Does the currency exposure affect stock returns of Chinese automobile firms?

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Abstract

This study examines the symmetric and asymmetric exchange rate exposures of Chinese automobile firms at different time horizons. Empirical findings reveal that firm returns are less likely to be affected by currency movements at short-term (daily) horizons due to restrictions on the currency daily trading band, but (a)symmetric exchange rate exposures appear to be significant at relatively longer horizons after the launch of RMB internationalisation, particularly for monthly horizons. Possible hedging strategies could be the application of Forward Exchange Agreements, price difference between onshore and offshore RMB exchange rate, foreign reserves and other quantitative methods. Since returns of foreign capital shares tend to rise with the application of RMB, firms may also consider listing shares on foreign stock exchange in addition to the domestic market and produce products simultaneously in foreign nations through international expansion.

JEL Codes: C58, F3, G15.

Keywords: exchange rate exposure, RMB internationalisation, Chinese automobile firms.

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1 Introduction

It has been a widely-held belief that exchange rate movements are a major source of macroeconomic uncertainty that affect the profitability and value of international firms (Dornbusch and Fischer, 1980; Adler and Dumas, 1984; Jorion, 1990; Muller and Verschoor, 2006; 2007). The currency exposure in the literature is defined as the sensitivity of firm values to exchange rate changes.[1] Unanticipated changes in exchange rates, in particular for independent floating rates, are a basic feature of the international financial market. Previous studies on currency exposure are exclusively focused on advanced economies with floating rates (Bodnar and Gentry, 1993; Khoo, 1994; He and Ng, 1998; Williamson, 2001; Muller and Verschoor, 2006). Howbeit, exchange rate exposure in emerging markets receives little attention due to their fixed or managed floating exchange rate policies. One of the interesting cases is the Chinese Yuan, or Renminbi (RMB), which is "deliberately" set to float within a narrow band that has benefited the Chinese economy. Nonetheless, the Chinese government is accelerating the pace of RMB internationalisation. The trading volume of the Chinese currency is experiencing dramatic increase in the international financial market. Although the RMB trading band is restricted at the daily level, unanticipated changes in the exchange rate might be subject to increase at longer horizons, for instance, the weekly or monthly horizons. This may expose Chinese firms to currency movements.

The 2008 financial crisis and its spillover effects to the global unfold the deep-rooted vulnerabilities and systemic risks of the existing international monetary system (Zhou, 2009). A reform of the system would be beneficial for the world economy, such as the reallocation of the Special Drawing Rights (SDR) within the IMF. Inspired from this, in March 2009, the People's Bank of China (PBOC) proposed to create an international reserve currency that is detached from individual countries and would be able to secure global financial stability in the long run. This symbolises the launch of RMB internationalisation. Since then, there have been several major milestones on the road to RMB internationalisation, for instance, the widen-

[1] A similar definition of exchange rate exposure is the impact of firm values exposed to unanticipated changes in exchange rate (Hodder, 1982; Dominguez and Tesar, 2001; Betts and Devereux, 2000).The financial mechanism about currency exposure is that exchange rate changes have a significant impact on international competitiveness and trade balance and, accordingly, affect real income and output. Firm returns respond to exchange rate changes since the current value of firmsâĂŹ future cash flows are expressed and incorporated into stock prices.

ing of the RMB daily trading band to 2% in 2014, the incorporation of the Yuan as the fifth member of the IMF SDR currency basket, and the creation of Dim Sum bonds and offshore RMB bond markets.[2] These movements clearly show that the authorities are gradually relaxing the currency restriction and actively promoting the Yuan in the global financial market. It could also be a positive response to the pressure on RMB appreciation from trade partners. It seems to suggest that a fully convertible Yuan can be expected in the next couple of years. On such an occasion, does the currency exposure matter for Chinese firms? This is the topic that the authors find interesting, especially the potential change in the currency exposure status after the launch of RMB internationalisation in March 2009.

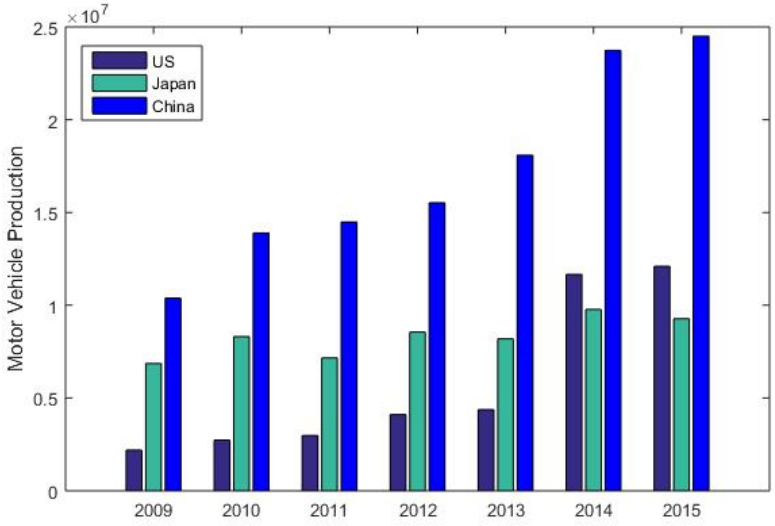


Figure 1: Annual Motor Vehicle Productions in the US, Japan and China

Currency risks in the Chinese auto industry should be an interest case in the context of an accelerating pace of RMB internationalisation as the Chinese motor vehicle products have seen an astonishing increase in recent years. According to the OICA,[3] the annual production of automobiles in China has overtaken that of the US and Japan combined since 2009 as shown in Figure 1. Global carmakers manage their costs and capital in China by contracting out the manufacture of whole vehicles to Chinese companies in order to gain a strategic option for their global

[2]In November 2015, the IMF includes the Yuan as the fifth member of its SDR currency basket with a weight of 10.92%, which is only lower than that of the USD (41.73%) and Euro (30.9%). By the end of 2015, China has signed RMB Bilateral Swap Agreements with 33 economic partners and initiated 15 RMB Offshore Clearing Banks. These movements help establish pools of offshore RMB liquidity.

[3]OICA is known as Organisation Internationale des Constructeurs d'Automobiles. It is the international Organization of Motor Vehicle Manufacturers that was funded in Paris in 1919. See more details via the website: www.oica.net.

operations (Gao, 2002), such as Toyota and BMW. This has been attributed to the dramatic increase in motor vehicle productions in China. On the other hand, the slowdown of the Chinese economy and the government's policy of internationalising the Yuan have stimulated Chinese automobile firms to seek overseas opportunities by means of overseas merges and acquisitions. These automobile firms have regular and irregular transactions and translations when they operate overseas. The currency exposure should be a great concern for firm managers and investors, since transaction and translation exposure are the two typical risks caused by the change in the exchange rate, which has a profound effect on firm values as stated in the literature.(Cuthbertson and Nitzsche, 2001; Shapiro, 2008)[4]

In the literature, empirical evidence shows that firm returns are symmetrically respond to the change in the exchange rate (Ajayi and Mougoué, 1996; Nieh and Lee, 2002; Phylaktis and Ravazzolo, 2005). However, Doidge et al. (2006) find that firms with high international sales outperform those with no international sales when the currency depreciates, whereas these firms underperform during periods of currency appreciations. This implies that currency depreciations may have different impact on firm returns than depreciations, i.e. asymmetric effects. Therefore, an increasing number of studies are shifting their interest to modelling asymmetric exchange rate exposure (Koutmos and Martin, 2007; Hsu et al., 2009; Cuestas and Tang, 2015). In spite of this, the currency exposure at different horizons are rarely investigated, especially in the case of the Chinese currency which has restrictions on the currency daily trading band. At the daily horizon, the RMB daily trading band is limited at 2%. It is within the expectation of investors and firm managers. They could offset possible currency exposures using certain hedging tools. While at longer horizons, the range of currency movements might go far beyond the current level since the market power plays a big part in determining the RMB exchange rate. As China currently owns 28% of the global automobile market share and the automobile industry contributes 2% of its national output, it therefore could be a major risk for Chinese automobile firms.

This paper examines both the symmetric and asymmetric exchange rate ex-

[4]The finance theory states that three kinds of typical risks caused by currency movement have an great impact on firm values: transaction exposure, translation exposure and operating exposure. The first two categories are basically accounting exposure and the last one concerns the exposure of the firm's present value of future operating cash flows resulted from the movement in the exchange rate.

posures of Chinese automobile firms at different time horizons, i.e. daily, weekly, monthly and quarterly. The measurement of symmetric exchange rate exposure is based on the traditional capital asset pricing model (CAPM) framework (Jorion, 1990; Martin and Mauer, 2003; Dominguez and Tesar, 2006). Taking into consideration the return in excess of the risk-free rate, the augmented CAPM (ACAPM) is introduced (Hsu et al., 2009; Huffman et al., 2010). A GARCH(1,1) specification is added to the framework if ARCH effects exist in the regression residuals of the CAPM and ACAPM models (Chue and Cook, 2008). In addition to the symmetric exchange rate exposure measurement, a nonlinear autoregressive distributed lagged (NARDL) model (Shin et al., 2014) is introduced to estimate the asymmetric effect of currency movements. The whole sample is divided into two subsample periods, i.e. before and after the announcement of RMB internationalisation in March 2009, in order to examine the change in the currency exposure of Chinese automobile firms.

This research contributes to the literature mainly in three aspects. First, the findings of this paper strengths firm managers and investors' understanding of the symmetric and asymmetric currency exposures in the Chinese automobile industry, in particular under the circumstance of an accelerating pace of RMB internationalisation. Second, the study contribute to the past literature on investigating exchange rate exposure at different time horizons with a managed floating currency policy.[5] It suggests that hedging strategies should focus on currency movements at weekly and monthly horizons. Third, empirical evidence shows that cross-listed auto firms (B-share firms in this case) relatively outperform those firms with a single-listed stock during ups and downs of currency movements. This could be an important implication for hedging currency exposures.

The remainder of this paper is organised as follows. Section 2 presents the theoretical model and econometric methods. Section 3 describes the data. Empirical findings and discussions are given in Section 4. The last section concludes the paper and proposes helpful policy implications for managing currency exposures.

[5]This evidence is particularly important for Chinese automobile firms as there is a restriction on the currency daily trading band and currency risks at longer horizons are commonly ignored by firm managers and investors.

2 Econometric Modelling

2.1 Theoretical Framework

The measurement of currency exposure in the literature is specified as a regression of firm returns on exchange rate movements and returns of market portfolio (Adler and Dumas, 1984; Jorion, 1990; Bodnar and Gentry, 1993; Dominguez and Tesar, 2001; Martin and Mauer, 2003; Chue and Cook, 2008). It is built on the conventional capital asset pricing model (CAPM) framework with the following form:

$$SR_{i,t} = \beta_{0,i} + \beta_{1,i} ER_{i,t} + \beta_{2,i} RM_t + \varepsilon_{i,t} \tag{1}$$

where $SR_{i,t}$ designates the total return of firm i, $ER_{i,t}$ and RM_t denote exchange rate changes and returns of market portfolio, $\varepsilon_{i,t}$ is the white noise error term. The coefficient $\beta_{1,i}$ measures the sensitivity of firm returns to the movement in the trade-weighted effective exchange rate (TWEER), or the bilateral real exchange rate (RER) of RMB/USD (units of USD per unit RMB).[6] $\beta_{2,i}$ measures the sensitivity of firm returns to market variations.[7] The inclusion of market returns eliminates the effects of other macroeconomic conditions on realised returns (Jorion, 1990; Williamson, 2001; Dominguez and Tesar, 2006), and also avoids the problem of endogeneity since firm returns cannot influence currency movements and returns of market portfolio.[8]

Investors expect that their investment returns should be above the return of the risk-free rate, for instance, government bonds. Therefore, researchers consider firm's excess returns by subtracting the risk-free rate (Fama and French, 1993). Following Hsu et al. (2009) and Huffman et al. (2010), the augmented CAPM is specified as follows:

[6] The trade-weighted effective exchange rate is widely used in previous studies as multinational firms usually involve a lot of overseas operations. The trade-weighted RMB effective exchange rate is defined as the price of one Chinese Yuan in units of foreign currencies. An appreciation (depreciation) of the Yuan will have a negative (positive) effect on firm values. This paper considers the bilateral real exchange rate an import source of risk for Chinese firms, since the historical RMB exchange rate was found to mainly pegged to the USD (Frankel and Wei, 2007), and the authorities still place a heavy weight on the USD in the currency basket.

[7] A literal explanation of the CAPM implies that only market risks should be related to firm's asset price, and thus only changes in market returns should be symmetrically relevant to firm returns. If the CAPM were the true model for asset pricing, $\beta_{1,i}$ should be equal to zero (Dominguez and Tesar, 2006). This study is only interested in the currency exposure beta. The sensitivity to market returns will not be detailed in the empirical analysis.

[8] This model is preferred by many researchers, such as Jorion (1990), Williamson (2001) and Dominguez and Tesar (2006).

$$(SR_{i,t} - RF_t) = \beta_{0,i} + \beta_{1,i} ER_{i,t} + \beta_{2,i}(RM_t - RF_t) + \varepsilon_{i,t} \tag{2}$$

where RF_t is the risk-free rate, $(SR_{i,t} - RF_t)$ and $(RM_t - RF_t)$ designate excess returns of firm i and the market portfolio, respectively. The test of currency exposure in Equations (1)-(2) is to examine the significance of parameter $\beta_{1,i}$. It is referred to the residual exposure elasticity of firm i relative to the market average (Dominguez and Tesar, 2006).

2.2 Modelling Symmetric and Asymmetric Exchange Rate Exposures

The popular approach for estimating currency exposures in Equations (1)-(2) is OLS. Nonetheless, the assumption of constant variance is usually rejected for financial time series data, for instance, exchange rates and stock prices, and ARCH effects commonly exist in the regression residuals. Therefore, we add a GARCH(1,1) specification into the market model if ARCH effects exist, otherwise, the original market model is estimated.[9] The theoretical models are written as the following:

$$\begin{aligned} SR_{i,t} &= \beta_{0,i} + \beta_{1,i} ER_t + \beta_{2,i} RM_t + \varepsilon_{i,t} \\ \varepsilon_{i,t} &= \mu_{i,t} \times (h_{i,t})^{\frac{1}{2}} \\ h_{i,t} &= \delta_i + \lambda_i \varepsilon_{i,t-1}^2 + \gamma_i h_{i,t-1} \end{aligned} \tag{3}$$

$$\begin{aligned} (SR_{i,t} - RF_t) &= \beta_{0,i} + \beta_{1,i} ER_{i,t} + \beta_{2,i}(RM_t - RF_t) + \varepsilon_{i,t} \\ \varepsilon_{i,t} &= \mu_{i,t} \times (h_{i,t})^{\frac{1}{2}} \\ h_{i,t} &= \delta_i + \lambda_i \varepsilon_{i,t-1}^2 + \gamma_i h_{i,t-1} \end{aligned} \tag{4}$$

where $h_{i,t}$ designates the conditional variances of residuals and $\mu_{i,t}$ is assumed to be i.i.d. The models specified in Equations (3)-(4) measures the responsiveness of firm returns to currency movements. The parameter $\beta_{1,i}$ indicates the linear adjustment of firm values to exchange rate changes. It is called symmetric exchange rate exposure. However, currency depreciations may have a stronger effect (in magni-

[9] The market model refers to Equations (1)-(2), as the two models take into account the effects of macroeconomic shocks by incorporating the variable of returns on market portfolios RM_t.

tude) on firm returns than currency appreciations. Therefore, this study introduces the nonlinear autoregressive distributed lagged (NARDL) model to estimate the asymmetric effects of currency movements. In the NARDL framework, exchange rate changes are decomposed into a positive shock and a negative shock (Shin et al., 2014).

$$ER_t^+ = \sum_{j=1}^{t} \Delta ER_j^+ = \sum_{j=1}^{t} max(\Delta ER_j, 0), \quad ER_t^- = \sum_{j=1}^{t} \Delta ER_j^- = \sum_{j=1}^{t} min(\Delta ER_j, 0) \tag{5}$$

RM_t and ERM_t (let $ERM_t = (RM_t - RF_t)$) can be decomposed on the same basis. The error correction model form for measuring asymmetric exchange rate exposure is expressed as:

$$\begin{aligned} \Delta SR_{i,t} =& \rho SR_{i,t-1} + \theta^+ ER_{t-1}^+ + \theta^- ER_{t-1}^- + \lambda^+ RM_{t-1}^+ + \lambda^- RM_{t-1}^- + \theta_\omega \omega_{t-1} + \\ & \sum_{j=1}^{p-1} \gamma_j \Delta SR_{t-j} + \sum_{j=0}^{q-1} (\pi_j^+ \Delta ER_{t-j}^+ + \pi_j^- \Delta ER_{t-j}^- + \Psi_j^+ \Delta RM_{t-j}^+ + \\ & \psi_j^- \Delta RM_{t-j}^- + \omega_{w,j} \Delta w_{t-j}) + \varepsilon_{i,t} \end{aligned} \tag{6}$$

Let $ESR_{i,t} = (SR_{i,t} - RF_t)$, then the error correction model for asymmetric exchange rate exposure measurement taking into consideration the return of risk-free rate is the following:

$$\begin{aligned} \Delta ESR_{i,t} =& \rho ESR_{i,t-1} + \theta^+ ER_{t-1}^+ + \theta^- ER_{t-1}^- + \lambda^+ ERM_{t-1}^+ + \lambda^- ERM_{t-1}^- + \\ & \theta_\omega \omega_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta ESR_{t-j} + \sum_{j=0}^{q-1} (\pi_j^+ \Delta ER_{t-j}^+ + \pi_j^- \Delta ER_{t-j}^- + \\ & \Psi_j^+ \Delta ERM_{t-j}^+ + \psi_j^- \Delta ERM_{t-j}^- + \omega_{w,j} \Delta w_{t-j}) + \varepsilon_{i,t} \end{aligned} \tag{7}$$

The parameters of interest in the above two equations are the positive and negative exchange rate shocks. $\beta_i^+ = -\theta^+/\rho$ and $\beta_i^- = -\theta^-/\rho$ are the coefficients on asymmetric long-run exchange rate exposures. $\gamma^+ = -\lambda^+/\rho$ and $\gamma^- = -\lambda^-/\rho$ are the coefficients on asymmetric effects from market returns, or excess market returns (Equation (7)). ω_{t-1} and $\Delta\omega_{t-j}$ are $k \times 1$ vectors of regressors that are the imposed

long-run and short-run symmetric restrictions on the NARDL.[10] β_i^+ and β_i^+ should have positive and negative signs respectively, as expected. The magnitude of β_i^- is expected to be larger than that of β_i^+, since currency depreciations usually have a bigger effect on firm values than currency appreciations.

3 Datasets and Variable Construction

3.1 Data Sources and Variable Construction

Since the daily RMB exchange rate is fluctuating within a predetermined band (2%),[11] investors or firm managers may have foreseen the limited range of currency movements that could be easily managed. This study therefore considers different horizons of exchange rate, including daily, weekly, monthly and quarterly data. The monthly closing prices of Chinese automobile firms are collected from the Wind Financial Terminal (WFT) database. The sample consists of 87 auto firms spanning the period from 04 January 1994 to 05 April 2016.[12] The remaining datasets with different frequencies are selected accordingly. The 7-day Treasury bills rate is used as a proxy of risk-free rate in this study given its properties of good mobility, active transactions, low risk and stable returns. It can be downloaded from the Chinese Dazhihui securities trading software.[13] Concerning market portfolios in China, the Shanghai and Shenzhen stock markets are the representative markets for stock trading. The representative stock indexes are the Shanghai Stock Exchange Composite Index (SHCOMP) and the Shenzhen Stock Exchange Component Index (SICOMP) respectively, which have the same data source as the risk-free rate. Although there are some shares listed in the Hong Kong stock market, the historical evidence shows that shocks from the Hong Kong market exhibit limited impact on the mainland stock market. This paper therefore constructs the aggregate market index with the linear combination of SHCOMP and SICOMP, since about 98% of sample firms are

[10] For simplicity, this study does not impose any long-run or short-run restrictions on the NARDL, as the main parameters of interest are the long-run βs (the mean exposure). Brun-Aguerre et al. (2015) also point out that imposing any long-run symmetry may lead to biases in estimation and inference.

[11] The Chinese authorities widened the currency daily trading band to 2% in 2014.

[12] Subject to data availability, some newly-listed firms may have smaller sample size.

[13] The Chinese bond market launched very late and the earliest data can only be traced back to 08 May 2006. Hence the models dealing with excess returns in Equations (2), (4) and (7) will only be estimated for that available period.

listed in the mainland stock market.[14]

Two types of exchange rates are adopted in this study: exchange rate of RMB/USD (units of USD per unit RMB) and the trade-weighted RMB effective exchange rate (TWEER). The bilateral exchange rate of RMB/USD is assumed to have significant impact on firm returns as the authorities assign a heavy weight to the USD in the currency basket. It is also collected from the Chinese Dazhihui securities trading software. TWEER is commonly used in the literature for measuring the sensitivity of firm returns to currency movements. This is supported by the fact in the case of China that the Yuan is increasingly becoming popular in international transactions and Chinese firms are exposed to the movements of multilateral exchange rates. TWEER is obtained from the Bank for International Settlements (BIS).

The measurement of currency exposure is the regression of firm returns on exchange rate changes and returns of market portfolio. Therefore, to conduct the empirical analysis, we need to construct relevant variables. Firm returns are expressed as natural logarithmic returns of two consecutive closing prices, that is $SR_t^i = ln(\frac{p_t^i}{p_{t-1}^i})$. The change in the exchange rate and returns of risk-free rate are constructed on the same basis: $ER_t^i = ln(\frac{er_t^i}{er_{t-1}^i})$, $Rfree_t^i = ln(\frac{rf_t^i}{rf_{t-1}^i})$. To construct market returns, this study takes the linear combination of the returns of SHCOM and SICOMP and assign equal weights to the two indexes, $RM_t = \frac{lnSHCOM_t + lnSICOM_t}{2}$.[15]

3.2 Descriptive Statistics

Table 1 reports summary statistics of firm returns and exchange rate changes. Four panels present summaries of different frequencies of variables that are applied in the empirical analysis. One significant feature can be seen from this table is that low frequency data (monthly and quarterly) exhibit more volatility than hight frequency data (daily and weekly). Exchange rate changes at longer horizons, for both RMB/USD and TWEER, obviously have larger means and standard deviations. This implies that different horizons of exchange rate shocks may have different impact on firm returns, i.e., currency movements at longer horizons might have larger effects on firm returns than currency movements at shorter horizons. Another feature presented in the table is the normality test. 22 out of 51 auto firm returns

[14] Only two automobile firms are selected from the Hong Kong stock market, as we are interested in the currency exposure status of Fortune 500 auto firms. See the detailed list sample firms in the appendix.

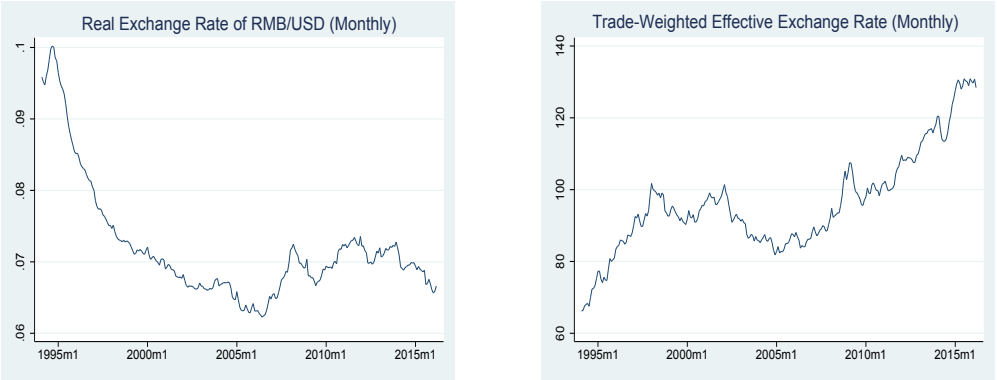
[15] $lnSHCOM_t$ and $lnSICOM_t$ are the natural log-returns of SHCOM and SICOM respectively.

are normally distributed in Panel D, while Jarque-Bera (JB) tests in other panels show that a very few number of firm returns are normally distributed (i.e. no more than 10). We thereby impose a t distribution on Equations (3)-(4), and the default assumption of a Gaussian distribution is selected for remaining models in the succeeding empirical analysis section.

Insert Table 1 about here.

Figure 2 gives plots of the monthly real rate of RMB/USD and TWEER.[16] The left panel shows that the real exchange rate of RMB/USD was declining before the global financial crisis, which implied that domestic goods and services were relatively cheap. After the crisis, the RMB exchange rate becomes relatively stable and fluctuates within a small range. The right graph reveals that the Chinese currency was strengthening against that of major trading partners, except for some slowdowns during the financial crisis.

Figure 2: Exchange Rate Series



4 Empirical Analysis

4.1 Measuring Symmetric Exchange Rate Exposure

Among the sample firms, eight of the listed auto firms are Fortune 500 firms and four listed shares are B-share auto firms.[17] It would be of interest to examine the currency exposure of these auto companies separately. We first investigate the currency exposure of auto firms using the nominal exchange rate for the daily and

[16] The US and China consumer price indexes (CPIs) are collected from the US Bureasu of Labor Statistics and National Bureau of Statistics of China respectively, in order to calculate the real exchange rate of RMB/USD.

[17] See the appendix for detailed list of sample auto firms. The descriptive statistics of subsample auto firms (Fortune 500 auto firms, B-share auto firms and other auto firms) are not presented in Table 1 for brevity.

weekly data, since no available price levels for the translation of the real exchange rate (RER) at short horizons. For the lower-frequency data (monthly and quarterly data), RER is adopted for the estimation as changes in price levels across countries should have an impact on the real value of the firm in the presence of foreign assets or liabilities (Williamson, 2001).

Table 2 reports the symmetric exchange rate exposure measurement using daily and weekly data. For Fortune 500 Chinese auto firms, there is no evidence indicating the existence of currency exposure when we examine the daily data. Negative exchange rate exposure appears after the announcement of RMB internationalisation in March 2009. About one third of the *B*-share firms receive significant impact from the change in the daily RMB/USD that puts downward pressure on firm returns. For remaining auto firms, both the number of positive and negative exposure betas increase, in particular in the significant negative exposure, i.e. 10% of the negative betas are statistically significant in the post-2009 subsample when we use the conventional CAPM (CCAPM). Comparatively, the augmented CAPM (ACAPM) model estimates do not present apparent difference in the estimated exposure betas, but the goodness of fit has been improved as indicated by the adjusted R-square ($\bar{R}^2$).

Insert Table 2 about here.

At the weekly horizon, Fortune 500 and other non-foreign currency traded shares are subject to currency movements. The significant coefficients in panel A do not exhibit any implications about currency exposures due to the small sample. Nevertheless, significant negative currency exposures have seen dramatic increase in the post-2009 subsample in panel C, which are relatively larger than the positive betas in magnitude.

Table 3 gives the estimates of symmetric exchange rate exposure using monthly and quarterly data. When the RER is introduced, no significant currency exposures can be identified from panel A, which might imply that returns of Fortune 500 Chinese auto firms are less likely to be affected by RER movements. After 2009, B-share firms receive significant positive impact from exchange rate changes, since the upturn of real rate of RMB/USD means the appreciation of RMB against USD, investors therefore would like to buy more *B* shares when USD becomes cheaper.[18] Currency exposures appear in panel C, but the significant exposure betas do not

[18]Note that *B* shares are traded in USD in the Shanghai Stock Exchange.

show any obvious difference before and after the launch of RMB internationalisation.

Insert Table 3 about here.

Table 4 reports the symmetric exchange rate exposure estimates using monthly and quarterly data when TWEER is introduced. A streaking feature in panel A shows that currency movements have a positive impact on the returns of Fortune 500 auto firms before 2009, but a negative impact on firm returns after the launch of RMB internationalisation. Interestingly, *B*-share auto firms are less likely to be exposed to TWEER changes. This is determined by the nature of their trading currency (USD), which has little relationship to the trade-weighted RMB real effective exchange rate. Empirical evidence reveals that common auto firms in panel C receive positive currency exposures before 2009 that help increase firm returns. However, after 2009, the number of significant negative exposures increases as demonstrated in all subsample estimates in panel C. It suggests that after the launch of RMB internationalisation firm returns deteriorate.

Insert Table 4 about here.

For the symmetric exposure measurement, this study adds a GARCH (1,1) specification to the CAPM. The results show that ARCH effects exist in daily and weekly time series data, but ARCH effects are less likely to be present in monthly and weekly data, especially for *B*-share auto firms (no ARCH effects). The symmetric exchange rate exposure estimates using data at different time horizons prove that the augmented CAPM improves the goodness of fit. Compared to the evidence from low frequency data, firm returns are more likely to be exposed currency movements at longer time horizons, i.e., monthly and quarterly horizons. This is due to the restriction on the daily trading band of the RMB exchange rate. As we are interested in the average exchange rate exposure of the sample Chinese auto firms, the estimated mean exposure can also be explained in the usual way. For instance, the average exposure beta for ordinary auto firms in the post-2009 sample in panel C of Table 3 is -0.569 at the monthly horizon, then it can be interpreted that a 1% increase in the RER reduces average auto firm returns by 0.569%. The estimates from the incorporation of a TWEER variable reveal that currency movements help increase firm returns before 2009, which might be due to the strong economic fundamentals in China in the past decades. But after the launch of RMB internationalisation, these firms, except for *B*-share auto firms, are receiving negative exposures from TWEER changes. This is consistent with the findings in the paper of Cuestas et al.

(2016) who studied the currency exposure of Chinese financial firms.

4.2 Measuring Asymmetric Exchange Rate Exposure

The preceding subsection discusses the estimates of symmetric exchange rate exposure. The numbers of significant positive and negative exposure betas vary among different subsamples and time horizons. To see how the ups and downs in exchange rates affect firm returns, we now turn to the analysis of asymmetric exchange rate exposure. Table 5 shows the estimation results of asymmetric exchange rate exposure using daily and weekly data. When nominal rate of RMB/USD is applied in this case, potential asymmetric effects are quite small and barely significant, as indicated by the asymmetry test ($\beta^+ - \beta^-$). In panel A, the post-2009 subsample estimates using augmented NARDL show the existence of asymmetric effects, but the gap between the positive shock (β^+) and negative shock (β^-) is very small. The estimated average positive currency shock and negative shock are -0.458 and -0.465, respectively. Although the estimates from weekly data show little difference between the two betas, the effects have been positive. It indicates currency movements tend to rise firm returns after the launch of RMB internationalisation at the weekly horizon. As for the estimates for *B*-share auto firms in panel B, there are no asymmetries since the daily fluctuation of nominal RMB/USD can not affect *B*-share returns.

Insert Table 5 about here.

In addition, asymmetric currency exposures appear in some of the auto firms in panels C, but the numbers are very small relative to the total number of firms estimated in each subsample. The positive shock and negative shock do not present any significant disparities both in magnitudes and signs as well. This further confirms the conclusion in the symmetric exposure estimates in Table 2 that returns of Chinese automotive firms are less likely to be affected by the change in the exchange rate with a short-term horizon, i.e. daily and weekly horizons.

Table 6 gives summaries of asymmetric RER exposure measurements using data at monthly and quarterly horizons. In panel A, the NARDL model estimates reveal that RER movements have asymmetric effects on returns of Fortune 500 auto firms, and the positive shock dominates the asymmetry as evidenced by the application of both monthly and quarterly data in the post-2009 subsample. It means that currency

appreciations (RER increases) have a stronger effect on currency depreciations (RER decreases), but both shocks tend to increase firm returns.

Insert Table 6 about here.

Panel B shows that asymmetric effects exist in the augmented NARDL (ANARDL) estimates using monthly data. Three out of four B-share auto firm returns are exposed to asymmetries. When RMB appreciates relative to the USD, firm returns are stimulated to rise due to a cheaper USD. The coefficient for β^+ is 1.91, which can be interpreted that an upturn in the RER by 1% increase average auto firm returns by 1.91%. Interestingly, RER decreases (RMB depreciation) also tends to lift firm returns. It might be due to the increase in RMB ordinary share returns of the same company,[19] but the effect is smaller than that of currency appreciations. Although asymmetries appear in the pre-2009 subsample using quarterly data for the NARDL framework, the PSS test cannot reject the null hypotheses, which indicates the nonexistence of long-run relationship among these variables.

Evidence in panel C shows that the number of asymmetries increases at both the monthly and quarterly horizon. Positive shocks again have a stronger effect on firm returns than negative shocks in the NARDL estimates after the launch of RMB internationalisation. A possible reason for this could be the expansion of overseas market, which encourages Chinese firms to sell excess products and make more profits. However, the augmented NARDL estimates present negative coefficients for the two betas when using quarterly data. It might indicate the importance of risk premium or the unique feature of the ANARDL. Notice that the number of asymmetries is small (5 out of 41) and some models are misspecified as indicated by the LM test. The higher model fit (see $\bar{R}^2$) may suggest the existence of collinearity problem.

Table 7 reports the asymmetric exchange rate exposure measurement using monthly and quarterly data. TWEER is applied for the measurement. As shown in panel A, asymmetries exist in the NARDL estimates at the monthly horizon based on the subsample of before 2009, but no asymmetric effects are identified after the launch of RMB internationalisation. At the quarterly horizon, the NARDL estimates show strong asymmetric effects. The average asymmetric coefficients for β^+ and β^- are 5.054 and -5.194 in the post-2009 subsample, respectively. This can be

[19] Most Chinese firms list their stock both in RMB ordinary share (A-share) markets and foreign capital share (B-share) markets. When RMB appreciates B-share markets flourish, while A-share markets surge when RMB depreciates.

interpreted that the appreciation of the Chinese currency (against its main trading partners) increases average firm returns by 5.054%, while the currency depreciation decreases firm returns by 5.194%.

Insert Table 7 about here.

Panel B gives the asymmetric exposure estimates for B-share auto firms. The results from the ANARDL estimates at the monthly horizon indicate that negative currency shock has a stronger effect on firm returns in magnitude than positive currency shock does. Other subsample estimates suggest little evidence on the asymmetric effects.

For remaining ordinary Chinese auto firms in panel C, empirical results imply that asymmetric effects increase both in the numbers of shocks and in magnitude in the post-2009 subsample. The number of asymmetries increase from ten to thirty-three as presented in the NARDL estimates at the monthly horizon. After 2009, firm returns receive a higher positive shock that decreases firm returns. Before 2009, the negative currency shock tends to lift firm returns (β^- equals 0.843), but it exerts downward pressure (β^- equals -0.410) on firm returns after the launch of RMB internationalisation. Similar patterns can be seen from the NARDL estimates at the quarterly horizon, but the downward pressure on firm returns is much heavier in magnitude. Nevertheless, the number of asymmetries presented at the quarterly horizon is smaller than the monthly horizon. This suggests that asymmetric currency shock is more likely to be present at the monthly horizon. The internationalisation of the RMB exposes Chinese auto firms to negative exposures from TWEER changes.[20]

The NARDL estimates suggest that the movement in the TWEER has negative exposure on auto firm returns after 2009. The number of firms receiving asymmetric effects increases after the announcement of RMB internationalisation. Both shocks put downward pressure on ordinary Chinese auto firms,[21] as shown in Table 7, but the positive shock (RMB appreciation against the main trading partners) has

[20] Positive effects shown in the ANARDL estimates at the quarterly horizon might be due to the nonexistence of asymmetries, see $\beta^+ - \beta^-$.

[21] This is different from the RER exposure that tends to increase firm returns. Since the increase in the RER makes the USD become cheaper, which exhibits a beneficial shock to firm returns. Transactions in foreign capital share markets become active, which stimulate the returns of other shares to increase. While the increase in the TWEER indicates that the currencies of main trading partners are becoming cheaper and foreign products are more competitive than Chinese products. Firm profits decline in this case, and thus firm returns deteriorate.

a strong effect on firm returns than the negative shock does (RMB depreciation).[22] When TWEER increases, Chinese exports become less competitive compared overseas products. This generates downward pressure on firm returns, vice versa. This is presented in the pre-2009 sample. Interestingly, Fortune 500 auto firms are less likely to be affected by asymmetric shocks from TWEER movements. It could be explained that Fortune 500 auto firms may have more sophisticated skills to manage currency risks, and the returns of B-share auto firms are correlated with the movement in the RER rather than the TWEER.

The estimated asymmetric parameters have expected signs in Panel B and Panel C before the announcement of RMB internationalisation in 2009, but after that, currency movements only have negative impact on firm returns. This indicates that the move towards RMB internationalisation has negative impact on firm values, and the negative shock dominates the asymmetric effects. This is presented in the test of the whole sample period at the monthly horizon when the TWEER is introduced.[23] It means that a downturn in the TWEER (RMB depreciation) has larger impact on firm values than RMB appreciations, as a strong currency is more likely to be accepted and used in international transactions, which generate less adverse effects on firm values, and vice versa. Therefore, a stable currency should be one of the key interests of an open economy.

4.3 Discussions

The preceding two subsections have analysed both the symmetric and asymmetric exchange rate exposures of Chinese automotive firms. The measurement of currency exposures at different horizons has very meaningful findings. Empirical evidence shows that currency movements at longer horizons generate (a)symmetric exchange rate exposure to Chinese automobile firms, while currency movements at shorter horizons have little impact on firm returns. This is especially significant after the announcement of RMB internationalisation in March 2009. It proves that currency

[22] Chinese automobile firms are expanding their operations overseas by ways of purchasing foreign companies. This enables these firms to produces their products in destination countries, which could be an effective way of reducing exchange rate pass-through effect, since firms receive a smaller portion of cost shocks if they produce products simultaneously in other nations (Gron and Swenson, 1996).

[23] At shorter horizons, currency exposures nearly do not exist due to the restrictions on currency daily trading band. However, currency movements have significant effects on firm values at longer horizons. In addition, asymmetric exchange rate exposures affect firm values and this is particularly true after the launch of RMB internationalisation in 2009.

exposure indeed matters in the Chinese automobile industry. At the daily horizon, currency exposures do not exist as the fluctuation range of the RMB exchange rate is expected, i.e.2%. Weekly horizons also provide weak evidence on asymmetric effects in the NARDL estimates. This further proves that the currency daily trading band indeed protects Chinese firms from currency shocks. While at longer horizons, i.e. monthly and quarterly, currency exposures appear among Chinese auto firms according to the empirical test, since currency movements might beyond the 2% band and generate unanticipated currency risks. This suggests that firm managers and investors need to pay attention to the currency exposure from unexpected changes in the exchange rate at longer horizons.

The empirical findings confirm that currency exposures of Chinese automobile firms indeed exist at longer horizons. This is explained that the restriction on the currency daily trading band in China has little effect on currency movements at longer horizons, and exchange rate changes at the monthly and quarterly horizons generate significant impact on firm returns, especially after the launch of RMB internationalisation in 2009. In addition, the existence of asymmetric currency exposure suggests that currency appreciations have relatively larger effects on firm returns than currency appreciations as the trade weighted effective exchange rate is introduced. Firm managers and investors need to pay close attention to currency risks from the movements of RMB effective exchange rate rather than the bilateral USD/RMB exchange rate.

5 Concluding Remarks

This study investigates both the symmetric and asymmetric exchange rate exposures of Chinese automobile firms in the context of an accelerating pace of RMB internationalisation. Empirical evidence shows that Chinese automobile firms are less likely to be affected by currency movements at short-term horizons, but symmetric exposure appears to be significant among common auto firms at the weekly horizon after the launch of RMB internationalisation. Asymmetric RER shocks exist among Chinese automobile firms at the monthly horizon, which help raise firm returns after 2009. By contrast, asymmetric TWEER shocks put downward pressure on firm returns at the monthly horizon after the announcement of RMB internationalisation, and the negative shock dominates the asymmetric effects.

As for policy implications, we suggest that Chinese automobile firms need to hedge currency exposures at the monthly horizon. The exposures at the short-term (daily) horizon can be negligible due to the ongoing managed floating currency policy. Since asymmetric TWEER shocks also exhibit significant exposure effects on firm returns at the monthly horizon, the hedging strategy should refer to the weights assigned to major currencies, rather than the USD alone. Several approaches could be applied by Chinese auto firms to reduce currency risks:[24] (1) set the exchange rate at a fixed rate through the Forward Contract, in particular, if a firm operates overseas or receives payments from exports. This could avoid potential currency exposure from dramatic fluctuations in the exchange rate in the long run; (2) flexible use of the difference of between onshore and offshore RMB exchange rate markets; (3) keep a reasonable amount of foreign exchange reserves (foreign currencies)in case of potential investment and transaction payments abroad; (4) the quantitative method recommended by the IMF is Value at Risk (VaR), which monitors the foreign exchange exposure in a given holding period and confidence interval from a statistical perspective;[25] and (5)firm managers may also consider listing shares on one or more foreign stock exchange in addition to the domestic market, as empirical evidence shows that returns of B-share auto firms tend to rise with an increase in the RER.

[24]Firm returns respond to currency movements as the current value of firms' future cash flows are expressed and incorporated into stock prices(Dornbusch and Fischer, 1980). Therefore, the hedging strategies proposed here mainly focus on the stabilisation of cash flows of a firm.

[25]This research mainly focuses on the test of currency exposure. The proposed hedging strategies are beyond the scope of this research and could be studied further in another project. Therefore, those suggestions mentioned here are very brief.

References

Adler, M. and B. Dumas (1984). Exposure to currency risk: definition and measurement. *Financial Management*, 41–50.

Ajayi, R. A. and M. Mougouė (1996). On the dynamic relation between stock prices and exchange rates. *Journal of Financial Research 19*(2), 193–207.

Betts, C. and M. B. Devereux (2000). Exchange rate dynamics in a model of pricing-to-market. *Journal of International Economics 50*(1), 215–244.

Bodnar, G. M. and W. M. Gentry (1993). Exchange rate exposure and industry characteristics: evidence from Canada, Japan, and the USA. *Journal of International Money and Finance 12*(1), 29–45.

Brun-Aguerre, R., A. Fuertes, and M. Greenwood-Nimmo (2015). Heads I Win, Tails You Lose: Asymmetry in Aggregate Exchange Rate Pass-Through. *Journal of the Royal Statistical Society: Series A.*, forthcoming.

Chue, T. K. and D. Cook (2008). Emerging market exchange rate exposure. *Journal of Banking & Finance 32*(7), 1349–1362.

Cuestas, J. C., Y. Huang, and B. Tang (2016). Does the Yuan's Overseas Expansion Increase the Currency Exposure of Chinese Financial Firms? *Sheffield Economics Working Paper Series* (006), 1–32.

Cuestas, J. C. and B. Tang (2015). Asymmetric Exchange Rate Exposure of Stock Returns: Empirical Evidence from Chinese Industries. *Working Paper, Department of Economics, University of Sheffield*.

Cuthbertson, K. and D. Nitzsche (2001). *Financial engineering: derivatives and risk management*. Wiley.

Doidge, C., J. Griffin, and R. Williamson (2006). Measuring the economic importance of exchange rate exposure. *Journal of Empirical Finance 13*(4), 550–576.

Dominguez, K. M. and L. L. Tesar (2001). A reexamination of exchange-rate exposure. *The American Economic Review 91*(2), 396–399.

Dominguez, K. M. and L. L. Tesar (2006). Exchange rate exposure. *Journal of International Economics 68*(1), 188–218.

Dornbusch, R. and S. Fischer (1980). Exchange rates and the current account. *The American Economic Review 70*(5), 960–971.

Fama, E. F. and K. R. French (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics 33*(1), 3–56.

Frankel, J. A. and S.-J. Wei (2007). Assessing China's exchange rate regime. *Economic Policy 22*(51), 576–627.

Gao, P. (2002). A tune-up for china's auto industry. *The McKinsey Quarterly*, 144–156.

Gron, A. and D. L. Swenson (1996). Incomplete exchange-rate pass-through and imperfect competition: The effect of local production. *The American Economic Review 86*(2), 71–76.

He, J. and L. K. Ng (1998). The foreign exchange exposure of Japanese multinational corporations. *The Journal of Finance 53*(2), 733–753.

Hodder, J. E. (1982). Exposure to exchange-rate movements. *Journal of International Economics 13*(3), 375–386.

Hsu, C.-C., R. Yau, and J.-Y. Wu (2009). Asymmetric exchange rate exposure and industry characteristics: evidence from Japanese data. *Hitotsubashi Journal of Economics*, 57–69.

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

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

Khoo, A. (1994). Estimation of foreign exchange exposure: an application to mining companies in Australia. *Journal of International Money and Finance 13*(3), 342–363.

Koutmos, G. and A. D. Martin (2007). Modeling time variation and asymmetry in foreign exchange exposure. *Journal of Multinational Financial Management 17*(1), 61–74.

Martin, A. D. and L. J. Mauer (2003). Exchange rate exposures of US banks: a cash flow-based methodology. *Journal of Banking & Finance 27*(5), 851–865.

Muller, A. and W. F. Verschoor (2006). Asymmetric foreign exchange risk exposure: Evidence from US multinational firms. *Journal of Empirical Finance 13*(4), 495–518.

Muller, A. and W. F. Verschoor (2007). Asian foreign exchange risk exposure. *Journal of the Japanese and International Economies 21*(1), 16–37.

Nieh, C.-C. and C.-F. Lee (2002). Dynamic relationship between stock prices and exchange rates for g-7 countries. *The Quarterly Review of Economics and Finance 41*(4), 477–490.

Pesaran, M. H., Y. Shin, and R. J. Smith (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics 16*(3), 289–326.

Phylaktis, K. and F. Ravazzolo (2005). Stock prices and exchange rate dynamics. *Journal of International Money and Finance 24*(7), 1031–1053.

Shapiro, A. C. (2008). *Multinational Financial Management*. John Wiley & Sons.

Shin, Y., B. Yu, and M. Greenwood-Nimmo (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in Honor of Peter Schmidt*, pp. 281–314. Springer.

Williamson, R. (2001). Exchange rate exposure and competition: evidence from the automotive industry. *Journal of Financial Economics 59*(3), 441–475.

Zhou, X. (2009). The reform of the international monetary system. *Equilibri 13*(2), 161–166.

Table 1: Summary Statistics

Var.(N)	Mean	Std.Dev	Min	Max	JB_{prob}(N)	Obs.
Panel A: Daily Data						
Auto firm returns (87)	0.000	0.037	-0.540	0.161	0.004(2)	2,872
Rfree	0.000	0.429	-5.081	6.174	0.000	2,413
Market returns	0.000	0.020	-0.182	0.261	0.000	5,408
RMB/USD	0.000	0.001	-0.018	0.020	0.000	5,408
Panel B: Weekly Data						
Auto firm returns (87)	0.000	0.083	-0.593	0.378	0.013(2)	599
Rfree	0.000	0.980	-6.683	6.174	0.000	505
Market returns	0.001	0.045	-0.263	0.585	0.000	1,119
RMB/USD	0.000	0.002	-0.029	0.020	0.000	1,119
Panel C: Monthly Data						
Auto firm returns (80)	0.001	0.169	-0.662	0.550	0.035(7)	152
Rfree	-0.003	1.281	-5.802	5.862	0.000	118
Market returns	0.006	0.100	-0.291	0.651	0.000	265
RMB/USD	-0.001	0.009	-0.034	0.026	0.001	265
TWEER	0.003	0.015	-0.047	0.044	0.847	265
Panel D: Quarterly Data						
Auto firm returns (51)	0.005	0.276	-0.722	0.777	0.251(22)	68
Rfree	-0.001	1.199	-3.623	2.194	0.023	39
Market returns	0.023	0.184	-0.351	0.538	0.190	87
RMB/USD	-0.004	0.017	-0.049	0.037	0.970	87
TWEER	0.007	0.028	-0.077	0.077	0.131	87

Notes: Table 1 presents descriptive statistics of variables with different frequencies, namely daily, weekly, monthly and quarterly. Auto firm returns designate the average returns of sample firms. Numbers in parentheses mean the number of auto firms for each panel. Rfree indicates the risk-free rate. RMB/USD is the real exchange rate of RMB/USD (units of USD per unit of RMB). TWEER designates the trade-weighted RMB effective exchange rate. JB_{prob}(N) is the average p-values of the Jarque-Bera (JB) test for normality and numbers in parentheses are the number of significant JB statistics.

Table 2: Measuring Symmetric Exchange Rate Exposure (Daily & Weekly, NER)

	Daily				Weekly			
	CCAPM		ACAPM		CCAPM		ACAPM	
	B2009	A2009	B2009	A2009	B2009	A2009	B2009	A2009
Panel A: Fortune 500 auto firms								
Mean	-0.356	-0.016	-0.885	-0.09	-0.178	0.713	-1.442	0.607
Pos.(%)	1	4	1	4	1	6(33.3%)	1(100%)	6(16.7%)
Neg.(%)	5	4	5	4	5	2	5(20%)	2(50%)
$\bar{R}^2$	0.362	0.343	0.994	0.997	0.355	0.297	0.995	0.997
$ARCH_{No.}$	3	5	4	4	4	5	1	5
N	6	8	6	8	6	8	6	8
Panel B: *B*-share auto firms								
Mean	-0.686	0.122	-0.827	-0.083	-0.185	0.002	1.553	-0.097
Pos.(%)	1	3	1	1	3	1	3	2
Neg.(%)	3	1	3	3(33.3%)	1(100%)	3	1	2
$\bar{R}^2$	NA	0.244	NA	0.997	NA	0.176	0.995	0.997
$ARCH_{No.}$	4	2	4	2	4	2	2	2
N	4	4	4	4	4	4	4	4
Panel C: Other auto firms								
Mean	-0.684	-0.036	-0.850	0.042	0.012	-0.384	0.054	-0.227
Pos.(%)	9	35(2.86%)	6	43(9.30%)	20(5%)	30(13.3%)	22	30(10%)
Neg.(%)	32	40(10%)	35(14.3%)	32(12.5%)	21(9.5%)	45(28,89%)	19	45(13.3%)
$\bar{R}^2$	0.311	0.244	0.992	0.994	0.312	0.250	0.994	0.993
$ARCH_{No.}$	18	44	20	34	10	21	4	30
N	41	75	41	75	41	75	41	75

Notes: This table reports the results of the symmetric exchange rate exposure estimates according to Equations (1)-(4) using daily and weekly data. Nominal exchange rate (NER) is used for the measurement. CCAPM and ACAPM designate the conventional CAPM (Equation(1)) and augmented CAPM (Equation (2)), respectively. B2009 and A2009 mean before and after the announcement of RMB internationalisation in March 2009. NA means this item is not available. Mean in the first row reports the average exposure beta. Pos.(%) and Neg.(%) indicate the numbers of positive and negative exchange rate exposures, respectively, and % in parentheses represent the percentage of significant positive or negative exchange rate exposures. $\bar{R}^2$ designates the average adjusted R-square. $ARCH_{No.}$ means the number of symmetric exchange rate exposure estimates that exhibits ARCH effects. N means the number of firms estimated in each subsample.

Table 3: Measuring Symmetric Exchange Rate Exposure (Monthly & Quarterly, RER)

	Monthly				Quarterly		
	CCAPM		ACAPM		CCAPM		ACAPM
	B2009	A2009	B2009	A2009	B2009	A2009	All
Panel A: Fortune 500 auto firms							
Mean	-0.069	0.010	-0.444	-0.048	-1.793	0.313	-0.729
Pos.(%)	3	2	1	2	1	4	1
Neg.(%)	3	5	5	5	5	2	5
$\bar{R}^2$	0.415	0.371	0.983	0.993	0.440	0.472	0.969
$ARCH_{No.}$	1	2	1	1	0	0	0
N	6	7	6	7	6	6	6
Panel B: *B*-share auto firms							
Mean	1.366	2.203	1.091	1.992	0.255	3.524	1.408
Pos.(%)	4	4(50%)	3	4(50%)	2	3	3(33.3%)
Neg.(%)	0	0	1	0	2	1	1
$\bar{R}^2$	0.230	0.290	0.986	0.993	0.33	0.292	0.966
$ARCH_{No.}$	0	0	0	0	0	0	0
N	4	4	4	4	4	4	4
Panel C: Other auto firms							
Mean	-0.460	-0.569	-0.539	-0.447	-0.425	-0.273	-0.769
Pos.(%)	14(7.14%)	22(9.1%)	15	24(12.5%)	9(11.1%)	15(13.3%)	13
Neg.(%)	27(7.41%)	47(4.26%)	26(3.85%)	45(4.4%)	31(3.22%)	26(3.85%)	28(3.57%)
$\bar{R}^2$	0.367	0.310	0.980	0.990	0.397	0.389	0.964
$ARCH_{No.}$	4	7	1	8	4	7	7
N	41	69	41	69	41	41	41

Notes: This table reports the results of the symmetric exchange rate exposure estimates according to Equations (1)-(4) using monthly and quarterly data. RER is used for the measurement. CCAPM and ACAPM designate the conventional CAPM (Equation(1)) and augmented CAPM (Equation (2)), respectively. B2009 and A2009 mean before and after the announcement of RMB internationalisation in March 2009. Mean in the first row reports the average exposure beta. Pos.(%) and Neg.(%) indicate the numbers of positive and negative exchange rate exposures, respectively, and % in parentheses represent the percentage of significant positive or negative exchange rate exposures. $\bar{R}^2$ designates the average adjusted R-square. $ARCH_{No.}$ means the number of symmetric exchange rate exposure estimates that exhibits ARCH effects. N means the number of firms estimated in each subsample.

Table 4: Measuring Symmetric Exchange Rate Exposure (Monthly & Quarterly, TWEER)

	Monthly				Quarterly		
	CCAPM		ACAPM		CCAPM		ACAPM
	B2009	A2009	B2009	A2009	B2009	A2009	All
Panel A: Fortune 500 auto firms							
Mean	0.478	-0.519	2.006	-0.511	-0.462	-1.397	-0.893
Pos.(%)	5(20%)	2	5(40%)	2	3	3	3
Neg.(%)	1	5(20%)	1	5(20%)	3	3(66.7%)	3(66.7%)
$\bar{R}^2$	0.420	0.355	0.986	0.994	0.444	0.523	0.971
$ARCH_{No.}$	1	1	1	1	0	0	0
N	6	7	6	7	6	6	6
Panel B: B-share auto firms							
Mean	-0.656	-0.243	-0.140	-0.009	0.341	-0.726	-0.678
Pos.(%)	1	2	1	2	3	0	1
Neg.(%)	3	2	3	2	1	4	3
$\bar{R}^2$	0.231	0.271	0.986	0.993	0.331	0.227	0.965
$ARCH_{No.}$	0	0	0	0	0	0	0
N	4	4	4	4	4	4	4
Panel C: Other auto firms							
Mean	0.421	-0.103	1.060	-0.098	1.663	-0.487	-0.052
Pos.(%)	21(9.68%)	28	29(13.79%)	27(7.41%)	35(31.43%)	14(7.14%)	24(4.17%)
Neg.(%)	10	41(2.44%)	12	42(4.76%)	5	27(14.81%)	17(17.65%)
$\bar{R}^2$	0.368	0.309	0.980	0.990	0383	0.380	0.964
$ARCH_{No.}$	3	8	4	7	7	5	6
N	41	69	41	69	41	41	41

Notes: This table reports the results of the symmetric exchange rate exposure estimates according to Equations (1)-(4) using monthly and quarterly data. TWEER is used for the measurement. CCAPM and ACAPM designate the conventional CAPM (Equation(1)) and augmented CAPM (Equation (2)), respectively. B2009 and A2009 mean before and after the announcement of RMB internationalisation in March 2009. Mean in the first row reports the average exposure beta. Pos.(%) and Neg.(%) indicate the numbers of positive and negative exchange rate exposures, respectively, and % in parentheses represent the percentage of significant positive or negative exchange rate exposures. $\bar{R}^2$ designates the average adjusted R-square. $ARCH_{No.}$ means the number of symmetric exchange rate exposure estimates that exhibits ARCH effects. N means the number of firms estimated in each subsample.

Table 5: Measuring Asymmetric Exchange Rate Exposure (Daily & Weekly, NER)

	Daily				Weekly			
	NARDL		ANARDL		NARDL		ANARDL	
	B2009	A2009	B2009	A2009	B2009	A2009	B2009	A2009
Panel A: Fortune 500 auto firms								
β^+	-4.125	0.097	-1.467	-0.458	-5.253	1.818	-2.838	0.727
β^-	-4.126	0.100	-1.533	-0.465	-5.311	1.960	-3.153	0.669
$\beta^+ - \beta^-$	1	1	1	3	0	2	0	3
PSS	6	8	6	8	6	8	6	8
$LM(2)$	4	5	6	6	6	8	5	6
$ARCH$	3	3	2	3	4	4	5	5
$\bar{R}^2$	0.651	0.630	0.995	0.999	0.653	0.672	0.998	0.999
N	6	8	6	8	6	8	6	8
Panel B: B-share auto firms								
β^+	0.628	0.793	5.647	0.397	-3.042	1.702	6.991	0.584
β^-	0.627	0.796	5.561	0.419	-2.992	1.825	6.302	0.660
$\beta^+ - \beta^-$	0	0	0	0	0	1	1	0
PSS	4	4	4	4	4	4	4	4
$LM(2)$	3	3	4	4	4	4	3	4
$ARCH$	0	2	0	2	0	2	1	2
$\bar{R}^2$	0.562	0.596	0.998	0.999	0.547	0.572	0.999	0.999
N	4	4	4	4	4	4	4	4
Panel C: Other auto firms								
β^+	-0.172	-0.222	0.091	0.165	-1.256	1.734	-0.851	2.141
β^-	-0.176	-0.222	0.078	0.167	-0.995	1.892	-1.085	2.130
$\beta^+ - \beta^-$	7	5	2	2	2	8	1	5
PSS	41	73	41	75	36	66	32	72
$LM(2)$	36	57	32	59	34	64	33	63
$ARCH$	27	38	22	38	32	53	40	51
$\bar{R}^2$	0.657	0.621	0.996	0.998	0.661	0.645	0.998	0.998
N	41	75	41	75	40	75	40	75

Notes: This table presents the results of asymmetric exchange rate exposure measurements according to Equations (6) and (7) using daily and weekly data. Nominal exchange rate (NER) is used for the measurement. NARDL and ANARDL designate the nonlinear framework in Equation(6) and (7), respectively. B2009 and A2009 mean before and after the announcement of RMB internationalisation in March 2009. β^+ and β^- are the average exposure betas for positive and negative currency shocks, respectively. $\beta^+ - \beta^-$ reports the number of estimates that the null $\beta^+ - \beta^- = 0$ is rejected in the asymmetry test. PSS denotes the Pesaran et al. (2001) F-test of the null hypothesis $\rho = \beta^+ = \beta^- = \lambda^+ = \lambda^- = 0$ against the alternative of joint significance. The critical value used in this study for the PSS F-test is 4.14 at the 10% level. $LM(2)$ denotes the number of NARDL estimates that accept the null hypothesis (no serial correlation) in the Breusch-Godfrey test. $ARCH$ indicates the number of NARDL estimates that do not have ARCH effects. $\bar{R}^2$ denotes the average adjusted R^2. N is the number of firms estimated in each subsample.

Table 6: Measuring Asymmetric Exchange Rate Exposure (Monthly & Quarterly, RER)

	Monthly			Quarterly		
	NARDL		ANARDL	NARDL		ANARDL
	B2009	A2009	All	B2009	A2009	All
Panel A: Fortune 500 auto firms						
β^+	-0.645	1.423	-0.764	9.032	22.528	-7.854
β^-	-0.178	0.851	-0.840	50.854	19.74	-6.243
$\beta^+ - \beta^-$	0	5	0	0	2	0
PSS	2	2	5	0	0	0
$LM(2)$	6	4	5	6	1	1
$ARCH$	3	5	5	6	4	6
$\bar{R}^2$	0.654	0.702	0.996	0.673	0.817	0.989
N	6	7	7	6	6	6
Panel B: B-share auto firms						
β^+	1.103	2.262	1.910	-3.554	9.241	157.222
β^-	1.824	1.175	1.185	3.432	5.785	-42.845
$\beta^+ - \beta^-$	1	1	3	3	0	1
PSS	3	0	3	0	1	1
$LM(2)$	3	2	3	3	0	1
$ARCH$	4	3	4	3	4	4
$\bar{R}^2$	0.601	0.572	0.997	0.622	0.480	0.987
N	4	4	4	4	4	4
Panel C: Other auto firms						
β^+	-1.245	2.252	0.053	1.471	21.156	-14.178
β^-	0.397	1.812	-0.368	-4.294	18.195	-15.973
$\beta^+ - \beta^-$	4	10	21	2	7	5
PSS	28	15	45	3	5	10
$LM(2)$	29	53	50	16	6	14
$ARCH$	31	65	64	32	37	40
$\bar{R}^2$	0.673	0.650	0.996	0.687	0.747	0.993
N	35	69	69	35	41	41

Notes: This table presents the results of asymmetric exchange rate exposure measurements according to Equations (6) and (7) using daily and weekly data. RER is used for the measurement. NARDL and ANARDL designate the nonlinear framework in Equation (6) and (7), respectively. B2009 and A2009 mean before and after the announcement of RMB internationalisation in March 2009. β^+ and β^- are the average exposure betas for positive and negative currency shocks, respectively. $\beta^+ - \beta^-$ reports the number of estimates that the null $\beta^+ - \beta^- = 0$ is rejected in the asymmetry test. PSS denotes the Pesaran et al. (2001) F-test of the null hypothesis $\rho = \beta^+ = \beta^- = \lambda^+ = \lambda^- = 0$ against the alternative of joint significance. The critical value used in this study for the PSS F-test is 4.14 at the 10% level. $LM(2)$ denotes the number of NARDL estimates that accept the null hypothesis (no serial correlation) in the Breusch-Godfrey test. $ARCH$ indicates the number of NARDL estimates that do not have ARCH effects. $\bar{R}^2$ denotes the average adjusted R^2. N is the number of firms estimated in each subsample.

Table 7: Measuring Asymmetric Exchange Rate Exposure (Monthly & Quarterly, TWEER)

	Monthly			Quarterly		
	NARDL		ANARDL	NARDL		ANARDL
	B2009	A2009	All	B2009	A2009	All
Panel A: Fortune 500 auto firms						
β^+	-0.643	-0.605	0.364	-4.974	5.054	-8.294
β^-	-0.041	-0.389	0.457	1.221	-5.194	-7.178
$\beta^+ - \beta^-$	3	0	0	2	2	0
PSS	3	2	4	1	0	0
$LM(2)$	3	5	5	3	0	1
$ARCH$	5	5	5	6	5	3
$\bar{R}^2$	0.656	0.660	0.996	0.762	0.715	0.992
N	6	7	7	6	6	6
Panel B: B-share auto firms						
β^+	-0.291	-1.778	-1.040	-1.067	7.131	-12.130
β^-	0.206	-0.693	-1.445	1.844	-5.148	-10.286
$\beta^+ - \beta^-$	0	1	2	0	0	1
PSS	3	1	3	0	1	1
$LM(2)$	4	4	3	3	1	2
$ARCH$	4	4	4	4	4	4
$\bar{R}^2$	0.582	0.567	0.997	0.485	0.622	0.985
N	4	4	4	4	4	4
Panel C: Other auto firms						
β^+	-0.494	-1.957	-0.427	-0.166	-47.231	10.728
β^-	0.843	-0.410	-1.042	1.289	-13.095	6.624
$\beta^+ - \beta^-$	10	33	14	7	8	1
PSS	32	37	53	2	9	7
$LM(2)$	29	46	47	16	7	13
$ARCH$	31	66	63	28	38	36
$\bar{R}^2$	0.682	0.679	0.997	0.697	0.757	0.991
N	35	69	69	30	41	41

Notes: This table presents the results of asymmetric exchange rate exposure measurements according to Equations (6) and (7) using daily and weekly data. TWEER is used for the measurement. NARDL and ANARDL designate the nonlinear framework in Equation (6) and (7), respectively. B2009 and A2009 mean before and after the announcement of RMB internationalisation in March 2009. β^+ and β^- are the average exposure betas for positive and negative currency shocks, respectively. $\beta^+ - \beta^-$ reports the number of estimates that the null $\beta^+ - \beta^- = 0$ is rejected in the asymmetry test. PSS denotes the Pesaran et al. (2001) F-test of the null hypothesis $\rho = \beta^+ = \beta^- = \lambda^+ = \lambda^- = 0$ against the alternative of joint significance. The critical value used in this study for the PSS F-test is 4.14 at the 10% level. $LM(2)$ denotes the number of NARDL estimates that accept the null hypothesis (no serial correlation) in the Breusch-Godfrey test. $ARCH$ indicates the number of NARDL estimates that do not have ARCH effects. $\bar{R}^2$ denotes the average adjusted R^2. N is the number of firms estimated in each subsample.

Appendix: List of Chinese Automobile Firms

Share Code	Abbrev.	Firm (CHN)	Share Code	Abbrev.	Firm (CHN)
Panel A: Fortune 500 auto firms			002510.SZ	TQM	天汽模
01958.HK	BJQC	北京汽车	002536.SZ	XBGF	西泵股份
000800.SZ	YQJC	一汽轿车	002590.SZ	WAKJ	万安科技
000927.SZ	YQXL	一汽夏利	002592.SZ	BLKJ	八菱科技
600006.SH	DFQC	东风汽车	002593.SZ	RSJT	日上集团
600104.SH	SQJT	上汽集团	002594.SZ	BYD	比亚迪
601238.SH	GQJT	广汽集团	002602.SZ	SJHT	世纪华通
00157.HK	JLKG(JLQC)	吉利汽车	002625.SZ	LSGF	龙生股份
000625.SZ	CAQC	长安汽车	002662.SZ	JWGF	金威股份
			002664.SZ	XZDJ	信质电机
Panel B: B share auto firms			002703.SZ	ZJSB	浙江世宝
200030.SZ	FAB	富奥B	002708.SZ	GYGF	光洋股份
200550.SZ	JLB	江铃B	002715.SZ	DYGF	登云股份
200581.SZ	SWFB	苏威孚B	002725.SZ	YLGF	跃岭股份
200625.SZ	CAB	长安B	002765.SZ	LDCD	蓝黛传动
			300100.SZ	SLGF	双林股份
Panel C: Other auto firms			300176.SZ	HTJM	鸿特精密
000030.SZ	FAGF	富奥股份	300237.SZ	MCKJ	美晨科技
000338.SZ	WCDL	潍柴动力	300258.SZ	JDKJ	精锻科技
000550.SZ	JLQC	江铃汽车	300304.SZ	YYDQ	云意电气
000559.SZ	WXQC	万向钱潮	300432.SZ	FLJG	富临精工
000572.SZ	HMQC	海马汽车	600066.SH	YTKC	宇通客车
000581.SZ	WFGK	威孚高科	600081.SH	DFKJ	东风科技
000700.SZ	MSKJ	模塑科技	600093.SH	HJGF	禾嘉股份
000710.SZ	TXYB	天兴仪表	600148.SH	CCYD	长春一东
000760.SZ	STE	斯太尔	600166.SH	FTQC	福田汽车
000868.SZ	AKKC	安凯客车	600178.SH	DADL	东安动力
000951.SZ	ZGZQ	中国重汽	600213.SH	YXKC	亚星客车
000957.SZ	ZTKC	中通客车	600303.SH	SGGF	曙光股份
000980.SZ	JMGF	金马股份	600375.SH	STXM	ST星马
002048.SZ	NBHX	宁波华翔	600418.SH	JWQC	江淮汽车
002085.SZ	WFAW	万丰奥威	600480.SH	LYGF	凌云股份
002101.SZ	GDHT	广东鸿图	600501.SH	HTCG	航天晨光
002126.SZ	YLGF	银轮股份	600523.SH	GHGF	贵航股份
002213.SZ	TEJ	特尔佳	600609.SH	JBQC	金杯汽车
002265.SZ	XYGF	西仪股份	600686.SH	JLQC	金龙汽车
002283.SZ	TRQZ	天润曲轴	600698.SH	HNTY	湖南天雁
002284.SZ	YTGF	亚太股份	600699.SH	JSDZ	均胜电子
002328.SZ	XPGF	新朋股份	600715.SH	WTKG	文投控股
002355.SZ	XMGQ	兴民钢圈	600741.SH	HYQC	华域汽车
002363.SZ	LJJX	隆基机械	600742.SH	YQFW	一汽富维
002406.SZ	YDCD	远东传动	600760.SH	ZHHB	中航黑豹
002434.SZ	WLY	万里扬	600960.SH	BHHS	渤海活塞
002448.SZ	ZYNP	中原内配	601633.SH	CCQC	长城汽车
002454.SZ	SZGF	松芝股份	601689.SH	TPJT	拓普集团
002488.SZ	JGGF	金固股份	601777.SH	LFGF	力帆股份

Notes: Abbre. indicates the abbreviation of the firm name. Firm(CHN) is the firm name in Chinese. HK, SZ and SH designate the Hong Kong, Shenzhen and Shanghai stock exchanges, respectively.