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by Sourafel Girma, Yundan Gong and Holger Görg

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Keywords: Innovation, FDI, finance, China

JEL classification: O31, F23, G32

**Sourafel Girma**
University of Nottingham
Nottingham, NG7 2RD, UK
Telephone:+44 115 856 6656
E-Mail: sourafel.girma@nottingham.ac.uk

**Yundan Gong**
University of Nottingham
Nottingham, NG7 2RD, UK
E-Mail: yundan.gong@nottingham.ac.uk

**Holger Görg**
Kiel Institute for the World Economy
24100 Kiel, Germany
Telephone +49 431 8814 258
E-Mail: holger.goerg@ifw-kiel.de

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# Foreign direct investment, access to finance, and innovation activity in Chinese enterprises

Sourafel Girma
*University of Nottingham*

Yundan Gong
*University of Nottingham*

Holger Görg
*Christian-Albrechts-Universität and Institut für Weltwirtschaft, Kiel*

**Abstract**

This paper investigates the link between inward FDI and innovation activity in China, using a very comprehensive and recent firm level database. We pay particular attention to the impact of domestic access to finance. Our results show that firms with foreign capital participation or those with good access to domestic bank loans innovate more than others do. We also find that inward FDI at the sectoral level is positively associated with domestic innovative activity only if firms engage in own R&D or if they have good access to domestic finance. However, access to finance only plays a role for private or collectively owned firms, less so for state-owned enterprises. Furthermore, we distinguish the effect of sector level inward FDI into technology transfer and FDI affecting domestic credit opportunities and find that the latter is of very little significance for SOEs and is also independent of their access to finance. By contrast, it is an important channel through which FDI affects the innovation of domestic private and collectively owned enterprises.

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## I. Introduction

Since undergoing economic reforms starting in 1979, China has now emerged as a rapidly growing manufacturing base and exporting nation. This stirred much recent debate in the popular press as well as among academics. For the further development of the Chinese economy, technological progress is crucial. In this regard two features of the economy are particularly notable: Firstly, China has become an important location for R&D and innovative activity by domestic enterprises at least since the mid-1990s (e.g., Jefferson et al., 2003). Secondly, China has become an important host country for inward foreign direct investment (FDI); indeed, according to OECD (2004), China overtook the US as the largest recipient of FDI in the world in 2003.[1]

The purpose of this paper is to provide a detailed analysis of whether there is a link between the increased levels of inward FDI and innovation activity by Chinese domestic enterprises, using a particularly rich and recent firm level dataset for the period 1999 to 2005. In this regard we pay particular attention to the importance of domestic access to finance. We believe that China is an interesting case to study because of the juxtaposition of a very impressive record in attracting FDI with a highly inefficient and state-dominated domestic financial system. As is well documented, the Chinese financial system if widely regarded as inefficient and skewed towards providing financial resources for (largely inefficient) state-owned enterprises (e.g., Huang, 2003). It is therefore of paramount policy interest to investigate whether this is related to domestic firms' ability to benefit (or otherwise) from the increased influx of foreign direct investment into the economy.

Why would one expect the increased influx of FDI to have had any effect on product innovation carried out by domestic enterprises? Firstly, a domestic firm receiving an injection of foreign capital can be expected to face lower financial constraints which may hinder

[1] See, for example, Amiti and Javorcik (2007), Wei (2003) and Lemoine (2000) for analyses of the increased inflow of FDI and determinants thereof.

innovation (Harrison and McMillan, 2003). Also, it may bring with it an inflow of technology. After all, multinational enterprises (MNEs) are assumed to have a superior technology compared to domestic firms (Markusen, 2002) and, hence, a foreign capital inflow through an acquisition, joint venture or some other form of capital transfer may lead to the installation of the foreign technology in the domestic firm. Both of these processes could manifest themselves in increasing innovative activity.

At the level of the industry, inward FDI may also affect innovation through impacting credit opportunities or technology transfer. As to the former, increased inflows of FDI can change credit opportunities for domestic firms as shown by Harrison and McMillan (2003) and Harrison et al. (2004) and, therefore, affect their innovation activity. In terms of technology transfer, the superior knowledge brought into the economy through FDI may leak to domestic firms through, e.g., worker movements, imitation etc, similar to the arguments made in the literature on productivity spillovers (e.g., Görg and Greenaway, 2004). These firms may then be able to engage in more innovation activity.

To investigate these issues empirically we use a rich panel data set of some 240,000 domestic enterprises in Chinese manufacturing industries for the period 1999 to 2005. Our paper contributes to the literature on innovation and technology adoption in developing and transition countries. While this literature, which is reviewed by Keller (2004) and Pack (2006), has amassed a large body of evidence for a number of countries, econometric work focussing particularly on China is still limited, although the policy and academic interest in the Chinese economy has grown immensely. In that regard, the most closely related paper is Jefferson et al. (2006).[2] They model, inter alia, a knowledge production function to estimate

[2] There are, of course, a number of other more loosely related papers that should be noted. Hu et al. (2005) estimate the determinants of firm level productivity using a similar dataset to Jefferson et al. (2006). They focus on the role of own firm R&D as well as technology purchased from foreign or domestic sources on firm level productivity. As to the evidence on productivity spillovers and technology diffusion from FDI, Girma and Gong (2007) use a dataset on Chinese state-owned enterprises to investigate the link between inward FDI spillovers

the determinants of innovation activity in Chinese enterprises, using firm level data for roughly 20,000 enterprises for 1997 to 1999. They find that firm size and own R&D expenditure are important factors for firms' innovation.

We expand on their analysis in a number of ways: Firstly, we investigate the impact of inward FDI at the firm and industry level on innovation activity, and the role of firm characteristics in that regard. This is an issue not covered by Jefferson et al. (2006) but which is of significant policy interest. Secondly, we pay particular attention to the role of access to finance for innovation, and in the link between access to finance and a firms' ability to benefit from positive spillovers from inward foreign direct investment. This has, to the best of our knowledge, not been investigated in the literature thus far. Thirdly, while Jefferson et al. (2006) include dummy variables for different types of ownership we investigate in particular whether the determinants of innovation activity, and most interestingly the effect of inward FDI, differs for different types of firms according to whether they are privately owned, state-owned or collectively owned. Fourthly, our dataset has greater coverage of firms and is for a more recent time period.

Our results show that, not unexpectedly, firms with foreign capital participation and good access to finance innovate more than others. We also find that inward FDI at the sectoral level is positively associated with domestic innovative activity only if firms engage in own R&D activities (i.e., have some "absorptive capacity") or if they have good access to domestic finance. The latter points to a possible adverse effect of domestic credit constraints on firms' ability to benefit from inward FDI. However, exploiting a feature of our dataset and distinguishing firms into state-owned, private, and collectively owned enterprises shows that access to finance only plays a role for the latter two. As is well-documented SOEs are largely inefficient, but enjoy preferential access to domestic financial resources, hence, access to

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and productivity of Chinese state-owned enterprises, while Berthelemy and Demurger (2000) use regional level data to investigate the role of inward FDI for regional growth in China.

finance provides no bottleneck to them. Furthermore, we distinguish the effect of sector level inward FDI into technology transfer and FDI affecting domestic credit opportunities. Here we find that the latter is of very little significance for SOEs and is also independent of their access to finance. By contrast, it is an important channel through which FDI affects domestic private and collectively owned enterprises.

The remainder of the paper is structured as follows. Section II describes the empirical approach, while Section III introduces the data set and provides some summary statistics. Econometric results are discussed in Section IV and Section V concludes.

**II. Empirical approach**

In our empirical model a domestic firm (indexed by *i*) either innovates at time *t* with positive rate of innovation ($S_{it} > 0$) or it does not ($S_{it} = 0$). To determine the relationship between FDI and the rate of product innovation we formulate a Tobit model in terms of a latent variable model as follows:[3]

$$\begin{aligned} S_{it}^{*} &= \alpha_1 FC_{it-1} + \alpha_2 FDI_{jt-1} + \alpha_3 FIN_{it-1} + \alpha_4 X_{it-1} + \alpha_5 FIN_{it-1} * FDI_{jt-1} \\ &+ \alpha_6 RD_{it-1} * FDI_{jt-1} + D_r + D_j + D_t + \varepsilon_{it} \\ S_{it} &= 0 \qquad if\ S_{it}^{*} \le 0 \\ S_{it} &= S_{it}^{*} \qquad if\ S_{it}^{*} > 0 \end{aligned} \tag{1}$$

where the dependent variable *S* is defined as the share of innovation output (that is products involving the use of new process innovation and novel technology) in total output. This variable, hence, measures the output of the innovation process and is therefore a more suitable measure than, e.g., R&D which is an input into the innovation process (see also Criscuolo et al., 2005). On the right-hand-side, the *D* variables in equation (1) are full sets of regional (*r*), industry (*j*) and time (*t*) dummies.

[3] Definitions of all the variables, plus summary statistics, are provided in Table 1 which is discussed in the next section.

*X* is a vector of firm level determinants of innovation which includes R&D intensity, the ratio of employee training expenditure to total wage bills, export intensity, subsidies, age and the firm's market share within the three-digit industry. The choice of these firm level covariates is guided by theoretical considerations as well as existing empirical evidence. R&D is an important input into the innovation process and is, hence, included in the model. A similar argument can be made for human capital, which is an important determinant of innovation. One proxy for human capital available to us is the amount of training provided by a firm and we include this in the empirical analysis. Criscuolo et al. (2005) argue and provide evidence that firms that are active on export markets are more innovative and we allow for this by controlling for firms' export intensities. Furthermore, subsidies can help firms to engage more in innovation (e.g., Görg and Strobl, 2007) and we, therefore, include a measure of the level of production related grants in our model. As Jefferson et al. (2004) argue, the age of a firm may also be important in explaining innovation activity as it is a proxy for a firms' experience, and, hence, the possibility for learning effects. We therefore follow their approach and include firm age in the equation. Finally, Aghion et al. (2005) discuss at lengths the role of competition for innovation, and Aitken and Harrison (1999) demonstrate that multinationals may affect the competitive landscape in the domestic economy, leading to an increase in competition for domestic firms. To take account of this we include a firm's market share as an indicator of the competitive position of a firm in our model.

*FIN* is a measure of firms' access to finance in terms of their ability to obtain loans from domestic banks. As is well known (e.g., Hall, 2002) financial constraints are a serious impediment to innovation activity. This may be even more so in China which has a very regulated and inefficient financial sector and lending is skewed towards providing loans to inefficient state-owned enterprises (e.g., Huang, 2003).

To capture the central issue of this paper, namely, the impact of foreign direct investment on innovative activity in Chinese domestic firms, *FC* is a measure of foreign capital participation in firm *i* to allow for the fact that firms with some share of foreign capital may be more innovative active for the reasons discussed above. *FDI* is a vector of industry-region specific FDI indices to capture the potential spillover or crowding out effects of the extent of foreign direct investment at the industry level.

We allow the effect of *FDI* to vary according to a firm's R&D activity and access to finance by including two interaction terms in the empirical estimation of equation (1), interacting *FDI* with R&D intensity and *FDI* with *FIN*, respectively. The former captures the notion that firms with higher absorptive capacity are better able to benefit from the technology transferred by incoming FDI.[4] The second interaction term allows firms with better access to finance to benefit more from inward FDI be they are less financially constrained and therefore may be better able to implement the new technology, and may be less affected by reductions in the availability of domestic finance due to demand for loans by foreign firms.

All covariates in the empirical model are lagged by one period in order to mitigate potential endogeneity concerns. Still, there are some firm level variables in the above specification that are arguably potentially endogenous. One prominent example is R&D intensity as it is a major input into the product innovation process, and the choice of this input is likely to be correlated with factors that determine the firm's decision to innovate. Similar arguments can also be made regarding the potential endogeneity of the other firm level variables. In order to deal with this potential problem, we also treat all lagged firm level variables except age as potentially endogenous in order to check the robustness of our results.

[4] See Girma (2005) for a discussion of the importance of absorptive capacity, and an empirical illustration using firm level data for the United Kingdom.

To do so we use an instrumental variables technique for Tobit models due to Blundell and Smith (1986).[5]

Twice lagged values of the potentially endogenous variables are used as instruments. Our assumption is that *conditional* on the regressors, these variables are asymptotically uncorrelated with the error term of the model. Ultimately, however, this is an empirical issue, and we test our assumption using the Sargan/Hansen test for the validity of instrumental variables. We also employ additional instruments, viz., (i) share of state-owned enterprises in region/industry; (ii) share of loss making state-owned enterprises in region/industry, (iii) level of regional financial development (share of bank loans to the private sector) and (iv) whether the firm is politically affiliated with local, regional or central governments. These instruments are designed to account for the endogeneity of sector level FDI and access to finance. For example, the share of the state sector is a proxy for state dominance in the sector/region, and to the extent that state-dominated sectors/regions have different access to finance this is a reasonable instrument for firm level access to finance. Similar arguments can be made for the share of loss making SOEs and the level of regional financial development. Furthermore, a large number of enterprises in China are affiliated to some level of government administration. The function of the relevant government body is to offer credit guarantees and political protection to the affiliated private firms. This political affiliation variable is strongly related to firms' access to finance since China's financial system is still dominated by the four big state banks. By using different levels of political affiliation as instruments, we make the realistic assumption that the effect of political affiliation on innovation comes mainly through

[5] The estimation of Tobit models with endogenous regressors essentially involves two steps: (i) generate residual terms from linear regressions of each endogenous variable on the instrumental variables and all other exogenous regressors, and (ii) estimate a standard Tobit model by including the residual terms from step (i) in the list of covariates. The standard errors are bootstrapped to take into account for the fact that residual terms are generated regressors. The residual terms are correction terms for the endogeneity problem, and jointly statistically significant coefficients can be taken as evidence in favour of the hypothesis that instrumented variables are indeed endogenous. A one-step variant of this estimator involving stronger distributional assumptions is also available (Newey, 1987). However, this fails to attain convergence in our data. This type of convergence problem is frequently encountered when there are more than one endogenous regressors.

its effects on finance. Again, however, ultimately the relevance of the instruments is an empirical issue which we test for in the estimation below.

## III. Database description and variable construction

Our econometric analysis draws on confidential data from the Annual Report of Industrial Enterprise Statistics compiled by the State Statistical Bureau of China (SSB). The report covers the population of state-owned enterprises and all non-state firms with annual turnover of over five million Renminbi (just above $600,000). It is estimated that the firms contained in the data set account for about 85-90% of total output in most industries. The SSB performs several logical tests to ensure the accuracy of the information in the report and identify illogical data.

The data set includes information on firm ownership structure, industry affiliation, geographic location, establishment year, employment, gross output, product innovation, R&D, value added, net fixed assets, exports, and employee training expenditures.[6] The data set available to us spans the period 1999 to 2005, and comprises more than 1.3 million observations from about 446,000 firms. It is worth noting that we used the whole sample to construct various variables of interest (e.g. share of foreign firms in an industry-region or the firms' market share). However, the econometric work is confined to domestic-owned enterprises, in view of the objective of this paper.

The SSB assigns to each firm in the database a categorical variable indicating its ownership status. Nevertheless, it is also possible to construct a continuous measure of ownership composition from the database by looking at the fraction of paid-in capital contributed by the state, private domestic and foreign investors. Using this measure of ownership, we define a firm as being state-owned, collectively or private if the state,

[6] Nominal values are deflated using industry-specific ex-factory price indices obtained from the China Statistical Yearbook 2006.

collectives or private individuals are the majority investors in the firm, respectively. In the final analysis 239,085 domestic firms (with 630,900 total observations) have the necessary information for the econometric estimation.

The data set provides information on the extent of foreign capital participation at the level of the firm. This enables us to calculate the share of foreign ownership in the domestic enterprise and identify the direct effects of FDI on domestic firms' innovative activity. On the other hand, in order to estimate the indirect (spillover) effect of FDI at the level of the industry we calculate, for each of the 171 three-digit industries and 31 provinces, the proportion of output accounted for by companies with foreign ownership in the industry and region.[7] This measure of industry-region FDI is also alternatively defined as the proportion of new products accounted for by multinational companies (FDI innovation) as well as the share of domestic bank loans taken by foreign multinationals (FDI loan) in order to try and distinguish the effect of sectoral level inward investment on innovation through technology transfer or affecting credit opportunities.

Table 1 gives the definition of the variables used in the analysis along with some summary statistics. A number of points are noteworthy. Firstly, there are no substantial differences in either innovation activity or the level of R&D or training between state-owned enterprises, private or collectively owned firms apparent in these summary statistics. However, as expected we do find that state-owned enterprises receive on average higher

[7] Officially, foreign-owned multinationals are defined in the data as enterprises with at least 25% share of foreign capital. There are also domestically-owned enterprises which have foreign capital participation of less than 25 percent which are not considered in this definition. We exploit the richness of our data set and weigh the output of firms with foreign capital by the extent of their foreign participation, measured by the share of foreign capital at the level of the firm. Under this definition of sectoral FDI, firms that are classified as domestic but have some foreign capital will also (proportionally) contribute to aggregate output of the foreign sector. Note that the recent literature on productivity spillovers from FDI has pointed out that domestic firms can benefit not only from horizontal (as calculated here) but also vertical spillovers through customer-supplier linkages (e.g., Javorcik, 2004). In an earlier draft of the paper we also calculated such vertical measures (backward and forward spillovers) but found them to be consistently statistically insignificant. Hence, we do not include them in the analysis that follows.

shares of bank loans as well as larger subsidies from government. On the other hand, they are less export intensive and receive lower inflows of foreign capital.

*[Table 1 here]*

In Table 2, we report the pattern of product innovation development between 1999 and 2005 for SOEs across the two-digit industries. There are a number of noteworthy points. Firstly, the proportion of innovating firms has risen over time in most sectors. However, the share of new product sales in total sales, while generally quite significant, has slightly declined in most sectors. Secondly, labour intensive sectors (e.g., food manufacturing and paper products) have in general the lowest proportion of innovators. However, export-competing labour intensive sectors (e.g., textile industry) exhibit a relatively large number of innovators. Finally, the product innovation intensity is remarkably similar across labour intensive (e.g. plastic products), capital-intensive (transport equipment) and technology intensive (e.g. medical and pharmaceutical products) sectors.

*[Table 2 here]*

**IV. Discussion of the results**

Table 3, column (1) presents the benchmark Tobit model which controls for firm heterogeneity through allowing for firm random effects. Furthermore, the model includes two additional dummy variables for private and collectively owned firms.

The estimation shows that R&D intensity exerts a positive and significant influence on the rate of product innovation. This is as expected given that R&D intensity is a major input in the product innovation process. We also find that firms that invest in employee training have higher innovation intensity. This suggests that there may be complementarity between human capital investment and innovation as discussed by, for example, Redding (1996). Also, we find a positive relationship between production innovation and exporting, and that firms that enjoy higher market shares in their industry are more likely to engage in product

innovation activity. Furthermore, firms' receipt of subsidies is positively related to innovation. Again, these findings are in line with the international literature discussed above. As concerns firm age, our results suggest that older firms are more likely to engage in product innovation than their younger counterparts. This points to the importance of experience in the innovation process.[8]

More closely related to the central issue of our paper, we find evidence that firms with some foreign capital participation are more likely to engage in product innovation. As discussed above, this may be either due to the influx of new technology, or the reduction in financial constraints associated with the capital injection.[9] Unfortunately, with the data at hand we cannot distinguish between these two rival hypotheses. Furthermore, we find that access to finance is positively associated with innovation. The magnitude of the effect of firm level foreign capital is economically significant. For example, a doubling of the foreign share is associated with a 13.5 percentage point change in the share of new products in total output, all else constant. The economic significance of access to domestic finance is equally noteworthy. A standard deviation (2.519) increase in this variable leads to a 10 percentage point increase in innovation intensity.

Turning our attention to the indirect effects of FDI at the sector/region level, it is evident that firms only benefit from inward FDI if they are R&D active or if they have good access to domestic finance in the form of bank loans. Taking the point estimates at face value, firms with R&D intensities of at least 0.45 (and zero domestic bank loans), or firms with a ratio of bank loans to assets of at least 4.2 (and zero R&D) are able to benefit from FDI.

[8] Note that Jefferson et al. (2004) find no statistically significant relationship between age and innovation in their analysis of a smaller sample of Chinese firms. Note that our sample is much larger, and our estimation controls for a much larger number of covariates than they did.

[9] Another reason why foreign-owned firms may in general be more innovation active is that they employ more skilled workers. In our estimation we control for the quality of the workforce using a variable on labour training, hence we control at least partly for this possibility.

These two threshold values are well beyond the mean values in our sample as reported in Table 1.

The results in column (1) treat all variables as exogenous. This may not be a too heroic assumption, given that (i) all covariates are lagged one period, (ii) we include dummies for private and collectively owned firms, and (iii) we allow for unobserved firm level heterogeneity by including firm random effects. However, there may still be a lingering concern with endogeneity and to deal with this more formally we estimate the model also using the endogenous Tobit model as discussed in Section 2 (see column 2). Of course, the reliability of the endogenous Tobit hinges on the validity of instruments used. To our knowledge there are no formal tests of the validity of instruments within the context of these endogenous Tobit specifications. Nevertheless, in order to gauge the appropriateness of the instruments we also estimate a linear instrumental variables model (using the same set of instruments as for the endogenous Tobit) and obtain a Sargan test statistic of the implied overidentifying restrictions. The test result, which is reported in column (3), suggests the validity of the instrumental variables. Reassuringly, the results of the estimations in both columns (2) and (3) are very much in line with our baseline equation in column (1), both in terms of statistical significance and magnitude of the coefficients. In what follows, we therefore focus our attention on estimations using the Tobit estimator allowing for firm random effects, as in column (1).

*[Table 3]*

While the estimations thus far allow for firm level heterogeneity, it constrains the coefficients of the independent variables to be the same for all types of firms. This may be an unrealistic assumption given the large differences in performance between state-owned enterprises and other types of firms in China. We therefore exploit the ownership dimension of our dataset more and break the sample into (i) state-owned, (ii) private and (iii) collectively

owned enterprises, as defined in section 3 and estimate equation (1) separately on the different samples. This is reported in Table 4, columns (1) to (3). As can be seen, there are some striking differences in the effects of the covariates on innovation across the three ownership types. We focus our discussion on the effects of foreign capital, finance and sector level FDI as this is the central theme of this paper.

Firstly, we find that the relationship between access to finance and innovation is most pronounced amongst private and collectively owned firms that are known to suffer from discrimination by the country's financial system compared to SOEs. Secondly, the coefficient on foreign capital is largest for SOEs, suggesting that injections of foreign capital are associated with the highest positive impact on innovation for these types of firms. This may reflect the inefficiencies in these firms, which imply that foreign capital, which as a result may reduce inefficiencies, has the highest benefits for them.[10] Perhaps the most striking result, however, is that the interaction term of *FDI* and access to finance is positive, as before, for private and collectively owned firms, but statistically insignificant for SOEs. Hence, access to finance plays no role in generating spillovers to state-owned enterprises. As is well-documented these enterprises are largely inefficient, but enjoy preferential access to domestic financial resources.

Taking a different slice of the data we distinguish loss making from profit making firms in our data (columns 4 and 5). The former group is, of course, mostly associated with state-owned enterprises in China. Results are in line with expectations: there is no role for access to finance for innovation in loss making enterprises, and access to finance also does not matter in terms of benefiting from indirect effects from sector level inward FDI.[11]

*[Table 4]*

[10] This is in line with recent work by Bartel and Harrison (2005) which show that state-owned enterprises in Indonesia benefit hugely from foreign ownership in the enterprise.

[11] As a robustness check, we also re-estimated Table 4 using the endogenous Tobit estimator. Results are very similar and are, hence, not reported to save space.

We discussed above that the two main ways in which sector level FDI can affect domestic innovation is through technology transfer or through affecting credit opportunities for domestic firms. In the next step in our analysis we try to distinguish these two channels by calculating two different FDI measures: (i) aggregate innovation by foreign multinationals calculated as innovation output by foreign multinationals in a sector-region over total innovation output, and (ii) aggregate borrowing by foreign multinationals as the share of domestic bank loans in total bank loans in the sector-region. The results of this exercise are reported in Table 5.

A glance at the results in columns (1) to (3) shows that the effects of the two variables are broadly similar to private and collectively owned firms. FDI, either through technology transfer or affecting credit opportunities, only has a positive effect depending on firms' R&D activity and financial situation in terms of access to bank loans. This is different for state-owned enterprises, however. While there is a positive effect of technology transfer by multinationals for SOEs that do invest in their own R&D the firms' financial position does not play any role in mitigating the effect of FDI technology. Furthermore, there is no direct statistically significant relationship between FDI affecting credit opportunities and SOEs' ability to innovate, and the impact of this channel of FDI does not depend on the SOEs' ability to access domestic bank loans. This again suggests that SOEs' preferential access to domestic financial resources implies that financial aspects do not represent any constraints for them.

In alternative estimations in columns (4) and (5) we distinguish our data again into loss making and profit making enterprises. Results for loss makers closely resemble those for

SOEs, showing that access to finance is relatively unimportant for these types of firms, as far as innovation is concerned.[12]

*[Table 5]*

**V. Conclusions**

This paper investigates the link between inward FDI and innovation activity in China, using a large and recent firm level database. We pay particular attention to the impact of domestic access to finance in this regard, as the financial system in China has been widely described as inefficient and skewed towards SOEs. Hence, it is of immense policy interest to see how this may effect domestic firms' ability to benefit (or otherwise) from inward FDI.

Our econometric analysis shows that access to finance is an important issue for firms' innovation activity, and their ability to benefit from inward FDI. This, however, is mainly the case for private and collectively owned firms, less so for state-owned firms which are the beneficiaries from the current financial system.

In particular we find that firms with foreign capital participation, or those with good access to domestic bank loans innovate more than others – these are the firms with low financial constraints. We also find that inward FDI at the sectoral level is positively associated with domestic innovative activity only if firms engage in own R&D activities (i.e., have some "absorptive capacity") or if they have good access to domestic finance. The latter points to a possible adverse effect of domestic credit constraints on firms' ability to benefit from inward FDI. However, exploiting a feature of our dataset and distinguishing firms into state-owned, private, and collectively owned enterprises shows that access to finance only plays a role for the latter two. As is well-documented SOEs are largely inefficient, but enjoy preferential access to domestic financial resources, hence, access to finance provides no bottleneck to

[12] We carried out one further robustness check where we included squared terms of foreign capital, FDI innovation and FDI loans in the estimations. Results, which are not reported here to save space, are robust to this slight modification of the estimating equation.

them. Furthermore, we distinguish the effect of sector level inward FDI into technology transfer and FDI affecting domestic credit opportunities. Here we find that the latter is of very little significance for SOEs and is also independent of their access to finance. By contrast, it is an important channel through which FDI affects the innovation of domestic private and collectively owned enterprises.

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**Table 1**
**Variables definition and summary statistics**

| Variable | Definition | SOE | | PRIVATE | | COLLECTIVE | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std. dev | Mean | Std. dev | Mean | Std. dev |
| Product innovation | Share of output involving new process or product innovation | 0.041 | 0.150 | 0.034 | 0.151 | 0.021 | 0.116 |
| | Restricted sample of firms with non-zero product innovation | 0.319 | 0.295 | 0.390 | 0.350 | 0.369 | 0.331 |
| R&D | R&D expenditure divided by sales | 0.002 | 0.021 | 0.002 | 0.013 | 0.001 | 0.007 |
| | Restricted sample of firms with non-zero R&D expenditure | 0.013 | 0.046 | 0.012 | 0.337 | 0.008 | 0.018 |
| Labour training | Employee training expenditure per employee | 0.007 | 0.027 | 0.008 | 0.035 | 0.008 | 0.037 |
| | Restricted sample of firms with non-zero labour training outlay | 0.015 | 0.037 | 0.021 | 0.053 | 0.037 | 0.053 |
| Export intensity | Share of exports in total sales | 0.043 | 0.164 | 0.127 | 0.298 | 0.110 | 0.281 |
| | Restricted sample of exporters | 0.307 | 0.328 | 0.580 | 0.380 | 0.594 | 0.374 |
| Market shares | Firm’s share of sales in total three-digit industry region sales | 0.044 | 0.134 | 0.022 | 0.082 | 0.021 | 0.073 |
| Domestic finance | Domestic bank loans normalised by total asset. | 1.806 | 2.519 | 0.825 | 1.874 | 0.876 | 1.886 |
| Subsidy | Log of production subsidy from local and central governments | 0.983 | 2.335 | 0.642 | 1.843 | 0.796 | 2.052 |
| Age | Log year since establishment | 3.147 | 0.914 | 1.848 | 0.935 | 2.569 | 0.806 |
| Foreign capital | Share of foreign multinationals capital in firm’s total capital | 0.002 | 0.033 | 0.004 | 0.050 | 0.006 | 0.060 |
| FDI | The share of foreign multinationals’ sales in three digit industry-region total sales | 0.143 | 0.181 | 0.194 | 0.191 | 0.175 | 0.182 |
| FDI innovation | The share of multinationals’ innovative output in digit industry-region total innovation | 0.097 | 0.196 | 0.140 | 0.212 | 0.127 | 0.206 |
| FDI loan | The share of multinationals' domestic bank loans over total domestic bank loans | 0.099 | 0.161 | 0.168 | 0.198 | 0.148 | 0.184 |
| Number of firms | 239085 (total) | 34549 | | 148694 | | 55842 | |
| Total observations | 630900 (total) | 125357 | | 316461 | | 189082 | |

**Table 2:**
**Sectoral and temporal pattern of product innovation for SOEs**

| | **Fraction of innovators** | | **New product sales/total sales** | |
|---|---|---|---|---|
| *Two-digit industry classification* | 1999 | 2005 | 1999 | 2005 |
| 13-Food Processing | 0.020 | 0.101 | 0.323 | 0.166 |
| 14-Food Production | 0.043 | 0.116 | 0.292 | 0.239 |
| 15-Beverage Industry | 0.060 | 0.120 | 0.272 | 0.251 |
| 16-Tobacco Processing | 0.123 | 0.211 | 0.149 | 0.152 |
| 17-Textile Industry | 0.173 | 0.172 | 0.307 | 0.296 |
| 18-Garments and Other Fibre Products | 0.035 | 0.065 | 0.450 | 0.453 |
| 19-Leather, Furs, Down and Related Products | 0.041 | 0.081 | 0.494 | 0.397 |
| 20-Timber Processing | 0.028 | 0.068 | 0.462 | 0.230 |
| 21-Furniture Manufacturing | 0.042 | 0.100 | 0.360 | 0.214 |
| 22-Papermaking and Paper Products | 0.040 | 0.072 | 0.371 | 0.190 |
| 23-Printing and Record Medium Reproduction | 0.018 | 0.059 | 0.375 | 0.350 |
| 24-Cultural, Educational and Sports Goods | 0.094 | 0.092 | 0.335 | 0.389 |
| 25-Petroleum Refining and Coking | 0.050 | 0.064 | 0.289 | 0.209 |
| 26-Raw Chemical Materials and Chemical Products | 0.092 | 0.107 | 0.313 | 0.332 |
| 27-Medical and Pharmaceutical Products | 0.204 | 0.252 | 0.358 | 0.372 |
| 28-Chemical Fibre | 0.140 | 0.104 | 0.267 | 0.394 |
| 29-Rubber Products | 0.102 | 0.098 | 0.320 | 0.305 |
| 30-Plastic Products | 0.091 | 0.102 | 0.382 | 0.339 |
| 31-Nonmetal Mineral Products | 0.037 | 0.107 | 0.381 | 0.230 |
| 32-Smelting and Pressing of Ferrous Metals | 0.058 | 0.069 | 0.296 | 0.248 |
| 33-Smelting and Pressing of Nonferrous Metals | 0.060 | 0.097 | 0.329 | 0.335 |
| 34-Metal Products | 0.061 | 0.079 | 0.334 | 0.311 |
| 35-Ordinary Machinery | 0.142 | 0.132 | 0.295 | 0.320 |
| 36-Special Purposes Equipment | 0.178 | 0.172 | 0.348 | 0.373 |
| 37-Transport Equipment | 0.141 | 0.155 | 0.355 | 0.347 |
| 39-Other Electronic Equipment | 0.148 | 0.140 | 0.361 | 0.418 |
| 40-Electric Equipment and Machinery | 0.268 | 0.232 | 0.476 | 0.533 |
| 41-Electronic and Telecommunications | 0.257 | 0.257 | 0.353 | 0.460 |
| 42-Instruments and meters | 0.057 | 0.070 | 0.392 | 0.330 |

**Table 3:**
**Innovation spillovers from FDI and access to finance:**
**Results from alternative estimators**

| COEFFICIENT | (1) PANEL TOBIT | (2) TOBIT IV | (3) Linear GMM |
|---|---|---|---|
| R&D | 2.312*** | 4.323*** | 2.118*** |
| | (30.4) | (19.0) | (10.8) |
| Labour training | 0.481*** | 0.862*** | 0.700*** |
| | (11.5) | (7.22) | (3.65) |
| Export intensity | 0.252*** | 0.238*** | 0.217*** |
| | (39.3) | (24.4) | (18.5) |
| Market share | 0.576*** | 0.600*** | 0.901*** |
| | (41.6) | (29.7) | (21.0) |
| Finance | 0.0413*** | 0.0696*** | 0.0684*** |
| | (46.9) | (35.6) | (23.8) |
| Subsidy | 0.0271*** | 0.0313*** | 0.0399*** |
| | (38.8) | (24.7) | (18.3) |
| Age | 0.0505*** | 0.0487*** | 0.00197*** |
| | (27.4) | (19.2) | (6.69) |
| Foreign capital | 0.135*** | 0.217*** | 0.168*** |
| | (6.85) | (5.54) | (3.65) |
| FDI | -0.643*** | -0.797*** | -0.500*** |
| | (-45.8) | (-35.3) | (-23.5) |
| FDI * R&D | 1.428*** | 1.881*** | 1.241*** |
| | (88.1) | (54.2) | (26.1) |
| FDI * finance | 0.153*** | 0.0922** | -0.00929 |
| | (8.22) | (2.21) | (-1.51) |
| Private firms | 0.0463*** | 0.0634*** | 0.0389*** |
| | (9.39) | (10.8) | (12.4) |
| Collective firms | -0.110*** | -0.0686*** | -0.0800*** |
| | (-21.9) | (-11.5) | (-7.15) |
| Observations | 630900 | 390352 | 390352 |
| p-value from Hansen's test of overidentication | | | .179 |

Notes:

1. All specifications includes time, regional and industry fixed effects
2. t statistics in parentheses
3. *** p<0.01, ** p<0.05, * p<0.1
4. All regressors are lagged by one period in all regressions
5. Because of the use of twice-lagged variables as instruments in the Tobit IV and linear GMM models, the number of observations in the estimations has declined sharply.
6. State-owned firms form the base group in all regressions.

**Table 4**
**FDI spillovers and access to finance:**
**Estimates from panel Tobit models with firm-specific heterogeneity**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| COEFFICIENT | STATE | PRIVATE | COLLECTIVE | LOSS MAKERS | PROFIT MAKERS |
| | | | | | |
| R&D | 1.100*** | 2.857*** | 6.591*** | 1.034*** | 3.213*** |
| | (12.3) | (24.3) | (19.5) | (8.27) | (32.8) |
| Labour training | 0.552*** | 0.464*** | 0.415*** | 0.345*** | 0.449*** |
| | (6.40) | (7.84) | (4.56) | (2.99) | (9.90) |
| Export intensity | 0.363*** | 0.232*** | 0.274*** | 0.267*** | 0.252*** |
| | (25.5) | (26.2) | (19.2) | (15.6) | (36.4) |
| Market share | 0.487*** | 0.535*** | 0.497*** | 0.435*** | 0.625*** |
| | (29.7) | (22.8) | (11.5) | (14.8) | (39.7) |
| Finance | 0.0085*** | 0.0384*** | 0.0406*** | 0.0372 | 0.0470*** |
| | (31.7) | (26.8) | (18.9) | (0.66) | (46.7) |
| Subsidy | 0.0235*** | 0.0335*** | 0.0163*** | 0.0243*** | 0.0268*** |
| | (24.3) | (29.8) | (9.69) | (14.7) | (34.9) |
| Age | 0.0478*** | 0.0465*** | 0.0806*** | 0.0218*** | 0.0409*** |
| | (15.0) | (17.9) | (17.1) | (5.93) | (21.6) |
| Foreign capital | 0.333*** | 0.0978*** | 0.135*** | 0.0816* | 0.123*** |
| | (7.73) | (3.35) | (3.45) | (1.68) | (5.68) |
| FDI | -0.502*** | -0.631*** | -0.838*** | -0.358*** | -0.684*** |
| | (-19.4) | (-32.0) | (-25.1) | (-10.9) | (-43.9) |
| FDI * R&D | 1.106*** | 1.474*** | 1.560*** | 1.178*** | 1.478*** |
| | (42.8) | (62.6) | (38.5) | (30.7) | (82.2) |
| FDI * finance | 0.0975 | 0.0575* | 0.250*** | 0.128 | 0.112*** |
| | (1.42) | (1.93) | (5.50) | (1.21) | (5.29) |
| Observations | 125357 | 316461 | 189082 | 117001 | 513899 |

Notes:

1. All specifications includes time, regional and industry fixed effects
2. t statistics in parentheses
3. *** p<0.01, ** p<0.05, * p<0.1
4. All regressors are lagged by one period.

**Table 5**
**Access to finance by FDI firms and innovation spillovers to domestic firms**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| COEFFICIENT | STATE | PRIVATE | COLLECTIVE | LOSS | PROFIT |
| | | | | | |
| R&D | 0.823*** | 2.914*** | 5.197*** | 1.134*** | 2.591*** |
| | (7.99) | (36.1) | (24.1) | (13.2) | (42.0) |
| Labour training | 0.250** | 0.338*** | 0.300*** | 0.294*** | 0.309*** |
| | (2.32) | (8.32) | (5.20) | (3.71) | (10.6) |
| Export intensity | 0.247*** | 0.105*** | 0.133*** | 0.144*** | 0.119*** |
| | (13.3) | (17.8) | (15.5) | (13.0) | (27.0) |
| Market share | 0.350*** | 0.460*** | 0.282*** | 0.347*** | 0.431*** |
| | (16.0) | (27.4) | (10.4) | (17.1) | (40.1) |
| Finance | 0.0011*** | 0.0289*** | 0.0281*** | 0.028 | 0.0311*** |
| | (19.1) | (27.8) | (19.6) | (1.21) | (44.9) |
| Subsidy | 0.0172*** | 0.0234*** | 0.0117*** | 0.0159*** | 0.0181*** |
| | (14.0) | (29.6) | (10.8) | (14.0) | (35.5) |
| Age | 0.0309*** | 0.0404*** | 0.0590*** | 0.0383*** | 0.0437*** |
| | (7.51) | (21.6) | (19.2) | (13.6) | (30.8) |
| Foreign capital | 0.205*** | 0.0542*** | 0.0737*** | 0.0698** | 0.0757*** |
| | (3.23) | (2.64) | (2.92) | (2.09) | (5.26) |
| FDI innovation | -0.0345** | -0.110*** | -0.0452*** | -0.091* | -0.034*** |
| | (-2.35) | (-9.01) | (-2.72) | (-1.82) | (-10.4) |
| FDI innovation * R&D | 0.384*** | 0.518*** | 0.314*** | 0.409*** | 0.443*** |
| | (8.74) | (24.3) | (9.82) | (11.7) | (30.1) |
| FDI innovation * finance | -0.0191 | 0.0205** | 0.0490** | -0.0067 | 0.0677** |
| | (-0.91) | (2.22) | (2.75) | (-1.19) | (2.46) |
| FDI loan | -0.190 | -0.493*** | -0.475*** | -0.277*** | -0.433*** |
| | (-1.49) | (-35.2) | (-22.3) | (-12.0) | (-42.1) |
| FDI loan * R&D | 0.653*** | 0.828*** | 0.864*** | 0.735*** | 0.764*** |
| | (11.2) | (36.3) | (24.5) | (17.8) | (47.5) |
| FDI loan * finance | 0.0026 | 0.0115** | 0.0378** | -0.00185 | 0.059** |
| | (0.90) | (2.03) | (2.47) | (-0.26) | (2.57) |
| Observations | 125357 | 316461 | 189082 | 117001 | 513899 |

Notes:

1. All specifications includes time, regional and industry fixed effects
2. t statistics in parentheses
3. *** p<0.01, ** p<0.05, * p<0.1
4. All regressors are lagged by one period.