

# **Monetary policy, credit constraints, and firm exports: Evidence from**

## **China**

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### **Abstract**

Motivated by the credit channel of monetary policy transmission literature and the recently developed credit constraints and trade literature, this study makes the first attempt in the literature to investigate how monetary policy affects exports through the credit channel in China. Using unique Chinese firm level data, we find strong evidence that, by alternating credit supply conditions, monetary policy has large and significant effects on firm export probability and export revenue, and the effects are significantly stronger for financially more constrained firms. Our results are robust to alternative samples and measures of monetary policy and credit constraints.

*Keywords:* monetary policy; credit channel; credit constraints; exports

*JEL classification:* E44, E51, E52, F14, F23, G32

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## 1. Introduction

How does monetary policy affect exports? While existing studies primarily focus on the conventional exchange rate channel, we propose a new channel through which monetary policy (combined with credit constraints) can potentially have an impact on exports: the credit channel.<sup>1</sup> Our study is motivated by the credit channel of monetary policy transmission literature in monetary economics (e.g., Bernanke and Blinder, 1992; Bernanke and Gertler, 1995; Gertler and Gilchrist, 1994; Kashyap et al., 1993) and the recently developed credit constraints and exports literature in international trade (e.g., Amiti and Weinstein, 2009; Beck, 2002; Chor and Manova, 2010; Feenstra et al., 2011; Ju and Wei, 2011; Manova, Wei, and Zhang, 2011; Minetti and Zhu, 2010). The former posits that, due to credit market frictions, firms often find it more difficult/costly to obtain external finance during tight-money periods, while the latter emphasizes the crucial role of access to credit in facilitating firm exports. Combining the above two literatures, we hypothesize that, by alternating credit supply conditions, monetary policy should have a negative effect on firm export activities, and this effect should be larger for financially more constrained firms.

We then put this novel hypothesis into a test using a unique Chinese firm level dataset. There are several reasons why we are particularly interested in China. First, Chinese exports play an important and growing role in world trade and have raised

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<sup>1</sup> See, among others, Bacchetta and van Wincoop (2000), Frankel and Wei (1993), Rose and van Wincoop (2001), Sekkat and Varoudakis (2000), Sercu and Uppal (2003) for the effects of exchange rate and volatility on trade. Also, see Mishkin (1995) for an excellent summary of the exchange rate channel.

many issues and debates recently. Understanding its firm export behavior, therefore, is of great importance to the trade literature. Second, similarly, given the rising role of China in the world economy, its monetary policy will not only have impacts on its own economy, but influences on the world economy as well. Understanding the conduct and transmission mechanism of Chinese monetary policy is thus of great interest to both researchers and policymakers. Third, as detailed in Section 2.2, there are several institutional features that make Chinese monetary policy unique and ideal for examining the credit channel of monetary policy transmission.

We start our empirical analysis by first examining the average effect of monetary policy on firm export probability and revenue. We find that a reduction in bank loan supply significantly lowers both firm export probability and export revenue in China. More interestingly, we also investigate how credit constraints impact the effects of monetary policy. We show that changes in credit supply conditions have significantly stronger effects for financially more constrained firms. Our results are robust to alternative samples and measures of monetary policy and financial constraints.

To further disentangle demand and supply factors in our measures of monetary policy, we then examine the effects on export to output ratio. This identification strategy is based on two important features on exporting. First, it depends more on foreign demand relative to output. Second, it is also more credit dependent. We find that a fall in the loan to GDP ratio significantly reduce firms' export to output ratio and the negative effects of a tightening are significantly smaller for financially less

constrained firms. This finding is consistent with the credit channel hypothesis.

Overall, the empirical results are strongly in favor of the theoretical predictions.

Our study makes several important contributions. First, we identify a new channel through which monetary policy can influence exports. We show that, in addition to the conventional exchange rate channel, by alternating credit supply conditions, monetary policy can also have a large and significant effect on firm export activities through the credit channel in China. Second, our results complement nicely with the existing findings in the credit channel literature and the credit constraints and exports literature. On the one hand, they are consistent with those reported in previous studies on the credit channel of monetary policy. On the other hand, our results provide additional support to the credit constraints and exports literature as they suggest that changes in credit supply conditions can have large effects on firm exports, and the effects are significantly stronger for financially more constrained firms. Finally, our findings also have important policy implications for the conduct of monetary policy in countries with an underdeveloped financial sector, such as China.

The rest of the paper is organized as follows. Section 2 describes our datasets and key variable definitions. Sections 3 and 4 report our main empirical results on firm export probability and revenue, respectively. To disentangle demand and supply factors in our measures of monetary policy, we examine the effects on firm export to output ratio in Section 5. A variety of robustness checks are conducted in Section 6. Section 7 offers our conclusions.

## **2. Data**

### ***2.1. Data Sources***

Our main data source is the annual surveys of Chinese manufacturing firms conducted by the National Bureau of Statistics of China (NBSC). This dataset covers all state-owned enterprises (SOEs) and non-state-owned enterprises with annual sales of 5 million RMB or higher for the years 1998-2007. It is an unbalanced sample with increasing number of firms from 165118 firms in 1998 to 336730 firms in 2007. For each firm, the survey data contains detailed export and production information, financial statements information as well as firm identification (e.g., company name, telephone number, zip code, contact person, etc.). This dataset has been widely used by previous studies on Chinese economy (e.g., Feenstra et al., 2011; Brandt et al. 2012; Song et al., 2011).

### ***2.2. Measures of monetary policy stance***

There are two important institutional features of Chinese monetary policy. First, unlike most advanced economies, China's financial sector is underdeveloped and does not have a fully market-based benchmark interest rate. Second, China's financial sector is overwhelmingly dominated by commercial banks, particularly large state-owned banks. Historically, the conduct of China's monetary policy was mainly through direct administrative controls of bank loans. Before the 1998 monetary policy reform, the People's bank of China set annual total bank loan quotas and distributed bank loans among different banks and across different regions. In January 1998, the People's bank of China announced that it would no longer set explicit loan quotas for

commercial banks and also officially switched to M2 growth as its intermediate target. Nonetheless, the central bank still sets an implicit loan quota at the beginning of each year (and often adjusts it in the middle of the year) and closely monitors banks' lending behavior (particularly that of large state-owned banks). As a result, bank loan control keeps playing a crucial role in the conduct of monetary policy even in the post-1998 era. A recent study by Sheng and Wu (2008) finds that, during the 1998-2006 period, the People's bank of China had a de facto dual intermediate target: bank loans and M2. Specifically, the central bank uses bank loans to influence the real economy and uses M2 to influence the financial markets. They also show that the conventional money channel does not exist in China, and its main transmission mechanism of monetary policy is through the credit channel. Therefore, in our study, we use total bank loan to GDP ratio as our main measure of China's monetary policy stance.<sup>2</sup> Nonetheless, we also use M2 growth as an alternative measure monetary policy stance to ensure robustness of our results.

### ***2.3. Proxies for credit constraints***

To test our hypotheses, it is also crucial to find an appropriate proxy of credit constraints. Several proxies have been considered in the related literatures. First, a large number of studies have well documented that firm ownership plays a key role in obtaining external finance in China (e.g., Boyreau-Debray and Wei 2005; Dollar and Wei, 2007; Héricout and Poncet, 2007; Huyghebaert et al., 2006; Guariglia et al. 2011, Manova et al., 2011; Poncet et al. 2010; Riedel et al., 2007; Song et al. 2011). China's

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<sup>2</sup> In addition to loan/GDP ratio, we also tried loan growth rate. The results are very similar.

state-run bank-dominated financial system prefers to offer credit to state-owned firms than domestic private firms. The latter faces higher credit constraints and have to rely mainly on internal finance or finance from the informal financial sector (e.g., Allen et al., 2005; Ayyagari et al., 2010). In addition, compared to domestic private firms, firms with partial or full foreign ownership are also less constrained as they are able to borrow from parent companies which have access to international financial markets. Motivated by the above facts, a recent study by Manova et al. (2011) uses firm organizational structure as their measure of credit constraints faced by Chinese firms. Here we employ the same strategy and exploit the systematic variation in export behavior across firms with different ownership and across periods with different credit supply conditions to establish a causal effect of monetary policy and credit constraints on firm exports. Following Dollar and Wei (2007), we use *de facto* firm ownership rather than the registered *de jure* firm organizational structure as proxy of access to external finance as firm organizational structure often change overtime. We divide firms in our sample into four groups based on the equity information provided in survey data. Specifically, we define a wholly foreign-owned firm if its foreign equity share is 100%. A joint venture is defined as a firm with positive foreign equity share. We then create a category of majority state-owned firms if the state equity share is over 50% and with no foreign share. The rest firms are considered as domestic private firms. We expect that domestic private firms are more credit constrained and are, thus, more likely to be affected by domestic credit supply conditions.

Second, recent studies in the trade and finance literature have also exploited differences in the sensitivity to credit availability across sectors (e.g. Chor and Manova, 2012; Manova, 2008, 2012; Manova et al. 2011). Following these studies, we consider four sector financial vulnerability variables, namely external finance dependence, R&D intensity, inventories to sales ratio, and asset tangibility, as our second set of credit constraint measures. External finance dependence captures firms' requirements for outside capital and is constructed using Rajan and Zingales' (1998) method. R&D intensity is defined as the share of R&D spending in total sales. The ratio of inventories to sales ratio captures the duration the manufacturing process and the working capital associated with inventory maintenance. While external finance dependence and R&D intensity reveal firms' long-term investment requirements and reflect mainly fixed costs, inventories ratio captures firms' short-run liquidity needs and thus are associated mostly with variable costs. Asset tangibility is calculated as the ratio of tangible assets to total book-value assets. Data for those four measures are obtained from Manova et al. (2011).<sup>3</sup> In our empirical analyses, we expect to find that the effects of monetary policy are significantly stronger for firms with higher levels of external finance dependence, R&D intensity, inventories ratio or lower levels of asset tangibility.

Finally, studies in the credit channel of monetary policy transmission often use firm size to measure a firm's access to external finance (e.g., Bernanke et al., 1996; Gertler and Hubbard, 1998; Gertler and Gilchrist, 1994; Kashyap et al., 1994;

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<sup>3</sup> See Manova et al. (2011) for detailed discussions on constructing those variables.

Kashyap and Stein, 1995; Oliner and Rudebusch, 1995, 1996). A potential complication of this approach is that, while firm size is important in getting external finance, it is also likely to reflect industry characteristics, which makes the results difficult to interpret. Nonetheless, as a robustness check, we still use firm size, measured by (log) total assets, as an alternative proxy for credit constraints in this study. A finding that monetary policy has weaker effects on larger firms' export activities will be supportive evidence to our hypotheses.<sup>4</sup>

### 3. The effects on export probability

#### 3.1. The average effects of monetary policy

We first examine the effects of monetary policy on firm export probability using a probit model by regressing the export dummy on a constant term, a measure of monetary policy, and a lagged dependent variable. The probit model is specified as the following:

$$EXP_{it}^* = \alpha_0 + \alpha_1 MP_t + \gamma X_{it} + \varepsilon_{it} \quad (1)$$

$$EXP_{it} = 1 \text{ if } EXP_{it}^* > 0; \text{ } EXP_{it} = 0 \text{ otherwise}$$

where  $EXP$  is an indicator for whether the latent variable  $EXP^*$  is positive,  $MP$  represents a measure of monetary policy, and  $\varepsilon$  is a random error with a standard normal distribution.  $X$  is a set of commonly used control variables including

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<sup>4</sup> Some studies have also used firm balance-sheet variables as measures of financial constraints (e.g., Berman and Héricout, 2008; Minetti and Zhu, 2010; Mu ùls, 2008). A disadvantage of this strategy, however, is that it is difficult to establish a causal link between credit constraints and exports as balance-sheet variables are endogenous to firms' exporting behavior (e.g., Greenway et al. 2007).

ownership dummies, log productivity, log total asset as a measure of firm size, firm age, and real effective exchange rate.<sup>5</sup>

The results are reported in the first column Table 1. We find strong evidence that monetary policy has statistically significant effects on firm export probabilities as the estimated coefficient on loan to GDP ratio is positive and highly significant. In particular, a reduction in loan to GDP ratio is associated with a significantly lower export probability. Moreover, the estimated effect is also quantitatively important. The estimated marginal effect of loan to GDP ratio is 0.022.<sup>6</sup> That is, a one standard deviation reduction (increase) in loan to GDP ratio lowers firm export probability by roughly 1 percentage point on average.<sup>7</sup> Given that the export probability in the sample is only about 24.5%, the above estimated marginal effect is economically meaningful.

As for the control variables, we find that estimated coefficients on foreign-owned and joint venture dummies are positive and significant while the one on state-majority dummy is negative and significant. The results thus suggests that, compared to domestic private firms, foreign-owned firms joint venture are more likely to export but state-owned firms are less likely to export. There is also strong evidence that larger, older, and more productive firms are more likely to export. Finally, depreciation in real effective exchange rate significantly increases export probability.

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<sup>5</sup> Firm productivity is estimated using Levinsohn and Petrin's (2003) method.

<sup>6</sup> Marginal effects are evaluated at the sample means of all covariates.

<sup>7</sup> This number is obtained by multiplying the estimated marginal effect by the sample standard deviation.

### 3.2. The interaction effects of monetary policy and credit constraints

The above results show that a fall in loan to GDP ratio significantly reduces firm export probability. In this section, we explore further whether this effect depends on credit constraints. We examine first the potential heterogeneous effects of monetary policy across firm ownership. In Column (2) of Table 1, we add the interaction terms between loan to GDP ratio and the ownership dummies to the probit regression.

$$EXP_{it}^* = \alpha_0 + \alpha_1 MP_t + \beta_1 MP_t * Df_{it} + \beta_2 MP_t * Djv_{it} + \beta_3 MP_t * Ds_{it} + \gamma X_{it} + \varepsilon_{it} \quad (2)$$

$$EXP_{it} = 1 \text{ if } EXP_{it}^* > 0; \text{ } EXP_{it} = 0 \text{ otherwise}$$

where  $Df$ ,  $Djv$ , and  $Ds$  are dummies for foreign-owned firms, joint ventures and state-owned firms, respectively.  $MP * Df$ ,  $MP * Djv$  and  $MP * Ds$  are the corresponding interaction terms. The omitted group here is domestic private firms.

The estimated coefficient on loan to GP is found to be positive and significant, indicating that a drop in loan to GDP ratio significantly lowers domestic private firms' (the omitted group) export probability. More interestingly, we also find that the estimated coefficients on the three interaction terms are all negative and significant at the 1% level. That is, compared to domestic private firms, the effects of monetary policy on export probability are significantly smaller for foreign-owned firms, joint ventures, and state-owned firms, which are financially less constrained. The estimated interaction effects are also of quantitative importance. For example, the estimated coefficient on loan to GDP ratio for foreign-owned firms and joint ventures are 0.047 (0.094-0.047) and 0.044 (0.094-0.050), respectively. Both are only about half of that

on domestic private firms (0.094). The one on state-owned firms is even slightly negative (0.094-0.111).

In the third column of Table 1, we also include year dummies,  $v_t$ , as additional regressors in the probit regression to control for the impacts of common time trend variables on firm export probabilities.

$$EXP_{it}^* = \alpha_0 + \beta_1 MP_t * Df_{it} + \beta_2 MP_t * Djv_{it} + \beta_3 MP_t * Ds_{it} + \gamma X_{it} + v_t + \varepsilon_{it} \quad (3)$$

$$EXP_{it} = 1 \text{ if } EXP_{it}^* > 0; \text{ } EXP_{it} = 0 \text{ otherwise}$$

The monetary policy variable and real effective exchange rate submerge once year dummies are included. Nonetheless, the results confirm our previous finding that monetary policy has a larger effect on financially more constrained domestic private firms even after controlling for common time trend. The estimated coefficients on the three interaction terms are again found to be negative and highly significant.

Next, in Columns (4) and (5) of Table 1, we investigate the interaction effects of monetary policy and our second measure of credit constraint, firm size. In Column (4), the estimated coefficient on loan/GDP is positive and significant, but the coefficient on the interaction term is negative and significant, meaning that the positive effect of loan/GDP on firm export probability diminishes with firm size. Since larger firms are financially less constrained, their export decisions are less likely to be affected by changes in credit supply conditions. Column (5) further includes year dummies to the regression. The main results remain unaffected. We again find that the effects of loan/GDP on firm export probability are significantly smaller for

larger firms. The estimated effects of the control variables are similar to those reported in previous columns of Table 1.

Finally, we explore the interaction effects between monetary policy and measures of sector financial vulnerability. We employ four measures of financial vulnerability commonly used in the literature, namely external finance dependence, R&D intensity, inventories to sales ratio, and asset tangibility. For each measure, we create an interaction term and estimate the following probit model:

$$EXP_{it}^* = \alpha + \beta MP_t * FV_{it} + \gamma X_{it} + v_t + \varepsilon_{it} \quad (4)$$

$$EXP_{it} = 1 \text{ if } EXP_{it}^* > 0; EXP_{it} = 0 \text{ otherwise}$$

where  $MP * FV$  represents the interaction term between monetary policy and a financial vulnerability measure.

The results are reported in Columns (1)-(4) of Table 2. In all regressions, we find that the estimated coefficients on the interaction terms have expected signs and are highly significant, indicating that that monetary policy have larger effects for firms that have higher levels of external finance dependence, R&D intensity, inventory ratio or lower levels of asset tangibility. The evidence obtained here is thus consistent with those demonstrated in Table 1. In general, we find that the effects of monetary policy on export probability are significantly stronger for financially more constrained firms.

With regard to the controls, we still find that foreign-owned and joint ventures have higher export propensity while state-owned firms are less likely to export. In

addition, export probabilities are significantly higher for larger, older, and more productive firms in China.

#### **4. The effects on export revenue**

##### ***4.1. The average effects of monetary policy***

The analysis has so far examined the effects of monetary policy and credit constraints on firms' decisions on exporting. In this section, we explore further the effects on firm export revenue. An econometric issue in estimating the effects on export revenue is that there are non-exporting firms and firms that only export in certain years in the enterprise survey data. Since factors that influence a firm's export decision are also likely to affect its export revenue, simply discard these observations and use the OLS estimation method will lead to biased estimates. To avoid this potential sample-selection bias, here we estimate the effects of monetary policy on firm export revenue using the following tobit model and treat zero export revenue as left-censored observations:

$$y_{it}^* = \alpha_0 + \alpha_1 MP_t + \beta X_{it} + \varepsilon_{it} \quad (5)$$

$$y_{it} = y_{it}^* \text{ if } y_{it}^* > 0; y_{it} = 0 \text{ otherwise}$$

where the observable variable is  $y_{it}$  is defined as  $\ln(1 + \text{export revenue})$  and is equal to the latent variable  $y_{it}^*$  whenever the latent variable is positive and zero otherwise.  $X$  is the same set of control variables used in the previous probit regressions including firm ownership dummies, log productivity, firm size and age.

We report this tobit regression results in Column (1) of Table 3. The estimated coefficient on loan to GDP ratio is found to be positive and significant at the 1% level. The evidence thus suggests strongly that a reduction in loan to GDP ratio significantly reduces firm export revenues. In addition, the estimated effects are also economically large. The estimated marginal effects of loan to GDP ratio is 0.745, indicating that, on average, a one standard deviation change in loan to GDP ratio changes export revenue by roughly 15.9% of the sample mean value in the same direction.

With regard to the control variables, we find that foreign-owned firms and joint ventures export significantly more than domestic private firms while state-owned firms export significantly less. Productivity, size, age, and real depreciation are all found to have significant positive effects on firm export revenue.

#### ***4.2. The interaction effects of monetary policy and credit constraints***

In this section, we include in our tobit regressions interaction terms between loan to GDP ratio and measures of credit constraints to investigate the interaction effects on firm export revenue. Columns (2) and (3) of Table 3 illustrates the heterogeneous effects of monetary policy across firm ownership. In Column (2), the estimated coefficient on loan/GDP, which captures the effect of monetary policy on the omitted domestic firms, is 1.028 and statistically significant. In addition, the results also suggest strongly that effects of monetary policy on export revenues are significantly weaker for financially less constrained foreign-owned firms, joint ventures, and state-owned firms as the estimated coefficients on the three interaction terms are all negative and highly significant. Quantitatively, the differences between

the effects of monetary policy on domestic private firm and those on other firms are quite substantial. The estimated coefficients of loan/GDP on foreign-owned firms and joint ventures are 0.367 (1.028-0.661) and 0.418 (1.028-0.610), respectively, and are substantially smaller than that on domestic private firms. The estimated effect of loan/GDP on state-owned firms is even slightly negative. Overall, the evidence suggests strongly that monetary policy has significantly larger impacts on financially more constrained domestic private firms.

Column (3) includes year dummies as additional regressors. Our main results are not affected by controlling for common time trends. We continue to find that, compared to financially more constrained domestic private firms, other firms are significantly less affected by changes in loan/GDP.

Next, we test further the impact of firm size on the effects of monetary policy. We expect that the effects of an increase in bank loan supply would be significantly larger for financially more constrained small firms. The results shown in the last two columns of Table 3 strongly support our hypothesis. In both columns, we find that the estimated coefficients on the interaction term between loan/GDP and firm size are negative and significant, implying that the positive effects of loan/GDP on firm export revenue indeed diminish with firm size.

Finally, we explore the interaction effects of monetary policy and measures of financial vulnerability on firm export revenue. The results are summarized in Table 4. The estimated coefficients on the interaction terms are all significant with expected

signs. Bank loan supply has a significantly larger effect on firms with higher levels of external finance dependence, R&D intensity, inventories to sales ratio but lower levels of asset tangibility.

Overall, the results obtained from various measures of credit constraints are quite consistent and are all strongly in favor of our main hypothesis: a fall (an increase) in bank loan supply has a larger negative (positive) effect on export revenue in financially more constrained firms. The behavior of the control variables in all regressions is also fairly consistent. Productivity, size and age all have significantly positive effects on firm export revenue. We also find that, compared to domestic private firms, foreign-owned firms and joint ventures export significantly more while state-owned firms export significantly less.

## **5. Disentangling demand and supply**

While we have presented strong evidence supporting our hypothesis, there are two potential complications regarding to our measures of monetary policy. First, changes in loan to GDP ratio can be the outcome of the central bank's countercyclical monetary policy and can thus be potentially endogenous. We argue, however, there are three reasons why our results are unlikely to be affected. First, exporting depends mainly on foreign demand rather than domestic aggregate demand conditions, and thus the potential endogeneity problem is likely to be small in our case. Second, even if we are not able to fully rule out the endogeneity bias, note that this bias is downward as lower export revenues will lead to an increase in loan to GDP ratio. Removing the bias would actually strengthen our results, making the average positive

effect of monetary policy even larger. Finally, aggregate demand shocks are likely to be common to all firms and are thus not consistent with our finding of heterogeneous effects of monetary policy across different firms.

The second complication is that the observed equilibrium bank loans may actually reflect firms' demand for loans rather than credit supply conditions. For example, a favorable aggregate demand shock would increase firms' demand for loans and lead to an increase in equilibrium loan values. We believe, however, that this is unlikely to be the case as China's bank loan market has historically been characterized by severe credit rationing, and the equilibrium quantity of bank loans is determined mainly by supply side. Nonetheless, to fully address this concern, here we extend our analysis to examining the effects of monetary policy and credit constraints on firm export to output ratio. This identification strategy relies on two important features of exports. First, compared to output, export depends more on foreign demand and less on domestic aggregate demand conditions. Second, it is well documented in the credit constraints and trade literature that exports are more credit dependent than domestic production (e.g., Amiti and Weinstein, 2008; Feenstra et al., 2011; Manova, 2011; Manova et al., 2011; Minetti and Zhu, 2010; Mu ùls, 2008). If observed changes in bank loan to GDP ratios are caused by domestic output-induced fluctuations in demand for loans, then one should expect to see a negative correlation between bank loans and export to output ratio. For instance, a negative domestic aggregate demand shock can lead to a drop in loan demand and a rise in export to output ratio in the same time. Suppose, instead, that changes in bank loans mainly reflect credit supply

conditions, then a positive relationship should emerge as exporting activities are more dependent upon credits.

The tobit estimation results are reported in Table 5. To save space, we shall from now on only report the estimated coefficients on our variables of interest. While not reported, in all regressions we include a constant and the full set of control variables. Column (1) shows the average effect on loan/GDP on firm export to output ratio. The results are in favor of our argument as loan/GDP is found to have positive and significant effect on firm's export to output ratio. The rest of the columns look into the interaction effects of monetary policy and credit constraints while controlling for year dummies. Columns (2) and (3) examine the interaction effects between monetary policy and firm ownership and size, respectively. The next four columns explore the interaction effects between monetary policy and financial vulnerability variables. All interaction terms have expected signs, and most of them are highly significant. The only insignificant interaction term is the one with R&D intensity. In general, the results are consistent with our previous finding. That is, credit constraints have systematically influences on the effects of monetary policy. In particular, the impacts of monetary policy are significantly stronger for financially more constrained firms.

## **6. Sensitivity Analysis**

### ***6.1. Excluding state-owned firms***

To ensure the robustness of our results, we now conduct a variety of sensitive analyses. Our first robustness check is to use a more restrictive sample. Following

Manova, Wei, and Zhang (2011), we exclude from the sample firms whose majority shareholder is the state. According to the authors, these firms' participation in international trade is not necessarily governed by profit maximization as the Chinese government often controls state-owned firms' activities. The estimation results obtained from this smaller sample are reported in Table 6. Panel A shows the effects of monetary policy and credit constraints on firm export probability estimated using probit models. Panels B and C examine the effects on firm export revenue and export to output ratio using tobit models. Excluding state-owned firms does not alter our main findings. All interaction terms have correct signs, and almost all of them are statistically significant.

### ***6.2. Using an alternative measure of monetary policy***

Next, we check if our results are sensitive to an alternative measure of monetary policy. In particular, we consider M2 growth rate, China's de jure intermediate target, as an alternative measure of monetary policy stance. We re-run the probit and tobit regressions using this new measure of monetary policy and report the results in Panels A-C in Table 7. Using alternative measures of monetary does not affect our main findings either. First, while not reported, we find that an increase in M2 growth is associated with a significantly higher export probability, export revenue, and export to output ratio. More importantly, the results reported in Table 7 confirm that the positive effects of M2 growth are also significantly stronger for financially more constrained firms.

### ***6.3. The effects on the intensive margins***

So far we have been focusing on examining the effects of monetary policy and credit constraints on firm export probability and revenue using a sample that includes both exporting and non-exporting firms. In this section, we provide additional evidence on the intensive margins of trade by restricting our sample to including exporting firms only. We consider the following two-way fixed effects model:

$$exprev_{it} = \alpha + \beta MP_t * FC_{it} + \gamma X_{it} + v_t + u_i + \varepsilon_{it} \quad (6)$$

where *exprev* is export revenue and *FC* represents our measures of credit constraints.  $u_i$  denotes firm fixed effects.

Table 8 reports the effects on the intensive margins of trade. Panels A and B correspond to our two measures of monetary policy, loan/GDP and M2 growth, respectively. The first column shows the interaction effects between monetary policy and firm ownership, and the second column illustrates the interaction effects of firm size. Columns (3)-(6) demonstrate the interaction effects of monetary policy and financial vulnerability variables.

Unlike the decisions on becoming an exporter which are mainly determined the fixed costs associated with entering a foreign market, the decisions on adjusting export quantities mainly have to do with variable costs. As a result, the interaction effects shown in Table 8 are somewhat weaker than those reported in previous tables. In the first column, we find that the interactions terms between monetary policy and the foreign-own and state-owned dummies remain negative and significant, but the ones between monetary policy and the joint venture dummy become positive and even significant in panel B. In the second column, we find that firm size significantly

impacts the effect of monetary policy on the intensive margins only in panel A. More interestingly, in the next four columns of Table 8, we find that the only financial vulnerability that can significantly influence the effects of monetary policy on the intensive margins of firm exports is the inventories ratio. This finding should not be surprising as inventories ratio mainly captures firms' short-run liquidity needs and thus are associated mostly with variable costs while other financial vulnerability variables reveal firms' long-term investment requirements and reflect mainly fixed costs. As a result, one should expect to obtain a significant interaction effect between monetary policy and inventories ratio on the intensive margins of exports, which are associated with mainly variables costs. Overall, the addition evidence on the intensive margins of trade is also consistent with our main hypotheses.

In sum, our robustness checks tell a very consistent message: a drop in loan to GDP ratio or M2 growth significantly reduces firms' export probability and revenues, and this negative effect is significantly more pronounced for financially more constrained firms measured by their ownership, size, and financial vulnerability.

## **7. Conclusions**

Motivated by the credit channel of monetary policy transmission literature and the recently developed credit constraints and trade literature, this study makes the first attempt in the literature to investigate how monetary policy affects firm exports through the credit channel in China. Using unique Chinese firm level data, we find strong and robust evidence that, by alternating credit supply conditions, monetary policy has quantitatively large and statistically significant effects on firm export

probability and export revenue. More interestingly, we also show that the effects are significantly stronger for financially more constrained firms. Our findings are robust to alternative samples, measures of monetary policy and financial constraints. We also make efforts to empirically disentangle the demand and supply factors in our measures of monetary policy.

Our results thus reveal a new channel through which monetary policy can influence exports. In addition to the conventional exchange rate channel, monetary policy can also impact firm exports through a credit channel. This finding has important policy implications for the conduct of monetary policy in countries with a less developed financial sector such as China. For future research, it would be interesting to use cross country data to generalize our findings.

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Table 1: The effects of Loan/GDP, firm ownership, and firm size on export probability

	(1)	(2)	(3)	(4)	(5)
Loan/GDP	<b>0.073***</b> <b>(0.002)</b>	0.094*** (0.003)		0.239*** (0.013)	
Foreign owned	1.358*** (0.006)	1.854*** (0.066)	1.934*** (0.066)	1.358*** (0.006)	1.359*** (0.006)
Joint venture	0.953*** (0.007)	0.485*** (0.063)	1.262*** (0.063)	0.953*** (0.007)	0.942*** (0.007)
State majority	-0.519*** (0.008)	0.659*** (0.076)	-0.174*** (0.078)	-0.518*** (0.008)	-0.534*** (0.008)
Loan/GDP*Foreign owned		<b>-0.047***</b> <b>(0.006)</b>	<b>-0.054***</b> <b>(0.006)</b>		
Loan/GDP*Joint venture		<b>-0.050***</b> <b>(0.006)</b>	<b>-0.030***</b> <b>(0.006)</b>		
Loan/GDP*State majority		<b>-0.111***</b> <b>(0.007)</b>	<b>-0.067***</b> <b>(0.007)</b>		
Loan/GDP*Size				<b>-0.017***</b> <b>(0.001)</b>	<b>-0.020***</b> <b>(0.001)</b>
Productivity	0.067*** (0.002)	0.068*** (0.002)	0.075*** (0.002)	0.067*** (0.002)	0.075*** (0.002)
Size	0.069*** (0.002)	0.069*** (0.002)	0.068*** (0.002)	0.247*** (0.014)	0.278*** (0.014)
Age	0.006*** (0.0002)	0.006*** (0.0002)	0.006*** (0.0002)	0.006*** (0.0002)	0.006*** (0.0002)
Real effective exchange rate	0.002*** (0.0003)	0.002*** (0.0003)		0.002*** (0.0003)	
Year dummies	no	no	yes	no	yes
# observations	1687313	1687313	1687313	1687313	1687313
Pseudo R-squared	0.15	0.15	0.16	0.15	0.16

Notes: All regressions include a constant term. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table2: The interaction effects of loan/GDP and financial vulnerability on export probability

	Ext finance dependence	R&D intensity	Inventories ratio	Asset tangibility
Loan/GDP*financial vulnerability	<b>0.013***</b> <b>(0.001)</b>	<b>0.084***</b> <b>(0.010)</b>	<b>0.637***</b> <b>(0.006)</b>	<b>-0.264***</b> <b>(0.002)</b>
Foreign owned	1.306*** (0.006)	1.305*** (0.006)	1.265*** (0.006)	1.217*** (0.006)
Joint venture	0.916*** (0.007)	0.915*** (0.007)	0.904*** (0.007)	0.861*** (0.007)
State majority	-0.394*** (0.009)	-0.395*** (0.009)	-0.349*** (0.009)	-0.380*** (0.009)
Productivity	0.076*** (0.002)	0.076*** (0.002)	0.073*** (0.002)	0.074*** (0.002)
Size	0.085*** (0.002)	0.086*** (0.002)	0.095*** (0.002)	0.106*** (0.002)
Age	0.007*** (0.0002)	0.007*** (0.0002)	0.006*** (0.0002)	0.005*** (0.0002)
Year dummies	Yes	Yes	Yes	Yes
# observations	1507950	1507950	1507950	1507950
Pseudo R-squared	0.15	0.15	0.17	0.18

Notes: All regressions include a constant term, control variables and year dummies. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table 3: The effects of Loan/GDP, firm ownership, and firm size on export revenue

	(1)	(2)	(3)	(4)	(5)
Loan/GDP	<b>0.745***</b> <b>(0.021)</b>	1.028*** (0.028)		2.546** (0.129)	
Foreign owned	12.765*** (0.043)	19.767*** (0.480)	20.360*** (0.480)	12.764*** (0.043)	12.751*** (0.043)
Joint venture	9.459*** (0.056)	16.926*** (0.540)	13.647*** (0.546)	9.460*** (0.056)	9.333*** (0.057)
State majority	-5.612*** (0.086)	7.095*** (0.825)	2.242*** (0.839)	-5.608*** (0.086)	-5.765*** (0.086)
Loan/GDP*Foreign owned		<b>-0.661***</b> <b>(0.046)</b>	<b>-0.718***</b> <b>(0.046)</b>		
Loan/GDP*Joint venture		<b>-0.610***</b> <b>(0.051)</b>	<b>-0.407***</b> <b>(0.052)</b>		
Loan/GDP*State majority		<b>-1.202***</b> <b>(0.079)</b>	<b>-0.757***</b> <b>(0.080)</b>		
Loan/GDP*Size				<b>-0.182***</b> <b>(0.013)</b>	<b>-0.211***</b> <b>(0.013)</b>
Productivity	0.884*** (0.016)	0.887*** (0.016)	0.958*** (0.017)	0.884*** (0.016)	0.957*** (0.017)
Size	0.792*** (0.016)	0.792*** (0.016)	0.787*** (0.016)	2.720*** (0.133)	3.018*** (0.135)
Age	0.062*** (0.002)	0.062*** (0.002)	0.060*** (0.002)	0.062*** (0.002)	0.060*** (0.002)
Real effective exchange rate	0.026*** (0.003)	0.025*** (0.003)		0.026*** (0.003)	
Year dummies	no	no	yes	no	yes
# observations	1687313	1687313	1687313	1687313	1687313
Pseudo R-squared	0.07	0.07	0.07	0.07	0.07

Notes: All regressions include a constant term. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table4: The interaction effects of loan/GDP and financial vulnerability on export revenue

	Ext finance dependence	R&D intensity	Inventories ratio	Asset tangibility
Loan/GDP*Financial vulnerability	<b>0.110***</b> <b>(0.008)</b>	<b>0.567***</b> <b>(0.092)</b>	<b>6.136***</b> <b>(0.056)</b>	<b>-2.541***</b> <b>(0.020)</b>
Foreign owned	12.066*** (0.044)	12.062*** (0.045)	11.322*** (0.045)	10.784*** (0.046)
Joint venture	8.906*** (0.057)	8.903*** (0.057)	8.508*** (0.056)	8.049*** (0.057)
State majority	-4.133*** (0.091)	-4.147*** (0.091)	-3.613*** (0.091)	-3.864*** (0.090)
Productivity	0.952*** (0.017)	0.949*** (0.017)	0.898*** (0.017)	0.900*** (0.017)
Size	0.931*** (0.016)	0.938*** (0.017)	1.013*** (0.016)	1.106*** (0.016)
Age	0.062*** (0.002)	0.061*** (0.002)	0.051*** (0.002)	0.047*** (0.002)
Year dummies	Yes	Yes	Yes	Yes
# observations	1507950	1507950	1507950	1507950
Pseudo R-squared	0.07	0.07	0.08	0.08

Notes: All regressions include a constant term, control variables and year dummies. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table 5: The effects on export to output ratio

	No interaction	Ownership	Size	Ext finance dependence	R&D intensity	Inventories ratio	Asset tangibility
Loan/GDP	<b>0.054***</b> <b>(0.002)</b>						
Loan/GDP*Foreign owned		<b>-0.050***</b> <b>(0.004)</b>					
Loan/GDP*Joint venture		<b>-0.023***</b> <b>(0.004)</b>					
Loan/GDP*State majority		<b>-0.050***</b> <b>(0.006)</b>					
Loan/GDP*Size			<b>-0.017***</b> <b>(0.001)</b>				
Loan/GDP*Financial vulnerability				<b>0.006***</b> <b>(0.001)</b>	<b>0.005</b> <b>(0.007)</b>	<b>0.492***</b> <b>(0.004)</b>	<b>-0.204***</b> <b>(0.002)</b>
Year dummies	no	yes	yes	yes	yes	yes	yes
# observations	1685345	1685345	1685345	1506094	1506094	1506094	1506094
Pseudo R-squared	0.13	0.13	0.13	0.12	0.12	0.15	0.15

Notes: All regressions include a constant term, control variables and year dummies. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table 6: Excluding state-owned firms

		Ownership	Size	Ext finance dependence	R&D intensity	Inventories ratio	Asset tangibility
Panel A: Export probability	Loan/GDP*Foreign owned	<b>-0.054***</b> <b>(0.006)</b>					
	Loan/GDP*Joint venture	<b>-0.031***</b> <b>(0.006)</b>					
	Loan/GDP*Size		<b>-0.019***</b> <b>(0.001)</b>				
	Loan/GDP*Financial vulnerability			<b>0.011***</b> <b>(0.001)</b>	<b>0.073***</b> <b>(0.010)</b>	<b>0.642***</b> <b>(0.006)</b>	<b>-0.268***</b> <b>(0.002)</b>
Panel B: Export value	Loan/GDP*Foreign owned	<b>-0.706***</b> <b>(0.045)</b>					
	Loan/GDP*Joint venture	<b>-0.411***</b> <b>(0.051)</b>					
	Loan/GDP*Size		<b>-0.198***</b> <b>(0.014)</b>				
	Loan/GDP*Financial vulnerability			<b>0.088***</b> <b>(0.008)</b>	<b>0.490***</b> <b>(0.092)</b>	<b>6.115***</b> <b>(0.058)</b>	<b>-2.550***</b> <b>(0.020)</b>
Panel C: Export to output ratio	Loan/GDP*Foreign owned	<b>-0.050***</b> <b>(0.004)</b>					
	Loan/GDP*Joint venture	<b>-0.024***</b> <b>(0.004)</b>					
	Loan/GDP*Size		<b>-0.016***</b> <b>(0.001)</b>				

Loan/GDP*Financial vulnerability	<b>0.004***</b>	<b>0.003</b>	<b>0.498***</b>	<b>-0.208***</b>
	<b>(0.001)</b>	<b>(0.007)</b>	<b>(0.005)</b>	<b>(0.002)</b>

Notes: All regressions include a constant term, control variables and year dummies. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table 7: Using alternative measure of monetary policy

		Ownership	Size	Ext finance dependence	R&D intensity	Inventories ratio	Asset tangibility
Panel A: Export probability	M2 growth*Foreign owned	<b>-2.236***</b> <b>(0.202)</b>					
	M2 growth*Joint venture	<b>-0.481***</b> <b>(0.183)</b>					
	M2 growth*State majority	<b>-1.987***</b> <b>(0.201)</b>					
	M2 growth*Size		<b>-0.937***</b> <b>(0.041)</b>				
	M2 growth*Financial vulnerability			<b>0.892***</b> <b>(0.060)</b>	<b>5.828***</b> <b>(0.682)</b>	<b>43.538***</b> <b>(0.411)</b>	<b>-18.067***</b> <b>(0.144)</b>
Panel B: Export value	M2 growth*Foreign owned	<b>-21.534***</b> <b>(1.461)</b>					
	M2 growth*Joint venture	<b>-5.161***</b> <b>(1.604)</b>					
	M2 growth*State majority	<b>-21.312***</b> <b>(2.181)</b>					
	M2 growth*Size		<b>-8.973***</b> <b>(0.392)</b>				
	M2 growth*Financial vulnerability			<b>7.410***</b> <b>(0.557)</b>	<b>39.634***</b> <b>(6.249)</b>	<b>419.273***</b> <b>(3.855)</b>	<b>-173.715***</b> <b>(1.338)</b>
Panel C: Export to	M2 growth*Foreign owned	<b>-2.087***</b> <b>(0.117)</b>					

output ratio	M2 growth*Joint venture	<b>-0.302**</b> <b>(0.120)</b>				
	M2 growth*State majority	<b>-1.350***</b> <b>(0.154)</b>				
	M2 growth*Size		<b>-0.704***</b> <b>(0.028)</b>			
	M2 growth*Financial vulnerability			<b>0.376***</b> <b>(0.004)</b>	<b>0.427</b> <b>(0.485)</b>	<b>33.598***</b> <b>(0.300)</b>

Notes: All regressions include a constant term, control variables and year dummies. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.

Table 8: The effects of monetary policy and credit constraints on the intensive margins of trade

		Ownership	Size	Ext finance dependence	R&D intensity	Inventories ratio	Asset tangibility
Panel A: Loan/GDP	Loan/GDP*Foreign owned	<b>-0.011*</b> <b>(0.007)</b>					
	Loan/GDP*Joint venture	<b>0.009</b> <b>(0.007)</b>					
	Loan/GDP*State majority	<b>-0.043***</b> <b>(0.017)</b>					
	Loan/GDP*Size		<b>-0.014***</b> <b>(0.002)</b>				
	Loan/GDP*Financial vulnerability			<b>-0.002</b> <b>(0.002)</b>	<b>0.010</b> <b>(0.033)</b>	<b>0.043**</b> <b>(0.019)</b>	<b>-0.005</b> <b>(0.006)</b>
Panel B: M2 growth	Loan/GDP*Foreign owned	<b>-0.535**</b> <b>(0.211)</b>					
	Loan/GDP*Joint venture	<b>0.730***</b> <b>(0.231)</b>					
	Loan/GDP*State majority	<b>-1.448***</b> <b>(0.465)</b>					
	Loan/GDP*Size		<b>0.039</b> <b>(0.065)</b>				
	Loan/GDP*Financial vulnerability			<b>-0.125</b> <b>(0.121)</b>	<b>1.662</b> <b>(2.062)</b>	<b>2.406**</b> <b>(1.188)</b>	<b>-0.281</b> <b>(0.387)</b>

Notes: All regressions include a constant term, control variables and year and firm fixed effects. Firm clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level.