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The Dynamics of Foreign Exchange Derivative Use in China

Yidi Sun and Bruce Morley *

Department of Economics, University of Bath, Bath BA2 7AY, UK; ys940@bath.ac.uk
* Correspondence: bm232@bath.ac.uk; Tel.: +44-1225-386497

Abstract: The aim of this study is to determine the main factors affecting the use of foreign exchange hedging instruments by Chinese firms, following their regulatory changes in the derivative markets. The original contributions to this literature include the use of a panel dataset of 316 Chinese firms with the data running from 2012 to 2017 and a dynamic random effects probability approach. The results suggest the main determinants of derivative use are the overseas trade conducted by these firms, with some evidence of non-linearity, as well as firms being more likely to use derivatives when there is more information asymmetry and agency problems, potentially due to greater controls on their use in China.

Keywords: hedging; derivative; dynamic panel; exports

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1. Introduction

Over recent years the use of hedging products and other derivative instruments has become increasingly popular in China's foreign exchange markets. With the recent rise in exports and greater flexibility with the Chinese exchange rate, there is a strong motivation for Chinese firms to use these instruments to hedge against foreign exchange risk. The aim of this study is to use a dynamic model to assess the main factors determining the rise in the use of foreign exchange derivatives in manufacturing firms from an emerging economy, which has experienced substantial increases in overseas trade over recent years. This study would be of interest to not only firms in emerging economies with substantial levels of overseas trade, but also derivative traders who are interested in which firms are likely to use derivative instruments.

One of the main motivations for hedging foreign exchange risk is that managers tend to be risk averse and hedging can minimize the risk exposure of the firm and so increase its value by smoothing the volatility of cash flows, reducing the volatility of stock returns and mitigating against the costs of financial distress and agency. Thus, it is important to examine what determines the use of derivatives and thus to identify how firm value can be maximised in an imperfect market. Mian (1996) and Ameer (2010) have developed an empirical approach focusing on the determinants of corporate hedging and find firm specific characteristics, such as size, growth opportunities and profitability, do affect the decisions on the use of derivatives. In addition, corporate governance and managerial ownership can influence hedging strategies due to the existence of agency costs and conflicts of interest between shareholders and managers, as shown by Doidge et al. (2007) and Fauver and Naranjo (2010).

As the Chinese economy has developed rapidly, firms have increasingly expanded their business abroad, so experiencing foreign exchange exposure due to increased exchange rate variability and this has facilitated the increased use of derivative products. As a result China has developed a new regulatory framework for these new products and in 2003 the China Bank Regulatory Commission (CBRC) was established. In 2004, the CBRC introduced the first set of regulations relating to the use of derivative products, formally setting out the requirements in terms of risk management when using derivative products and also defining which institutions could deal in these products. The introduction of more

formal regulations to the derivative market then provided an impetus for their increased popularity in China[1]. However, as became evident during the 2008 financial crisis, derivative markets can induce instability across the financial system, so it is important to examine these markets and their determinants.

This study builds on the previous literature, mostly orientated towards the US and UK markets and which has been more focused on using cross-sectional analysis with a fixed effects static model to analyse factors that influence derivative usage. In this study we have a panel dataset of 316 manufacturing Chinese firms with the data running from 2012 to 2017. Apart from the contribution to the literature stemming from the use of a recent dataset from a major emerging economy, the main contributions of this study are firstly, that we use a dynamic random effects probability panel model to account for the dynamic relationship between past and current decisions on using derivatives. One of the key factors determining whether a firm opts to use derivative products is likely to be whether they have used them previously. Secondly, we examine this relationship for a sample of manufacturing firms in an emerging economy, in this case China, just after the new regulatory framework for these products was introduced. Thirdly, we have incorporated variables representing foreign exposure and international factors such as the exchange rate into the analysis.

Following the introduction we include a brief review of the literature, then we explain the methodological approach we have used. We then analyse the data and results and finally we offer some conclusions and policy implications.

2. Literature Review

Much of the early literature on the use of derivatives was theoretical, mainly focusing on constructing theoretical models to estimate risk exposure and the effects of hedging strategies, which emphasized the importance of risk management to firms. The Modigliani–Miller (MM) theory suggested that the capital structure of a firm is irrelevant to the firm's value when the market is complete and with perfectly transparent information. In reality, the existence of taxes and the transaction costs of bankruptcy provide incentives for firms to conduct risk management, as suggested by Mayers and Smith (1982). Furthermore, Smith and Stulz (1985) provided a value maximising function to explain how hedging behaviour affects the wealth of shareholders through different channels including taxes, the transaction costs of bankruptcy and the costs of financial distress and managerial compensation.

The risk management theories relating to hedging are supported by many of the empirical studies. Nance et al. (1993) showed that 61.5% out of 169 firms used derivatives to hedge in 1986. The evidence suggests most hedging is a means to manage risks; for instance, Bartram et al. (2009) found 64.9% out of 2231 firms in the United States used derivatives to mitigate against risk exposure. Outside the U.S., Allayannis et al. (2012), using data from 1546 non-U.S. firms with foreign sales from 39 countries between 1990 and 1999, found that 61% of the firms used foreign currency derivatives to hedge and were more profitable than firms that did not use derivatives.

There is no real consensus over the effectiveness of derivatives to control risk associated with the foreign exchange markets. For instance, the exchange rate exposure puzzle suggested by Dominguez and Tesa (2001) and Bartram et al. (2010), suggested that there is no statistically significant foreign exchange exposure for firms, which could be explained by the efficient use of foreign currency derivatives. However, Brown et al. (2006) found 84% and 76% of U.S. non-financial firms used derivatives to alleviate the impact of exchange rate changes and interest rate movements on firms, respectively.

Smith and Stulz (1985) suggested that hedging to mitigate risk exposure is associated with the costs of financial distress, which implies effective risk management could lower the probability of encountering financial difficulties for the firm. Purnanandam (2008) proposed a new model on hedging by including financial distress costs and found that these costs were one of the main incentives for hedging, especially in industries with high

levels of concentration. Many empirical studies have shown that financial distress and managerial incentives are significant determinants of hedging, such as Bartram et al. (2009), who showed that financial distress is statistically significant for larger firms but manager incentives are more significant for smaller firms. Additionally, the decision by a firm on whether to hedge or not using derivatives is mostly dependent on the individual firm's characteristics such as its size, rather than the characteristics of the country it operates in.

There have been many other factors considered as determinants of derivative use, mostly based on U.S. data. For instance, Smith and Stulz (1985) and Chen et al. (1998) demonstrated that risk aversion motivates managers to use derivatives to smooth the volatility of cash flows or stock returns. Gay and Nam (1998) considered underinvestment as a determinant and suggested that hedging helps to avoid underinvestment problems due to the positive relationship between derivative usage and a firm's growth opportunities. Managerial ownership has also been shown to be positively associated with the use of foreign exchange derivatives (Adkins et al. 2007). Using a measure of managerial compensation, such as option awards, they found a negative relationship with derivative usage. Marshall et al. (2013) identified managerial ownership as a determinant of foreign exchange hedging and found the concentration of ownership is negatively related to the use of hedging. Carroll et al. (2017) showed that economies of scale are one of the main drivers of derivative usage along with foreign exchange exposure using a sample of European countries, whilst interest rate derivatives are driven by the nature and size of the company's debt. Bae et al. (2018) found the main drivers of derivative usage in Korea are the levels of firm exports, foreign currency debt and exposure to the exchange rate. Dharmiyanti and Darmayanti (2020), using Indonesian firm data, found that only the firm size has a significantly positive effect on the decision to hedge foreign exchange risk. Other factors, such as growth opportunities and liquidity, have no significant effect.

Corporate governance has also been shown to have a significant effect, including internal governance and the external governance in the country where the firm operates. Allayannis et al. (2003) and Lel (2012) concluded that the role of corporate governance is important when firms make decisions on the use of foreign currency derivatives. They found that firms with strong governance preferred to use foreign currency derivatives to hedge their exchange risk exposure. In addition to firm-level characteristics, market opinions and expectations are also important reasons for the use of derivatives. In addition, Bartram et al. (2009) explored the determinants of derivative usage at the country level and showed that the size and efficiency of derivative's markets influenced the firm's decision. Based on a review of previous studies, Geyer-Klingeberg et al. (2019) suggested that firms do not attach equal importance to all these factors, with different firms having a variety of motivations.

Although there is a limited literature on the determinants of derivative usage in China, there have been a number of studies that have examined the exposure of mostly Chinese banks to movements in the exchange rate. These include Aggarwal et al. (2011), who estimated the currency exposure arising from the different trading partners of China and found evidence of a significant level of exposure, although the magnitude was less than in other studies on non-Chinese firms. Ye and Hutson (2011) found that Chinese banks are highly exposed to movements in the exchange rate, which has become even more pronounced since the financial crisis. They suggest that this is not due to the hot money inflows into China and investment sentiment. Adcock et al. (2017) showed similar evidence of exposure to these risks but only when non-linearities were accounted for. They also find that the risk exposure is reduced when banks have used derivatives.

3. Model and Methods

3.1. The Determinants of Foreign Exchange Derivative Usage

The discrete choice approach to modelling has been used extensively when analysing derivative usage in the literature, for instance, Bartram et al. (2009) used the probit estimation of derivative decision making, including three classic types of derivative instruments,

to find out which country specific factors and firm factors affect the decision. Nance et al. (1993) used the logit model. This study uses two types of probit model, including a static probit model as in Fauver and Naranjo (2010) as well as the dynamic approach, to examine the use of foreign currency derivatives. The basic static model is a standard random effects probit model, which follows Heckman's (1987) method to solve the initial conditions problem. A binary variable is used due to the unavailability of consistent continuous derivatives data disclosed in China.

As with Smith and Stulz (1985) and Gay and Nam (1998), we include measures of the agency problems between managers and shareholders, which can result in underinvestment, in order to determine whether agency problems affect the use of foreign currency derivatives when firms experience information asymmetry. As we concentrate on foreign exchange markets, the degree of foreign sales is also included as one of the determinants of derivatives usage and we would expect a positive sign. However, it is also possible that as a firm exports more, it uses an increased variety of foreign currencies so could, in effect, be hedging this exposure itself through a process of diversifying the risk across all the currencies it trades in. This would suggest a non-linear relationship between derivative use and foreign exposure, initially rising with foreign sales, then falling, producing a non-linear inverted U-shaped Kuznets type relationship.

The model specification is as follows

$$FCD_{it} = \beta_1 EXP_{it} + \beta_2 AGENCY_{it} + \beta_3 INFORMATION_{it} + \gamma CONTROL_{it} + \alpha_i + u_{it} \quad (1)$$

The dependent variable, shown on the left-hand side, is the use of derivatives by each firm during the sample period and equals 1 when firm i chooses to use foreign currency derivatives in year t and 0 when firm i does not use them. On the right-hand side, EXP_{it} represents the ratio of foreign sales to total sales of the firm i in year t, called the export ratio, to estimate the degree of foreign sales of the firm. This is because derivatives will tend to be used by firms with a large foreign risk exposure, as in Allayannis and Ofek (2001). The managed floating exchange rate regime has allowed the renminbi to float around a central parity and the floating band has been continuously expanding after 2010, although it is still heavily managed, especially against the US dollar, which is the main currency for international settlements in foreign transactions. Therefore, potentially we could get differing results with different export currencies amounting to an omitted variable. However, as the export sales data are all in renminbi, we are unable to distinguish their destination and currency. $AGENCY_{it}$ refers to measures of the agency problems of the firm i in year t, as measured by ownership structure, including the ownership concentration and agency costs, as in Marshall et al. (2013). In this case ownership concentration is the proportion of internal (INTERNAL OWNERSHIP) and institutional ownership (INSTITUTIONAL OWNERSHIP). The second measure of agency costs is the ratio of total sales to total assets (SALES/ASSETS), as in Leland (1998) and Fauver and Naranjo (2010), indicating that firms with a higher ratio of sales to total assets have a higher propensity to use derivatives because lower agency costs allow managers to concentrate on investments with higher returns. Based on the hypotheses that higher insider ownership and lower institutional ownership represent higher agency costs, as in Chen et al. (2007), the expectation in developed economies is for a negative relationship between agency problems and the use of foreign currency derivatives.

The variable $INFORMATION_{it}$ measures the transparency of the information on the asset and the asset's opaqueness. The greater the asset's opaqueness the more likely managers are to take advantage of private information for their personal interest and speculate with derivatives rather than concentrating on the firm's profitability, which could harm the efficiency of the firm's performance. This opaqueness is measured by the ratio of intangible assets to total assets (INTANGIBLE ASSETS/ASSETS), as intangible assets are more likely to be opaque and understood best by the firm's managers. As intangible assets to assets increases, the extent of the asset's opaqueness rises, which will decrease the transparency of information in the market, as noted by Fauver and Naranjo (2010).

The term $CONTROL_{it}$ represents a vector of variables controlling the firm's characteristics, such as size, leverage and debt capacity. α_i refer to individual effects which are constant over time and u_{it} are assumed to be normally distributed in the random effects model. Based on Geyer-Klingeberg et al. (2019), the most common control variables relate to differences in firms' characteristics, including size, leverage, the quick ratio, financial distress costs, operating income and growth opportunities[2]. Size is measured by taking the logarithm of total assets, which helps to scale the data. The size effect on derivatives usage remains controversial (SIZE). The majority of studies indicate larger firms are more likely to use derivatives due to large exchange rate exposure. The capital structure is captured by the firm's leverage (LEVERAGE), which is a proxy for the probability of financial distress and closely associated with the probability of hedging, being measured by total debt to total assets. Smith and Stulz (1985) illustrated that greater financial distress is more likely to motivate firms to hedge. As a result, debt to earnings before interest, taxes, depreciation and amortization (EBITDA) are used to measure the firm's ability to pay off the incurred debt (DEBT/EBITDA). The quick ratio (QR) is used to measure the short-term liquidity of the firm and the ratio of operating income to sales (OPERATING INCOME/SALES) and the ratio of capital expenditure to sales (CAPITAL EXPENDITURE/SALES) are used to proxy the profitability and the growth opportunities. The probability of using derivatives is higher for firms with higher growth since they are more likely to hedge risk and invest in productive projects. The use of these control variables also occurred in Allayannis and Ofek (2001), Allayannis and Weston (2001), Purnanandam (2008) and Bartram et al. (2009). Therefore, the main model (1) with control variables stated explicitly is

$$\begin{aligned} FCD_{it} = {} & \beta_1 EXP_{it} + \beta_2 AGENCY_{it} + \beta_3 INFORMATION_{it} + \gamma_1 SIZE_{it} + \gamma_2 LEVERAGE + {} + \gamma_3 QR + \gamma_4 \text{ DEBT EBITDA} \\ & + \gamma_5 \text{OPERATING INCOME SALES} + \gamma_6 \text{CAPITAL EXPENDITURE SALES} + \alpha_i + u_{it} \end{aligned} \quad (2)$$

3.2. The Dynamics of Derivative Usage

It is also important to consider the dynamics of derivative usage as foreign currency derivatives usually involve long contracts to hedge long-term exchange rate risk. Thus, we need to incorporate the lagged dependent variable into Equation (1) because behaviour during the past year is one of the most important factors relating to the firm's risk management strategies for the next year. This effect is usually used by continuous time models rather than discrete choice models. However, Stewart (2006) proposed a model which allows for the inclusion of a lagged dependent variable, based on a random effects dynamic probit model implementing the Heckman estimator in a more convenient way and allowing for endogeneity in the specification.

Following Stewart's (2006, 2007) approach, the latent equation for the random effects dynamic model is as follows

$$FCD_{it}{}^{*} = \rho FCD_{it-1} + \beta_1 EXP_{it} + \beta_2 AGENCY_{it} + \beta_3 INFORMATION_{it} + \gamma CONTROL_{it} + \alpha_i + u_{it} \quad (3)$$

$$FCD_{it} = \begin{cases} 1, & FCD_{it}{}^{*} \geq 0 \\ 0, & FCD_{it}{}^{*} < 0 \end{cases}$$

$FCD_{it}{}^{*}$ is the latent dependent variable and FCD_{it} is the observed binary variable that is equal to 1 when the firm uses foreign currency derivatives and 0 otherwise, and FCD_{it-1} represents the derivatives usage from the previous year. We will focus on the lagged effect of derivatives usage on the current decision and the null hypothesis is $\rho = 0$. In the dynamic model, the initial conditions are an important consideration, as suggested by Stewart (2006); the standard probit model assumes the initial observation to be uncorrelated with the individual effects, resulting in an inconsistent estimator due to existing endogeneity in most cases, while the Heckman (1987) estimator specifies the initial conditions as a linear reduced form of a vector of exogeneous variables to solve the initial conditions problem.

To simplify Equation (3), the model specification uses X_{it} to represent a vector of explanatory variables, containing the main variables and control variables; the new equation is

$$FCD_{it}{}^{*} = \rho FCD_{it-1} + \beta X_{it} + \alpha_i + u_{it} \quad (4)$$

The composite error term could be represented by

$$\varepsilon_{it} = \alpha_i + u_{it} \quad (5)$$

$$Corr(\varepsilon_{it}, \varepsilon_{ij}) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_u^2} \quad t, j = 2, \ldots T \; t \neq j \quad (6)$$

The standard normal probit random effects model includes the assumption that the composite error term is uncorrelated with the independent variables, which means no correlation between unobserved effects and explanatory variables. However, this assumption is not true in most empirical cases. Stewart (2006) chose the Mundlak–Chamberlain approach that allows for the relationship between the time-invariant individual effects and the explanatory variables. This approach used either the means of the explanatory variables or a combination of their lags and leads to represent the time-invariant individual effects, for example, $\alpha_i = \overline{X_i} b + \delta_i$, $\delta_i \sim$ iid. Then, α_i is replaced by this form in Equation (4) and the transition probability of the derivative usage is given by its use from the last time period, the other explanatory variables and individual effects for each firm are then estimated by the following equation, where Φ is the cumulative normal distribution function

$$[FCD_{it} | x_{it}, FCD_{it-1}, \alpha_i] = \Phi[(\rho FCD_{it-1} + \beta X_{it} + \alpha_i)(2FCD_{it} - 1)] \quad (7)$$

The initial conditions problem exists due to the correlated effects between the initial observed parameters and time-invariant individual effects and would lead to inconsistent estimators. To solve the initial values problem, Stewart (2006) follows Heckman's method to generate a linearized reduced form of the individual effects and puts it into the original equation so as to improve the consistency of the estimator. Thus, the derivative usage of firms when $t = 1$ are presented by a linear relationship with a vector of exogenous instrumental variables as in the following:

$$FCD_{i1}{}^{*} = \mu Z_{i1} + \theta_i, \; i = 1, \ldots, N \quad (8)$$

where Z_{i1} is a vector of exogenous instrumental variables and θ_i is correlated with the time-invariant individual effects but is independent of the error term u_{it} for $t \geq 2$. Then, using orthogonal projections, it can be represented by

$$\theta_i = a\alpha_i + u_{i1} \quad (9)$$

Thus, replacing θ_i in Equation (8) by (9), the latent dependent variable for the first period can be written as

$$FCD_{i1}{}^{*} = \mu Z_{i1} + a\alpha_i + u_{i1}, i = 1, \ldots, N \quad (10)$$

Following Heckman's method to solve the initial conditions problem, the joint probability of the observed foreign currency derivative usage for each firm, given the unobserved time-invariant individual effects is

$$\Phi[(\mu Z_{i1} + a\alpha_i)(2FCD_{i1} - 1)] \prod_{t=2}^{T} \Phi[(\rho FCD_{it-1} + \beta X_{it} + \alpha_i)(2FCD_{it} - 1)] \quad (11)$$

Applying the maximum likelihood estimation proposed by Heckman (1987), the maximum likelihood for firms is given by,

$$\prod_{i}\int_{\alpha^*}\left\{\Phi[(\mu Z_{i1}+a\sigma_\alpha\alpha^*)(2FCD_{i1}-1)]\prod_{t=2}^{T}\Phi[(\rho FCD_{it-1}+\beta X_{it}+\sigma_\alpha\alpha^*)(2FCD_{it}-1)]\right\}dF(\alpha^*) \quad (12)$$

$$\text{where } \alpha^*=\frac{\alpha}{\sigma_\alpha}, \sigma_\alpha=\sqrt{\rho/(1-\rho)} \quad (13)$$

F is the distribution function of α^* and α is assumed to be normally distributed. The Gaussian–Hermite quadrature can be used to calculate the integral over α^*. The Heckman approach allows for unobserved heterogeneity and employs maximum likelihood estimation to solve the initial conditions problems.

4. Results and Discussion

4.1. Data and Summary Statistics

The data is taken from the Shenzhen stock exchange, one of the main markets in China. As there has been an increase in foreign exchange risks for Chinese firms in recent times, firms are more likely to use foreign currency derivatives, especially in the manufacturing sector, so we have focused on foreign exchange derivatives. In addition, disclosure of foreign currency derivative usage is clearer and more complete than other derivatives based on different underlying assets. Thus, we have chosen listed firms in the manufacturing industry, which is classified by the CSRC (China Securities Regulatory Commission), and collected the data related to the use of forward contracts, swaps and futures whose underlying asset is a foreign currency, from each of the company's annual reports. Due to concentrating on the use of foreign currency derivatives, only multinational corporations (MNCs) are considered, as is the case in Allayannis and Ofek (2001) and Pantzalis et al. (2001). The MNCs have been selected based on the ratio of foreign sales to total sales being greater than 10%. After excluding the firms with incomplete information and firms with extremely limited data, we obtained 316 firms' data running from 2012 to 2017. All the accounting data has been obtained from the Wind database, while the use of derivatives is hand collected by checking the annual reports of each firm for each year.

Table 1 summarizes the descriptive statistics; on average approximately 40% of the total firms used foreign currency derivatives. The number of users (firms with foreign currency derivatives) increased before 2015 and then fell back. By observing differences between users and non-users, we find that the degree of foreign sales is higher for users than non-users, which suggests that firms with a higher proportion of foreign business are more likely to use foreign currency derivatives. Derivative users also have more problems with information and agency, which differs to other studies and raises important questions about Chinese corporate finance. The control variables, leverage, the quick ratio and the long-term debt ratio, do not show distinct differences between users and non-users, but the average of users' total assets is higher than non-users' over the sample period. As we expected, firms using foreign currency derivatives have higher assets than firms who do not use derivatives. The operating income to total sales is used to measure the profitability of firms and according to the descriptive statistics, non-users tend to have lower profitability than users. However, the opposite occurs for the growth opportunities of firms, which is measured by capital expenditure to total assets. On average, users have fewer growth opportunities than non-users over the sample period.

Table A2 presents the correlation matrix for the variables in the sample (In Appendix A). As we can see from the table, all the correlations between paired variables are below 0.5, suggesting no evidence of serious multicollinearity. The level of exports is positively related to the foreign currency derivative usage. Focusing on the proxies for information transparency, we find that intangible assets has a positive correlation with foreign currency derivative use, consistent with the findings of Fauver and Naranjo (2010) that firms with opaque assets are more likely to use derivatives. The proxies for agency problems, internal

to external ownership and sales to total assets, show a positive correlation with the use of derivatives. Higher proportions of institutional shares and higher ratios of sales to total assets suggest better firm monitoring and fewer agency problems, while higher internal ownership indicates more concentrated ownership structures, which would lead to higher agency costs.

Table 1. Descriptive Statistics.

	2017		2016		2015		2014		2013		2012	
	Users	Non-Users	Users	Non-Users	Users	Non-Users	Users	Non-Users	Users	Non-Users	Users	Non-Users
FCD	94	222	94	222	101	215	97	219	76	240	69	247
Foreign sales/million, £	5251	1309	4227	1009	3640	957	3054	1103	3294	883	3423	746
Total sales/million, £	14,071	4914	11,326	3755	9563	3495	8241	4411	8450	4011	8479	3600
Total assets/million, £	19,833	8802	17,137	7620	12,480	6878	9348	6999	9022	5842	9000	5110
Export ratio	0.442	0.285	0.437	0.302	0.440	0.298	0.428	0.302	0.478	0.294	0.517	0.294
Quick ratio	1.319	1.773	1.558	1.813	1.793	1.622	2.321	1.796	3.518	1.820	2.437	2.317
Debt/EBITDA	3.456	4.190	5.028	0.786	1.742	3.823	2.908	2.954	3.826	7.286	4.037	−1.653
Information asymmetry	0.054	0.044	0.058	0.046	0.054	0.049	0.051	0.048	0.049	0.048	0.049	0.047
Internal ownership	0.322	0.293	0.337	0.290	0.341	0.309	0.360	0.326	0.368	0.343	0.375	0.354
Institutional ownership	0.444	0.343	0.446	0.356	0.423	0.355	0.431	0.342	0.419	0.343	0.310	0.320
Operating income to sales	0.067	0.060	0.070	0.029	0.056	0.010	0.070	0.044	0.064	0.034	0.061	0.051
Leverage	0.286	0.233	0.273	0.212	0.239	0.237	0.241	0.244	0.238	0.264	0.222	0.245
Sales to assets	0.686	0.571	0.679	0.519	0.724	0.538	0.763	0.598	0.803	0.624	0.832	0.626
Capital expenditure to sales	1.679	2.758	1.315	3.273	1.661	3.845	0.749	1.636	0.583	1.820	0.654	1.490

Notes: FCD represents the number of firms using foreign currency derivative; Export ratio refers to the ratio of foreign sales to total sales; Leverage is the ratio of total debt to total equity; The ratio of debt to EBITDA is measured by the ratio of debt to earnings before interest, taxes, depreciation and amortization; Information asymmetry is estimated by intangible assets to total assets; Internal ownership indicates the proportion of the value of the first shareholder; Institutional ownership represents the institutional ownership concentration of firms.

4.2. The Determinants of the Use of Foreign Currency Derivatives

The first stage involves finding factors that could determine the use of foreign currency derivatives for MNCs. We first employ a simple t-test for the difference in the average of the variables across foreign currency derivative and non-derivative using firms. The results in Table 2 show that firms using derivatives have a significantly larger size, higher profitability and fewer growth opportunities, while there is no significant difference in the quick ratio, debt to EBITDA and leverage. The level of exports of the firms using derivatives is significantly higher than firms without derivatives. Additionally, the table shows that firms using derivatives have more opaque assets at the 5% significance level. Firms not using derivatives have a significantly lower proportion of first share holders and a lower proportion of institutional ownership. Table 3 contains the results from the static Probit models, specification 1 is the base model, whilst 2 and 3 consider the importance of information asymmetry and agency problems in the financial markets. Specification 4 includes all the addressed factors and control variables in the regression. The probit model has robust standard errors clustered by firm and year and Table 4 provides the average marginal effects on derivatives usage.

Table 2. T-test of equality.

	Non-Users	Users	Difference	*t*-Test
EXP	0.296	0.453	−0.157	−14.318 ***
SIZE	15.047	15.462	−0.416	−7.762 ***
OPERATING INCOME/SALES	0.038	0.065	−0.026	−3.729 ***
CAPITAL EXPENDITURE/SALES	2.439	1.151	1.288	3.7912 ***
QR	1.866	2.095	−0.229	−1.207
LEVERAGE	0.240	0.251	−0.012	−1.140
DEBT/EBITDA	2.865	3.437	−0.572	−0.277
INTANGIBLE ASSETS/ASSETS	0.047	0.053	−0.006	−2.419 **
INTERNAL OWNERSHIP	0.320	0.349	−0.028	−4.024 ***
INSTITUTIONAL OWNERSHIP	0.343	0.417	−0.075	−6.368 ***
SALES/ASSETS	0.581	0.742	−0.161	−10.263

Notes: The Difference is the mean value of non-derivatives using firms minus the mean value of derivatives using firms. **, *** represents 1% and 0.1% significance level, respectively.

Table 3. Determinants of foreign currency derivatives: Static model.

	(1)	(2)	(3)	(4)
EXP	3.837 ***	3.773 ***	3.783 ***	3.704 ***
	(5.99)	(5.79)	(6.05)	(5.82)
SIZE	0.749 ***	0.768 ***	0.760 ***	0.779 ***
	(5.26)	(5.33)	(5.50)	(5.54)
LEVERAGE	−0.515	−0.474	−0.581	−0.541
	(−0.97)	(−0.84)	(−1.19)	(−1.03)
QR	0.0153	0.0173	0.0185	0.0212
	(0.88)	(1.00)	(1.11)	(1.28)
DEBT/EBITDA	0.00110	0.000949	0.000994	0.000831
	(0.79)	(0.70)	(0.77)	(0.65)
OPERATING INCOME/SALES	−0.503	−0.459	−0.605	−0.574
	(−0.56)	(−0.53)	(−0.68)	(−0.66)
CAPITAL EXPENDITURE/SALES	−0.0401 *	−0.0410 *	−0.0325 *	−0.0346
	(−1.77)	(−1.72)	(−1.65)	(−1.63)
INTANGIBLE ASSETS/ASSETS		5.816 **		6.055 ***
		(2.44)		(2.61)
INTERNAL OWNERSHIP			0.173	0.217
			(0.20)	(0.24)
INSTITUTIONAL OWNERSHIP			0.509	0.578
			(1.28)	(1.45)
SALES/ASSETS			0.977 ***	0.996 ***
			(2.92)	(2.92)
CONSTANT	−14.05 ***	−14.62 ***	−14.99 ***	−15.63 ***
	(−6.25)	(−6.42)	(−6.82)	(−6.95)
/lnsig2u	1.499 ***	1.521 ***	1.381 ***	1.396 ***
	(7.47)	(7.49)	(6.89)	(6.84)
N	1896	1896	1896	1896

Notes: *, **, *** represents 5%, 1% and 0.1% significance levels, respectively.

In contrast to much of the previous literature, this paper additionally considers the proportion of foreign sales to total sales as a determinant of derivatives usage. It can be seen from Table 3 that the coefficient on the export ratio is significant at the 1% level across all specifications, which implies that firms are more likely to employ risk management strategies by using foreign currency derivatives as the export ratio increases. As foreign sales take up a large proportion of total sales, firms would be more sensitive to changes in exchange rates. As a result, firms are more likely to choose foreign currency derivatives to reduce the risk of these exchange rate changes. In combination with the results of the average marginal effects from Table 4, the export ratio increases the probability of using currency derivatives by approximately 47.7%, which suggests that the degree of foreign business is one of the main motivations for hedging with foreign currency derivatives. In terms of control variables across different specifications, as we expected, the firm size, measured by the total assets, is positively related to the use of foreign currency derivatives at the 1% significance level. Large firms are more likely to have a higher probability of using foreign currency derivatives than small firms, as large firms would have more foreign exchange exposure. As can be seen from Table 4, a 1% increase in size would improve the probability of derivatives usage by about 10%. The leverage and the ratio of debt to EBITDA have no significant effects on the use of derivatives, which differs to the previous literature from developed countries, such as Fauver and Naranjo (2010). Also, liquidity, which is measured by the quick ratio, is not a significant determinant of derivatives usage. The ratio of operating income to sales is not a significant factor that could affect derivatives

usage, which indicates that the profitability of firms is not relevant to the use of foreign currency derivatives. However, the growth opportunity measure is significant, but not in the fourth specification which includes the measures for information asymmetry and agency problems together. In addition, the ratio of capital expenditure to total sales does not show any significant marginal effects for hedging with currency derivatives.

The effects of information asymmetry and agency problems produce differing results to Fauver and Naranjo (2010), reflecting the differing market conditions in China compared to the more developed economies. Fauver and Naranjo (2010) suggested that the negative effect was due to the firms' managers selectively using derivatives for speculation and the management of self interests. In China, where the financial environment is generally more controlled, according to the results, the opposite effect seems to be prevalent. In the second specification, intangible assets to total assets are used to represent the information asymmetry, which means that a higher ratio of intangible assets to total assets would result in severe problems of information asymmetry. It can be seen from these results that increased problems of information asymmetry lead to a higher probability of using derivatives by firms at the 1% significance level in the fourth specification. Additionally, Table 4 indicates that there is a positive marginal effect of intangible assets to assets on derivatives usage. The same conclusion occurs for agency problems in the third specification. We find that firms with higher sales to total assets are more likely to use foreign currency derivatives, but ownership concentration does not significantly affect derivative usage. Regarding Tables 3 and 4, the fourth specification also includes the ratio of intangible assets to total assets and shows that this ratio is more sensitive to the use of foreign currency derivatives, but the ownership concentration does not affect the decision to use foreign currency derivatives.

Table 4. Average marginal Effects.

	(1)	(2)	(3)	(4)
EXP	0.482 ***	0.469 ***	0.485 ***	0.471 ***
	(6.66)	(6.37)	(6.78)	(6.46)
SIZE	0.094 ***	0.096 ***	0.098 ***	0.099 ***
	(5.84)	(5.92)	(6.33)	(6.39)
LEVERAGE	−0.065	−0.059	−0.075	−0.069
	(−0.96)	(−0.84)	(−1.18)	(−1.03)
QR	0.002	0.002	0.002	0.003
	(0.88)	(1.01)	(1.11)	(1.28)
DEBT/EBITDA	0.000	0.000	0.000	0.000
	(0.80)	(0.70)	(0.77)	(0.65)
OPERATING INCOME/SALES	−0.063	−0.057	−0.078	−0.073
	(−0.56)	(−0.53)	(−0.68)	(−0.66)
CAPITAL EXPENDITURE/SALES	−0.005	−0.005	−0.004	−0.004
	(−1.74)	(−1.70)	(−1.64)	(−1.62)
INTANGIBLE ASSETS/ASSETS		0.723 *		0.769 **
		(2.48)		(2.64)
INTERNAL OWNERSHIP			0.022	0.028
			(0.20)	(0.24)
INSTITUTIONAL OWNERSHIP			0.065	0.073
			(1.30)	(1.47)
SALES/ASSETS			0.125 **	0.127 **
			(2.88)	(2.85)
N	1896	1896	1896	1896

Notes: *, **, *** represents 5%, 1% and 0.1% significance levels, respectively.

4.3. The Dynamics of the Use of Foreign Currency Derivatives

One of the main drivers for using derivative products is likely to be whether the firm has experience of using them previously. Focusing on the results from Table 5, the lagged dependent variable exhibits a significant effect at the 1% significance level over all four specifications using the two different approaches, supporting the need to incorporate a lagged dependent variable in this specification. At the same time, the size of the firm is still a significant determinant of currency derivatives usage. Information asymmetry measured by the intangible assets to total assets shows a positive effect at the 5% significance level on the decision to use derivatives in specification 2 but not in specification 4, which contains all the explanatory variables. In specifications 3 and 4, the higher the agency problems the higher probability of using foreign currency derivatives. However, it seems that the ownership structures do not exhibit significant effects on derivatives usage.

Table 5. The dynamics of foreign currency derivatives usage.

	(1)		(2)		(3)		(4)	
	Standard	**Heckman**	**Standard**	**Heckman**	**Standard**	**Heckman**	**Standard**	**Heckman**
L.FCD	2.377 ***	2.196 ***	2.380 ***	2.073 ***	2.327 ***	2.073 ***	2.329 ***	2.061 ***
	(14.65)	(17.98)	(15.55)	(8.95)	(15.57)	(9.64)	(16.31)	(9.66)
EXP	1.130**	1.291 ***	1.140 **	1.168 ***	1.148 **	1.159 ***	1.159 ***	1.183 ***
	(1.98)	(5.62)	(2.17)	(3.79)	(2.45)	(3.76)	(2.68)	(3.88)
SIZE	0.189 **	0.205 ***	0.194 **	0.220 ***	0.165 **	0.184 ***	0.170 **	0.192 ***
	(2.21)	(3.87)	(2.38)	(3.17)	(2.26)	(2.72)	(2.40)	(2.79)
LEVERAGE	−0.033	−0.053	−0.024	0.012	0.056	0.078	0.061	0.086
	(−0.12)	(−0.18)	(−0.09)	(0.04)	(0.21)	(0.25)	(0.23)	(0.26)
QR	−0.001	0.000	−0.001	0.001	0.003	0.005	0.004	0.005
	(−0.12)	(0.01)	(−0.12)	(0.07)	(0.44)	(0.32)	(0.49)	(0.33)
DEBT/EBITDA	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(−0.39)	(−0.52)	(−0.45)	(−0.48)	(−0.36)	(−0.35)	(−0.42)	(−0.44)
OPERATING INCOME/SALES	−0.128	−0.079	−0.186	0.002	0.069	0.186	0.016	0.147
	(−0.25)	(−0.14)	(−0.37)	(0.00)	(0.12)	(0.31)	(0.03)	(0.24)
CAPITAL EXPENDITURE/SALES	−0.030 *	−0.030 *	−0.037 *	−0.034 *	−0.018	−0.017	−0.023	−0.022
	(−1.65)	(−1.78)	(−1.77)	(−1.75)	(−1.19)	(−1.05)	(−1.28)	(−1.18)
INTANGIBLE ASSETS/ASSETS			2.572 **	2.887 **			2.753 **	3.101 **
			(2.08)	(2.35)			(2.14)	(2.47)
INTERNAL OWNERSHIP					0.206	0.224	0.212	0.231
					(0.53)	(0.56)	(0.54)	(0.57)
INSTITUTIONAL OWNERSHIP					0.266	0.344	0.266	0.348
					(1.10)	(1.33)	(1.12)	(1.32)
SALES/ASSETS					0.461 **	0.441 **	0.477 **	0.472 **
					(1.97)	(2.27)	(2.03)	(2.38)
CONSTANT	−4.605 **	−4.882 ***	−4.805 ***	−5.232 ***	−4.757 ***	−5.065 ***	−4.976 ***	−5.367 ***
	(−3.09)	(−6.12)	(−3.33)	(−4.67)	(−3.48)	(−4.53)	(−3.72)	(−4.65)
N	1580	1580	1580	1580	1580	1580	1580	1580

Notes: *, **, *** represents 5%, 1% and 0.1% significance levels, respectively.

Comparing the results to the standard estimation and the Heckman estimator, this suggests that the Heckman estimation gives a further reduction in the coefficients of the lagged derivatives usage across the four different specifications. For example, it is shown that under the standard estimation, which regards the initial conditions, the coefficient on the lagged dependent variable is 2.329 in specification 4. The coefficient experiences an 11% reduction when using the Stewart (2006) approach, decreasing to 2.061. The estimated effects of all other explanatory variables are smaller than the estimated effects from using the standard estimation. Therefore, it can be seen from the results that the lagged effects have been better scaled by using Stewart (2006)'s approach.

The analysis was also conducted with the inclusion of industry dummy variables, as set out in Table 6, to determine whether controlling for the different manufacturing industries affects the result. As in Table A1 in the appendices, there are nine separate industries, where the dummy variable takes the value of 1 for the industry and 0 otherwise. Although the dummy variables are nearly all significant across the specifications, they don't materially affect the overall results. However, the results suggest a differing demand for derivative products across industries.

Table 6. Robustness test for the dynamic model with industry dummies.

	(1)	(2)	(3)	(4)
L.FCD	2.359 *** (24.44)	2.366 *** (24.41)	2.318 *** (23.65)	2.326 *** (23.60)
EXP	1.215 *** (5.77)	1.194 *** (5.66)	1.240 *** (5.66)	1.218 *** (5.56)
SIZE	0.190 *** (4.14)	0.194 *** (4.18)	0.167 *** (3.37)	0.171 *** (3.41)
LEVERAGE	−0.056 (−0.21)	−0.032 (−0.12)	0.048 (0.18)	0.067 (0.24)
QR	−0.004 (−0.48)	−0.004 (−0.46)	0.000 (0.03)	0.000 (0.06)
DEBT/EBITDA	−0.000 (−0.35)	−0.001 (−0.43)	−0.001 (−0.35)	−0.001 (−0.44)
OPERATING INCOME/SALES	−0.118 (−0.21)	−0.163 (−0.29)	0.0882 (0.15)	0.0406 (0.07)
CAPITAL EXPENDITURE/SALES	−0.029 (−1.78)	−0.036 (−1.81)	−0.017 (−1.12)	−0.022 (−1.18)
D1	3.511 *** (10.5)	3.604 *** (10.42)	0.121 (0.31)	3.089 *** (9.28)
D2	3.680 *** (17.48)	3.770 *** (17.49)	0.303 (1.24)	3.291 *** −15.05
D3	3.910 *** (11.02)	3.954 *** (11.58)	0.493 ** (2.99)	3.178 *** −9.12
D4	4.001 *** (11.93)	4.053 *** (11.99)	3.128*** (9.68)	3.581 *** −10.72
D5	3.849 *** (30.96)	3.916 *** (29.61)	3.329 *** (15.29)	3.436 *** (25.91)
D6	3.924 *** (25.53)	3.926 *** (25.27)	3.275 *** (9.02)	3.345 *** (18.63)
D7	3.831 *** (27.43)	3.890 *** (26.83)	3.663 *** (11.01)	3.454 *** (22.93)
D8	3.710 *** (31.34)	3.810 *** (29.97)	3.497 *** (27.01)	3.302 *** (25.1)
INTANGIBLE ASSETS/ASSETS		2.364 * (2.48)		2.644 ** (2.63)
INTERNAL OWNERSHIP			3.483 *** (19.46)	0.165 (0.43)
INSTITUTIONAL OWNERSHIP			3.526 *** (23.59)	0.307 (1.28)
SALES/ASSETS			3.330 *** (25.9)	0.511 ** (3.11)
CONSTANT	−8.436 *** (−12.41)	−8.674 *** (−12.36)	−8.244 *** (−11.59)	−8.392 *** (−11.40)
N	1580	1580	1580	1580

Notes: The Difference is the mean value of non-derivatives using firms minus the mean value of derivatives using firms. *, **, *** represents 5%, 1% and 0.1% significance level, respectively.

Table 7 presents the various robustness tests for the dynamic probit model by including the exchange rate and a non-linear exports variable in the regressions. The exchange rate is represented by the amounts of renminbi per dollar over the sample period. Overall, the results have not changed with the lagged derivatives usage being significantly related to current hedging decisions and also the level of exports and the firm size remaining as significant effects on the use of derivatives across different specifications. Furthermore, as expected, the use of derivatives is negatively related to the exchange rate[3], which suggest that firms are more likely to hedge with derivatives when the renminbi has appreciated to a high level, as this could create an expectation of a future depreciation so incurring a potential future loss to the firm unless it hedges.

Table 7. Robustness tests for the dynamic model.

	(1)	(2)	(3)	(4)	(5)	(6)
L.FCD	2.239 ***	2.250 ***	2.221 ***	2.223 ***	2.327 ***	2.332 ***
	(18.18)	(18.33)	(16.03)	(16.12)	(16.29)	(15.81)
EXP	1.286 ***	1.289 ***	1.281 ***	1.295 ***	1.155 **	1.506 *
	(5.60)	(5.62)	(4.74)	(4.81)	(2.69)	(2.42)
SIZE	0.238 ***	0.242 ***	0.216 ***	0.221 ***	0.167 *	0.170 *
	(4.35)	(4.41)	(3.53)	(3.60)	(2.37)	(2.32)
LEVERAGE	−0.128	−0.121	−0.028	−0.020	0.063	0.049
	(−0.43)	(−0.40)	(−0.09)	(−0.06)	(0.24)	(0.18)
QR	−0.001	−0.001	0.003	0.004	0.004	0.004
	(−0.07)	(−0.07)	(0.24)	(0.28)	(0.48)	(0.51)
DEBT/EBITDA	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(−0.54)	(−0.62)	(−0.44)	(−0.54)	(−0.42)	(−0.44)
OPERATING INCOME/SALES	0.013	−0.044	0.146	0.095	0.021	0.006
	(0.02)	(−0.08)	(0.26)	(0.16)	(0.04)	(0.01)
CAPITAL EXPENDITURE/SALES	−0.025	−0.031	−0.016	−0.020	−0.023	−0.022
	(−1.52)	(−1.69)	(−0.95)	(−1.10)	(−1.28)	
ER	−0.548 ***	−0.546 ***	−0.496 **	−0.488 **		
	(−2.84)	(−2.82)	(−2.51)	(−2.46)		
INTANGIBLE ASSETS/ASSETS		2.565 *		2.898 ***	2.753 *	3.493 *
		(2.47)		(2.62)	(2.15)	(2.13)
INTERNAL OWNERSHIP			0.131	0.133	0.214	0.182
			(0.35)	(0.35)	(0.55)	(0.45)
INSTITUTIONAL OWNERSHIP			0.346	0.349	0.268	0.465
			(1.41)	(1.41)	(1.13)	(1.07)
SALES/ASSETS			0.455 **	0.479 ***	0.476 *	0.479 *
			(2.55)	(2.66)	(2.03)	(2.01)
RESEARCH AND DEVEOPMENT EXPENDITURE					0.000	
					(0.70)	
EXP*INTANGIBLE ASSETS/ASSETS						−2.318
						(−0.75)
EXP*INSITUTIONAL OWNERSHIP						−0.560
						(−0.59)
CONSTANT	−1.879	−2.072	−2.389	−2.677	−4.933 ***	−5.080 ***
	(−1.43)	(−1.56)	(−1.67)	(−1.85)	(−3.71)	(−3.65)
N	1580	1580	1580	1580	403	1580

Notes: *, **, *** represents 5%, 1% and 0.1% significance levels, respectively.

The inclusion of the squared export term alongside the linear export term, to account for any non-linear relationship between exports and derivative use, produces a negative squared term, however, it is only significant at 10%, whilst the non-squared term remains positive and significant. This suggests a weak inverted U-shaped relationship between exports and derivative use, as expected, with derivative use rising initially as exports rise, but then declining for larger exporters as they are able to hedge internally.

A final set of robustness tests included adding a further variable for the firm's research and development expenditure to the specification. The intangible assets/total assets variable has been used to proxy for information asymmetry, however, it could also represent the level of innovations within a firm. To model how innovative a firm is more explicitly, we have added the research and development expenditure variable, however, it is not significant and has not materially affected the overall results, including the assets/intangible assets variable, it is not proxying for innovation. However, this was on a reduced sample as not all of the firms had data on research and development expenditure. We have also added two interaction terms, this involves interacting the export variable with the information asymmetry variable and the agency cost variable. The results are in column 6 and show both variables are not significant, suggesting the levels of exports of a firm do not interact with information asymmetry or agency costs when a firm is deciding on whether to hedge.

5. Conclusions and Discussion

This study uses both the static probit regression and dynamic probit regression to explore the determinants of foreign currency derivatives among Chinese multinationals listed on the Shenzhen stock exchange. The findings show that the inclusion of the dynamic effect in this model is important and the degree of foreign sales are positively and predominantly linearly related to the use of foreign currency derivatives, which suggests that firms with a higher proportion of foreign sales to total sales are more likely to use them to minimize their foreign exchange exposure. As with Fauver and Naranjo (2010), larger firms are more likely to use foreign currency derivatives, which suggests that larger firms are more likely to use risk management. In addition, the increasing growth opportunities available to firms enhances the probability of using foreign currency derivatives, which implies that a good investment environment would motivate the development of a derivatives market.

Both information asymmetry and agency problems are significantly related to the use of foreign currency derivatives, but firms are more likely to use derivatives when there is more information asymmetry and agency problems, which is contrary to other literature. This finding could be because the Chinese financial markets and derivatives markets are not as efficient and transparent as in the U.S. and U.K. and the regulation of the markets is, as yet, not as developed. Compared with standard random effects models, the Stewart (2006) approach, which allows for endogeneity and implementing the Heckman estimator, performs better. Thus, the previous decision to use foreign currency derivatives could signal the decision to use derivatives and risk management strategies during the next period.

The policy implications arising from this study are that the factors determining derivative use in China differ to those in some other countries, so the authority will need to take these into account as it develops its regulatory environment for the derivatives market. This is important because, as seen during the 2007/08 financial crisis, the ineffective regulation of these markets can have serious implications for their stability and the wider financial sector. Future research could focus on the non-linear nature of these relationships, which may become more evident as derivatives become more widespread. The main limitations of the study are that a longer time series of data would have been beneficial, as data was not available before 2012. In addition, more comprehensive proxies for information asymmetry and agency costs could be added as the data becomes available. Overall, the results are similar to previous studies, although the information asymmetry and agency costs effects have differing signs to previous studies such as Fauver and Naranjo (2010) that used U.S. data. This was due to the restricted opportunities in China to use hedging instruments for

speculation compared to the U.S. Overall the main drivers of derivative usage are exposure to foreign markets, as in Bae et al. (2018), and the size of the firm, as in Dharmiyanti and Darmayanti (2020). As noted, the main implication of the study is the importance of derivatives to hedge risk for firm's that are active in overseas markets, as China's exchange rate becomes more volatile. Future research as more data becomes available, could analyse how the relationship varies across the currencies the exports are denominated in and how the deregulating of the Chinese derivative markets affects the factors driving their use.

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Appendix A

Table A1. The classification of manufacturing sector.

Industry Dummy	Industry Classification	The Number of Firms
D1	Food and beverages manufacturing	6
D2	Textile	15
D3	Wood products and furniture manufacturing	3
D4	Paper making and products and printing	7
D5	Chemicals and plastic manufacturing	72
D6	Ferrous and non-ferrous metal foundries and presses	34
D7	Engineering equipment manufacturing	69
D8	Electronic equipment manufacturing	107
D9	Miscellaneous manufacturing	3

Table A2. Correlation coefficients.

Variables	FCD	EXP	SIZE	OI/ SALES	CAPEX/ SALES	QR	LEVERAGE	DEBT/ EBITDA	IA/ASSETS	INTERNAL OWNERSHIP	INSTITUTIONAL OWNERSHIP	SALES/ ASSETS
FCD	1											
EXP	0.31	1										
SIZE	0.18	−0.08	1									
OI/SALES	0.09	0.08	0.06	1								
CAPEX/SALES	−0.08	−0.01	−0.07	−0.69	1							
QR	0.02	0.11	−0.16	0.15	0	1						
LEVERAGE	0.02	−0.04	0.42	−0.29	0.07	−0.29	1					
DEBT/EBITDA	0.01	−0.01	0.05	0	−0.02	−0.02	0.04	1				
IA/ASSETS	0.06	0	−0.06	−0.08	0.07	−0.01	−0.01	0.03	1			
INTERNAL OWNERSHIP	0.09	0.03	0.07	0.08	−0.08	0.01	−0.03	0	−0.04	1		
INSTITUTIONAL OWNERSHIP	0.15	0.14	0.28	0.03	−0.03	−0.04	0.07	0.02	−0.04	0.36	1	
SALES/ASSETS	0.23	−0.01	0.1	0.05	−0.19	−0.16	0.05	0	−0.06	0.16	0.2	1

EXP, SIZE, OI/SALES, CAPEX/SALES, QR, IA/ASSETS refer to the ratio of foreign business to total sales, the logarithm of total assets, the ratio of operating income to total sales, the ratio of capital expenditure to total sales, quick ratio and intangible assets to total assets.

Notes

[1] For example according to the BIS, approximately 60% of foreign exchange trading in China's interbank foreign exchange market was made up of derivative products in 2018, having risen from a negligible amount in 2005.

[2] Another common difference between firms in China is whether they are controlled by the state. There were 27.5% firms that were state controlled in this sample, in which the state in some form was the largest shareholder. Using a dummy variable to represent the firm's ownership, we found no significant effect of being state controlled on the use of derivatives, so removed this variable from the subsequent analysis.

[3] Exchange rate volatility was also tried as an extra explanatory variable, but was not as significant as the exchange rate, its inclusion also did not affect the overall results.

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