shanghai A-share. SHB: Shanghai B-share. SZA: Shenzhen A-share. SZB: Shenzhen B-share. SHSE: Shanghai Stock Exchange (including those sample firms from the Shanghai stock market). SZSE: Shenzhen Stock Exchange (including those sample firms from the Shenzhen stock market). SHSZ: total sample firms from the Shanghai and Shenzhen stock market. SHAI: Shanghai A-share Index. SHBI: Shanghai B-share Index. SZAI: Shenzhen A-share Index. SZBI: Shenzhen B-share Index. SHCOMP: Shanghai Composite Index. SICOMP: Shenzhen Component Index. NER: Nominal exchange rate. RER: Real exchange rate. TWEER: Trade-weighted effective exchange rate.

	Two-factor model			Market model			Three-factor model(excess return)		
	NER	RER	TWEER	NER	RER	TWEER	NER	RER	TWEER
AFHF	0.162	2.863	-1.272	-2.977	0.783	0.879	-3.380	0.121	0.903
	(0.01)	(11.29)***	(1.93)	(6.99)***	(2.88)*	(3.56)*	(9.15)***	(0.07)	(3.75)*
Building construction	2.894	2.456	-1.846	-0.284	0.048	0.154	-0.421	0.012	0.164
	(2.05)	(9.05)***	(4.65)**	(0.13)	(0.02)	(0.21)	(0.30)	(0.000)	(0.25)
Chemicals	2.428	2.534	-2.573	-0.450	0.531◇	-0.518	-1.074	0.230	-0.518
	(1.24)	(8.36)***	(8.18)***	(0.26)	(3.01)*	(2.10)	(1.05)	(0.37)	(2.10)
Coal and petroleum	2.892	2.944	-3.030	-0.681	0.265	-0.855	0.090	0.502	-1.043
	(1.45)	(9.28)***	(9.36)***	(0.33)	(0.27)	(2.84)*	(0.01)	(1.08)	(4.61)**
Commercial chains	1.304	1.755	-2.573	-1.639	-0.498	-0.809	-1.895	-0.508	-0.831◇
	(0.42)	(4.56)**	(9.81)***	(2.54)	(1.22)	(3.26)*	(3.82)**	(1.79)	(8.62)***
Communication	1.994	1.939	-1.946	-1.001	-0.355	-0.090	-0.886	-0.504	0.046
	(0.99)	(5.63)**	(5.38)**	(1.10)	(0.73)	(0.05)	(0.86)	(1.67)	(0.01)
Computer	1.944	2.163	-1.631	-1.148	-0.183	0.309	-0.855	-0.278	0.356
	(0.81)	(6.07)**	(3.18)*	(0.96)	(0.13)	(0.36)	(0.55)	(0.34)	(0.53)
Construction materials	3.075	2.706	-3.043	-0.211	-0.301	-0.629	0.399	0.260	-1.020
	(2.15)	(6.89)***	(8.41)***	(0.04)	(0.44)	(1.95)	(0.13)	(0.32)	(4.86)**
Electrical equipment	2.478	1.530	-2.360	-0.747	-0.865	-0.518	-0.888	-0.917	-1.033
	(1.46)	(3.24)*	(7.76)***	(0.77)	(4.09)**	(1.51)	(1.08)	(5.12)**	(5.04)**
Electronic information	4.277	3.560	-2.302	0.918	0.518	0.049	1.288	0.826	-0.147
	(3.40)*	(15.10)***	(5.46)**	(1.02)	(1.45)	(0.01)	(1.77)	(3.32)*	(0.12)
Foreign trade	2.868	3.564	-2.620	-1.125	0.062	0.167	0.016	1.122	-0.628
	(1.06)	(10.29)***	(5.01)**	(1.29)	(0.02)	(0.18)	(0.00)	(5.16)**	(1.48)
Instruments and meters	3.131	2.499	-2.357	0.196	0.290	-0.546	-0.110	0.053	-0.338
	(2.35)	(9.16)***	(7.63)***	(0.03)	(0.36)	(1.29)	(0.01)	(0.01)	(0.52)

Table 3. Exchange rate exposure at the industry level

Notes: The exchange rate exposure at industry level was modelled in the form of equation (1)-(3) separately. This table represents the exposure coefficients with Wald tests estimated industry by industry. The econometric strategy for estimating exchange rate exposure is the DCC GARCH model (see equation (4)). Each model has been conducted a single ARCH test before using the DCC GARCH approach. If the homoscedasticity of the error terms $\varepsilon_{j,t}$ does not hold, the GARCH(1,1) process will be allowed for the disturbance in the variances. Otherwise, only the mean model will be estimated. None of the linear regression tests have ARCH effects in the two-factor CAPM model estimates. For the three-factor model, the following industries have been included an ARCH and GARCH term in the DCC GARCH test: AFHF(RER and TWEER), Chemicals(NER,RER and TWEER), Electrical Equipment(NER and TWEER), Electronic Information(NER,RER and TWER) and Foreign Trade(NER,RER and TWEER). For the three-factor model, the following industries have been incorporated in an ARCH and GARCH term: AFHF(RER and TWEER), Building Construction (NER), Chemicals (RER and TWEER), Commercial Chains (NER, RER and TWEER), Electrical Equipment (NER and TWEER), Electronic Information (NER, RER and TWEER). The values in parentheses are Wald tests statistics. ◇ indicates that the lagged exchange rate variable has been included. ***,** and * indicate the rejection of null hypothesis at the 1%, 5% and 10% level, respectively.

	Two-factor model			Market model			Three-factor model(excess return)		
	NER	RER	TWEER	NER	RER	TWEER	NER	RER	TWEER
Machinery	4.523	2.361	-2.580	0.846	-0.509	-0.272	1.316	-0.085	-0.560
	(3.93)**	(6.26)**	(7.17)***	(1.35)	(2.63)	(0.73)	(2.83)*	(0.07)	(2.89)*
Medicine	2.941	2.571	-1.35	0.199	0.532	0.401	-0.243	0.126	0.665
	(2.31)	(11.03)***	(2.66)	(0.03)	(1.31)	(0.73)	(0.05)	(0.08)	(2.03)
Non-ferrous metals	4.127	3.276	-4.028	-0.282	-0.083	-1.247	-0.083	0.426	-1.822
	(2.10)	(8.03)***	(12.00)***	(0.06)	(0.03)	(9.22)***	(0.01)	(0.66)	(20.60)***
Paper-making and printing	2.569	3.091	-2.294	-0.488	0.645◇	-0.044	0.246	0.821	-0.239
	(1.21)	(11.03)***	(5.46)**	(0.38)	(3.81)*	(0.01)	(0.10)	(5.62)**	(0.44)
Steel	2.730	2.797	-2.449	-1.231	-0.211	0.016	-0.753	-0.004	-0.749
	(1.18)	(7.58)***	(5.41)**	(1.74)	(0.27)	(0.00)	(0.84)	(0.00)	(3.48)*
Textile and garment	3.719	3.224	-1.903	0.354	0.362	0.107	0.502	0.563	-0.079
	(2.59)	(12.24)***	(3.73)*	(0.26)	(0.96)	(0.10)	(0.44)	(2.14)	(0.06)
Tourism and hotel	3.630	2.252	-2.270	0.569◇	0.223	-0.390	0.466	0.049	-0.384
	(3.07)*	(7.02)***	(6.76)***	(0.47)	(0.00)	(1.11)	(0.25)	(0.02)	(1.26)
Traffic equipment	3.622	2.503	-1.773	0.606	0.214	0.141	0.441	0.057	0.243
	(3.32)*	(9.67)***	(4.37)**	(0.45)	(0.30)	(0.13)	(0.23)	(0.02)	(0.40)
Transportation & logistics	2.718	2.225	-2.180	-0.745	-0.573	-0.123	-0.637	-0.466	-0.233
	(1.50)	(6.01)**	(5.45)**	(0.79)	(2.00)	(0.10)	(0.55)	(1.24)	(0.38)
Vehicles	4.213	3.003	-2.731	0.553	0.195	-0.540	1.473	0.602	-0.817
	(3.34)*	(10.41)***	(8.00)***	(0.30)	(0.23)	(1.94)	(2.44)	(2.49)	5.76**
Wine and food	1.678	1.183	-1.862	-0.955	-0.889	-0.243	-1.848	-1.265	0.172
	(0.85)	(2.45)	(5.99)**	(0.97)	(4.63)**	(0.33)	(3.29)*	(9.76)***	(0.16)
Other industries	3.696	9.85	-2.315	0.127	0.241	-0.077	0.612	0.492	-0.305
	(2.54)	(9.85)***	(5.58)**	(0.02)	(0.31)	(0.03)	(0.36)	(1.39)	(0.50)

Table 3. *continued*

Notes: The exchange rate exposure at industry level was modelled in the form of equation (1)-(3) separately. This table shows the exposure betas with Wald tests estimated industry by industry. The econometric strategy for estimating exchange rate exposure is the DCC GARCH model (see equation (4)). Each model has been examined the ARCH effect before using the DCC GARCH approach. For the three-factor model, the following industries are incorporated in an ARCH and GARCH term: Non-ferrous Metals(TWEER), Paper Making and Printing (NER, RER and TWEER), Tourism and Hotel (NER, RER and TWEER), Transportation and Logistics (NER, RER and TWEER) and Vehicles (NER, RER and TWEER). For the three-factor model, the following industries have been incorporated in an ARCH and GARCH term: Non-ferrous Metals(NER, RER and TWEER), Paper Making and Printing (NER, RER and TWER), Steel (NER, RER and TWEER), Textile and Garment (NER, RER and TWEER), Tourism and Hotel (NER, RER and TWEER), Transportation and Logistics (NER, RER and TWEER) and Vehicles (NER, RER and TWEER). The mean model is estimated in the remaining industries based on different theoretical models and exchange rate changes. Those values in parentheses are Wald tests statistics. ◇ indicates that the lagged exchange rate changes has been included. ***,** and * indicate the rejection of null hypothesis at the 1%, 5% and 10% level, respectively.

		Mean	Median	Std.Dev	$N^{+}(\%)$	$N^{-}(\%)$
	NER	2.901	2.893	1.023	6(25%)	0(0)
Two-factor model	RER	2.869	2.553	1.602	23(95.83%)	0(0)
	TWEER	-2.308	-2.309	0.589	0(0)	22(91.67%)
	NER	-0.400	-0.367	0.902	0(0)	1(4.17%)
Market model	RER	0.019	0.129	0.467	3(12.5%)	2(8.33%)
	TWEER	-0.195	-0.107	0.465	1(4.17%)	3(12.5%)
	NER	-0.259	-0.097	1.110	1(4.17%)	3(12.5%)
Three-factor model	RER	0.093	0.089	0.559	3(12.5%)	2(8.33%)
	TWEER	-0.346	-0.322	0.604	1(4.17%)	8(33.33%)

Table 4. Summary statistics of exposure betas at the industry level

Notes: N^{+} and N^{+} designate the number of significant positive and negative exposure coefficients respectively. The numbers in brackets are the percentages of significant betas accounting for the total number of industries.
Data Source: Author's calculation referring to Table 3.

	Two-factor model			Market model		
	NER	RER	TWEER	NER	RER	TWEER
SHA$_{Large}$	0.106	-0.400	-0.059	0.099	-0.397	-0.063
SHA$_{Medium}$	0.253	-0.188	-0.346	0.257	-0.227	-0.340
SHA$_{Small}$	0.429**	0.163	-0.261	0.399**	0.146	-0.260
Variation$_{SHA}$	1.54	5.49*	1.06	1.10	5.65*	1.07
SHB$_{Large}$	0.569*	0.401	-0.909***	0.599*	0.405	-0.927***
SHB$_{Medium}$	0.865**	0.327	-0.973**	0.816*	0.273	-0.932**
SHB$_{Small}$	0.646	0.722	-1.033	0.460	0.585	-0.977
Variation$_{SHB}$	0.48◇	0.19◇	0.04◇	0.27◇	0.13	0.00◇
SZA$_{Large}$	1.151	0.526	-1.939*	0.505	0.133	-1.015***
SZA$_{Medium}$	-0.179	-0.453**	-0.014♠	-0.221	-0.481***	0.013♠
SZA$_{Small}$	-0.017	-0.265	0.832♠	-0.115	-0.331	0.243
Variation$_{SZA}$	1.96	1.27	9.01**	19.50***	9.05**	36.28***
SZB$_{Large}$	-0.267	-0.477	-0.020	-0.221	-0.452	-0.070
SZB$_{Medium}$	0.299♠	-0.065	-0.256♠	0.283♠	-0.094	-0.192♠
SZB$_{Small}$	0.606	0.356	-0.393	0.591	0.324	-0.280
Variation$_{SZB}$	4.80*	2.82	0.59◇	4.68◇*	2.97◇	0.19
SHSE$_{Large}$	0.165	-0.301	-0.143	0.162	-0.300	-0.145
SHSE$_{Medium}$	0.367	-0.091	-0.448	0.373	-0.118	-0.444
SHSE$_{Small}$	0.422**	0.215	-0.336	0.425**	0.202	-0.335
Variation$_{SHSE}$	0.87	3.14	1.52	1.02	3.09	1.57
SZSE$_{Large}$	0.700	0.172	-1.346**	0.893	0.149	-1.513**
SZSE$_{Medium}$	-0.113	-0.414**	-0.045♠	-0.085	-0.418**	-0.071♠
SZSE$_{Small}$	0.021	-0.231	0.012♠	0.069	-0.238	-0.029♠
Variation$_{SZSE}$	1.88	1.45	7.19**	2.86	1.50	9.75***
SHSZ$_{Large}$	0.309	-0.175	-0.519♠	0.333	-0.193	-0.532♠
SHSZ$_{Medium}$	0.129	-0.266	-0.282♠	0.177	-0.245	-0.293♠
SHSZ$_{Small}$	0.106	-0.163	0.016♠	0.113	-0.173	0.012♠
Variation$_{SHSZ}$	1.81	0.96	7.87**	1.83	0.97	8.45**
			(7.36)**			(7.69)**

Table 5. Exchange rate exposure at the firm level

Notes: This table reports the exposure coefficients estimated from equation (1) and equation (2). The three-factor model is not estimated due to the very few number of observations. *Variation*(with subscripts) gives the test that whether the exposure betas vary across firm sizes in the same market. For example, the null hypothesis of exposure betas estimated from Shanghai A-share market: $\beta_{SHA_{Large}} = \beta_{SHA_{Medium}} = \beta_{SHA_{Small}}$, if the null is rejected, it indicates that there is a linkage between firm size and exchange rate exposure. ◇ designates that there is no cross-equation contemporaneous correlations in the residuals, thus each equation estimated by SUR is equivalent to the OLS estimation. ♠ indicates that the exposure beta of the lagged exchange rate changes is statistically significant (not reported), although the level exchange rate variable is insignificant. The numbers in brackets report the variation tests of the lagged exchange rate changes. ***,** and * indicate that the coefficients are significant at the 1%, 5% and 10% level, respectively.