

Financial constraints and exports: Evidence from Chinese firms

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Abstract: This paper assesses the role of credit constraints for exports at the firm level. Theoretical models by Chaney (2005), Manova (2010), and others suggest that credit constraints are detrimental for exports. We examine this hypothesis empirically at the firm level by using data on Chinese enterprises compiled by the National Bureau of Statistics of China. We approximate credit constraints by financial variables such as a firm's debt ratio or the liquid-to-total-capital ratio. We then consider the impact of these financial fundamentals on the extensive and the intensive margins of firm-level exports. In particular, we focus on the impact of credit constraints on a firm's propensity to export at all (which we model by means of a logit model) and on a firm's export-to-sales ratio (which we model by a fractional response model based on Papke and Wooldridge (1996)). The empirical results confirm the negative relationship between exports and credit constraints suggested by previous theoretical work. Credit constrained firms are less likely to be exporters and have lower export quotas. The results are robust when using alternative explanatory variables and including further explanatory variables.

Key Words: Exports; Financial constraints; Chinese firms

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1 Introduction

Credit constraints affect fixed costs of market entry and expansion investments of firms. Especially, this seems to be true for young and/or innovative firms with limited collateral (e.g., fixed assets) in dynamic sectors.¹ For such firms, not only market entry and continuation as such but also the decision to penetrate foreign markets via exports is relevant and affected by constrained finances. A young theoretical literature already explores the role of financial constraints for market entry domestically and through exporting. However, empirical work on the matter is still relatively scarce, especially, at the level of the firm. It is this paper's goal to contribute to the latter strand of work.

We employ a large Chinese firm-level data-set which corresponds to a Census of all firms with an annual turnover for more than about 700,000 US dollars within the period of 2001-2005. Certainly, for China, these may be considered to be the larger firms. However, it is the relevant group when considering the decision to export at all. In that sample, only about 29 percent of all firms export and the propensity to export is clearly skewed towards larger entities. For these firms, we observe export volume, balance sheet information about sales, profit, employment, asset, and debt positions together with information about foreign ownership. These bits of information allow us to determine the influence of various measures of financial constraints on two outcomes of interest: the propensity to export at all (i.e., the *extensive margin* of exporting) and the extent of exporting in terms of a firm's total sales (conditional on positive exports, this reflects the *intensive margin* of exporting). Both outcomes are limited dependent variables. Accordingly, we adopt estimation strategies which respect this fact and estimate logit models about the propensity to export and fractional response models for export shares. Since 71% of the Chinese firms in the sample are non-exporters, we estimate two-part fractional response models to acknowledge a mass point of the data at zero exports.

¹See Egger and Keuschnigg (2010a) for a survey of literature supporting this view.

We employ four measures of financial constraints: the long-run- debt-to-capital ratio, the financial-cost-to-liquid-funds ratio, the liquid-asset-to-capital ratio, and the ratio of the surplus of profits over long run debts to total assets (see Bridges and Guariglia, 2008, for the use of similar measures). The former two are positively related to financial constraints while the latter two are negatively related to financial constraints. The results of our empirical analysis can be summarized as follows. First, we identify a clear negative impact of greater financial constraints by any measure on the extensive margin of exporting. An increase in financial constraints by one standard deviation in these measures reduces the propensity to export - the *extensive margin* of exporting – by about two percentage points (i.e., by about ten percent). This is a lot! About the same holds true for the intensive margin of exports.

The remainder of the paper is organized as follows. The next section summarizes the state of the literature on financial constraints and exporting with regard to both theory and empirical analysis. Section 3 contains the empirical analysis of our paper, and the last section offers some conclusions.

2 Literature

2.1 Theoretical models

A young theoretical literature on the role of financial constraints for exports models firms as heterogeneous in terms of their productivity (see Chaney, 2005; Muuls, 2008; Egger and Keuschnigg, 2010b; and Manova, 2010).²

²This literature follows Melitz (2003) to model firms as to differ in their labor (or total factor) productivity. Chaney (2005) and Manova (2010) follow Melitz (2003) closely by assuming that firms operate on imperfectly competitive product markets, while Egger and Keuschnigg (2010b) assume perfect competition at product markets. Moreover, non-exporters are less productive than exporters in Chaney (2005) and Manova (2010) as in Melitz (2003), while all active firms export in Egger and Keuschnigg (2010b), so that the latter paper does not support empirical work about the extensive margin of exports at the firm

Chaney (2005) expands Melitz' (2003) model to account for liquidity constraints and internal finance to the firm. Firms are heterogeneous with regard to both their productivity and liquidity. For the decision to participate in the export market at all (the *extensive margin*) both factors matter: more liquid (wealthier) and more productive firms are more likely to export than others. Regarding the quantity exported per firm (the *intensive margin*) only the productivity and not the liquidity affects the exported volumes.³

While Chaney (2005) focuses on *internal finance*, Manova (2010) extends Melitz' (2003) model to account for issues of *external finance* through borrowing. Specifically, she focuses on heterogeneous firms from different countries and in different sectors. The better a firm's financial situation – i.e., the better a country's contracting environment regarding accessibility of external finance and the lower the need of external finance of the firm's sector – the more likely is participation in the export market. Firms which are more affected by credit constraints participate less likely in the export market at all and, if they do, they do not export as much as others. Hence, in contrast to Chaney (2005), both the *extensive margin* and the *intensive margin* of exports are negatively affected by credit constraints.

Muuls (2008) incorporates the possibility of both internal and external financing into Melitz' (2003) model. She finds that financially constrained firms are prevented from exporting at all and, in case they participate in any export market, they serve fewer destinations than firms which are not affected by credit constraints. Hence, when considering a firm's aggregate exports across all markets, financial constraints provide for an impact on both the *extensive margin* and the *intensive margin* of exports as in Manova (2010).

Li and Yu (2009) extend Melitz' (2003) model and consider credit constraints which vary across different types of firms. In particular, affiliates of multinational firms have access

level. Unlike Melitz (2003), the three mentioned papers assume that capital markets are imperfect so that not all principally profitable firms (in the absence of capital market imperfections) are provided with the necessary external capital to operate.

³In a somewhat different model, Berman and Hericourt (2008) come to a similar conclusion as Chaney (2005), namely that only the extensive margin but not the intensive margin of exports is affected by financial constraints.

to internal financing from their parent company and are therefore affected by (external) credit constraints to a lesser extent than independent firms.⁴ Since exporting is associated with higher fixed costs than serving the domestic market only, multinational affiliates are more likely to be exporters than independent firms.⁵

2.2 Empirical evidence

Whether firms operate under financial constraints or not is typically not directly observable. Hence, empirical work suggests using various observable measures which are supposed to approximate the intensity of financial constraints to firms. A prominently used proxy thereof is the sensitivity of investment to cash flow; see Fazzari et al. (1988) for an early application. With perfect capital markets, a firm's investment should be independent of its financial situation. But if capital markets are imperfect, a firm's investment volume depends crucially on financial factors such as the availability of internal finance, new debt, or equity. Fazzari et al. (1988) define firms as financially constrained by means of the dividends paid by a firm and show that financially constrained firms have a higher investment-to-cash flow sensitivity.⁶ Among others, the findings of Hoshi et al. (1991) and Gilchrist and Himmelberg (1995) provide supportive evidence of the view of Fazzari et al. (1988). However, subsequent empirical research suggested the investment-to-cash flow sensitivity to be ambiguously related to financial constraints. For instance, Kaplan and Zingales (1997) show that firms which are less financially constrained exhibit greater

⁴Not only the multinationals themselves, but also firms which are connected to multinationals through supply linkages are less affected by credit constraints (see Javorcik and Spatareanu (2009).)

⁵In an approach which is only loosely related to the one of Li and Yu (2009), Buch et al. (2010) investigate the influence of credit constraints on both exports and foreign direct investment and find that the latter is more severely affected by financial constraints than the former.

⁶The basic idea behind that approach is the following. Financially constrained firms pay lower dividends because they need the funds for internal finance. Therefore the investment of those enterprises depends stronger on internal finance. Empirically, this can be measured by regressing a firm's level of investment on its cash flow that is regarded as a measure of a firm's internal financing capacity. Following the view of Fazzari et al. (1988) the coefficient of the cash flow variable should be greater for financially constrained firms.

investment-to-cash flow sensitivities than others. This view is supported by Kadapakkam et al. (1998) and Cleary (2006).⁷

Therefore, alternative proxies of financial constraints have been used since. Some authors suggested using self-reported intensities of financial constraints by firms as collected in surveys (e.g., von Kalkreuth and Murphy, 2005; Arndt et al., 2008). Others motivated the use of financial ratios that are used in credit checks (e.g., Greenaway et al., 2007; Bridges and Guariglia, 2008). Yet others have argued in favor of using indices considering several factors (e.g., Musso and Schiavo, 2008; Lamont et al., 2001). While research on the direct or indirect measurement of financial constraints may be regarded as relatively mature, the empirical literature on the consequences of these constraints on export activity is relatively young.

Previous research investigated the role of financial constraints for exports on the level of both the country and sector as well as the firm. Early evidence on a detrimental effect on aggregate exports was delivered by Beck (2002, 2003) and Hur et al. (2006), among others. Recently, Manova (2010) investigates data about 107 countries and 27 sectors for 1985-1995 and substantiates her theoretical propositions: that financially developed countries are more likely to export at all and then ship greater quantities. These effects are more pronounced in sectors with a greater requirement for outside finance or the requirement of fewer assets than others.

Muuls (2008) applies an index that predicts a firm's risk of default in a sample of Belgian firm within the period 1999-2005. Firms that are exposed to more severe credit constraints exhibit a smaller propensity to export, they export to fewer destinations, and they export smaller quantities to the average destination served.⁸ Berman and Hericourt (2008) explore

⁷See Bellone et al. (2010) for a detailed discussion.

⁸Greenaway et al. (2007) use firm level data on UK manufacturing firms over the period 1993-2003 to shed light on the opposite. Approximating financial constraints by financial ratios, their results suggest that participation in export markets improves a firm's financial health. Bridges and Guariglia (2008) arrive at a similar conclusion.

firms from nine developing countries for 2000-2005 and use financial ratios as proxies of financial constraints. They find that better access to finance enhances the participation in the export market. Regarding the intensive margin, they draw the conclusion that better financial health does not increase the size of exports. Using a sample of French manufacturing firms over the period of 1993-2005, Bellone et al. (2010) illustrate that better access to financial markets increases the probability of firm's internationalization and also shortens the time before that happens. Among the export starters they find a negative relationship between financial health and export intensity. The authors approximate financial constraints by using financial ratios and a score index derived by Musso and Schiavo (2008) that accounts for several factors such as firm size, profitability, and liquidity among others.

Due to China's increasing role in the global economy, several papers deal with Chinese firms in particular. By using a data-set for the 2000-2007 period Li and Yu (2009) conclude that Chinese firms with less severe credit constraints export more. Regarding the firm type, foreign enterprises which enjoy lower credit constraints have higher exports than domestic companies. Investigating the period of 1999-2002, Du and Girma (2007) show by using financial ratios that better financial funds enhance the export intensity. Manova et al. (2009) investigate the period from 2003-2005 and use several measures for a sector's financial dependence. Credit constraints restrict a firm's overall export sales, hamper their capacity to enter more destinations and limit the range of traded products. Regarding the firm type, foreign affiliates and joint ventures exhibit a better export performance than private domestic firms.

3 Empirical analysis

This section investigates the influence of credit constraints on Chinese firms' exports empirically. After summarizing our main hypotheses in subsection 3.1 we introduce the data-set

of Chinese firms in subsection 3.2. Subsection 3.3 contains a methodological discussion, while the results are summarized in subsection 3.4. The empirical analysis closes with a summary of additional robustness checks in subsection 3.5.

3.1 Hypotheses

According to the theoretical literature summarized in subsection 2.1, we derive the following two hypotheses on the impact of financial constraints on the extensive and intensive margin of trade.

Extensive margin:

We refer to the extensive margin of exports as the decision of a firm to participate in the export (world) market at all or not. In line with Chaney (2005), Manova (2010) and others, we may formulate the following hypotheses.

Hypothesis 1: Firms that are subject to credit constraints are less likely to be exporters than others.

Intensive margin:

The intensive margin relates to the quantity exported by a firm. The theoretical model by Manova (2010) (not Chaney, 2005) suggests the following testable hypothesis.⁹

Hypothesis 2: Credit constrained firms export less in terms of their total sales than firms that are not affected by credit constraints.

The subsequent subsections deal with the empirical investigation of these two hypotheses.

⁹Recall from section 2 that the theoretical literature is not unequivocal about the impact of financial constraints on the intensive margin of exports.

3.2 Data and descriptive statistics

We examine the aforementioned two hypotheses empirically by using data on Chinese enterprises as compiled by the National Bureau of Statistics of China (NBS) over the period 2001-2005. Since we are mainly interested in long-term relationships, we use averages for all data over the five years throughout.¹⁰ The data-set covers firms with an annual turnover of more than five Million Yuan (about 700,000 US dollars). Most of the variables contained in the data-set are based upon balance sheet and income statement items. For instance, the data-set contains information on sales, employment, exports, but also variables which are informative about a firm's financial situation. The latter type of variables can be used to formulate various proxies of financial constraints. In general, we delete implausible firm observations for important variables such as firms with negative exports within the sample period and firms with non-positive employment or sales. Since many variables are balance sheet and income statement items, the General Accounting Principles (GAAP) are followed and firms with total assets that are smaller than liquid, fixed, or net fixed assets are also deleted from the sample. In total, this leaves us with a data-set of 570,000 cross sectional observations. Of those, only 28.9% are exporters. The average export-to-sales ratio of exporters amounts to about 0.551, which renders the average export-to-sales ratio of all firms (including non-exporters) to be about 0.159.

In particular, we construct four measures of financial constraints based on financial statements in the data-set. Specifically, we employ the *debt ratio* which is described by the ratio of long run debts to total capital at the firm level. This variable captures the share of total capital as provided by outside investors for a longer period of time. A higher debt ratio can be associated with stronger credit constraints. The *financial cost ratio* shows the ratio of financial fees and costs to the liquid funds. The latter consists of liquid assets and cash flow. This financial ratio shows which part of the liquid funds has to be paid

¹⁰For instance, we would not want to attribute a firm's switching forth and back between exporting and non-exporting to the importance of financial constraints.

for the external provision of capital. A higher financial cost ratio can be associated with higher credit constraints. The *profitability ratio* is defined as the ratio of profit minus long run debts over total assets. It indicates the share of total assets that can be financed by the surplus of earned profits over long run debts. The higher the share, the more able is a firm to finance its assets by its operating activities. The *liquidity ratio* captures the liquid-assets-to-total-capital ratio and describes the share of capital kept in assets that can be liquidated within one year. A higher liquidity ratio implies a better liquidity situation and can be associated with lower credit constraints.

– Table 1 about here –

Table 1 provides summary statistics for the key variables. As said before, about 29% of the firms are exporters with an average export-to-sales ratio of about 0.551. On average, they are bigger than non exporting firms in terms of sales, employment, and total assets. Exporters achieve higher profits and generate a higher cash flow on average. Regarding balance sheet data, the pattern is similar: exporters have more capital in total, equity, and also total debts. Moreover, exporters own more assets than non-exporting firms in terms of total, liquid, and fixed assets.

Empirical evidence shows that exporters are bigger, more productive, and they use capital more intensively in production than firms that only serve the domestic market. Therefore these three factors - among others - serve as controls in our estimations. The variable *Employment* approximates firm size. *Productivity* is expressed in terms of the sales-to-employment ratio and *Capital intensity* is measured by the capital-to-employment ratio. These three controls enter the regression in logs.

In order to control for firm-specific factors of influence on exporting, we include two additional variables: *State-owned* is a dummy variable taking the value one for state-owned firms and zero else; *Foreign-owned* is a dummy variable taking the value one for foreign-owned enterprises and zero else. They are constructed by use of the registration code in

the data-set.¹¹

According to Table 1, there are 411,215 non-exporters and 166,880 exporters in the data-set for which we provide descriptive statistics in terms of mean and standard deviation of variables, separately. The upper part of the table, entitled *Basic variables*, summarizes those variables which the controls are based upon. The second part, entitled *Controls*, provides statistics for the control variables. The part at the bottom of the table, entitled *Financial constraints* summarizes features of the variables which are supposed to capture aspects of financial constraints (such as the *Debt ratio* or the *Financial cost ratio*) or the lack of financial constraints (such as the *Profitability ratio* or the *Liquidity ratio*).

The statistics in Table 1 suggest the following conclusions. First, on average, exporters are bigger and slightly more productive than non-exporting enterprises. This is consistent with evidence from other data-sets. There are more foreign-owned firms among exporters than among entities which are only active at the Chinese market. The opposite holds true for state-owned firms. On average, exporters have a lower *Debt ratio* and a lower *Financial cost ratio* than non-exporting firms. Moreover, exporters have a higher *Profitability ratio* and a higher *Liquidity ratio* than non-exporters. Hence, at a first glance and unconditional on other control variables, the descriptive statistics for Chinese firms indicate that financial constraints reduce the probability of exporting constraints than exporters. It is the purpose of the empirical evidence below to shed light on the hypotheses more thoroughly in terms of multivariate regressions.

¹¹The registration code is a three-digit code which provides details on the firm type: the code 110 identifies state-owned enterprises and codes with 2 or 3 as the first digit represent foreign-owned firms. Code 2 represents firms from Hong Kong, Macao, or Taiwan, and code 3 refers to foreign-owned enterprises which are held elsewhere.

3.3 Specification and estimation

This subsection describes the methods used to estimate the impact of financial constraints on exports empirically. Both the extensive and intensive margin of trade are of interest. We investigate these issues by means of three regression models.

Estimation of effects on the extensive margin only: Logit model

The extensive margin of exporting – the decision to participate in the export market at all or not – is specified by a binary outcome model explaining the probability of a firm of being an exporter. We define a binary variable $Expd_i$ for exporting (unity) versus non-exporting (zero) for firm i as

$$Expd_i = \begin{cases} 0, & \text{if } Exports_i = 0 \\ 1, & \text{if } Exports_i > 0, \end{cases} \quad (1)$$

where $Exports_i$ is the total value of average annual exports between 2001 and 2005 for firm i . We can think of the decision to export versus not export at all as to be driven by a latent variable capturing net profit gains from exporting.

The conditional expectation for $Expd_i$ is then

$$E(Exports_i|x_i) = Pr(Expd_i = 1|x_i) = Pr(Exports_i > 0|x_i) = F(x_i\beta), \quad (2)$$

where x_i denotes the $(1 \times k)$ vector of determinants firm i 's exporting, β is the corresponding $(k \times 1)$ vector of unknown parameters, and $F(\cdot)$ is a cumulative distribution function.

We apply a logit model so that $F(\cdot)$ is replaced by the cumulative logistic distribution function $\Lambda(\cdot)$ and estimate the following equation by maximum likelihood

$$Pr(Expd_i = 1|x_i) = \Lambda(\beta_0 + \beta_1 Employment_i + \beta_2 Productivity_i + \beta_3 Capital\ intensity_i + \beta_4 State - owned_i + \beta_5 Foreign - owned_i + \beta_6 Financial\ constraints_i + z_i\gamma). \quad (3)$$

As said before, *Employment*, *Productivity*, and *Capital intensity* are measured in logs. *State-owned* and *Foreign-owned* are dummy variables indicating the ownership structure. *Financial constraints* represents one of the four suggested measures of credit constraints. For each measure thereof, we run a separate regression. Notice that we do not assume that the measures of *Financial constraints* or the covariates enter $\Lambda(\cdot)$ in a linear fashion, but we allow them to enter also as squared terms and interacted in an exhaustive way with all other regressors in the model. All the squared terms and interactions are subsumed in the vector z_i in (3) and their parameters are captured by the vector γ .

To evaluate the estimation quality of the model, the following criteria are used: McFadden’s pseudo R^2 (which corresponds to one minus the ratio of the estimated model relative to the constant-only model), the sensitivity explaining the fraction of exporters correctly predicted as exporters by the model, the specificity explaining the fraction of non exporters correctly predicted by the model, and the percentage of the correctly predicted outcomes in total. Additionally, the correlation of actual and predicted outcome is considered. Since the main assumption for estimating the coefficients for outcome $Exports_i$ consistently is the correct formalization of $E(Exports_i|x_i)$, we apply a link test.¹²

Joint estimation of effects on the intensive and extensive margins: Fractional response model

We explore the intensive and extensive margins of exporting by using the export-to-sales ratio as a dependent variable as indicated in Hypotheses 1 and 2. For this we pool data on firms with zero and positive export-to-sales ratios so that inference of about effects on the intensive margin only are not possible. By definition, the export-to-sales ratio is a fraction with extreme values of zero and one, and with positive densities at both boundaries. For such a variable, linear models are not suited since they may lead to model predictions

¹²The link test assesses the functional form of the conditional mean. It regresses a dependent variable y_i on \hat{y}_i (i.e., the model prediction of y_i) and \hat{y}_i^2 without the original explanatory variables and tests whether the coefficient of \hat{y}_i^2 is zero or not. An advantage of this test is its availability for a wide range of models.

outside the support region and they will lead to heteroscedastic parameter estimates.¹³ To circumvent such estimation problems, we apply the fractional response model developed by Papke and Wooldridge (1996). This model defines the range of the predictions between zero and one in order to avoid implausible values outside the support region without needing any ad-hoc transformations to handle observations at the boundaries of the support region (i.e., non-exporters and only-exporters). Papke and Wooldridge (1996) make the following assumption for the conditional mean of a fractional variable

$$E(Expr_i|x_i) = G(x_i\beta), \quad (4)$$

where $0 \leq Expr_i \leq 1$ represents the fractional dependent variable, i.e., the export-to-sales ratio, and x_i the vector of explanatory variables of firm i . $G(\cdot)$ is the cumulative distribution function that ensures that the model predictions lie in the support region. The equation is also defined for positive values at the boundaries 0 and 1. As possible specifications for $G(\cdot)$, Papke and Wooldridge (1996) suggest a cumulative distribution function such as the logistic or the standard normal distribution function. Following them, we apply a logistic distribution function $\Lambda(\cdot)$ and estimate this equation by

$$E(Expr_i|x_i) = \Lambda(\beta_0 + \beta_1 Employment_i + \beta_2 Productivity_i + \beta_3 Capital\ intensity_i + \beta_4 State - owned_i + \beta_5 Foreign - owned_i + \beta_6 Financial\ constraints_i + z_i\gamma). \quad (5)$$

Again, the covariates and the elements of z_i are defined as in the binary logit model. To evaluate the model estimates, we use the Akaike information criterion and the correlation of predicted and real export-to-sales ratios. Since the crucial assumption for estimating the coefficients consistently is the correct formalization of $E(Expr_i|x_i)$, we apply a link test as with the logit model.

¹³A detailed discussion of problems in estimation with fractional dependent variables is given in Ramalho and da Silva (2009).

Separate estimation of effects on the extensive and intensive margins: Two-part fractional response model

To cover the possibility that variables can affect the decision of being an exporter and the export-to-sales ratio differently, it is useful to apply a two-part model where models for both margins are estimated separately. For econometric reasons, such a procedure may be warranted in our application due to the high share of zeros in the export-to-sales ratio – recall that only 29% of all firms in the sample are exporters. For economic reasons, such an approach is useful, since, unlike the one-part fractional response model, it allows to identify effects of financial constraints on the extensive and intensive margins of exporting separately.

High shares of boundary values can cause convergence problems of the numerical optimization of fractional response models (and violate the assumption of proportionate frequencies at the boundaries). A two-part model may account for an excessive number of zeros. Here, we follow Ramalho and da Silva (2009) and Oberhofer and Pfaffermayr (2009) in estimating the model. The first part of the model addresses the binary decision about export market participation similar to (1). Specifically, define

$$Expd_i = \begin{cases} 0, & \text{if } Expr_i = 0 \\ 1, & \text{if } Expr_i \in (0, 1], \end{cases} \quad (6)$$

where $Expr_i$ is the export-to-sales ratio and $Expd_i$ is the binary variable which takes the value 1 for exporters and zero for non-exporters, as before. The conditional mean of the export-to-sales ratio is then described by

$$E(Expr_i|x_i) = Pr(Expd_i = 1|x_i) = Pr(Expr_i > 0|x_i) = Pr(Expr_i \in (0, 1]|x_i) = F(x_i\beta), \quad (7)$$

where x_i is a vector of explanatory variables for observation i and β is a vector of coefficients. $F(\cdot)$ is a cumulative distribution function.

The second part addresses positive export-to-sales ratios, i.e., the ones of exporters which relates to the intensive margin of exporting only. The assumption regarding the conditional mean for the second part of the model is

$$E(Expr_i|x_i, Expr_i \in (0, 1]) = G(x_i\delta), \quad (8)$$

where x_i is a vector of explanatory variables for observation i and δ is a vector of coefficients. $G(\cdot)$ is a cumulative distribution function. Another way to decompose $E(Expr_i|x_i)$ is

$$\begin{aligned} E(Expr_i|x_i) &= E(Expr_i|x_i, Expr_i = 0) * Pr(Expr_i = 0|x_i) \\ &+ E(Expr_i|x_i, Expr_i \in (0, 1]) * Pr(Expr_i \in (0, 1]|x_i), \end{aligned} \quad (9)$$

where the first part is zero, so that

$$E(Expr_i|x_i) = E(Expr_i|x_i, Expr_i \in (0, 1]) \cdot Pr(Expr_i \in (0, 1]|x_i) = G(x_i\delta) \cdot F(x_i\beta). \quad (10)$$

Both components may be obtained from separate regressions. For a consistent estimation of δ and β , the correct formalization of both $E(Expr_i|x_i, Expr_i \in (0, 1])$ and $Pr(Expr_i \in (0, 1]|x_i)$ is required.

We estimate the two parts as follows. For the first part – the *extensive margin* – we estimate a logit model by maximum likelihood using all observations as in (3). For the second part – the *intensive margin* (i.e., the export-to-sales ratio of exporters only) – we apply a fractional response model by using only firms with a positive export-to-sales ratio and otherwise identical to (5).

3.4 Results

This subsection describes the results of the three types of models described above – the one-part logit model, the one-part fractional response model, and the two-part fractional response model. For each model, one table summarizes the estimation results – including information about the goodness of fit – and a second table reports the marginal effects of the covariates.¹⁴

Results for the extensive margin: Logit model

Tables 2 and 3 summarize the estimation results of equation (3). All marginal effects in Table 3 are highly significant. They support previous empirical work to the extent that bigger and more productive firms have a higher propensity to export. State-owned firms are less likely while foreign-owned firms are more likely to be exporters. These relationships are qualitatively unaffected by the inclusion of measures of financial constraints in the empirical models. Measures of credit constraints matter in the following way. Firms which are leveraged to a greater extent in terms of a higher debt ratio (and, hence, more credit constrained) are less likely to be exporters, and so are firms with a higher financial cost ratio. On the contrary, more profitable (and, hence, less credit constrained) firms display a higher propensity to export and so do firms which are more liquid. All of those results are consistent with a negative impact of financial constraints on the export propensity at the firm level.

And financial constraints matter a lot. For instance, according to Table 1, the standard deviation of the *Debt ratio* is about 0.1. According to Table 3, the marginal effect of that variable is about -0.222 . Hence, the propensity of exporting declines by approximately two percentage point when raising the average firm’s debt ratio by one standard deviation.

¹⁴Notice that parameter estimates are not informative about the quantitative impact on outcome (i.e., the probability of exporting at all and the export-to-sales ratio) for two reasons in our case. First, we estimate non-linear models so that marginal effects of continuous variables and the ones from switching an explanatory dummy variable from zero to unity can not be directly inferred from the parameter estimates. Second, we employ an exhaustive set of squared and interactive terms which complicates matters even further.

Given that the average propensity to export is about 0.289 according to Table 1, this means that the average propensity to export declines by almost 8 percent in response. Notice that the sensitivity of the export propensity is even bigger with respect to other measures of financial constraints: raising the *Financial cost ratio* by one standard deviation of its value reduces the average propensity to export by more than 12 percent; reducing the *Profitability ratio* by one standard deviation of its value reduces the export propensity by almost 11 percent; and reducing the *Liquidity ratio* by one standard deviation of its value reduces the export propensity by more than 13 percent. These responses are more than half as strong as the ones of a one-standard deviation decline in firm productivity.

– Tables 2 and 3 about here –

Including measures of financial constraints also tends to raise the model’s goodness of fit in terms of the Pseudo R^2 and also sensitivity, specificity, and correctly predicted outcome rise. Regarding our assumption of the correct specification of the conditional mean, the link test improves and indicates a correct formalization in three models which include measures of financial constraints.

Results for the undistinguishable intensive and extensive margins: One-part fractional response model

Table 4 contains the parameter estimates and some information about goodness of fit for the one-part fractional response model as in equation (5), and Table 5 summarizes the marginal effects of the explanatory variables of interest. In line with economic theory, larger firm size (employment) and higher productivity result in higher export-to-sales ratios. Foreign-owned firms have a higher export-to-sales ratio than domestically-owned ones, which is consistent with both cherry-picking foreign firm behavior with regard to acquisitions and joint ventures as well as technology transfer within firms between developed and developing countries. State-owned firms export less than non-state-owned ones, which is consistent with both less competitive pressure on state-owned firms as well as a

specific sectoral orientation of such entities. These findings are qualitatively unchanged if we include measures of financial constraints in the regressions.

– Tables 4 and 5 about here –

The effects of financial constraints on firm-level export-to-sales ratios are qualitatively similar to those of the extensive margin models. Firms with a higher *Debt ratio* or a higher *Financial cost ratio* have a lower export-to-sales ratio than others and so do ones with a lower *Profitability ratio* or a lower *Liquidity ratio*, according to Table 5. However, these results only partly confirm Hypothesis 2, since the data are pooled for exporters and non-exporters. As with the logit results for the extensive margin, the goodness of fit tends to increase if we include measures of financial constraints (e.g., the correlation of actual and predicted values increases). The link test results do not cast doubt on the models specifications in general. However, we know that the excessive number of zero export-to-sales ratios in the data is fundamentally at odds with the assumptions. Therefore, we proceed to the two-part model results without discussing the quantitative effects of financial constraints on the export-to-sales ratios in detail.

Results for the extensive and intensive margins separately: Two-part fractional response model

Tables 6 and 7 summarize the results for the two-part fractional response model. Therein, we focus on the second part – the intensive margin –, since the findings about the extensive margin correspond exactly to the logit model results summarized in Tables 2 and 3 under the adopted assumptions. The explanatory power of the second part of the fractional response model is even slightly better than the one of the first part. Overall, we consider the model fit to be exceptionally good for the fairly parsimonious models estimated at the firm level. The results of the link test do generally not cast doubt on the specification of the second part of the fractional response model.

– Tables 6 and 7 about here –

Interestingly, the results for firm size (employment) and productivity are reverse for the intensive margin as compared to the extensive one: larger and more productive exporting firms tend to have lower export-to-sales ratios than smaller and less productive exporters. Otherwise, the findings for the two margins are aligned with regard to the control variables in the benchmark models excluding financial constraints: foreign-owned exporters have higher export-to-sales ratios than domestically-owned ones (akin to the decision of exporting at all) and state-owned enterprises display lower export-to-sales ratios than non-state-owned firms (akin to the decision of exporting at all). These results are qualitatively unchanged, if we include any of the measures of financial constraints.

The effects of financial constraints on the intensive margin of export-to-sales ratios are the same as the ones on the decision to export at all in qualitative terms: firms with a higher *Debt ratio*, a higher *Financial cost ratio*, a lower *Profitability ratio*, or a lower *Liquidity ratio*, have ceteris paribus lower export-to-sales ratios than others, according to Table 7, which accounts for the presence of interactive effects and the general nonlinearity of the impact of determinants in fractional response models.

What about the quantitative effect of financial constraints on the intensive margin of trade? Let us again resort to the original experiment of a one-standard-deviation increase in the severity of financial constraints – i.e., an increase in the *Debt ratio* or the *Financial cost ratio*, and a decline in the *Profitability ratio* or the *Liquidity ratio*. To compute the corresponding effect, multiply the corresponding one-standard-deviation change for exporters from Table 1 by the corresponding coefficient of the marginal effect in Table 7. As with the extensive margin, we may express the corresponding results in terms of percentage changes of the dependent variable, i.e., the average export-to-sales ratio which amounts to about 0.551 for exporters. According to our results, such a change in the financial constraints leads to a response of the export-to-sales ratio for the average exporter of between -4.8% (for the *Liquidity ratio*) and -13% (for the *Debt ratio*). These effects on the intensive margin are larger in absolute terms than the one of a corresponding change

in firm productivity.

3.5 Robustness checks

We explore the robustness of our findings along several lines. We briefly discuss results here but suppress tables in the interest of brevity (they are available upon request from the authors). First, we used total assets and, alternatively, firm revenues rather than employment as alternative measures of firm size. All of the corresponding results were qualitatively similar to the ones reported in the paper. Alternatively, we used a discrete firm size class variable and use dummy variables for big firms (with more than 2000 employees) and medium-sized firms (with in between 300 and 2000 employees) instead of the continuous employment variable. Such a strategy may be warranted with measurement error of the employment variable. As found before, large and medium-sized firms are more likely to be exporters than small ones and they have a higher export-to-sales ratio on average. However, as before, large exporters have smaller export-to-sales ratios than medium-sized ones, and medium-sized exporters have smaller export-to-sales ratios than small ones. Hence, it seems to be a general feature of Chinese firms that large exporters are relatively more oriented towards the domestic market than small ones, even though large firms have a higher export propensity than small ones. The conclusions about the role of financial constraints are qualitatively unaffected by those changes.

Second, we use an alternative measure of productivity, namely (the log of) value added relative to employment. It is calculated by subtracting total intermediate inputs usage for production from sales and then dividing by employment. The results regarding the marginal effects of the financial constraints remain qualitatively unchanged.

Third, we distinguish firms by the origin of the paid-in capital. In our data-set capital is provided by individuals, the state, collectives, or foreign enterprises. With those data at hand, we can replace the dummy variable indicating (some) state ownership by the corre-

sponding fraction of assets held by the state, and the foreign ownership dummy variable by the corresponding fraction of assets held by foreign firms. However, there is no indication whatsoever that the crude measurement of state or foreign ownership distorts the results quantitatively in an important way.

Finally, we check the sensitivity of the results with regard to the inclusion of an explanatory variable capturing a firm's research orientation. Research-oriented enterprises are particularly exposed to financial constraints: such firms tend to be young, have limited tangible assets, and returns to their investment (in research and development) are relatively risky (see Keuschnigg and Egger, 2010b). Moreover, previous research found a significant influence of innovations on exporting; see, e.g., Lachenmaier and Wössmann (2006), Pla-Barber and Alegre (2007), or Becker and Egger (2009), among others. Therefore, we include the ratio of sales of new products to total sales as a measure of realized innovations at the firm level. In our data, more innovative firms have a higher propensity to export and a higher export-to-sales ratio. However, conditional on exporting, innovative firms have a lower export-to-sales ratio. The latter is consistent with innovative firms to be relatively younger and smaller than other ones. However, the inclusion of this variable does not change our conclusions with regard to financial constraints, neither in qualitative nor in quantitative terms.

4 Conclusion

This paper's goal is to shed light on the quantitative influence of financial constraints on firm-level exports. One strand of previous theoretical work on the matter suggests that financial constraints reduce both a firm's probability to export at all as well as exporters' exports (see Manova, 2010). In contrast, a second strand of work suggests that only the probability of exporting at all but not the intensive margin of exports is affected by credit constraints (see Chaney, 2005). We investigate the two hypotheses about the impact of

financial constraints on the extensive and intensive margin of exporting at the firm level empirically by using data on Chinese enterprises compiled by the National Bureau of Statistics of China. This data-set provides detailed information on an enterprise's employment, output, firm type, and its financial situation through balance sheet and income statement data. The latter are used to construct variables indicating a firm's exposure to financial constraints. We employ four such measures: the long-run-debts-to-capital ratio, the financial-costs-to-financial-funds ratio, the ratio of the surplus of profit over long run debts to total assets, and the liquid-assets-to-capital ratio. We use these ratios and explore their influence on the extensive and intensive margin of exports.

The decision to participate in the export market at all is modeled by means of a logit model. Apart from the binary exporting decision, we consider a firm's export-to-sales ratio and model the role of financial constraints and other variables for it by a fractional response model based on Papke and Wooldridge (1996). Since a fractional response model for export-to-sales ratios per se includes non-exporting as well as exporting firms, those results can not be interpreted as to pertain to the intensive margin of exporting. Moreover, there is an exuberant number of exporters in the data so that the assumptions maintained by the fractional response model are violated. Therefore, we employ two-part fractional response models which allow us to specifically analyze and disentangle the impact of financial constraint variables as well as other covariates on the extensive and the intensive margin of firm exports.

We find that financial constraints matter a lot to exporting. First, the impact of an increase of financial constraints on the extensive margin (exporting at all) is at least half as strong as the one of a decline in firm productivity when considering one-standard-deviation changes in variables. The response of export propensity to a one-standard-deviation increase in financial constraints is about ten percent. The impact of financial constraints on the intensive margin of exporting is almost as strong: there, a one-standard-deviation increase in financial constraints reduces the export-to-sales ratio of exporters by slightly less than

ten percent (averaged across all measures employed). These results suggest that – besides “classical” factors such as firm size, productivity, capital intensity – financial constraints matter in an important way for firm-level exports. This calls for more attention to financial factors such as the role of banks and financial intermediaries or trade credit in theoretical work explaining trade patterns and trade volume than has been devoted in the past.

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5 Tables

Table 1: Descriptive statistics

| | Non exporters | | Exporters | |
|------------------------------|---------------|--------------------|-----------|--------------------|
| | 411215 | | 166880 | |
| | Mean | Standard deviation | Mean | Standard deviation |
| Basic variables | | | | |
| Sales | 31'705 | 62'817 | 57'901 | 100'083 |
| Export value | 0 | 0 | 28'033 | 83'423 |
| Export-to-sales ratio | 0 | 0 | 0.551 | 0.382 |
| Employment | 160 | 238 | 289 | 375 |
| Total assets | 32'067 | 70'597 | 55'326 | 108'464 |
| Profit payable | 145 | 614 | 265 | 908 |
| Cash flow | 1'100 | 3'076 | 2'171 | 4'745 |
| Total capital | 33'268 | 78'056 | 58'914 | 121'078 |
| Owners equity | 12'502 | 31'553 | 23'509 | 49'221 |
| Total debts | 20'260 | 49'164 | 34'258 | 73'841 |
| Total fixed assets | 12'635 | 32'043 | 20'709 | 46'448 |
| Total liquid assets | 16'318 | 37'228 | 30'597 | 59'367 |
| Controls | | | | |
| Log (employment) | 4.516 | 0.998 | 5.108 | 1.039 |
| Log (productivity) | 5.063 | 1.014 | 5.065 | 0.925 |
| Log (capital intensity) | 4.896 | 0.960 | 4.808 | 1.032 |
| Foreign-owned (Dummy) | 0.086 | 0.280 | 0.410 | 0.492 |
| State-owned (Dummy) | 0.118 | 0.323 | 0.033 | 0.179 |
| Financial Constraints | | | | |
| Debt Ratio | 0.056 | 0.114 | 0.038 | 0.090 |
| Financial Cost Ratio | 0.036 | 0.049 | 0.027 | 0.034 |
| Profitability Ratio | -0.071 | 0.143 | -0.040 | 0.109 |
| Liquidity Ratio | 0.555 | 0.230 | 0.600 | 0.202 |

Notes:

1. All basic variables except the number of employees are in 1'000 Yuan.
2. Values below the 1 % percentile and over 99 % percentile are considered as outliers and are dropped from the sample.
3. Financial constraints are calculated as follows: debt ratio=long run debts/capital, financial cost ratio=financial costs/(liquid assets + cash flow), profitability ratio=(profit payable-long run debts)/total assets, liquid asset ratio = liquid assets/capital.

Table 2: Logit model

Dependent variable: Export dummy variable

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| Employment | 0.970*** (0.041) | 0.977*** (0.042) | 0.837*** (0.043) | 0.784*** (0.067) | 0.818*** (0.070) |
| Productivity | 1.581*** (0.052) | 1.592*** (0.053) | 1.287*** (0.054) | 1.392*** (0.082) | 1.439*** (0.085) |
| Capital intensity | -1.323*** (0.043) | -1.329*** (0.044) | -0.991*** (0.047) | -1.116*** (0.073) | -1.134*** (0.074) |
| State-owned | -2.648*** (0.126) | -2.724*** (0.131) | -3.131*** (0.148) | -3.067*** (0.180) | -3.060*** (0.186) |
| Foreign-owned | 3.997*** (0.078) | 3.963*** (0.079) | 4.107*** (0.084) | 4.249*** (0.137) | 4.337*** (0.145) |
| Employment × employment | -0.020*** (0.003) | -0.018*** (0.003) | -0.014*** (0.003) | 0.001 (0.005) | -0.002 (0.005) |
| Productivity × productivity | -0.220*** (0.005) | -0.219*** (0.005) | -0.207*** (0.005) | -0.206*** (0.008) | -0.198*** (0.008) |
| Capital intensity × capital intensity | -0.042*** (0.004) | -0.043*** (0.004) | -0.032*** (0.004) | -0.031*** (0.007) | -0.018** (0.007) |
| Employment × productivity | -0.056*** (0.006) | -0.060*** (0.006) | -0.058*** (0.006) | -0.030*** (0.009) | -0.026*** (0.009) |
| Employment × capital intensity | 0.026*** (0.005) | 0.029*** (0.005) | 0.024*** (0.005) | -0.005 (0.008) | -0.01 (0.009) |
| Employment × state-owned | 0.108*** (0.016) | 0.120*** (0.017) | 0.110*** (0.016) | 0.199*** (0.023) | 0.192*** (0.024) |
| Employment × foreign-owned | -0.117*** (0.009) | -0.126*** (0.009) | -0.124*** (0.009) | -0.106*** (0.016) | -0.113*** (0.017) |
| Productivity × capital intensity | 0.254*** (0.007) | 0.253*** (0.007) | 0.239*** (0.007) | 0.229*** (0.012) | 0.205*** (0.013) |
| Productivity × state-owned | -0.409*** (0.025) | -0.392*** (0.026) | -0.413*** (0.026) | -0.387*** (0.036) | -0.394*** (0.038) |
| Productivity × foreign-owned | -0.190*** (0.012) | -0.191*** (0.013) | -0.196*** (0.013) | -0.184*** (0.021) | -0.167*** (0.022) |
| Capital intensity × state-owned | 0.617*** (0.025) | 0.610*** (0.026) | 0.658*** (0.026) | 0.574*** (0.036) | 0.577*** (0.036) |
| Capital intensity × foreign-owned | -0.087*** (0.012) | -0.075*** (0.012) | -0.084*** (0.012) | -0.157*** (0.021) | -0.175*** (0.021) |
| Constant | -5.841*** (0.201) | -5.827*** (0.203) | -6.919*** (0.223) | -5.397*** (0.319) | -5.458*** (0.334) |
| Debt ratio | | -2.369*** (0.318) | | | |
| Debt ratio × debt ratio | | -0.526** (0.233) | | | |
| Debt ratio × employment | | -0.101*** (0.037) | | | |
| Debt ratio × productivity | | -0.252*** (0.053) | | | |
| Debt ratio × capital intensity | | 0.635*** (0.046) | | | |
| Debt ratio × state-owned | | 0.171 (0.134) | | | |
| Debt ratio × foreign-owned | | -0.285*** (0.098) | | | |
| Financial cost ratio | | | -6.226*** (1.415) | | |
| Financial cost ratio × financial cost ratio | | | -1.511 (1.827) | | |
| Financial cost ratio × employment | | | -0.311* (0.164) | | |
| Financial cost ratio × productivity | | | -0.219 (0.223) | | |
| Financial cost ratio × capital intensity | | | 0.987*** (0.183) | | |

(cont.)

Table 2: Logit model (cont.)

Dependent variable: Export dummy variable

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|---|---------------------|---------------------|----------------------|----------------------|----------------------|
| Financial cost ratio × state-owned | | | 1.241** (0.623) | | |
| Financial cost ratio × foreign-owned | | | -1.869*** (0.472) | | |
| Profitability ratio | | | | 1.528*** (0.434) | |
| Profitability ratio × profitability ratio | | | | -0.568** (0.273) | |
| Profitability ratio × employment | | | | 0.145*** (0.053) | |
| Profitability ratio × productivity | | | | 0.391*** (0.076) | |
| Profitability ratio × capital intensity | | | | -0.621*** (0.069) | |
| Profitability ratio × state-owned | | | | -0.142 (0.172) | |
| Profitability ratio × foreign-owned | | | | 0.150 (0.144) | |
| Liquid asset ratio | | | | | 4.254*** (0.179) |
| Liquid asset ratio × liquid asset ratio | | | | | -3.184*** (0.075) |
| Liquid asset ratio × employment | | | | | 0.183*** (0.018) |
| Liquid asset ratio × productivity | | | | | 0.377*** (0.025) |
| Liquid asset ratio × capital intensity | | | | | -0.532*** (0.023) |
| Liquid asset ratio × state-owned | | | | | 0.605*** (0.092) |
| Liquid asset ratio × foreign-owned | | | | | -0.146*** (0.041) |
| Number of observations | 547342 | 541364 | 537711 | 195079 | 179806 |
| McFadden's pseudo R-squared | 0.182 | 0.183 | 0.189 | 0.196 | 0.194 |
| Sensitivity | 39.85% | 40.32% | 41.08% | 39.93% | 38.90% |
| Specificity | 92.63% | 92.48% | 92.34% | 92.96% | 93.33% |
| Correctly classified | 77.41% | 77.34% | 77.42% | 78.17% | 78.28% |
| Correlation predicted and real export dummy | 0.394 | 0.396 | 0.401 | 0.400 | 0.397 |
| Linktest | | | | | |
| Export dummy hat | 1.007*** (0.004) | 1.006*** (0.004) | 1.003*** (0.004) | 1.004*** (0.007) | 1.004*** (0.007) |
| Export dummy hat squared | 0.006** (0.002) | 0.006** (0.002) | 0.003 (0.002) | 0.004 (0.003) | 0.003 (0.004) |

Notes:

1. Employment, productivity and capital intensity are in logs. State-owned and foreign-owned are dummy variables indicating state and foreign owned firms.

2. Financial constraints are calculated as follows: debt ratio = long run debts/capital, financial cost ratio = financial costs/(liquid assets + cash flow), profitability ratio=(profit payable - long run debts)/total assets, liquid asset ratio = liquid assets/capital.

3. Robust standard errors are reported in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

4. Sensitivity explains the fraction of exporters which are correctly identified as exporters by the model. Specificity measures the proportion of non exporters which are correctly identified as non exporters by the model. Correctly classified subsumes the correctly identified outcome in total.

5. The link test uses the prediction of the dependent variable in its normal and squared form as covariates. Therefore the coefficients and standard errors of export dummy hat and export dummy hat squared are reported.

Table 3: Marginal effects logit model

Dependent variable: Export dummy variable

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Employment | 0.121*** (0.001) | 0.124*** (0.001) | 0.128*** (0.001) | 0.117*** (0.002) | 0.115*** (0.002) |
| Productivity | 0.050*** (0.001) | 0.047*** (0.001) | 0.045*** (0.001) | 0.044*** (0.002) | 0.053*** (0.002) |
| Capital intensity | -0.056*** (0.001) | -0.052*** (0.001) | -0.051*** (0.001) | -0.046*** (0.002) | -0.053*** (0.002) |
| State-owned | -0.182*** (0.003) | -0.179*** (0.003) | -0.191*** (0.003) | -0.177*** (0.004) | -0.179*** (0.004) |
| Foreign-owned | 0.464*** (0.002) | 0.456*** (0.002) | 0.466*** (0.002) | 0.463*** (0.004) | 0.463*** (0.004) |
| Debt ratio | | -0.222*** (0.014) | | | |
| Financial cost ratio | | | -0.803*** (0.044) | | |
| Profitability ratio | | | | 0.229*** (0.015) | |
| Liquid asset ratio | | | | | 0.175*** (0.004) |

Notes:

1. Marginal effects evaluated at the mean. Standard errors are reported in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

2. Employment, productivity and capital intensity are in logs. State-owned and foreign-owned are dummy variables indicating state and foreign firms.

3. The financial constraints are calculated as follows: debt ratio=long run debts/capital, financial cost ratio=financial costs/ (liquid assets + cash flow), profitability ratio=(profit payable-long run debts)/total assets, liquid asset ratio=liquid assets/capital.

Table 4: One-part fractional response model

Dependent variable: Export-to-sales ratio

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| Employment | 1.072*** (0.043) | 1.076*** (0.044) | 0.984*** (0.046) | 1.077*** (0.072) | 1.126*** (0.075) |
| Productivity | 1.291*** (0.056) | 1.317*** (0.057) | 0.751*** (0.058) | 1.091*** (0.091) | 1.175*** (0.094) |
| Capital intensity | -1.082*** (0.046) | -1.088*** (0.047) | -0.551*** (0.051) | -0.689*** (0.080) | -0.788*** (0.083) |
| State-owned | -3.872*** (0.164) | -3.820*** (0.169) | -4.145*** (0.188) | -4.159*** (0.230) | -4.248*** (0.238) |
| Foreign-owned | 3.093*** (0.072) | 3.082*** (0.073) | 3.514*** (0.078) | 2.850*** (0.128) | 2.934*** (0.134) |
| Employment × employment | -0.028*** (0.003) | -0.025*** (0.003) | -0.025*** (0.003) | -0.019*** (0.005) | -0.026*** (0.005) |
| Productivity × productivity | -0.228*** (0.006) | -0.224*** (0.006) | -0.229*** (0.006) | -0.208*** (0.009) | -0.213*** (0.009) |
| Capital intensity × capital intensity | -0.088*** (0.005) | -0.087*** (0.005) | -0.098*** (0.005) | -0.093*** (0.009) | -0.086*** (0.009) |
| Employment × productivity | -0.044*** (0.006) | -0.051*** (0.006) | -0.035*** (0.006) | -0.024** (0.010) | -0.014 (0.010) |
| Employment × capital intensity | -0.037*** (0.005) | -0.030*** (0.005) | -0.045*** (0.005) | -0.082*** (0.009) | -0.092*** (0.009) |
| Employment × state-owned | 0.068*** (0.020) | 0.067*** (0.021) | 0.069*** (0.020) | 0.141*** (0.028) | 0.136*** (0.029) |
| Employment × foreign-owned | -0.061*** (0.008) | -0.082*** (0.008) | -0.080*** (0.008) | -0.011 (0.014) | -0.018 (0.015) |
| Productivity × capital intensity | 0.299*** (0.008) | 0.292*** (0.009) | 0.315*** (0.009) | 0.275*** (0.014) | 0.274*** (0.015) |
| Productivity × state-owned | -0.405*** (0.038) | -0.364*** (0.038) | -0.401*** (0.039) | -0.394*** (0.052) | -0.417*** (0.054) |
| Productivity × foreign-owned | -0.249*** (0.012) | -0.238*** (0.012) | -0.241*** (0.013) | -0.237*** (0.021) | -0.252*** (0.022) |
| Capital intensity × state-owned | 0.853*** (0.038) | 0.803*** (0.040) | 0.872*** (0.041) | 0.817*** (0.055) | 0.865*** (0.056) |
| Capital intensity × foreign-owned | 0.106*** (0.011) | 0.104*** (0.011) | 0.096*** (0.012) | 0.084*** (0.020) | 0.098*** (0.021) |
| Constant | -5.436*** (0.214) | -5.457*** (0.215) | -6.240*** (0.235) | -5.695*** (0.344) | -5.678*** (0.360) |
| Debt ratio | | -4.304*** (0.364) | | | |
| Debt ratio × debt ratio | | 3.534*** (0.252) | | | |
| Debt ratio × employment | | -0.104** (0.041) | | | |
| Debt ratio × productivity | | -0.309*** (0.060) | | | |
| Debt ratio × capital intensity | | 0.646*** (0.054) | | | |
| Debt ratio × state-owned | | 0.818*** (0.171) | | | |
| Debt ratio × foreign-owned | | 0.491*** (0.096) | | | |
| Financial cost ratio | | | -9.110*** (1.538) | | |
| Financial cost ratio × financial cost ratio | | | 7.493*** (1.950) | | |
| Financial cost ratio × employment | | | -0.081 (0.182) | | |
| Financial cost ratio × productivity | | | -1.204*** (0.240) | | |
| Financial cost ratio × capital intensity | | | 1.907*** (0.212) | | |

(cont.)

Table 4: One-part fractional response model (cont.)

Dependent variable: Export-to-sales ratio

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|--|---------------------|---------------------|----------------------|----------------------|----------------------|
| Financial cost ratio \times state | | | 1.877** (0.788) | | |
| Financial cost ratio \times foreign | | | -1.306*** (0.481) | | |
| Profitability ratio | | | | 3.137*** (0.502) | |
| Profitability ratio \times profitability ratio | | | | 0.552* (0.296) | |
| Profitability ratio \times employment | | | | 0.179*** (0.059) | |
| Profitability ratio \times productivity | | | | 0.104 (0.086) | |
| Profitability ratio \times capital intensity | | | | -0.543*** (0.080) | |
| Profitability ratio \times state | | | | -1.045*** (0.227) | |
| Profitability ratio \times foreign | | | | -0.446*** (0.142) | |
| Liquid asset ratio | | | | | 2.942*** (0.189) |
| Liquid asset ratio \times liquid asset ratio | | | | | -1.967*** (0.080) |
| Liquid asset ratio \times employment | | | | | 0.120*** (0.019) |
| Liquid asset ratio \times productivity | | | | | 0.691*** (0.028) |
| Liquid asset ratio \times capital intensity | | | | | -0.771*** (0.026) |
| Liquid asset ratio \times state | | | | | 0.361*** (0.122) |
| Liquid asset ratio \times foreign | | | | | -0.596*** (0.040) |
| Number of observations | 547342 | 541364 | 537711 | 195079 | 179806 |
| Correlation real and predicted export-to-sales ratio | 0.492 | 0.496 | 0.501 | 0.508 | 0.509 |
| AIC | 0.658 | 0.658 | 0.654 | 0.648 | 0.640 |
| Linktest | | | | | |
| Export-to-sales ratio hat | 0.996*** (0.008) | 0.997*** (0.008) | 0.983*** (0.008) | 0.998*** (0.012) | 0.999*** (0.013) |
| Export-to-sales ratio hat squared | -0.002 (0.003) | -0.001 (0.003) | -0.007** (0.003) | -0.001 (0.004) | -0.000 (0.004) |

Notes:

1. Employment, productivity and capital intensity are in logs. State-owned and foreign-owned are dummy variables indicating state and foreign owned firms.
2. Financial constraints are calculated as follows: debt ratio = long run debts/capital, financial cost ratio = financial costs/(liquid assets + cash flow), profitability ratio=(profit payable - long run debts)/total assets, liquid asset ratio = liquid assets/capital.
3. Robust standard errors are reported in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.
4. The link test uses the prediction of the dependent variable in its normal and squared form as covariates. Therefore the coefficients and standard errors of export-to-sales ratio hat and export-to-sales ratio hat squared are reported.

Table 5: Marginal effects one-part fractional response model

Dependent variable: Export-to-sales ratio

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Employment | 0.044*** (0.001) | 0.045*** (0.001) | 0.047*** (0.001) | 0.041*** (0.001) | 0.040*** (0.001) |
| Productivity | 0.017*** (0.001) | 0.014*** (0.001) | 0.013*** (0.001) | 0.018*** (0.001) | 0.022*** (0.001) |
| Capital intensity | -0.055*** (0.001) | -0.050*** (0.001) | -0.054*** (0.001) | -0.051*** (0.001) | -0.055*** (0.001) |
| State-owned | -0.104*** (0.002) | -0.098*** (0.002) | -0.108*** (0.002) | -0.103*** (0.002) | -0.102*** (0.002) |
| Foreign-owned | 0.349*** (0.002) | 0.332*** (0.002) | 0.356*** (0.002) | 0.341*** (0.004) | 0.339*** (0.004) |
| Debt ratio | | -0.290*** (0.008) | | | |
| Financial cost ratio | | | -0.594*** (0.027) | | |
| Profitability ratio | | | | 0.171*** (0.009) | |
| Liquid asset ratio | | | | | 0.110*** (0.002) |

Notes:

1. Marginal effects evaluated at the mean. Standard errors are reported in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

2. Employment, productivity and capital intensity are in logs. State-owned and foreign-owned are dummy variables indicating state and foreign owned firms.

3. The financial constraints are calculated as follows: debt ratio=long run debts/capital, financial cost ratio=financial costs/ (liquid assets + cash flow), profitability ratio=(profit payable-long run debts)/total assets, liquid asset ratio=liquid assets/capital.

Table 6: Two-part fractional response model

Dependent variables: Export-to-sales ratio

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| Employment | -0.479*** (0.048) | -0.479*** (0.049) | -0.531*** (0.051) | -0.445*** (0.084) | -0.366*** (0.088) |
| Productivity | -0.467*** (0.062) | -0.419*** (0.063) | -0.871*** (0.066) | -0.477*** (0.104) | -0.482*** (0.107) |
| Capital intensity | -0.561*** (0.051) | -0.571*** (0.052) | -0.114** (0.058) | -0.307*** (0.090) | -0.314*** (0.093) |
| State-owned | -1.773*** (0.211) | -1.700*** (0.212) | -1.507*** (0.232) | -1.548*** (0.306) | -1.552*** (0.322) |
| Foreign-owned | -0.118 (0.079) | -0.074 (0.079) | 0.325*** (0.085) | -0.832*** (0.140) | -0.752*** (0.146) |
| Employment × employment | 0.043*** (0.003) | 0.047*** (0.003) | 0.043*** (0.003) | 0.048*** (0.006) | 0.039*** (0.006) |
| Productivity × productivity | -0.050*** (0.006) | -0.048*** (0.005) | -0.067*** (0.006) | -0.027*** (0.009) | -0.036*** (0.009) |
| Capital intensity × capital intensity | -0.024*** (0.005) | -0.024*** (0.005) | -0.051*** (0.006) | -0.033*** (0.009) | -0.034*** (0.009) |
| Employment × productivity | 0.043*** (0.006) | 0.034*** (0.006) | 0.052*** (0.006) | 0.034*** (0.011) | 0.058*** (0.011) |
| Employment × capital intensity | -0.077*** (0.006) | -0.067*** (0.006) | -0.085*** (0.006) | -0.095*** (0.009) | -0.117*** (0.010) |
| Employment × state-owned | -0.106*** (0.022) | -0.115*** (0.022) | -0.109*** (0.022) | -0.123*** (0.032) | -0.135*** (0.034) |
| Employment × foreign-owned | 0.218*** (0.009) | 0.197*** (0.009) | 0.197*** (0.009) | 0.292*** (0.015) | 0.287*** (0.016) |
| Productivity × capital intensity | 0.132*** (0.009) | 0.127*** (0.009) | 0.169*** (0.009) | 0.102*** (0.015) | 0.115*** (0.015) |
| Productivity × state-owned | -0.084*** (0.032) | -0.031 (0.034) | -0.051 (0.034) | -0.088* (0.047) | -0.124*** (0.047) |
| Productivity × foreign-owned | -0.063*** (0.013) | -0.054*** (0.013) | -0.054*** (0.013) | -0.052** (0.022) | -0.079*** (0.023) |
| Capital intensity × state-owned | 0.435*** (0.037) | 0.368*** (0.039) | 0.398*** (0.040) | 0.414*** (0.054) | 0.476*** (0.054) |
| Capital intensity × foreign-owned | 0.058*** (0.012) | 0.049*** (0.012) | 0.044*** (0.012) | 0.103*** (0.022) | 0.125*** (0.022) |
| Constant | 5.566*** (0.248) | 5.449*** (0.249) | 5.696*** (0.277) | 5.229*** (0.424) | 5.067*** (0.444) |
| Debt ratio | | -3.031*** (0.415) | | | |
| Debt ratio × debt ratio | | 5.258*** (0.281) | | | |
| Debt ratio × employment | | -0.188*** (0.045) | | | |
| Debt ratio × productivity | | -0.182*** (0.062) | | | |
| Debt ratio × capital intensity | | 0.326*** (0.056) | | | |
| Debt ratio × state-owned | | 1.174*** (0.189) | | | |
| Debt ratio × foreign-owned | | 0.550*** (0.106) | | | |
| Financial cost ratio | | | -2.707 (1.843) | | |
| Financial cost ratio × financial cost ratio | | | 16.024*** (2.090) | | |
| Financial cost ratio × employment | | | -0.485** (0.210) | | |
| Financial cost ratio × productivity | | | -1.654*** (0.259) | | |
| Financial cost ratio × capital intensity | | | 1.671*** (0.227) | | |

(cont.)

Table 6: Two-part fractional response model (cont.)

Dependent variables: Export-to-sales ratio

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|--|---------------------|---------------------|---------------------|----------------------|----------------------|
| Financial cost ratio × state-owned | | | 2.113** (0.983) | | |
| Financial cost ratio × foreign-owned | | | -1.076** (0.459) | | |
| Profitability ratio | | | | 1.580*** (0.600) | |
| Profitability ratio × profitability ratio | | | | 1.395*** (0.323) | |
| Profitability ratio × employment | | | | 0.280*** (0.066) | |
| Profitability ratio × productivity | | | | -0.158* (0.087) | |
| Profitability ratio × capital intensity | | | | -0.164** -0.082 | |
| Profitability ratio × state-owned | | | | -1.399*** (0.246) | |
| Profitability ratio × foreign-owned | | | | -0.344** (0.157) | |
| Liquid asset ratio | | | | | -1.212*** (0.223) |
| Liquid asset ratio × liquid asset ratio | | | | | 0.726*** (0.093) |
| Liquid asset ratio × employment | | | | | 0.129*** (0.022) |
| Liquid asset ratio × productivity | | | | | 0.612*** (0.031) |
| Liquid asset ratio × capital intensity | | | | | -0.565*** (0.028) |
| Liquid asset ratio × state-owned | | | | | -0.377*** (0.136) |
| Liquid asset ratio × foreign-owned | | | | | -0.552*** (0.045) |
| Number of observations | 157815 | 157053 | 156468 | 54425 | 49708 |
| Correlation real and predicted export-to-sales ratio | 0.4301 | 0.4369 | 0.4405 | 0.4651 | 0.47 |
| AIC | 1.0649 | 1.0612 | 1.059716 | 1.036963 | 1.035134 |
| Linktest | | | | | |
| Export-to-sales ratio hat | 1.003*** (0.009) | 1.001*** (0.009) | 1.001*** (0.009) | 1.000*** (0.013) | 1.000*** (0.014) |
| Export-to-sales ratio hat squared | -0.007 (0.008) | -0.002 (0.008) | -0.002 (0.008) | 0.001 (0.012) | 0.004 (0.013) |

Notes:

1. Employment, productivity and capital intensity are in logs. State-owned and foreign-owned are dummy variables indicating state and foreign owned firms.
2. Financial constraints are calculated as follows: debt ratio = long run debts/capital, financial cost ratio = financial costs/(liquid assets + cash flow), profitability ratio=(profit payable-long run debts)/total assets, liquid asset ratio = liquid assets/capital.
3. Robust standard errors are reported in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.
4. The link test uses the prediction of the dependent variable in its normal and squared form as covariates. Therefore the coefficients and standard errors of export-to-sales ratio hat and export-to-sales ratio hat squared are reported.

Table 7: Marginal effects two-part fractional response model

Dependent variable: Export-to-sales ratio

| Independent variables | (1) | (2) | (3) | (4) | (5) |
|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Employment | -0.025*** (0.001) | -0.020*** (0.001) | -0.032*** (0.002) | -0.031*** (0.002) | -0.021*** (0.001) |
| Productivity | -0.037*** (0.002) | -0.039*** (0.002) | -0.018*** (0.003) | -0.025*** (0.003) | -0.033*** (0.002) |
| Capital intensity | -0.120*** (0.001) | -0.114*** (0.001) | -0.139*** (0.003) | -0.135*** (0.002) | -0.122*** (0.001) |
| State-owned | -0.163*** (0.010) | -0.158*** (0.010) | -0.143*** (0.014) | -0.154*** (0.013) | -0.159*** (0.010) |
| Foreign-owned | 0.230*** (0.002) | 0.222*** (0.002) | 0.221*** (0.004) | 0.224*** (0.004) | 0.227*** (0.002) |
| Debt ratio | | -0.671*** (0.023) | | | |
| Financial cost ratio | | | -1.223*** (0.079) | | |
| Profitability ratio | | | | 0.290*** (0.028) | |
| Liquid asset ratio | | | | | 0.120*** (0.005) |

Notes:

1. Marginal effects evaluated at the mean. Standard errors are reported in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

2. Employment, productivity and capital intensity are in logs. State-owned and foreign-owned are dummy variables indicating state and foreign owned firms.

3. The financial constraints are calculated as follows: debt ratio=long run debts/capital, financial cost ratio=financial costs/ (liquid assets + cash flow), profitability ratio=(profit payable-long run debts)/total assets, liquid asset ratio=liquid assets/capital.