Financial Effects and Firm Productivity: Evidence from Chinese Manufacturing Data

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Abstract

Finance has been found highly important in influencing firms' real activities and promoting aggregate growth. The linkage between finance and productivity, however, has been overlooked in the economic literature. Using a large panel of Chinese manufacturing firm data in 1998-2007 and establishing productivity models applying both direct and indirect approaches, we find that financial factors are highly decisive to firms' total factor productivity and production productivity. Increases of the availability of finance to firms can directly improve productivity at firm level. The effects of finance on productivity are also related to firm's liquidity, ownership, export status, state share, foreign investment and sensitivity of cash flow to productivity.

Key words: productivity, TFP, production function, finance, cash flow, ownership

JEL: D24, G32

1. Introduction

There are growing empirical studies of the imperfection of financial markets and growth, suggesting a negative relationship. Although the exact transmission channel through which finance affects growth is still unclear, existing literature (for example Levine, 2005) recognises that a well developed financial system can influence long-term growth through its ability to mitigate information and transaction costs, and to impact on savings rates, investment decisions and productivity. External financial constraints resulted from imperfect financial market are of particular interest to economists and policy makers because they have important implications for monetary policy transmission mechanism and tax policy.

The linkage between finance and firm activities stems from a violation of the Modigliani-Miller (1958) theorem. Agency costs and information asymmetries, as well as tax policies, lead to a divergence between the costs of internal and external funds, or even a rationing of external finance, and favouring the use of debt over that of equity financing (Myers and Majluf, 1984). One of the channels through which finance affects growth is its influence on firm productivity. Productivity most importantly exemplifies technological innovation. Solow's (1957) growth model well establishes technological progresses and skills as the prime drivers of increases in labour productivity. The bulk of empirical evidences show that the cross-country differences in the level or growth of gross domestic product (GDP) per capita is not due to factor accumulation but can be explained by differences in total factor productivity (TFP) (e.g. Hall and Jones, 1999; Easterly and Levine, 2001). Therefore, it is important to explore whether finance fosters growth by promoting productivity, which is a

key intermediate link between firm activities and growth. Ayyagari, Demirgüç-Kunt and Maksimovic (2007) argue that such effects would take place in the way that financial system can play an important role in supplying capital to innovative firms and directing their operations to be more efficient.

However, at firm level productivity-enhancing research and development (R&D) activities commonly bear high risks and uncertainty, and require large investments. Firms undertaking such innovative activities, on the other hand, typically hold relatively large R&D related intangible assets such as patents and knowledge, which are often not be able to use as collaterals. Consequently, innovative firms should have a distinct capital structure from non-innovative firms. Access to finance can facilitate innovative firms' investment in productivity-enhancing but risky projects. Therefore, at macro level if the financial system is supportive to such innovative activities in firms, firm-level and aggregate productivity and, hence, growth should benefit enormously.

We use a large panel of 578,577 manufacturing firms in China to study the direct relationship between finance and firm level productivity. The Chinese economy has experienced one of the fastest growths in the world in the past three decades. Scholars have attributed the phenomenal development to productivity growth, rather than capital or labour accumulation (e.g. World Bank, 1997; Zheng, Bigsten and Hu, 2009). Despite momentous financial deepening and diversification, and rapid credit growth, the main part of Chinese corporate investment is financed by internal funds, particularly for the domestic private firms (e.g. Ayyagari, Demirgüç-Kunt, and Maksimovic, 2008). China's experience is regarded by some scholars (e.g. Allen, Qian and Qian, 2005) as a counter example to the positive relationship between finance and growth which are often found in many other countries. Therefore, it is exceedingly interesting to investigate whether the possible channel of finance, productivity and growth works in China and how it works. Our focus in this paper is the linkage between finance and firm productivity, which further fuels growth.

There has been especially limited literature studying the direct relationship between firms' financial positions and productivity. Nucci, Pozzolo and Schivardi (2005), Gatti and Love (2008), and Badia and Slootmaeketrs (2008) have found some significant effects of measures of financial factors on firms' total factor productivity on Italian, Bulgarian and Estonian firms respectively. Our paper will contribute to fill in this important gap and enrich the literature. Particularly, we explore firm heterogeneity in this topic, which has not been well discussed in the literature. Our large data sample covering the entire Chinese manufacturing sector and the fact that Chinese firms rapidly improve productivity in lagged financial market environment will enable us to clearly test the relationship between finance and productivity.

To test the hypothesis that more availability of financial resource can increase firms' productivity we establish two alternative and complementary models of firm productivity: one uses total factor productivity and the other estimates a production function. We find that in general firms' financial position positively and significantly affect their productivity. We also further investigate private and foreign firms, which are not likely to have soft budget, and find robust findings that both types of firms have significant cash flow-productivity sensitivity. Illiquid private or foreign firms have stronger cash flow effects on their productivity than their liquid counterparts. Private exporters have higher cash flow-productivity sensitivity than private non-exporters, but foreign non-exporters have higher sensitivity than foreign exporters. For private firms such constraining effects of cash flow on their productivity appear to be mitigated if they have a non-negligible share of state holding

(more than 10%), but it's not the case if they have more than 10% of foreign share. Both private and foreign firm-years, which have high sensitivity of productivity to cash flow and in their low cash flow years, have higher cash flow effects on their productivity than the rest of firm-years.

The remaining paper is organised as follows. Section 2 reviews and discusses the relevant literature. Section 3 introduces the theoretical and empirical models and estimation methods. Section 4 describes our data. Section 5 analyses our results for the full sample and subsamples of private and foreign firms, and finally section 6 concludes.

2. Economic Background

2.1 Aggregate Level Studies

The positive relationship between finance and growth may be established through the ability of financial institutions to help to improve productivity. Most of the studies focus on the role of financial development at aggregate level. In their cross-country study, Beck, Levine and Loayza (2000) find that financial intermediaries in 63 countries exert a large, positive and long-run impact on TFP growth, which feeds through to overall economic growth. They also emphasise that their data do not confidently suggest that high levels of financial intermediary development promote growth by boosting the accumulation of capital or private savings rates. Levine and Zervos (1998) use data from 47 countries to study the empirical relationship between various measures of stock market development, banking development and long-term economic growth, which includes productivity (TFP), as well as output, capital stock and savings growth. Stock market liquidity and banking development are both found to be positively and robustly related to rates of GDP growth, capital accumulation and productivity growth. They argue that different and better financial services provided by stock market and banking sector can increase the ability to trade an economy's productive technologies and facilitates efficient resource allocation, physical capital formation and faster growth. Their results suggest that financial factors are an integral part of growth progress. Huang and Lin (2009) achieve similar results from a panel of 71 countries data, i.e. positive effects of financial intermediation development on GDP, capital accumulation and TFP growth. In particular, their research emphasises the non-linear pattern of the finance-growth nexus and finds that such positive effect is more pronounced in the low-income countries than in the high-income ones. Rajan and Zingales (1998) suggest that financial development has a substantial supportive influence on the rate of economic growth at both industry and country level, and this works by reducing the cost of external finance to financially dependent firms. Arestis, Demetriades and Fattouh (2003) collect data on a number of measures of financial constraints from 14 countries and find that financial development has positive effects on the aggregate productivity of capital stock.

Rioja and Valev (2004) find interesting difference of the effects of financial development on growth between developed and developing countries. In a panel of data from 74 countries they find that finance has a strong positive influence on productivity growth primarily in more developed economies, but in developing economies, finance affects growth primarily though capital accumulation. The finding on developing countries is not consistent with the findings by some other authors on China, which find productivity improvement rather than factor accumulation is the main contributor to growth. These arguments would make our

research more interesting, as we are trying to learn whether and how finance fosters productivity in China, a fast growing developing country.

King and Levine (1993) show that financial system development has a positive effect on productivity through improving the probability of successful innovation and thereby accelerates economic growth. An explanation on the mechanism by which the financial system may enhance productivity lies in that well developed financial markets can mobilise funds to finance the most efficient investment projects and diversify the risks associated with innovative activities (King and Levine, 1993), and also can offer easy and low-cost liquidation to firms undertaking innovation projects should firms need funds before the maturity of projects (Bencivenga, Smith and Starr, 1995). Aghion *et al.* (2007) show that perfect financial markets can encourage more long-term productivity-enhancing investments by reducing the liquidity risk connected to the investments, and credit constraints will lead to the opposite and lower mean growth.

2.2 Firm Level Studies

Financial constraints caused by information asymmetries and agency problems have been well demonstrated by literature to affect firm's activities, including fixed investment, inventories, employment, and wages (e.g. Benito and Hernando, 2007; Nickell and Nicolitsas, 1999). Firms facing financial constraints have difficulties in raising external finance. Due to the pecking order of financing costs (Myers and Majluf, 1984) financially constrained firms have to mainly rely on their own internal finance and pay premium to obtain debt and, less likely, equity finance. Therefore, they cannot choose their optimal capital structure and consequently cannot make optimal decisions on other real activities. Financially constrained firms may have to forego profitable investment opportunities when they are short of funds. This certainly distorts the efficient allocation of resources and reduces firm's efficiency and productivity. Further, if firms want to improve productivity by carrying out R&D activities, without a supportive financial system, they will find it extremely difficult to finance the highly risky R&D projects due to the classical concerns of external lenders.

2.2.1 Financial Constraints and Firms' Productivity

At firm level, the research on the topic of finance and productivity is much more limited. Productivity in this literature is often measured by firms' TFP, which itself is subject to different measurements. Nickell and Nicolitsas (1999) use UK panel data to examine the impact on firm productivity, as well as employment and wage rises, of increases in financial pressure, which is measured by borrowing ratio. It is found to have a positive but small effect on TFP. Nickell and Nicolitsas (1999)'s measure of TFP and estimation function are in line with our direct approach detailed in section 3. Their TFP is proxied by the logarithm of the output to capital ratio, and the model is derived from a production function with financial variables. Their finding is consistent with the bankruptcy theory. When financial pressure increases, bankruptcy risks amplify. Firm managers as well as employees have strong incentives to minimise the possibility of bankruptcy in order to keep their jobs. Hence, it is reasonable to expect them to increase their efforts to improve productivity. With similar methodology, Harris and Trainor (2005) use detailed plant level panel data on Northern Ireland manufacturing sector to study the effects of capital subsidies as a part of government policies of Selective Financial Assistance (SFA) on TFP. They argue that direct inclusion of determinants of output (and thus TFP) into a Cobb-Douglas production function should avoid the problems of inefficiency of the two-step process involving an estimation of TFP and

omitted variable bias. They augment the SFA dummies interacted with various other variables in a production function. By comparing firms which received subsidies with those which did not, the authors suggest that capital grants from government have a significant and positive effect on the level of production and TFP in manufacturing. Their results may also be interpreted as that external finance can help to increase firms' TFP. Ayyagari, Demirgüç-Kunt, and Maksimovic (2008) suggest that despite the weaknesses of China's formal financial system and the dominance of the use of internal finance by firms, financing from the formal financial institutions is associated with faster firm productivity growth, whereas funds raised from alternative channels do not have such positive effects on firms.

Gatti and Love (2008) using data from a cross-section of Bulgarian firms estimate the effects of access to credit on productivity. Their method involves the estimation of TFP variable first, which is similar to our indirect approach detailed in section 3 too. They then construct models to identify financial effects on TFP. The explanatory variables are mainly dummies to indicate firm size, industry type, ownerships and other variables of firm characteristics. They find access to credit to be positively and significantly associated with firm TFP.

Badia and Slootmaekers (2008) provide evidence on the link between financial constraints and firm-level productivity on the case of Estonia. The estimation methods of their paper is the combination of the two mentioned above, a direction inclusion of financial variables into a production function and a two-step process with an estimation of TFP variable first and a model to estimate TFP second. They find that a large number of their sample firms show some degree of financial constraints, measured by a constructed index, particularly young and highly indebted firms, but financial constraints do not lower productivity for firms in most of the sectors with the exception of R&D. The negative effects of financial constraints on productivity are outstandingly large for R&D firms. These results by Badia and Slootmaekers (2008) are again consistent with the argument that finance may shape firms' innovation activities, through which affect firms' productivity. The effects may be then transmitted to growth at firm level first and at aggregate level finally.

At micro level one of the channels through which access to finance affects growth is through enhancing firm innovation and, thus, productivity. Smith *et al*. (2004) analyse the relationship between the source of finance for Danish firm R&D activities and firm productivity. They estimate a production function taking into account the influence of source of R&D funding, ownership and innovative characteristics of firms, and industry specific effects. They only include firms with a positive R&D capital stock in their empirical analysis. Interestingly, in their sample productivity of those firms with R&D activities financed by public funding is not significantly different from that of the firms with R&D activities financed by firms' own funds. This may suggest that direct government helping hands are not necessary to increase firm productivity, as long as firms' productivity-enhancing activities can be financed elsewhere. With the similar motivation from firm innovation perspective Nucci, Pozzolo and Schvardi (2005) use data on a panel of Italian firms to study the relationship between firms' capital structure and TFP. They argue that firms undertaking innovative activities typically hold a large share of immaterial assets and their capital structures reflecting the propensity to innovate are likely to influence TFP levels. They construct a TFP model on firms' leverage, immaterial assets ratio and some other control variables including firm's cash flow, liquid assets ratio and size. The authors document a negative relationship between firms' leverage and productivity, and such negative relationship is stronger for firms with a lower share of short-term debt and lower liquidity.

2.2.2 Firms' Financial Positions

Some authors have also identified connections between firms' financing structure and productivity. Schiantarelli and Sembenelli (1997) find that for both the UK and Italian firms TFP depends positively on the length of debt maturity, i.e. the use of long-term debt can help to increase firm TFP. They estimate the Cobb-Douglas production function with long-term debt over total debt ratio and leverage as explanatory variables in addition to capital, labour and materials. They argue that such result is reasonable because on the demand side, firms prefer to use long-term debt as it controls for liquidation risks and involves less renegotiation of debt, and on the supply side, financial intermediaries are willing to provide long-term finance only to quality firms. Nunes, Sequeira and Serrasqueiro (2007) study the relationship between firms' leverage and labour productivity on a panel of Portuguese data, and find the relationship is nonlinear. They use quantile regressions to estimate labour productivity on firm's leverage, tangibility, size, growth and ownership. Leverage tends to negatively affect labour productivity for the majority of the firms with relatively lower labour productivity, and positively affect it for firms with high labour productivity. Pushner (1995) observes a strong negative relationship between leverage and firm TFP in Japan. A positive relationship between leverage and firms productivity may be explained by the bankruptcy argument mentioned above. A high level of leverage increases the bankruptcy probability and hence induces managers to spend more efforts to improve productivity. On the other hand, a negative relationship may arise due to an agency problem mentioned above as well. Banks often prefer to issue collateralised loans. Firms' productivity-enhancing R&D activities are negatively related to leverage due to its negative relationship with collaterals, but positively related to productivity. Then leverage is negatively related to productivity possibly through the link of R&D. The empirical results above may suggest that the overall impact of leverage on productivity may depend on the dominant effect of leverage and other firm characteristics. Subsequently, policies aiming at boosting borrowing may not help to increase productivity for all.

Guan and Lansink (2006) extend the capital structure and firms' productivity studies to the agricultural farms. Using the Malmquist productivity growth index to measure Dutch farm performance, they find that long-term debt increases farm productivity growth. Their method is also two-step. In the model specification, they use variables to measure farms' debt structure, investment, age, subsidy, size and various dummies to indicate other farm characteristics to explain the productivity index variable.

2.3 Shortcomings of Previous Studies and Our Contributions

However, some of these firms level researches on finance and productivity may suffer from methodological problems. Many of the variables in a productivity equation are likely to be jointly endogenous, i.e. they may be simultaneously determined with the dependent variable or the equation may be subject to mutual causality. It is important to treat the potential bias properly. Although Nucci, Pozzolo and Schivardi (2005) try to identify some exogenous factors affecting firms' capital structure, they use between and within effects separately in their estimations, which cannot rule not the possibility of endogeneity in their models. The data of Gatti and Love (2008) is a sample of cross-sectional data, which restricts the application of a dynamic model. Consequently, their static estimation model on TFP is likely to suffer from serial correlation. Their ordinary least square (OLS), instrumental variable (IV) and two-stage least square (2SLS) estimators cannot well control for the endogeneity bias either. Nunes, Sequeira and Serrasqueiro (2007) and Pushner (1995) both apply quantile

regression approach, and still their results are subject to the influence of endogenous determinants of productivity. The estimations of growth models by Beck, Demirgüç-Kunt, and Maksimovic (2005) are based on a cross-sectional dataset using random effects methods. Their estimators are again likely to suffer from similar problems as those papers mentioned above. Therefore, the results obtained by these authors may have to be interpreted with cautions.

Most of those studies above mainly try to discover a linkage between forms of finance and firm productivity, but few of them take firm heterogeneity into account. The studies focusing on firms' capital structure have recognised the roles played by different forms of finance in improving productivity. This gives us motivations to fill the gap in the literature and explore in more details the role of firm heterogeneity in the finance and productivity relationship, especially given our large dataset covering all the manufacturing sectors in China.

Therefore, our research will contribute, first of all, to the thin literature on finance and firm productivity using sophisticated methods to isolate the influence of endogenous variables. Second, we will explore the role of firm heterogeneity in this relationship. The characteristics of foreign investment and the export sector in China are quite typical in developing countries in terms of the motivation of foreign capital and the business type of the export sector. Therefore, our third contribution will be to use the Chinese data to investigate the relationship between productivity, finance and export. The links between finance and firm productivity are important. Our another contribution to use the evidence from Chinese firm data is particularly interesting, Chinese firms' productivity has evidently experienced large improvement in the past decades but the development of China's financial market is still much lagged. External sources and channels of finance are scarce and limited in number. Relative to the mature financial markets in the industrialised countries China's financial market is shallow and still in its infancy. Therefore, Chinese firms provide some ideal conditions for experiments on the relationship between finance and productivity. This possible relationship would be more observable in an environment where financial development is in an early stage and the improvement in firm productivity is fast.

3. Theoretical and Empirical Background

To analyse the relationship between firm level financial factors and productivity, we follow two alternative estimation procedures, a TFP model and a production function model. Firms' productivity is an unobservable firm characteristic. The so called total factor productivity can only be recovered as the residual between the actual output and the output estimated by an appropriate production function using actual inputs and outputs. Consequently, the estimation of TFP may be susceptible to measurement errors. A direct estimation of the production function can provide a good robustness check for the indirect estimation of a TFP model. We will discuss in more details below.

3.1 Firms' Total Factor Productivity

In this approach, we proceed in two steps. First, we obtain the TFP measurement by estimating a production function. Second, we establish a model to find the determinants of TFP and uncover whether financial factors exert any effects on TFP.

Assuming a Cobb-Douglas production function, a measure of TFP can be obtained by estimating the following equation

$$y_{it} = \alpha + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + e_{it} \qquad (1)$$

where y is firms' output, k is capital and l stands for labour. y, k and l are all in natural logarithm forms. i and t index firm and time respectively. ω_{it} is a productivity term known to the firm and correlated with the inputs. e_{it} is a random productivity shock. In this model, the logarithm of TFP is the residual of the actual and predicted output, i.e. $tfp_{it} = y_{it} - \hat{y}_{it}$.

Eq. (1) to estimate TFP has endogeneity and selection problems. Firm's unobserved productivity is correlated with its input decisions. Productive firms tend to input more capital and labour due to higher current and anticipated future investment opportunities. Large firms can expect large amount of investment returns, and thus can continue to operate at low level of current productivity, whereas some firms, such as small ones, may have to exit the market when their productivity is below a certain level.

To control for the endogeneity and selection biases, Olley and Pakes (1996) and Levinsohn and Petrin (2003) suggest using investment and intermediate inputs respectively to proxy for productivity. The methodologies proposed by the two papers are in line with each other. Both methods assume monotonic relationship between the proxy variable and the true productivity shocks, which suggests that their methods implicitly require positive investment or intermediate input, since in reality productivity shocks can hardly be negative. Hence, the Olley and Pakes (1996) estimation will systematically drop firm observations with non-positive investment, which is often the case, and reduce the efficiency of the estimation. On the other hand, most of the firms have positive intermediate input, such as materials and energy consumption. Therefore, we choose the Levinsohn and Petrin (2003) estimator to calculate our TFP variable. We estimate eq. (1) for TFP by 2-digit industries separately to allow for technological differences across industries.

According to Levinsohn and Petrin (2003) method, known as productivity ω_{it}, which is assumed to follow an exogenous Markov process, firm i decides whether to continue operation. If it decides to continue, it chooses the input variables labour, capital and materials. Its input demand function depends on capital and the known productivity, i.e. $m_{it} = m_{it}(k_{it}, \omega_{it})$. m_{it} is assumed to be monotonically increasing in ω_{it}. Therefore, ω_{it} can be obtained by inverting the input function, and it becomes a function of intermediate input

$$\omega_{it} = m_t^{-1}(m_{it}, k_{it}) = \phi_t(m_{it}, k_{it}) \qquad (2)$$

Substituting eq. (2) into eq. (1) yields

$$y_{it} = \beta_l l_{it} + \theta_t(m_{it}, k_{it}) + e_{it} \qquad (3)$$

where $\theta_t(m_{it}, k_{it}) = \alpha + \beta_k k_{it} + \phi_t(m_{it}, k_{it})$. Petrin, Poi and Levinsohn (2004) propose that using value added as measure of output, which is our case, the functional form $\theta_t(\cdot)$ can be approximated by a third-order polynomial expansion in m_{it} and k_{it}. Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004) show that consistent estimators $\hat{\beta}_l$ and $\hat{\beta}_k$ can be

obtained, and the tfp_{it} is then computed as the residual of eq. (1). We compute tfp_{jit} for each firm in each 2-digit industry.

In the second step of this indirect approach, we build an estimation model to inspect the relationship between firm total factor productivity and financial factors.

$$tfp_{jit} = a_0 + a_1 tfp_{j,i,t-1} + a_2 X_{it} + a_3 F_{it} + \nu_j + \nu_t + \nu_{jt} + \varepsilon_{it} \qquad (4)$$

where j denotes industry, X_{it} is a vector of firm i's characteristics, which include firms' size measured by the logarithm of real total assets, logarithm of firms' age, export variable, and regional dummy. F_{it} is a vector of financial variable, which is firms' cash flow to capital ratio or the ratio of tangible fixed assets to total assets, collateral. v_j are 2-digit industry dummies, which are in line with the ones used in the estimation of tfp_{jit} and to control for industry specific characteristics in terms of technology related productivity difference. v_t are time dummies capturing the time varying business cycle effects. v_{jt} are industry and time interacted dummies to capture industry specific business cycle effects and ε_{it} is an idiosyncratic error term. This specification is motivated by considerations of sensible variables to influence TFP in the general context as well as the Chinese data context. It will enable us to test whether and how financial variables have an effect on firm TFP.

The lagged *tfp* variable is important given our Levinsohn and Petrin (2003) method for its estimation. Levinsohn and Petrin (2003) assume that firm productivity follows a first-order Markov process. Therefore, the lagged *tfp* variable must be included to control for the serial correlation. However, the model may still be possible to yield inconsistent estimations, since conditional on lagged productivity we implicitly assume that the current *tfp* depends on the firm specific determinants and the financial determinants, which have been known to firms. Yet, the Markov process assumption in the Levinsohn-Petrin methodology implies that the current firm productivity should be an unpredictable shock, conditional on past productivity (Badia and Slootmaeters, 2008). As a consequence, even with an appropriate estimation of the *tfp* measure, the estimated financial effects on productivity may still be possibly biased.

The X_{it} variables are motivated by and similar to those used in Gatti and Love (2008) and Badia and Slootmaeters (2008). Firms' size and age have been found to be related to firms' productivity (e.g. Palangkaraya, Stierwald and Yong, 2009) and are widely used to explain productivity. Firms' export status is also argued by many researchers to be linked to productivity (e.g. Aw, Roberts and Xu, 2008). We use either firms' export intensity (export to sales ratio) or export status dummy in our models. Given China's economic policies and development mode, regional effects are correlated with many economic environment features, such as tax policy, legal protection, infrastructure, financial market development, etc, which will affect firms' performance. These economic environmental features are often more advantageous in the coastal region. We assign a coast dummy to indicate whether firms are located in the coastal provinces.[1] It equals to one if firm i locates in one of the coastal provinces, and zero otherwise.

The financial variables F_{it} are our key focus. The cash flow to capital ratio is the main variable used in the financial constraints literature as an indicator of firms' internal source of

[1] We define coastal region to include the following 10 provinces and municipalities: Beijing, Fujian, Guangdong, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin and Zhejiang. Non-coastal region includes the following 21 provinces and municipalities: Anhui, Hainan, Heilongjiang, Henan, Hubei, Hunan, Jiangxi, Jilin and Shanxi, Chongqing, Gansu, Guangxi, Guizhou, Inner Mongolia, Ningxia, Qinghai, Shaanxi, Sichuan, Tibet, Xinjiang, and Yunnan.

finance. If firms face difficulty in raising external finance, they have to rely on their own funds, which will limit their ability to carry out investments and force them to forego profitable opportunities. By inspecting this variable, we are looking for whether replying on internal finance retards firm's productivity. Collateral is important to obtain bank loans, particularly in China. Survey data by the World Bank showed that the inability to meet collateral requirement is the most important reason why firms' loan application was rejected by banks in China (Ayyagari *et al.*, 2008). Therefore, collateral should be an informative indicator about firms' ability in raising external finance, at least in our data case. We are interested in whether firms' financial position and the ability of raising debt can shape their productivity.

3.2 Firms' Production Function

To control for the measurement issues emerging from the indirect approach, we incorporate financial variables as well as other firm characteristics variables directly into the production function equation to investigate whether financial variables can directly influence the observable firm production. The combination of the direct estimation of production and the indirect estimation of TFP can verify the robustness of the effects that financial factor may have on firms' productivity. To control for firm size heterogeneity, we normalise a basic production function by capital first. Then adding controls for firm characteristics as well as augmenting financial factors, the normalised production function gives

$$Y_{it} / K_{it} = b_0 + b_1 Y_{i,t-1} / K_{i,t-1} + b_2 L_{it} / K_{it} + b_3 X_{it} + b_4 F_{it} + v_j + v_t + v_{jt} + \varepsilon_{it} \qquad (5)$$

where Y_{it}, K_{it} and L_{it} are firm i's output (measured by firms' value added), capital (firms' total fixed tangible assets) and labour (firms' number of employees) at time t respectively. X_{it} does not include the firm size variable any more, since the normalised equation has already controlled for size effect and the size variable in X_{it} is cancelled out by K_{it} to be a constant. F_{it} and v_j remain the same as in eq. (4). v_j is to capture industrial differences in firms' production capacity. v_t denotes the time-variant component of technological progress, representing the change of TFP over time. v_{jt} is the interaction between all the year and industry dummies to add further control for the industry specific business cycle effects. ε_{it} is an idiosyncratic error term, which is uncorrelated to inputs, financial factors and firm characteristics. The motivation for the specification in eq. (5) is similar as that for eq. (4). We try to model output per capital using variables that are generally accepted and additional variables that might be reasonable in the Chinese data context, so that eq. (5) allows us to test the relationship between firms' financial factors and productivity.

Both the TFP and production function approaches may suffer from potential endogeneity and simultaneity problems. We instrument eq. (4) with lags of *tfp*, all the firm character variables and financial variables, and eq. (5) with lags of output to capital ratio, labour to capital ratio, and all the firm character variables and financial variables. We also include year dummies, industry dummies and industry-year interacted dummies in all the regression equations as well as in instrument sets to control for time and industry specific effects.

By applying the above two models we try to test whether financial factors play a role in determining firms' productivity. Our hypothesis is that financial resources and firms' ability to raise external funds can enable firms to improve productivity, since finance can make it possible for firms to carry out productivity-enhancing but finance-dependent activities, and firms are more likely to make the optimal arrangements for production. Therefore, if finance

does exert an influence on firm productivity, we would expect positive and significant coefficients on financial variables in both of our models.

We also apply the sample splitting methodologies initiated by the landmark work in the financial constraints literature by Fazzari, Hubbard and Petersen (1988) to differentiate the financial effects on firms' productivity across heterogeneous firms. Following the literature we interact a number of dummies variables, which are used to separate firm years into subgroups according to their characteristics, with our financial variable cash flow to capital ratio. Instead of running separate regressions for each of the subgroups, this methodology allows us to keep the maximum possible sample size and degree of freedom and to compare the financial effects on firm productivity between the correspondent firm groups. In this study we apply firms' liquidity, which is their current assets less current liabilities as the share of their total assets, firms' exporting status, the share of state capital, the share of foreign capital, and cash flow to productivity sensitivity to split our sample firms. We consider these firm characteristics to be interestingly related to the cash flow-productivity nexus, and will discuss the motivations in detail in section 5. Our hypothesis here is that these firm characteristics matter for the financial effects on productivity. We expect that heterogeneous firms featured by these characteristics may display distinctive financial effects on their productivity.

3.3 Estimation Methods

All of our equations are estimated by system generalised method of moment (GMM) approach developed by Arellano and Bond (1991) and Blundell and Bond (1998). The possible simultaneity and endogeneity problems in our models can be well controlled for by system GMM estimators. Blundell, Bond and Windmeijer (2000) show that the system GMM estimator has substantial asymptotic efficiency gains relative to the first-difference GMM estimator. We treat all the regressors as endogenous and include year dummies, 2-digit industry dummies, year and industry interacted dummies in all the regressions and instrument sets.

The dynamic model specifications can only be appropriate if they are exempt from serial correlation in the first-difference residuals, which can be tested by Arellano-Bond statistics for autoregressive models, the *m* statistics. We include three or more lags of each regressors as instruments, and verify the appropriateness of our model specification by *m3* tests. The validity of the instrument sets is tested by Hansen/Sargan statistics (or *J* statistics). However, the Monte Carlo evidence of Blundell, Bond and Windmeijer (2000) shows that using system GMM on a large panel data to estimate a production function the Sargan test tends to over-reject the null hypothesis of instrument validity. Consistent with this, Nickell and Nicolitsas (1999) report significant Sargan test statistics for all of their reported estimation results on UK firms, and Benito (2005) and Benito and Hernando (2007) for several of theirs on Spanish and UK firms. Therefore, we are inclined to pay less attention to the *J* tests for our system GMM estimators given our large and short panel sample.

4. Data and Descriptive Statistics

Our main dataset is from Oriana census database, which contains firms' published annual report information. It is available from the Bureau van Dijk Electronic Publishing (BvDEP). Our dataset comprises balance sheets, and profit and loss information for 578,577 Chinese

manufacturing firms over the period 1998-2007 with 2,087,383 observations. In our sample for estimation, to control for the potential bias caused by outliers we remove the one percent tails for the distribution of the variables which are used to estimate our TFP variable, and of the variables in each of our regressions. We drop firms with less than three-year consecutive observations, which is a common practice for dynamic models. Since we use firms' export as a control variable, we delete a small number of firm-years with exports larger than sales, which might be due to data mistakes. Also excluding the observations with missing values, our final dataset is an unbalanced panel and contains over 227,000 firms in the manufacturing sector corresponding to more than 682,000 firm-year observations. Since we apply dynamic models, effectively our data only cover year 2001-2007. The observations in each of the data years range from the minimum of about 51,000 in 2001 to the maximum of nearly 153,000 in 2006. The annual observations of the later years from 2005 are considerably more than those in the earlier years.

Table 1 shows some descriptive statistics of the variables being used in the models of this study. We present the variable statistics according to firm ownerships as well, since as suggested by much literature and in the Chinese data case firms' ownership type may be associated with significant differences in their other characteristics. Most of the variables vary largely across the four ownership groups, namely state-owned enterprises (SOE), foreign, private and collective. The ownership type is defined by the owner of a firm's majority share (more than 50%), which is measured by the average paid-in-capital over the data period. Comparing to the method using the largest share of each year to define ownership, this definition does not allow firms to switch between groups, so it avoids the problems such as data mistakes. It is also because we do not believe that firms would adjust their behaviours promptly according to changes in their capital structure. By this method of classification the majority of our sample firm years, 67.4%, are privately owned, and 16.4%, 7.5% and 5.4% are foreign, collective and state firm years respectively.

In our sample, productivity measures of TFP, value added per capital, labour productivity (measured by sales per employee) vary considerably across the four groups. Foreign firms have the highest TFP and value added per capital, but only have the second highest sales per employee after private firms. Private firms have higher TFP but marginally lower value added per capital than collective firms. SOEs have the lowest values in all three productivity measures. On average it seems that foreign firms are the most productive, followed by private and collective firms and SOEs are the least productive ones. The profitability measure of return on sales is almost identical across foreign, private and collective firms at about 3%, but it is negative for SOEs. Firm size measured by their real total assets decreases from SOEs to foreign, private and collective firms. Particularly, SOEs on average are more than twice as large as private or collective firms. Labour intensity (measured by the number of employees to real total assets ratio) is the highest among collective firms and lowest among SOEs. Foreign firms have the second highest labour intensity, which possibly suggests that on average foreign capitals may be more interested in the labour intensive industries in China. Foreign and private firms are both a little less than 8 years old on average, whereas collective firms are almost twice and SOEs are more than three times as old as them. The age distribution seems to be closely related to the economic reform process of China. SOEs have always been a type of establishments since the pre-reform time. Collective firms were first to thrive when the urban economic reform began in the 1980s. Private and foreign firms started to grow rapidly in the 1990s. SOEs only export a very small portion of their total sales, less than 4%, collective firms 5.6% and private firms 11.1%. In contrast, foreign firms export nearly 46% of their sales. This is in line with the strategy of much foreign venture amid

globalisation. China has been a global manufacturing centre hosting a large number of foreign invested firms. Many of them are established to export and to take the cost advantage of China, particularly the quality and cost of labour. This is also echoed with their high labour intensity shown in our data. Foreign firms have the highest cash flow-capital ratio (1.013), closely followed by collective and private firms, which may be a reflection of their high and similar profitability. SOEs' cash flow is substantially lower than other firms, only about a third of other firms' level. It might be the results of their low profitability as well as the possibility that they do not save much of their cash flow as they are able to raise external finance when they need.

5. Results

5.1 Full Sample

We start with the indirect approach. The estimation results of eq. (4) are presented in Table 2. We estimate our model with five alternative specifications. The lagged dependent variable, firms' size, age and cash flow-capital ratio are always included, and they are always highly significant and positive in explaining firms' TFP. Firm size has a positive effect and age has a negative effect on firm productivity. Our preferred specification is in column 1, which also shows positive and significant coefficients for export over sales ratio and coastal dummy. Generally, firms' degree of exports and coastal location increase firms' TFP. Our sample firms' TFP is significantly and positively affected by their availability of internal cash flow. If these firms have more cash flow available, their TFP tends to increase. Every unit increase in the sample firm years' cash flow to capital ratio can lead to 0.11 percentage increases in firms' log TFP. When we replace the export-sales ratio with export dummy or exclude either or both export and coastal dummies in columns 2 to 5, the results are consistent. The coefficients of other variables are remarkably similar across the five regressions. The *m3* tests show that all the model specifications are appropriate.

Firms' exporting activities are often found to be positively related to their productivity, though the causality is somehow unclear. Productive firms may be able to make their products competitive in the international market, whereas engaging in international competition may push firms to further improve their productivity. Our model confirms the positive export-productivity relation in our data sample. China's economic policy has a strong regional dimension. Coastal regions receive obvious preferential policy treatments favouring economic development. It is not surprising to see that coastal location helps firms to improve productivity. Clearly, cash flow has significant and positive coefficients in all the specifications. This is highly sensible in the Chinese case, as credit constraints have been documented to impede firms' investment and growth in China. Our results indicate that firms' ability of using internal source of finance significantly and positively affect their TFP.

We further verify the robustness of our results and show the estimations in table 3. We eliminate the distressed firms, which have negative average cash flow over sample period. Note that we do not simply treat firms with negative cash flow in each year as distressed. If a firm has positive cash flow in most of its operational years and experiences negative cash flow due to some sort of shocks in a single year, it is not likely that this firm will behave very differently in that year. However, if a firm on average has negative cash flow, it is possible that the firm is truly distressed. By taking the average measure can also avoid the possible

data mistakes to some extent. Distressed firms may behave very differently from normal operating firms, since they must lift their cash flow back to positive level by all means to keep the firm afloat. Excluding these about 40,000 firm years hardly changes the effects of any of the explanatory variable, which suggests that the positive cash flow effect in our model is not driven by the distressed firms.

In column 2 of table 3 we use firms' collateral instead of cash flow as the financial indicator. The heavy reliance of collateralised bank loans and the lack of alternative means of finance in the Chinese credit market would suggest that collateral may well proxy firms' ability of raising external borrowing. Regression results show that collateral also has a positive and highly significant effect on TFP, though the magnitude of the coefficient is quite small. This means that firms' ability to collateralise external borrowing can significantly improve their TFP. Other variables still have consistent coefficients and significance.

We also replace the dependent variable by firms' return on sales (ROS) and labour productivity (LP) respectively in column 3 and 4 in order to verify the financial effects on firms' other aspects of performance. The sign on firm size turns to negative and insignificant in the two specifications. It may suggest that being large in size does not help to increase profitability and labour productivity in our sample. Age still always has negative effect on firm performance. Exporting may significantly increase firms' return on sales and labour productivity. Locating in the coastal region helps to increase firms' profitability but not labour productivity. The availability of cash flow can significantly enhance firms' both performances. There is no gross mis-specification in these models either as shown by *m3* tests.

Overall, the estimation results of the indirect approach in Table 2 and 3 show that firms' TFP is significantly and positively affected by financial factors. More cash flow or collateral can significantly improve firms' productivity.

We then turn to the direct approach of estimating firm productivity. The results are reported in Table 4. We conduct similar alternative model specifications and robustness checks as for the indirect approach. We estimate the model with and without export and coast variables, using alternative financial variables and excluding distressed firm-years. Firms' output is approximated by real total value added. In all the specifications the lagged output to capital ratio, labour to capital ratio, age and coast dummies are highly significant and positive in explaining firms' output to capital ratio. Firms' exporting status becomes irrelevant in some specifications but remains significant and positive in others. The main difference between the direct and indirect approach models is the effects of age. In the indirect approach age imposes strong negative effects on TFP, but in the direct approach it has positive effects on production. The reason for the different effects is perhaps because the TFP model may tend to pick up the productivity in term of, possibly, technological advantages, whereas the production function model may not. The economic policies in the recent years strongly encourage and in favour of high technology domestic and foreign firms. It is possible that younger firms in our sample adopt more new technologies and benefit more from such policies, and older firms may have more experience in production efficiency. China now host clusters of foreign invested firms, which bring in advanced technologies and management skills, and are often set up for export. Particularly, most foreign or private sample firms are younger, and most of the SOEs or collective firms are older.

The financial variables, cash flow and collateral, play significant and positive roles in determining firms' productivity in all specifications. Firms' production efficiency is highly sensitive to firms' availability of cash flow and collateral. In our preferred specification in column 1 every unit increase in cash flow to capital ratio will lead to about 0.39 unit increase in firms' per capital production. Again the *m3* tests suggest that our production function model specifications are all proper.

Therefore, both the indirect and direct approaches imply that financial factors significantly and positively affect Chinese firms' productivity overall.

5.2 Subsamples

Given the fact that SOEs and collective firms only take up small proportions of the sample data and that they are susceptible to soft budget constraints, which may be likely to overshadow any financial effects on firms' activities, we believe it is a good practice to separate out these firms and further investigate financial effects on firm productivity on private and foreign firms separately. We will give further motivations below. There are 369,078 private firms and 65,461 foreign firms in the sample, corresponding to 1,272,384 and 287,984 observations respectively.

5.2.1 Private firms

Private firms in China are essentially subject to market force, since they do not have the government support as SOEs do or the preferential policy treatment that foreign firms often receive. They were not formally recognised as an integral part of the economy until the early 1990s, which left them with no access to formal financial markets, and their property rights were not well protected until the implementation of the new Property Law in 2007. Despite the disadvantages in the market private manufacturing firms are among the fastest growing economic agents. Their share of total value added in our whole sample increased steadily from 38% in year 2000 to 48% in 2007.

The regression results by both TFP model and production function model presented in column 1 of table 6a and 6b show that overall private firms' productivity is significantly constrained by their availability of internal cash flow. When they have more cash flow relative to total capital, their productivity tends to increase. Same as in the full sample, in the TFP model lagged TFP variable, firms' total real assets, export share and coastal location have positive and highly significant effects on firms' TFP, but firms' age has negative effects. In the production function model, lagged real value added to capital ratio, labour to capital ratio and coastal location have strong positive effects on firms' production, but firms' age and export share have no significant effects. Both models well pass the *m3* tests.

We then further investigate how the effects of financial factors on productivity related to private firms' other characteristics.

Liquidity

Asset liquidity is the ease with which the asset can be traded. The more liquid a firm's assets, the greater their value can be in short-notice sales. Keeping liquid assets may incur high opportunity cost to firms, but firms with more liquid assets may be viewed as less risky by lenders. Theories suggest that more liquid assets increase firms' ability to raise cash on short

notice. However, excessive liquidity may reduce the credibility of the firms to their lenders, since, as Myers and Rajan (1998) argues the liquidity of the assets opens up various trading strategies that may be adverse to the lenders' interests. As a result, excessive liquidity can, in some circumstances, reduce firms' capacity to raise external finance. Nevertheless, firms' liquidity is clearly an aspect that external lenders would judge when they make lending decisions.

Firms with high share of liquid assets may be more able to undertake the uncertain productivity enhancing activities than firms with low or negative share of liquid assets and rely less on their floating cash flow for such activities. This is reasonable in the sense that liquid firms can quickly liquidise some of their assets in case they need extra funds to finance the uncertain productivity enhancing activities. Illiquid firms may not be able to do the same and, hence, are more dependent on their existing cash flow for productivity enhancing activities. Indeed, Nucci, Pozzolo and Schvardi (2005) find that low liquidity Italian firms suffer stronger negative effects of leverage on their TFP than their counterparts.

We separate the private firm sample into those with positive and non-positive liquidity, which is the ratio of net current assets to total assets. Negative liquidity should impose extra difficulty for firms to raise external fund since it increases firms' risk of bankruptcy. Using the benchmark of zero can also allow us to avoid a definition of excessive liquidity, which often varies greatly across different financial markets. The descriptive statistics in table 5 columns 1 to 3 show the comparison between private firm years with positive and non-positive liquidity. 60% of the private firm years have positive liquidity, but as high as 40% of them do not. Firm years with positive liquidity are much more productive than those with non-positive liquidity by all three measures of productivity. The former is also more profitable, more labour intensive and surely possess much more cash flow. Particularly their cash flow ratio is more than two times higher than the others'. They are also younger, have less assets and export smaller proportion of their sales. The *t* tests show that the mean values of these variables are significantly different across the two groups of firm years, though the magnitude of the difference may be small in some cases.

In the TFP model in table 6a column 2, all the non-financial variables attract highly significant and sensible coefficients. Both firms with positive or non-positive liquidity have significant cash flow effects on their TFP. The coefficient of the cash flow for the illiquid firms (0.197) is much higher than that of the other (0.114), and the χ^2 test shows that the difference is highly significant. The production function model in table 6b column 2 also shows similar results that the coefficient of the cash flow for the firms with non-positive liquidity (1.015) is much higher than that of the other (0.494). Therefore both models confirm that cash flow has a stronger positive effect on firms' productivity for illiquid firms than for liquid firms. The appropriateness of both models is confirmed by *m3* tests.

Export

In the international economics literature exporters are often documented to be more productive than non-exporters. This empirical finding is often cited as a reason for active export promotion in many developing countries. There are two common theoretical explanations for a positive correlation between the export status of a firm and its productivity. One is self-selection: only the productive firms are able to engage in export activities and compete in international markets. The other is 'leaning-by-doing' hypothesis: entering into export markets allows firms to gain new knowledge and expertise which contribute to

improve their productivity. There has been substantial evidence in favour of self-selection, such as Bernard and Jensen (1999) among many others. Van Biesebroeck (2005) among others finds evidence for 'learning-by-doing'. In our models the export share of sales also generally plays a positive and significant role in determining firms' productivity. However, these arguments may be more applicable to domestic exporters particularly in industrialised countries than foreign invested exporters. We examine the domestic private firms here first and will explore foreign exporters in the next section.

A large share of China's export is processing export, in which the exporting factories mainly import parts and input labour to assemble the final products. Such exporters are not expected to have better performance than otherwise similar non-exporters. They simply follow the instructions from their foreign clients to do some simple assembling, hardly undertake product design and mostly have no R&D activities. Consequently, domestic exporters may not have better access to external finance either. Such exporters, which are the main type of exporters in developing countries nowadays and an essential part in the international production chain, may not be properly described by the established trade theories above. Bellone *et al*. (2009) find evidence from a panel of French manufacturing firm data that financial constraints significantly affect firms' export decisions. In particular, better financial health and better access to external finance can make firms more likely to export. Greenaway, Guariglia and Kneller (2007), on the other hand, find that continuous exporters exhibit better financial health than non-exporters using a panel of UK manufacturing firms and participation in export markets improves firms' financial health. Our focus here is related to but very different from these authors' findings. They demonstrate that finance and export status of firms are closely related, whereas we try to identify whether financial effects on firms' productivity differ across export status. Their results suggest that exporters may face less financial constraints. Given the foreign investment and export sector in China and in developing foreign direct investment (FDI) host countries in general, we suspect that these authors' arguments may not apply to all the firms particularly in the developing FDI host countries. Financial constraints may differ across domestic and foreign exporters.

Figures in columns 4 to 6 of table 5 imply that private exporters seem to be more productive than non-exporters, as their TFP and value added per capital are higher. However, their labour productivity is much lower, which is possibly related with their high labour intensity. Indeed China's export sector mainly exports labour intensive goods, which is likely to be the results of the country's comparative advantage. Exporters' return on sales is lower than non-exporters. They are much larger and older. On average more than half of their total sales are exported. Private exporters also have lower level of cash flow to capital ratio on average. The differences between exporters and non-exporters are all highly significant as suggested by the *t* tests of the variable means.

In the TFP model in column 3 of table 6a both exporters and non-exporters have significant and positive cash flow effects on their TFP, and the effect is significantly stronger for the exporters. This pattern of financial effects on productivity is generally supported by the production function model, where the cash flow effect is marginally higher for the private exporters. Our models are appropriately specified and other non-financial variables fit well. These results have some useful policy implications. Many policy makers believe that encouraging exports is beneficial for raising productivity. While a number of recent studies find that finance is an important determinant to foster exports (e.g. Manova, 2008), our findings add that even for the indigenous exporters finance is an important factor to improve

productivity. If more financial resources can be channelled to domestic exporters, it can directly help them to improve productivity.

State share

Private firms are disadvantaged in the market receiving weak legal protection and unfavourable policy treatment. Many private firms, therefore, seek connections with the favourable market players such as SOEs which have the supports from authorities, and foreign firms which enjoy preferential policies. Particularly, both SOEs and foreign firms are known as less financially constrained than private firms. The former benefits from soft budget constraints, whereas the latter has easy access to international source of finance. We investigate whether direct state holding would help private firms to alleviate the constraining effects of financial factor on their productivity. We consider more than 10% of state share as a benchmark which is common in the literature. A minority share of less than 10% may be too small for the state influence to affect the private firms.

Table 5 columns 7 to 9 show that there are only 1.5 % of our private firm-years having more than 10% of state share. These firm years have higher TFP but lower value added per capital and labour productivity than the rest of the firm years. Their return on sales is lower and their export share of sales is only about half of the other. They are less labour intensive and older. Their cash flow over capital ratio is also lower. However, they are much larger in terms of real total assets. The differences between the two types of firm years are all highly significant. Relative speaking these private firms are big, established and domestic market oriented, but their performance is not necessarily better than others. It is interesting that we find among these 6662 firm-years which have more than 10% of state capital 4535 firm-years increased their state share during the sample period whereas only 463 firm-years reduced state share. It seems that majority of these private firms are enthusiastic to get more state capital, which is possibly because such state holding can help their business in some way.

Both TFP and production function models in column 4 of table 6a and 6b respectively show that private firm years with more than 10% of state share do not have a significant cash flow effect on their productivity, but other private firm years do have. Other variables in both models all have reasonable coefficients and significance, and both model specifications are appropriate. These results indicate that state holdings help private firms to relax the constraints that the availability of internal funds imposes on their productivity. The results are robust when we increase the benchmark up to 25% or drop it down to 0%.[2]

Foreign Share

As we mentioned above, for similar reasons private firms may also seek connections to foreign firms to benefit from the state policy. Huang (2003) argues that the motivation for Chinese domestic private firms seeking FDI is because they cannot finance their projects from domestic source. We test such supposition directly by examining whether foreign shares of more than 10% in private firms help them to ease cash flow effects on productivity. Foreign capital share is the most common measure of FDI at firm level. FDI is believed to be often associated with better productivity through the spillover effects from the productive multinational firms to the local host firms and beyond.

[2] The results are not reported to keep concision, but are available upon request.

In our sample 6.4 % of the private firm years have more than 10% of foreign shares as presented in table 5 columns 10 to 12. These firm years have higher TFP and value added per capital but lower labour productivity than their counterparts. Their profitability and cash flow to capital ratio are higher. They are much larger, younger and less labour intensive. Their export share is more than three times of that of the rest of firm years. Their high level of export engagement is perhaps a reason why they get a high level of foreign capital in their firm. All the differences between the two correspondent groups are again significant.

However, the regression results from both TFP and production function models suggest that no matter with or without more than 10% of foreign shares private firms experience positive and highly significant cash flow effects on their productivity. The cash flow coefficients for the two groups of firms are not statistically different from each other in both models, as suggested by χ^2 tests. Both models are well specified and other non-financial variables are sound. Hence, our results seem to show no evidence that a sensible level foreign capital can exempt private firms from constraining effects of finance on productivity. Foreign capital cannot help domestic private firms for finance as state capital may do. Again these results are robust when we lift the benchmark up to 25% or lower it down to 0%. Our results do not support Huang (2003)'s arguments.

Cash Flow-Productivity Sensitivity

Our approach to assess the impact of financial factors on firms' productivity is to test how sensitive firms' productivity is to the variation of financial variables. Hovakimian and Hovakimian's (2009) propose a method to directly measure the variation in firms' investment in associate with variation in cash flow. We borrow the formula to calculate a firm-level sensitivity of our measures of productivity to per capital cash flow (CPS_i) as follows

$$CPS_i = \sum_{i=1}^{n} (prod_{it} \times \frac{CF_{it}}{K_{i,t-1}} \Big/ \sum_{i=1}^{n} \frac{CF_{it}}{K_{i,t-1}}) - \frac{1}{n} \sum_{i=1}^{n} prod_{it}$$

where n is the number of annual observations for firm i, and $prod$ is either TFP or value added per capital in the respective models. This formula describes the difference between the cash flow weighted time-series average productivity of a firm and its simple arithmetic time-series average productivity. The minimum weight is set to zero in order to obtain non-negative legitimate weighted average, i.e. all the negative CF/K are set to zero in this formula. Hovakimian and Hovakimian's (2009) show evidence in their cash flow-investment study that firms with high sensitivity calculated by this formula have binding financial constraints in low cash flow years. We classify firm-years into two groups. One is the firm-years with CPS higher than the median value of the CPS variable and cash flow over capital ratio lower than its own time-series average. By this classification we identify high sensitive firms in their low cash flow years. We expect this group of firm-years to display significant cash flow effects on their productivity by our estimation models, as they have high cash flow-productivity sensitivity and they are short of cash flow at the time. The other group contains the rest of the firm-years. In our private firm sample, the first type of firm years, which is labelled as high in the results tables, is about 27.7% of the total number of firm-years.

Columns 13 to 15 of table 5 show the statistics comparison between the cash flow-TFP sensitive firm years in low cash flow years and other firm years. The sensitive firm years in low cash flow years are significantly less productive than other firm-years. Their TFP, value

added per capital and labour productivity are all lower. Their return on sales is also much lower. They are less labour intensive and a little older. They export less proportion of their sales. On average their cash flow per capital is less than half of the rest of the firm years'.

In the TFP model we calculate the sensitivity of firms' cash flow to capital ratio to their levels of TFP, and in the production function model we calculate the sensitivity of cash flow-capital ratio to firms' value added to capital ratio. In column 6 of table 6a high sensitive firm years in low cash flow years (the high group) have significantly higher and positive cash flow effects on their TFP (0.290) than other firm-years (the low group) (0.114). Other non-financial variables are all highly significant and have consistent and similar coefficients with those in other specifications. The production function model in column 6 of table 6b also shows a slightly higher cash flow effect on firms' value added per capital for the high sensitive firm years in low cash flow years than others, though the difference between the two groups is not statistically significant. Both *m3* tests suggest that the specifications are suitable.

5.2.2 Foreign Firms

Foreign firms in both industrialised economies and emerging economies are often believed to be productive given the fact that they are able to operate in a foreign country. In the globalisation age multinational firms are one of the major driving forces of international trade and resource optimisation in a global scale. Governments all over the world appear to be keen to attract foreign investment by various policy incentives. While foreign firms share many similar features with domestic private firms, they often enjoy more favourable environment, such as lower tax rate.

The 16.4% of foreign firm years in our whole sample seem to be the healthiest and most productive overall. Even so the estimation results for all the foreign firms by both TFP and production function models show a strong and positive cash flow effect on their productivity. In the TFP model in table 8a column 1 the lagged dependent variable and firms' size have significant and positive effects and firms' age has significant and negative effect. However, the positive effect of export share is only significant at 7.5% and coast dummy is insignificant. In the production function model in table 8b column 1 whereas all other variables are positive and significant, export share is not significant. 94% of the foreign firm years in our sample locate in the coastal region and foreign firms on average export nearly half of their total sales. It seems that for these mostly heavily export-oriented foreign firms operating in China export itself does not show a link with their productivity. We will explore this point in more details below.

We further investigate financial effects on foreign firms' productivity by some special characteristics of these firms.

Liquidity

By similar motivation of looking at private firms' liquidity, liquidity remains to be an interesting topic for foreign firms. Foreign firms appear to be somehow the best by the statistics in table 1. 76% of foreign firm years have positive liquidity, which is a much higher proportion than private firm years (60%). Table 7 columns 1 to 3 show that liquid foreign firm years seem to outperform the illiquid firm years to a large extent. Their productivity and profitability are much higher even if their size is smaller. Particularly their return on sales on average is nearly five times as high as that of the other. They are much more labour-intensive,

and a little older. Their export share is slight higher in magnitude. Unsurprisingly their cash flow ratio is more than two times as high as that of the illiquid firms. The differences of all the variables between the two groups are highly significant.

Both TFP and production function models for the foreign sample display a much higher and positive coefficients on the cash flow terms for the illiquid firm years than for the liquid firm years as shown in column 2 of table 8a and 8b. The respective χ^2 tests show the difference of the cash flow effects between the liquid and illiquid groups is significant. The results suggest that illiquid foreign firms suffer a much stronger constraining effect of cash flow on their productivity. Other variables in the two models perform well and neither model has gross mis-specification problem.

Export

Most of the empirical evidences on the relationship between firms' export status and productivity are based on the domestic indigenous firms including multinationals. Few studies have focused on foreign affiliates in the host country. Foreign exporters and domestic exporters have some fundamental differences in their operation and export activities. Kneller and Pisu (2004) investigate export behaviour of foreign firms in the UK and find that foreign firms are more export intensive and contribute a disproportionately large share of UK's total manufacturing export. These features are shared by the Chinese manufacturing sector. In our full sample, between 2000 and 2007 foreign firm-years count for 13.8% of the total observations, but their value of export takes up to 58.7% of the total export of all firm years. The linkage between export and productivity, and financial constraints are possibly very different across domestic and foreign exporters.

There has been little research on the productivity of foreign affiliates in developing countries or the financial effect on their productivity. Foreign firms, particularly those which are export-oriented, producing in developing countries are likely to be very different from those which produce in industrialised countries. While the latter arguably is mostly driven by market seeking purposes, the former is probably interested more in the low production cost in the developing countries than in their markets. The globalisation process has induced many firms in the industrialised countries to relocate their production lines to developing countries like China, which has low cost skilled labour and provides many preferential policy treatments to foreign investors. A large number of foreign firms are established purely for export. In our sample, 13% of the foreign firm-years export 100 percent of their products, 28% export more than 90 percent of their products, and 37% export more than three quarters of products. On average the foreign exporters in China export 67% of their products. Amid globalisation firms in open economies are forced to face international competitions in their local market. It can be the case that less productive firms are driven by market force to relocate their production abroad to reduce cost just to survive. In such case the firms may not be interested in the foreign developing market and export a majority of their products back to their home countries, and such firms may not necessarily be productive relative to local or other foreign non-exporters. On the other hand, multinational firms, which expand their business to foreign countries, produce and sell in the foreign markets, are possibly the real productive firms.

Also the foreign firms which are local market oriented may have to invest in R&D in order to suit their products to the local market and research the local business environment, whereas the foreign firms which are export oriented may not need to do so. The differences between

foreign exporters and non-exporters may suggest that finance may play different roles for their productivity.

As shown in columns 7 to 9 of table 7 two thirds of the foreign firm years in our data are exporters, whereas the rest one third sell all their products in the Chinese market. Indeed, the foreign non-exporters are somewhat more productive than the foreign exports. Their TFP and labour productivity are higher than exporters, but value added per capital is a little lower. They are smaller in size and younger, but more profitable and less labour intensive. Their cash flow to capital ratio is also higher. The differences between exporters and non-exporters are all highly significant for all the indicators.

The regression results in column 3 of table 8a and 8b indicate that the foreign non-exporters are subject to stronger cash flow effect on productivity. Non-exporters have higher cash flow coefficients than exporters and the differences are statistically significant. Both TFP and production model specifications are appropriate. While non-exporters seem to be better than the exporters by the descriptive statistics, they are actually affected more by the availability of their own cash flow for their productivity. This result may indicate potential economic inefficiency as the productive non-exporters have to heavily rely on their own cash flow to improve their productivity. Therefore, if the availability of finance to the productive foreign non-exports can be improved, the overall productivity and efficiency will be enhanced.

Cash Flow-Productivity Sensitivity

We also categorise foreign firm years into high and low groups, where high firm-years having above median value of cash flow-productivity sensitivity and their cash flow of the year below their own time-series average, and low group comprises the rest of the foreign firm-years. In columns 7 to 9 of table 7 we show the comparison between the high and low groups of firm years, where the sensitivity is calculated between cash flow to capital ratio and TFP. The high firm-years comprise about 27.6% of the total foreign firm-years. The high group of firm-years have much lower TFP and value added per capital than the low group, but a little higher labour productivity. High firm-years' return on sales is substantially lower than that of low firm-years, only less than a quarter of that of low firm-years'. High firm-years are larger, much less labour intensive, and slightly older. Their export share of sales is a little lower and their cash flow to capital ratio is less than half of the low firm-years'. All the differences between the two types of firm years are statistically significant at less than 1%.

Again, we use cash flow-TFP and cash flow-value added sensitivities respectively in the TFP model and production function model. In the TFP model in table 8a column 4 both the high and low firm-years have positive and significant cash flow effects on TFP, but high group of firm-years get a much higher cash flow coefficient (0.153) than the low firm-years (0.072). The χ^2 test shows that the difference is significant. However, similar to the private sample results, in the production function model in column 4 of table 8b the cash flow effects for the two groups of firm-years are similar in magnitude and the difference is insignificant. Those non-financial variables in both models are reasonable and significant. *m3* tests suggest that neither model has gross mis-specification problem.

These results for both private and foreign firms imply that our firm-level cash flow-productivity sensitivity does seem to properly identify firms whose productivity are more and less likely to depend on the availability of internal finance. Considering the summary statistics in table 5 and table 7 together, it is clear that private or foreign firm years with high

cash flow-productivity in their low cash flow years are inferior to the correspondent rest of the firm-years. These firms are less productive and less profitable, export less and have less cash flow, even though they are bigger in asset size. It seems to signify that firms' quality is negatively associated with their cash flow-productivity sensitivity. With same amount of additional finance these firms are able to raise their productivity more than other firms, but they on average have much less financial resources than others. Therefore, if the financial system can channel relatively more finance to this kind of firms, the overall efficiency of the economy will be improved.

6. Conclusions

We use a sample of 578,577 Chinese manufacturing firms over the period of 1998-2007 to study the impact of financial factors on firms' productivity. We establish a total factor productivity model as well as a production function model augmented with financial variables. Overall, Chinese firms' productivity measured by TFP and per capital output is significantly and positively affected by their availability of internal finance, cash flow. The results are robust to various model specifications, and the influence of distressed firms in the sample, alternative indicator of firms' ability of raising external finance, i.e. collateral, and alternative measures of firm performance including return on sales and labour productivity.

We further explore the finance-productivity relationship in the private and foreign owned firms taking firm heterogeneity into account. The productivity of both types of firms is dependent on their availability of internal cash flow. Illiquid private or foreign firm years have significantly stronger cash flow-productivity sensitivity than their respective liquid counterparts, which is possibly because illiquid firms are regarded by lenders as risky and less able to borrow. Private exporters display higher dependence of productivity on cash flow than non-exporters do. However, in the contrary, foreign non-exporters experience stronger constraining effects of cash flow on their productivity than foreign exporters do. These contrasting patterns of financial effects on productivity between exporters and non-exporter and between private and foreign firms are likely to relate to the situation of export sector and the role of foreign investments. State holding of shares can help private firms not to rely on finance for their productivity, but investment from foreign owners cannot help in the same way. We calculate two firms' cash flow-productivity sensitivity using TFP and value added per capital for the two alternative models respectively and identify firm years having high cash flow-productivity sensitivity in their low cash flow years. This type of private or foreign firm years is subject to stronger financial effects than others.

Our results show that firms' finance is positively linked to their productivity. Lack of financial resources and the ability of raising fund can hamper firm's productivity. Our findings suggest that increasing the accessibility of finance to firms can directly improve productivity at firm level. It will be particularly effective to channel finance to those good quality firms whose productivity are highly dependent on financial factors. Productivity improvement, which is typically a result of technological progress, has been a main source of growth. Economists are arguing that sustainable growth should be made through productivity improvement in the real sector. Factor accumulation has contributed enormously to China's economic growth in the past decades. Our results suggest that easing financial constraints to firms can significantly increase firm level productivity, which can support economic growth in the long term.

Appendix

A.1 Data Definitions

The main data source is the Oriana census database. The deflators are from the *China Statistical Yearbook* (various issues), which are published by the National Bureau of Statistics of China. We use the provincial capital goods deflator to deflate the capital variable and the provincial gross domestic product (GDP) deflator to deflate other variables. The construction of our variables is as follows

TFP: estimated using Levinsohn and Petrin (2003) method with value added as the dependent variable

Value added: = profit and loss for the period (net income) + income tax + cost of employees (wages) + depreciation + interest paid

Labour: the total number of employees at the balance sheet date of the company

Capital stock: firms' total tangible fixed assets

Age: firms' age = the current year – firm's year of establishment

Cash flow: = net income + annual depreciation. The regression variable is the cash flow / tangible fixed assets.

Collateral: = tangible fixed assets / total assets

Return on sales: = net income / sales

Labour productivity: = real sales / number of employees

A.2 Levinsohn and Petrin (2003) Method of TFP Estimation

A production function in logarithm form is written as

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_\tau \tau_t + \omega_t + \eta_t \qquad \text{(a)}$$

There are three inputs, a freely variable labour (l_t), a state variable capital (k_t) and another freely variable intermediate input (τ_t) (perhaps materials or energy etc.). The demand function for τ_t is given as $\tau_t = \tau_t(\omega_t, k_t)$ and it must be monotonic in ω_t for all relevant k_t to qualify as a valid proxy. The error term comprises a sate variable transmitted component (ω_t), which impacts firms' decision rules, and an *i.i.d.* component (η_t), which has no impact on firms' decisions.

With the monotonicity assumption one can invert the input demand function to obtain $\omega_t = \omega_t(\tau_t, k_t)$. Then one can rewrite eq. (a) as

$$y_t = \beta_l l_t + \phi_t(\tau_t, k_t) + \eta_t \qquad \text{(b)}$$

where $\phi_t(\tau_t, k_t) = \beta_0 + \beta_k k_t + \beta_\tau \tau_t + \omega_t(\tau_t, k_t)$. To obtain consistent non-parametric estimators one may take the expectation of eq. (b) conditional on τ_t and k_t. Because η_t is *i.i.d.* independent of τ_t and k_t, and $E[\phi_t(\tau_t, k_t) \mid \tau_t, k_t] = \phi_t(\tau_t, k_t)$, one can get

$$E[y_t \mid \tau_t, k_t] = \beta_l E[l_t \mid \tau_t, k_t] + \phi_t(\tau_t, k_t) \qquad \text{(c)}$$

Subtracting (c) from (b) yields

$$y_t - E[y_t \mid \tau_t, k_t] = \beta_l (l_t - E[l_t \mid \tau_t, k_t]) + \eta_t \qquad \text{(d)}$$

Since η_t is *i.i.d.* independent of l_t, OLS (restricting intercept to be zero) can give consistent estimate of β_l.

To obtain consistent β_k estimates, ω_t is further assumed to follow a first-order Markov process and capital is assumed not to immediately respond to productivity innovation shock ξ_t, which is given by $\xi_t = \omega_t - E[\omega_t \mid \omega_{t-1}]$.

One then may obtain a y_t^*, which is the output net of labour's contribution

$$y_t^* = y_t - \beta_l l_t = \beta_0 + \beta_k k_t + \beta_\tau \tau_t + E[\omega_t \mid \omega_{t-1}] + \eta_t^*$$

where $\eta_t^* = \xi_t + \eta_t$. The assumption $E[k_t \eta_t^*] = 0$ holds, because both ξ_t and η_t are uncorrelated with k_t. Assuming $E[\tau_{t-1} \eta_t^*] = 0$ consistent estimates of $E[\omega_t \mid \omega_{t-1}]$ and β_k can be obtained.

Finally, consistent estimate of TFP, which is the residual between output and the estimated output, can be obtained.

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Table 1: Descriptive Statistics

	All firm-years	Firm-years sorted by firm ownership			
		SOE	Foreign	Private	Collective
	(1)	(2)	(3)	(4)	(5)
TFP	3.887	2.941	5.184	3.682	3.366
	(3.624)	(3.351)	(4.443)	(3.357)	(3.202)
Y/K	2.561	1.327	3.007	2.552	2.566
	(3.405)	(2.261)	(3.895)	(3.335)	(3.319)
LP	3.087	1.484	3.190	3.251	2.585
	(3.415)	(2.219)	(3.520)	(3.452)	(3.168)
ROS	0.029	-0.006	0.030	0.032	0.031
	(0.063)	(0.098)	(0.074)	(0.054)	(0.066)
Real total assets	362.93	623.93	543.83	303.70	266.41
	(662.27)	(1013.92)	(787.94)	(588.60)	(459.86)
L/K	11.508	8.666	12.614	11.269	13.388
	(18.465)	(14.532)	(20.047)	(17.857)	(19.965)
age	9.591	24.844	7.714	7.986	15.820
	(9.234)	(15.467)	(4.002)	(7.636)	(10.954)
Exp/sales	0.162	0.038	0.458	0.111	0.056
	(0.325)	(0.148)	(0.426)	(0.274)	(0.197)
CF/K	0.927	0.350	1.013	0.947	0.982
	(1.485)	(0.927)	(1.634)	(1.460)	(1.596)
Number of observations (%)	672341	36346	109972	453268	50561
	(100%)	(5.4%)	(16.4%)	(67.4%)	(7.5%)

Notes: The table reports the sample means. Standard deviations are presented in parentheses. The subscript *i* indexes firms, and the subscript *t* time, where *t*=2001-2007. The sample excludes those firm-years with less than 3-year consecutive observations and those with exports larger than total sales, and 1 percent tails of the distribution of each variable. *TFP* represents firm's total factor productivity (using Levinsohn & Petrin 2003 method); *Y/K*, value added over total fixed tangible assets; *ROS*, return on sales (net income/sales); *LP*, labour productivity (real sales/number of employees); *L/K*, labour intensity (number of employees / real total assets); *age*, firm's age; *Exp/sales*, ratio of export over sales; *CF/K*, cash flow over total fixed tangible assets; The currency unit is thousand RMB *yuan* (approximately the exchange rate of USD : RMB = 1:6.8). Firm's ownership type is defined by the owner of firm's majority share (>50%) which is measured by the average paid-in-capital over the data period.

Table 2: The Effects of Financial Factors on Firms' TFP — Indirect Estimation

Dependent Variable: tfp_{it}	Full sample				
	(1)	(2)	(3)	(4)	(5)
$tfp_{i,t-1}$	0.642*** (0.017)	0.663*** (0.016)	0.646*** (0.017)	0.675*** (0.016)	0.686*** (0.016)
$size_{it}$	0.119*** (0.011)	0.118*** (0.011)	0.113*** (0.012)	0.136*** (0.010)	0.134*** (0.010)
age_{it}	-0.159*** (0.008)	-0.158*** (0.008)	-0.149*** (0.008)	-0.164*** (0.008)	-0.157*** (0.008)
$(Exp/sales)_{it}$	0.298*** (0.044)			0.342*** (0.042)	
Exp_{it}		0.194*** (0.028)			
$Coast_{it}$	0.619*** (0.076)	0.234*** (0.043)	0.733*** (0.089)		
CF/K_{it}	0.111*** (0.011)	0.121*** (0.010)	0.101*** (0.011)	0.131*** (0.010)	0.122*** (0.010)
Sample size	682483	682483	682483	682483	682483
m3(p-value)	0.846	0.876	0.847	0.876	0.904

Notes: All results are obtained by one-step system GMM estimation. The figures reported in parentheses are asymptotic standard errors. Constant, time dummies, industry dummies and industry-time interacted dummies are included in all specifications. Standard errors and test statistics are asymptotically robust to heteroscedasticity. *tfp* is the logarithm of *TFP*; *size* is the logarithm of firm's real total assets; *age* is the logarithm of firm's age; *Exp* is a dummy variable equal to 1 if firm *i* exports at time *t*, and equal to 0 otherwise; *Coast* is a dummy variable equal to 1 if firm *i* locates in the 10 coastal provinces at time *t*, and equal to 0 if in the rest 21 provinces. *m3* is a test for third-order serial correlation in the first-difference residuals, asymptotically distributed as standard normal $N(0,1)$ under the null of no third-order serial correlation. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. Please also see *Notes* to Table 1 and footnote 1. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Table 3: The Robustness of the Effects of Financial Factors on Firms' Performance

Dependent variable$_{it}$	*tfp*	*tfp*	*ROS*	*LP*
	Un-distressed firms only (mean(CF/K)>0)			
	(1)	(2)	(3)	(4)
Dependent variable$_{i,t-1}$	0.626*** (0.016)	0.751*** (0.015)	0.610*** (0.017)	0.879*** (0.015)
$size_{it}$	0.121*** (0.011)	0.045*** (0.009)	-0.001 (0.000)	-0.009 (0.008)
age_{it}	-0.142*** (0.008)	-0.121*** (0.010)	-0.009*** (0.001)	-0.101*** (0.008)
$(Exp/sales)_{it}$	0.292*** (0.043)	0.245*** (0.052)	0.009*** (0.003)	0.131** (0.052)
$Coast_{it}$	0.590*** (0.079)	0.735*** (0.087)	0.027*** (0.006)	0.038 (0.060)
CF/K_{it}	0.116*** (0.011)		0.004*** (0.001)	0.075*** (0.009)
$Collateral_{it}$		0.006*** (0.001)		
Sample size	640855	682214	674690	677006
m3(p-value)	0.863	0.666	0.364	0.573

Notes: The table reports one-step system GMM results. *Collateral* is firms' tangible fixed assets / total assets. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. Please also see *Notes* to Table 1 and 2.

Table 4: The Effects of Financial Factors on Firms' Productivity — Direct Estimation

Dependent Variable: Y/K_{it}	Full sample					Un-distressed firms only (mean(CF/K)>0)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Y/K_{i,t-1}$	0.655*** (0.051)	0.661*** (0.052)	0.692*** (0.064)	0.658*** (0.052)	0.721*** (0.065)	0.541*** (0.046)	0.896*** (0.036)
L/K_{it}	0.046*** (0.007)	0.046*** (0.007)	0.046*** (0.009)	0.049*** (0.008)	0.045*** (0.009)	0.061*** (0.007)	0.018** (0.008)
age_{it}	0.007*** (0.002)	0.006*** (0.002)	0.007*** (0.002)	0.010*** (0.002)	0.011*** (0.002)	0.008*** (0.002)	0.002 (0.003)
$(Exp/sales)_{it}$	0.083 (0.176)			0.342** (0.172)		0.155 (0.163)	0.055 (0.289)
Exp_{it}		0.196** (0.096)					
$Coast_{it}$	1.399*** (0.288)	0.967*** (0.169)	2.018*** (0.372)			1.462*** (0.297)	1.713*** (0.431)
CF/K_{it}	0.391*** (0.091)	0.394*** (0.093)	0.333*** (0.111)	0.430*** (0.092)	0.329*** (0.114)	0.591*** (0.076)	
$Collateral_{it}$							0.017*** (0.004)
Sample size	747763	747763	747763	747763	747763	678567	745985
m3(p-value)	0.867	0.881	0.844	0.885	0.855	0.389	0.671

Notes: The table reports one-step system GMM results. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. age is firm's age. Please also see *Notes* to Table 1, 2 and 3.

Table 5: Descriptive Statistics for Private Firms

	Liquidity			Exporter			State capital			Foreign capital			CF/K-TFP sensitivity		
	>0	<=0	t test	yes	no	t test	>10%	<=10%	t test	>10%	<=10%	t test	High	Low	t test
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
TFP	3.921 (3.386)	3.192 (2.784)	0.000	4.058 (3.420)	3.510 (3.098)	0.000	4.517 (3.999)	3.615 (3.162)	0.000	4.623 (3.810)	3.559 (3.118)	0.000	3.088 (2.533)	3.834 (3.370)	0.000
Y/K	3.137 (3.773)	1.662 (2.097)	0.000	2.900 (3.523)	2.446 (3.212)	0.000	1.991 (3.058)	2.552 (3.289)	0.000	2.666 (3.318)	2.535 (3.284)	0.000	1.716 (2.111)	2.860 (3.587)	0.000
LP	3.420 (3.481)	2.925 (3.085)	0.000	2.704 (2.790)	3.361 (3.457)	0.000	2.433 (2.730)	3.232 (3.343)	0.000	3.179 (3.277)	3.223 (3.340)	0.031	3.057 (3.065)	3.283 (3.433)	0.000
ROS	0.039 (0.049)	0.022 (0.047)	0.000	0.030 (0.046)	0.033 (0.050)	0.000	0.025 (0.064)	0.032 (0.049)	0.000	0.035 (0.058)	0.032 (0.048)	0.000	0.020 (0.048)	0.037 (0.049)	0.000
Real total assets	278.33 (527.16)	307.85 (529.83)	0.000	405.46 (713.74)	258.80 (460.32)	0.000	734.26 (994.40)	283.42 (515.10)	0.000	500.25 (738.14)	275.77 (507.68)	0.000	331.00 (547.94)	274.60 (519.93)	0.000
L/K	13.221 (19.754)	8.111 (12.532)	0.000	14.028 (20.565)	10.384 (16.340)	0.000	8.489 (13.820)	11.205 (17.442)	0.000	10.768 (16.298)	11.191 (17.469)	0.000	8.845 (13.376)	12.052 (18.632)	0.000
age	7.740 (6.773)	7.907 (7.677)	0.000	8.256 (7.302)	7.685 (7.105)	0.000	13.763 (13.303)	7.716 (6.976)	0.000	7.463 (4.817)	7.830 (7.284)	0.000	7.901 (7.328)	7.771 (7.083)	0.000
Exp/sales	0.107 (0.270)	0.119 (0.281)	0.000	0.524 (0.370)	0.000 (0.000)	0.000	0.056 (0.177)	0.113 (0.276)	0.000	0.330 (0.396)	0.097 (0.256)	0.000	0.099 (0.254)	0.117 (0.282)	0.000
CF/K_{it}	1.200 (1.626)	0.564 (0.926)	0.000	0.905 (1.309)	0.955 (1.451)	0.000	0.694 (1.303)	0.948 (1.423)	0.000	0.968 (1.429)	0.942 (1.421)	0.003	0.526 (0.770)	1.104 (1.574)	0.000
Number of observations (%)	264314 (59.7%)	178083 (40.3%)		94751 (21.4%)	347646 (78.6%)		6662 (1.5%)	435735 (98.5%)		28460 (6.4%)	413937 (93.6%)		122464 (27.7%)	319933 (72.3%)	

Notes: Liquidity is firms' ratio of (current assets – current liabilities) / total assets. High group in column 13 includes firm-years with CF/K-TFP sensitivities above the median value and CF/K value of year *t* lower than its own time-series average, and Low group in column 14 includes the rest of firm-years. t tests report the p-values of the difference between the variable mean of the correspondent groups, under H_0: difference = mean(group1) – mean(group2) = 0. The sample excludes those private firm-years with less than 3-year consecutive observations, those with exports larger than total sales, and 1 percent tails of the distribution of each variable. Please also see *Notes* to Table 1.

Table 6a: Differential Effects of Financial Factors on Private Firm's TFP — Indirect Estimation

Dependent Variable: tfp_{it}	All private firm-years	-/+ liquidity	exporters/ non-exporters	<=/>10% state capital	<=/>10% foreign capital	Low/high CF/K-TFP sensitivity
	(1)	(2)	(3)	(4)	(5)	(6)
$tfp_{i,t-1}$	0.630*** (0.022)	0.613*** (0.021)	0.631*** (0.024)	0.631*** (0.021)	0.623*** (0.022)	0.616*** (0.024)
$size_{it}$	0.127*** (0.014)	0.135*** (0.014)	0.128*** (0.016)	0.128*** (0.014)	0.133*** (0.015)	0.114*** (0.015)
age_{it}	-0.144*** (0.013)	-0.140*** (0.013)	-0.124*** (0.014)	-0.139*** (0.013)	-0.143*** (0.013)	-0.096*** (0.015)
$(Exp/sales)_{it}$	0.250*** (0.056)	0.254*** (0.055)	0.226*** (0.070)	0.248*** (0.055)	0.236*** (0.055)	0.279*** (0.065)
$Coast_{it}$	0.682*** (0.090)	0.646*** (0.088)	0.399*** (0.077)	0.617*** (0.085)	0.673*** (0.089)	0.609*** (0.091)
CF/K_{it}	0.119*** (0.014)					
$CF/K_{it} \times Type1$		0.197*** (0.028)	0.240*** (0.031)	0.121*** (0.014)	0.125*** (0.015)	0.114*** (0.014)
$CF/K_{it} \times (1-Type1)$		0.114*** (0.014)	0.113*** (0.017)	-0.034 (0.104)	0.107*** (0.031)	0.290*** (0.037)
χ^2 *(p-value)*		0.002	0.000	0.134	0.587	0.000
Sample size	450921	450921	450921	450921	450921	450921
m3 (p-value)	0.347	0.396	0.398	0.327	0.362	0.359

Notes: The table reports one-step system GMM results. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. *Type1* indicates firm-years without positive liquidity, exporters, firm-years with 10% or less state capital, firm-years with 10% or less foreign capital, and Low group of firm-years in relation to *CF/K-TFP* sensitivity (as defined in the last part of section 5.2.1) in columns 2-6 respectively. Therefore, (1-*Type1*) indicates the respective correspondent groups of firm-years. χ^2 test is under H_0: $CF/K_{it} \times Type1 = CF/K_{it} \times (1-Type1)$. Please also see *Notes* to Table 1, 2 and 5.

Table 6b: Differential Effects of Financial Factors on Private Firm's Productivity— Direct Estimation

Dependent Variable: Y/K_{it}	All private firm-years	-/+ liquidity	exporters/ non-exporters	<=/>10% state capital	>/<=10% foreign capital	Low/high CF/K-Y/K sensitivity
	(1)	(2)	(3)	(4)	(5)	(6)
$Y/K_{i,t-1}$	0.615*** (0.075)	0.632*** (0.120)	0.591*** (0.069)	0.583*** (0.069)	0.583*** (0.067)	0.418*** (0.042)
L/K_{it}	0.041*** (0.010)	0.048*** (0.015)	0.044*** (0.009)	0.044*** (0.009)	0.045*** (0.009)	0.064*** (0.006)
age_{it}	0.003 (0.003)	0.012*** (0.004)	0.004 (0.003)	0.004 (0.003)	0.002 (0.003)	0.007** (0.003)
$(Exp/sales)_{it}$	-0.394 (0.278)	-0.397 (0.377)	-0.337 (0.293)	-0.397 (0.268)	-0.431 (0.266)	-0.346 (0.219)
$Coast_{it}$	1.100** (0.433)	0.033 (0.523)	0.662* (0.379)	1.029** (0.410)	0.977** (0.411)	0.989*** (0.353)
CF/K_{it}	0.511*** (0.130)					
$CF/K_{it} \times Type1$		1.015*** (0.259)	0.697*** (0.176)	0.574*** (0.120)/	0.804*** (0.173)	0.890*** (0.068)
$CF/K_{it} \times (1-Type1)$		0.494** (0.205)	0.545*** (0.119)	0.437 (0.430)	0.556** (0.119)	0.898*** (0.145)
χ^2 *(p-value)*		0.099	0.280	0.743	0.137	0.952
Sample size	478573	478573	478573	478573	478573	478573
m3 (p-value)	0.618	0.747	0.656	0.624	0.654	0.926

Notes: The table reports one-step system GMM results. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. Please also see *Notes* to Table 1, 2, 5, and 6a.

Table 7: Descriptive Statistics for Foreign Firms

(fk50)

	Liquidity			Exporters			CF/K-TFP sensitivity		
	>0	<=0	t test	yes	no	t test	High	Low	t test
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TFP	6.097 (5.760)	4.576 (4.403)	0.000	5.684 (5.372)	5.811 (5.746)	0.000	4.820 (4.349)	6.072 (5.843)	0.000
Y/K	3.449 (4.301)	1.844 (2.792)	0.000	3.145 (4.045)	2.883 (4.039)	0.000	1.981 (2.546)	3.470 (4.419)	0.000
LP	3.715 (4.518)	3.094 (3.884)	0.000	3.172 (4.011)	4.350 (4.949)	0.000	3.723 (4.293)	3.503 (4.412)	0.000
ROS	0.043 (0.073)	0.009 (0.077)	0.000	0.031 (0.074)	0.040 (0.079)	0.000	0.010 (0.077)	0.044 (0.073)	0.000
Real total assets	566.95 (826.07)	655.86 (953.05)	0.000	614.23 (884.80)	537.15 (804.10)	0.000	663.82 (881.29)	559.88 (849.40)	0.000
L/K	13.016 (20.989)	8.891 (16.293)	0.000	13.400 (21.399)	9.219 (16.582)	0.000	8.953 (15.253)	13.179 (21.457)	0.000
age	7.809 (3.853)	7.029 (3.690)	0.000	7.894 (3.854)	7.067 (3.716)	0.000	7.688 (3.716)	7.593 (3.871)	0.000
Exp/sales	0.452 (0.424)	0.440 (0.424)	0.000	0.672 (0.345)	0.000 (0.000)	0.000	0.401 (0.411)	0.467 (0.428)	0.000
CF/K	1.276 (1.993)	0.482 (1.104)	0.000	1.025 (1.747)	1.198 (2.031)	0.000	0.507 (1.023)	1.303 (2.036)	0.000
Number of observations (%)	84670 (75.6%)	27279 (24.4%)		74750 (66.8%)	37199 (33.2%)		30951 (27.6%)	80998 (72.4%)	

Notes: The sample excludes those foreign firm-years with less than 3-year consecutive observations, those with exports larger than total sales, and 1 percent tails of the distribution of each variable. Please also see *Notes* to Table 1 and 5.

Table 8a: Differential Effects of Financial Factors on Foreign Firm's TFP — Indirect Estimation

Dependent Variable: tfp_{it}	All foreign firm-years	-/+ liquidity	exporters/ non-exporters	Low/high CF/K-TFP sensitivity
	(1)	(2)	(3)	(4)
$tfp_{i,t-1}$	0.545*** (0.028)	0.512*** (0.034)	0.515*** (0.034)	0.548*** (0.027)
$size_{it}$	0.301*** (0.023)	0.310*** (0.027)	0.320*** (0.027)	0.282*** (0.024)
age_{it}	-0.183*** (0.020)	-0.168*** (0.022)	-0.180*** (0.022)	-0.175*** (0.021)
$(Exp/sales)_{it}$	0.105* (0.059)	0.061 (0.064)	0.095 (0.071)	0.145** (0.061)
$Coast_{it}$	0.155 (0.231)	0.359 (0.240)	0.303 (0.246)	0.273 (0.229)
CF/K_{it}	0.108*** (0.017)			
CF/K_{it}×$Type1$		0.191*** (0.052)	0.073*** (0.019)	0.072*** (0.012)
CF/K_{it}×$(1-Type1)$		0.088*** (0.018)	0.124*** (0.023)	0.153*** (0.039)
χ^2 *(p-value)*		0.047	0.069	0.015
Sample size	113630	113630	113630	113630
m3 (p-value)	0.117	0.126	0.148	0.070

Notes: The table reports one-step system GMM results. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. Please also see *Notes* to Table 1, 2, 5 and 6a.

Table 8b: Differential Effects of Financial Factors on Foreign Firm's Productivity— Direct Estimation

Dependent Variable: Y/K_{it}	All foreign firm-years	-/+ liquidity	exporters/ non-exporters	Low/high CF/K-Y/K sensitivity
	(1)	(2)	(3)	(4)
$Y/K_{i,t-1}$	0.473*** (0.074)	0.391*** (0.069)	0.394*** (0.068)	0.336*** (0.056)
L/K_{it}	0.089*** (0.013)	0.093*** (0.011)	0.091*** (0.012)	0.098*** (0.010)
age_{it}	0.039*** (0.008)	0.035*** (0.007)	0.036*** (0.007)	0.032*** (0.007)
$(Exp/sales)_{it}$	0.204 (0.346)	0.295 (0.287)	0.428 (0.311)	0.100 (0.270)
$Coast_{it}$	6.260*** (2.290)	6.492*** (2.220)	5.567*** (2.058)	6.035*** (2.079)
CF/K_{it}	0.693*** (0.124)			
CF/K_{it}×$Type1$		1.315*** (0.245)	0.712*** (0.117)	0.947*** (0.083)
CF/K_{it}×$(1-Type1)$		0.756*** (0.111)	0.955*** (0.124)	0.871*** (0.174)
χ^2 *(p-value)*		0.030	0.059	0.570
Sample size	128161	128161	128161	128161
m3 (p-value)	0.837	0.923	0.785	0.996

Notes: The table reports one-step system GMM results. Instruments are all variables in each regression lagged three periods or earlier, time dummies, industry dummies and industry-time interacted dummies. Please also see *Notes* to Table 1, 2, 5 and 6a.