ANNALS OF ECONOMICS AND FINANCE **16-2**, 315–334 (2015)

How Local Financial Market Conditions, Interest Rates, and Productivity Relate to Decisions to Export*

Dingming Liu

Wang Yanan Institute for Studies in Economics, Xiamen University, 422 Siming South Road, Xiamen, China.
E-mail: dmliu@xmu.edu.cn

Pu Chen†

School of Economics, Renmin University of China, Beijing, China.
E-mail: puchen@ruc.edu.cn

and

Chunyang Wang‡

HSBC Business School, Peking University, Shenzhen, China.
E-mail: cywangecon@gmail.com

Theoretic and empirical studies argue that the differences in financial market development contribute to varying export levels in international trade. We illustrate this idea by studying a heterogeneous firm model expanded to include a borrowing constraint, and we find that in a developed financial system a change in interest rate exerts a significant effect on exports, due to the high dependence on external financing. Conversely, in less developed financial systems, where producers typically have to rely on internally generated capital, changes in the interest rate do not generate a significant effect on export levels.

Key Words: Exporters; Interest rate; Trade Volume.
JEL Classification Numbers: F1, F4, G3.

* This research is supported by Renmin University of China grants 12XNF015 and 12XNK018. We are grateful to Tim Kehoe, Fabrizio Perri and Thomas Holmes for advice and suggestions and the members of the Trade and Development workshop at the University of Minnesota for their suggestions and comments.

† Corresponding author. This research is supported by Renmin University of China grants 12XNF015, 12XNK018 and NFSC(71403227). We are grateful to Tim Kehoe, Fabrizio Perri and Thomas Holmes for advice and suggestions and the members of the Trade and Development workshop at the University of Minnesota for their suggestions and comments.

‡ Corresponding author.

1529-7373/2015

1. INTRODUCTION

This paper studies how the interaction of financial market imperfections and interest rates affect trade flow. The level of local financial market development impacts exporters' behavior through the credit market. By incorporating borrowing constraints in the model, we can study how the interest rate affects the exporters. In countries with less developed financial markets, high borrowing requirements keep most firms out of the credit market. Only a few firms have the financial stability to gain access to the credit market when they want to borrow to finance exports. Most small and medium firms have to depend on internally generated funds to finance their exports. In developed financial markets, where bankers have more resources and experience, the threshold for borrowing is low enough that most firms can utilize external financing to cover export costs. Since current world trade patterns demonstrate the relevance of heterogeneity in exporters and international trade, we think it is a logical extension to study how the interaction between financial market imperfections and interest rates affect heterogeneous exporter behavior.

An empirical study on international trade and firm level data reveals that international trade is closely connected with the micro behavior of individual firms. Eaton, Kortum, and Kramarz (2004, 2011) use firm level data from French exporters and find several relationships between firm heterogeneity in market participation, export destination, and sales. Bernard, Jensen, and Schott (2009) use a newly developed database linking international trade transactions in the United States with U.S. enterprises to examine the different characteristics of U.S. exporters, such as the total of traded goods, export and import intensity, and the workforces employed by the exporters. The heterogeneity of the exporters is an indispensable factor in the aggregate theory.

The literature on financial development and macroeconomic variables shows that the macroeconomic variables are highly correlated with financial development. Empirical studies on financial market development show that the financial market has a significant positive impact on exports. Beck (2002, 2003) finds that financial development exerts a large positive impact on exports and trade balances for manufactured goods. Through its healthy financial market a country can channel savings and foreign capital into domestic production efficiently, because the developed financial market is based on a mature legal and institutional system, which effectively improves the transparency between the principal and the agents, avoids adverse selection problems and reduces the cost of external financing. Other theories also show that a higher level of financial sector development has an impact on trade flow and trade patterns within the country. Kletzer and Bardhan (1987) study how imperfect credit markets affect the country's

comparative costs even if it has the same capitalization and technology, which shows that the trade pattern can be dependent on financial institution development. Ju and Wei (2005) combine the financial development and factor endowment to show that external dependence determines trade pattern. By examining OECD countries, Svaleryd and Vlachos (2005) find that specialization is determined mainly by the level of financial sector development. Do and Levchenko (2007) show that financial development is influenced by comparative advantage and that a country's financial development is closely related to its trade pattern. Manova (2013) uses a heterogeneous firm model to analyze the export outcomes generated by external finance dependence and credit constraints.

The main model of heterogeneous firms in international trade has been developed by Melitz (2003) and uses a monopolistic competition framework, a fixed cost to sell in the market, and an iceberg cost to move the goods from one market to another. Firm heterogeneity and efficiency lead the most productive firms to overcome the fixed cost required to export. We build on Melitz (2003) model and add a borrowing constraint to it. Through the model we can study the micro-behavior of exporters when the credit market worsens and interest rates change, thus implying aggregate export change. Chaney (2005) studies the liquidity distribution and international trade pattern and finds that a scarce liquidity distribution will lead to lower exports. Meanwhile Chaney (2005) offers the explanation of a lack of sensitivity of exports to exchange rate fluctuations.

The past financial crisis is primarily due to the frozen credit market. The frozen credit market precipitated the tumble in world exports from 2008 to 2009, during which world trade dropped by 35%. This shows that the credit market is one of the key factors in the economy and is closely related to exports. Through the credit market, corporations seek short term loans from banks to cover their cash flow needs, finance growth, and sell bonds to investors for their capital expansion and research and development projects. In a good credit market the banks and lending investors are able to obtain enough information from the firms so that they can reduce their own risk. Moreover this is an effective monitor to improve the performance of the firm by implementing proper incentives. At the same time highly productive firms are able to access external financing more easily even if they do not have excess assets to pledge and the projects they are taking are risky.

The firms in different countries, especially countries with different levels of financial market, behave quite differently when they make their decisions to borrow and invest. In the countries with developed financial markets the criteria to secure external financing are not restrictive; thus the firms that meet the requirements can borrow whenever they are willing to borrow. In this situation firms prefer external sources over internal funds to finance

their projects, increase the competitiveness in the market, and respond to changing markets quickly. On the other hand a developed financial market could lead to a decrease in borrowing once the credit market becomes frozen and interest rates rise. In this case the firms that depend on external financing have to stop borrowing and reduce expenditures, which causes a drop in their output. Therefore, a better credit market has a more significant effect on these firms. However, the situation is quite different in a less developed financial market. Without good accounting information to monitor the firm and reduce risk, the banks and investors in less developed financial markets are reluctant to take on the great risk of lending to most firms. Therefore, the threshold requirements to borrow are very high in these countries. Only a small subset of firms can borrow and most firms find it difficult to obtain external financing from the credit market in times of real need. Firms that have difficulty obtaining external financing have to depend on themselves to finance their projects. In these countries interest rate changes in their credit markets have little effect on the firms who are unable to borrow anyway. The few firms that can borrow are less affected by the credit market, since these firms are presumed to be able to repay their borrowing to the banks and investors on time. Even if the credit market worsens, they may still be able to borrow, albeit at higher cost. So, in this situation the credit market's weakness has little effect on the whole economy, because the majority of firms are not borrowing.

Interest rate is one of the important factors that determines export level. Changes in export level are related to many factors both inside and outside the country. Within the country, adoption of technological improvements and financial market imperfections can affect exporting. Outside the country exchange rates and trade barriers exert a significant effect on exporting. Generally, the export level in a given country is closely related to the fluctuation of the exchange rate of their currency. The devaluation of their currency improves their competitiveness among the other exporters in the world market; thus the exporter is able to export significantly more than before due to the price advantage. However, we observe that trade flow shows little response to exchange rate fluctuation. Therefore, some other factors must play a role in export fluctuation. In section 2 we show that credit market imperfections and interest rate changes can have a significant effect on export fluctuations.

Our model imposes a borrowing constraint on the firm. Restricted by a borrowing constraint, firms have to consider the trade off between the cost of borrowing and the profit from the foreign market. Furthermore the borrowing constraint restricts the firms' borrowing. In order to export, the firms have to overcome the fixed export cost as well as the borrowing constraint. When the firm makes the decision to export, the interest rate will act of its own accord to affect the firm's export and borrowing decisions.

In a developed financial market with a lower borrowing threshold most firms will rely on external financing to cover their export costs. In this case, if the credit market worsens and the interest rate jumps suddenly, this could have a dampening effect and push the exporters to reduce their borrowing and even cause some exporters to exit the foreign market. In countries with a less developed financial market, high requirement for borrowing keep most of firms out of the credit market. Only a few firms are able to access the credit market whenever they want to borrow. Most small and medium firms have to depend on themselves to finance their exports. In this case a credit market contraction and its accompanying higher interest rate would have only a small effect on the export level of the whole country.

The remainder of this paper is organized as follows: Section 2 describes the data, illustrates an econometric regression, and presents the main results from the regression. Section 3 presents the basic setting of the model. Section 4 analyzes the static problem. Section 5 concludes the overall analysis.

2. EMPIRICAL STUDY

In this section we consider how financial development and interest rates affect a country's exports. The theoretical model we use shows that the exports in the country with the better financial market can be vulnerable to changes in interest rates, while in the countries with a less developed financial market interest rates impact on export level is less significant. We focus on the interaction between financial market development, interest rates, and their linkage with exports.

We use data from World Development Indicators (WDI) of the World Bank, Financial Structure data set from the World Bank, as well as data from United Nations Conference on Trade and Development (UNCTAD). We use a sample of panel data with 84 countries over the period 1970-2008, excluding some countries without enough data for the variables over the period. The variables in the sample include export share, private credit share, real interest rate, real lending rate, total population, black market premium and growth rate of terms of trade.

We study the impact of interest rates on countries' exports. The dependent variable is export performance of a country which we measure as the export share of GDP. As for independent variables, we choose various variables to measure the conditions of a credit market. Private credit share is the credit provided by the bank and financial institutions to the private sector and is a widely accepted indicator of a country's credit market development. With a higher private credit share, a country can allocate resources within the economy more efficiently. We use two types of interest rate in our study, the real interest rate and real lending rate. Taking

consideration of inflation, the real interest rate, and real lending rate reflect the credit conditions that the firms have to face. Higher interest rates prevent firms from borrowing. The black market premium, terms of trade change, and population in the sample are used as control variables in the regressions. The black market premium, as a proxy for capital and exchange rate controls, tends to affect trade. The terms of trade change are also important to determine trade. We add an interaction term of credit market and interest rates to capture the effect of interest rates on exports under different credit market conditions.

We consider both cross sectional regressions and panel data analysis. The cross sectional analysis uses sample averages over period 1980-2007.

2.1. Regressions in a cross section of countries

The cross section regression uses the sample averaged over the period 1980 to 2007. Each country has one observation. The regression is as follows,

$$\begin{aligned}\text{Export share}_i =& \beta_0 + \beta_1 \text{Private credit}_i + \beta_2 \text{Interest rate}_i \\ &+ \beta_3 \text{Private credit}_i * \text{Interest rate}_i + \beta_4 \text{Control Variables}_i + \epsilon_i.\end{aligned} \tag{1}$$

The hypothesis to be tested in the model is whether a more financially developed market can help a country increase its ability to export and higher interest rates in the more financially developed countries generate a significantly negative effect on their exports than in the less financial developed countries.

Table 1 presents the results of OLS estimation of equation (1). We use two measures of the credit market conditions. The first column reports results of the OLS estimation of equation (1) using real interest rate. The second column presents the results of the OLS estimation of equation (1) using real lending rate.

The results in table 1 indicate that a higher level of private credit share generates a higher export share. In the first column we use the real interest rate as one of our regressors, while in the second column we use the real lending rate instead of the real interest rate. The private credit share clearly is significantly positive in both regressions. In the first column the real interest rate generates the expected significant negative effect on export share , while the private credit share and real interest rate interaction term is not significantly negative. In the second column, the real lending rate does not exert a significantly negative impact on the export share, but the interaction term becomes significantly negative in the regression. In

summary, we can show that the private credit share, interest rate, and interaction term are consistent with the hypothesis.[1]

TABLE 1.

Cross section regression

	(1) Export share	(2) Export share
Private credit share	0.137^{***}	0.172^{***}
	(0.021)	(0.017)
Real interest rate	-0.422^{***}	
	(0.078)	
Private credit share × Real interest rate	−0.006	
	(0.003)	
Population	-0.069^{***}	-0.069^{***}
	(0.003)	(0.003)
Black market premium	-0.008^{***}	-0.006^{**}
	(0.002)	(0.002)
Growth rate of terms of trade	-0.678^{***}	-0.658^{***}
	(0.197)	(0.199)
Real lending rate		-0.175^{***}
		(0.049)
Private credit share × Real lending rate		-0.007^{***}
		(0.002)

Notes: Heteroskedasticity robust standard errors are reported in parentheses. *** denotes test statistic significance at the 1% level. ** denotes test statistic significance at the 5% level. * denotes test statistic significance at the 10% level.

2.2. Regressions from the panel data

The cross section regression above explains the relationship between private credit share, interest rates and export share and the linkage between private credit share and interest rate. An interest rate change in differentiated financial markets can bring about rather different effects on export share. With the panel data we can take advantage of time series effect and control for the bias from any unobserved country effects. The specification

[1]We also use instrumental variables techniques to control for the endogeneity bias. In our regression, the legal origin of countries can serve as an instrument for our regression equation. La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997, 1998) have shown that the character of legal rules can affect the extent of a country's financial markets. Meanwhile, the legal origin can be regarded as an exogenous variable. Results are available on request.

of the regression model is as follows:

$$\begin{aligned}\text{Export share}_{it} =&\beta_0 + \beta_1 \text{Private credit}_{it} + \beta_2 \text{Interest rate}_{it} \\ &+\beta_3 \text{Private credit}_{it} * \text{Interest rate}_{it} \\ &+\beta_4 \text{Control variables}_{it} + \mu_i + \epsilon_{it},\end{aligned} \tag{2}$$

where i and t represent country and period, μ is the country specific effect.

Table 2 and Table 3 present the results of panel data regressions. We use real interest rates and real lending rates in Table 2 and 3, respectively.

Results from Table 2 and 3 confirm our previous findings. In Table 2, we use real interest rate in our regressions. In Column (1), we use population and black market premium as our control variables. We add controls for growth rate of terms of trade in Column (2). In the first column, we do not observe the term of real interest rate is statistically significant. However, we observe a significant negative interaction term. In column (2), both private credit and interaction term are highly statistically significant. We do not see a significant term of real interest rate. From the results of Table 2, we have seen that the effect of real interest rate on exports has been dampened by taking account of time series variations and country-specific effect. The results also show that the interaction term of real interest rate and credit is usually significant. This implies that the real interest rate impacts the exports differently in response to the conditions of credit market.

Results from Table 3 are similar to those in Table 2. We use real lending rate in Table 3 and examine its effect on exports. In column (1), we see no statistically significant effect of real lending rate on exports by excluding the growth rate of terms of trade. However, we see a moderately significant effect of interaction term on exports. In column (2), the term of real lending rate is not significant but the interaction term is.

3. THE MODEL

We embed exogenous credit constraints in an international trade model with heterogeneous firms. In the first part we establish the standard household problem; in the second part we characterize the firm's behavior under an imperfect credit market. We focus on exporter behavior and study how the interest rate impacts on the exporters.

There are two countries in this world, the home country and the foreign country. All of the variables related to the foreign country are denoted by an asterisk. Each household is endowed with L units of labor. There is a continuum of differentiated goods which can be traded internationally. The differentiated goods are produced by the firms indexed by z that have the productivity z.

TABLE 2.

Panel data regression: real interest rate

	(1) Export share	(2) Export share
Private credit share	0.101*	0.203*
	(0.044)	(0.044)
Real interest rate	−0.002	0.010
	(0.049)	(0.059)
Private credit share × Real interest rate	−0.004**	−0.005**
	(0.002)	(0.002)
Population	−0.100*	−0.068
	(0.042)	(0.047)
Black market premium	−0.002***	−0.002***
	(0.000)	(0.000)
Growth rate of terms of trade		0.054**
		(0.017)

Notes: Heteroskedasticity robust standard errors are reported in parentheses. *** denotes test statistic significance at the 1% level. ** denotes test statistic significance at the 5% level. * denotes test statistic significance at the 10% level.

TABLE 3.

Panel data regression: real lending rate

	(1) Export share	(2) Export share
Private credit share	0.093*	0.196*
	(0.045)	(0.045)
Real lending rate	−0.033	−0.031
	(0.050)	(0.054)
Private credit share × Real lending rate	−0.004*	−0.005*
	(0.002)	(0.002)
Population	−0.120*	−0.073
	(0.047)	(0.053)
Black market premium	−0.002***	−0.002***
	(0.000)	(0.000)
Growth rate of terms of trade		0.060**
		(0.019)

Notes: Heteroskedasticity robust standard errors are reported in parentheses. *** denotes test statistic significance at the 1% level. ** denotes test statistic significance at the 5% level. * denotes test statistic significance at the 10% level.

3.1. Household

We begin by describing the household's decision problem in their home country. The consumer derives utility according to the following utility function:

$$\left[\int a(z)^{\frac{\sigma-1}{\sigma}}\, dF(z) + \int x^*(z)\, b(z)^{\frac{\sigma-1}{\sigma}}\, dF^*(z)\right]^{\frac{\sigma}{\sigma-1}} \tag{3}$$

where $a(z)$ is the domestic consumption of home goods, $b(z)$ is the domestic consumption of foreign goods, $x(z) \in \{0, 1\}$ is the indicator of the export decision of the foreign firm with the productivity of z, $F(z)$ is the measure of the operating firm in its home country with productivity less than or equal to z and $F^*(z)$ is the corresponding measure in the foreign country.

The consumers receive wages from the firm. The budget constraint is given by:

$$\int a(z)\, p_a(z)\, dF(z) + \int x^*(z)\, b(z)\, p_b(z)\, dF^*(z) = wL \tag{4}$$

where $p_a(z)$ is the price of home goods indexed by z, $p_b(z)$ is the price of foreign goods indexed by z and w is the wage rate in the home country.

The household in the foreign country faces a similar decision problem with the wages (prices all labeled with stars).

The household's problem is to choose the consumption pattern among different goods in order to maximize his utility (27) subject to (4).

From the standard argument we can imply consumer spending on home and foreign goods,

$$p_a(z)a(z) = wL\left(\frac{p_a(z)}{P}\right)^{1-\sigma} \tag{5}$$

$$p_b(z)a(z) = wL\left(\frac{p_b(z)}{P}\right)^{1-\sigma} \tag{6}$$

where P is the equilibrium price in the home country,

$$P = \left[\int p_a(z)^{1-\sigma}\, dF(z) + \int x^*(z)\, p_b(z)^{1-\sigma}\, dF^*(z)\right]^{\frac{1}{1-\sigma}}. \tag{7}$$

3.2. Firms without credit constraints

In this part we analyze a single firm's decision problem. Firms in each country are assumed to be in a monopolistic competitive market. The firm with productivity z uses only one factor labor $l(z)$ to produce the output according to the CRS production function

$$y(z) = zl(z). \tag{8}$$

The firm has the fixed operating cost c_d to generate the endogenous exit.

The firm could be a potential exporter by the indicator of $x(z)$. Some of the output can be exported to the foreign country subject to a fixed export cost c_f and iceberg cost of exporting τ. The fixed export cost c_f is in terms of domestic labor, and includes the cost of obtaining the foreign market information, advertising in the foreign market, and setting up the distribution network, along with other associated costs. The iceberg cost of exporting is denominated in the same terms of the output. The firm has to produce τa^* units of output, where $\tau \geq 1$, in order to have a^* units of output delivered to the foreign country. The feasibility condition for the firm is

$$a(z) + x(z)\tau a^*(z) = y(z) \tag{9}$$

The firm in it home country faces the static profit maximization problem. The firm will choose output y, labor l, price p_a p_a^*, and export decision x to maximize the profit,

$$\Pi(z) = \max_{y,l,p_a,p_a^*,x\in\{0,1\}} p_a a + x p_a^* a^* - wl - xwc_f - wc_d, \tag{10}$$

subject to (8), (9) and the demand function

$$p_a a = wL\left(\frac{p_a}{P}\right)^{1-\sigma} \text{ and } p_a^* a^* = w^* L^* \left(\frac{p_a^*}{P^*}\right)^{1-\sigma} \tag{11}$$

We analyze the firm's static profit maximization problem. The firm chooses the equilibrium price in the home country and foreign country as,

$$p_a(z) = \frac{\sigma}{\sigma-1}\frac{w}{z} \text{ and } p_a^*(z) = \frac{\sigma}{\sigma-1}\frac{\tau w}{z}. \tag{12}$$

Given the pricing strategy (12), the firm has the variable profit Π_d in the home country,

$$\Pi_d(z) = \frac{wL}{\sigma}\left(\frac{\sigma}{\sigma-1}\frac{w}{zP}\right)^{1-\sigma}, \tag{13}$$

and the variable profit Π_f in the foreign country,

$$\Pi_f(z) = \frac{w^* L^*}{\sigma} \left(\frac{\sigma}{\sigma - 1} \frac{\tau w}{z P^*} \right)^{1-\sigma}. \tag{14}$$

Highly productivity firms will be able to charge a lower price, expand in the domestic and foreign markets and acquire a higher profit.

Therefore clearly there is a cutoff level in productivity which will determine the export status for the firm. Above this level the firm will choose to export and below it the firm will only focus on its domestic market. Only those firms which could generate a profit from the foreign market could export.

The static profit of the firm is given by

$$\Pi(z) = \Pi_d(z) - w c_d + \max(\Pi_f(z) - w c_f, 0). \tag{15}$$

3.3. Credit constrained exporter

In order to analyze the relationship between the exporter's decision criteria and the interest rate, we eliminate the credit market effect on domestic production, while imposing borrowing constraints on the firms that are willing and able to export.

For exporters the lenders may be reluctant to finance for different reasons, such as asymmetric information from the two markets or unenforceable contracts, as suggested by Matsuyama (2008). The exported goods end up in a foreign country, so it is not easy for lenders to obtain exact information about the exports and to monitor the exporter. These uncertainties greatly reduce the lenders' willingness to finance the exporter. The firm could also default on the contract with their lenders for some institutional and legal barriers which further complicates and constrains lending and borrowing.

In this section, we assume that the fixed export cost is so high that an internal finance option is not enough to cover it; therefore, the firm needs to get a short term loan from the bank in the local credit market to finance these fixed export costs. In other words, the credit market imperfections present high barriers which keep firms from easily financing their fixed export costs.

In order to obtain the necessary credit, the firm has to be able to generate the rate of return to lenders determined by this uncertain market, which is the interest rate r. Thus static profit for the firm is:

$$\Pi(z) = \Pi_d(z) - w c_d + \max(\Pi_f(z) - (1 + r) w c_f, 0). \tag{16}$$

Its expected variable profit needs to be larger than or at least equal to the opportunity cost of expanding into the export market in order for the

firm to be willing to borrow and invest, if and only if

$$\Pi_f(z) \geq (1+r)wc_f. \tag{17}$$

Prudent financial management requires that the firm only uses part of its variable profit in the foreign country for this. We assume no more than λ of the entire variable profit in the foreign country is available for the repayment. That is, the firm has to make sure that,

$$\lambda\Pi_f(z) \geq (1+r)\left(wc_f - (\Pi_d(z) - wc_d)\right). \tag{18}$$

Only when the above constraints are met is the firm able to borrow and invest. Accordingly, we can see that borrowing $wc_f - (\Pi_d(z) - wc_d)$ is limited by the variable profit on foreign sales, and a sufficiently high profit in the domestic market can overcome the credit market imperfections.

Before exporting takes place, the firm must be both willing and able to borrow; that is, when both (17) and (18) are satisfied. The export decision depends on both (17) and (18). $x(z) = 1$ if and only if (17) and (18) hold.

Which one of them is relevant is related to Π_d, λ, r and wc_f. If the variable profit on domestic sales is sufficiently large, $\Pi_d(z) - wc_d \geq (1-\lambda)\, wc_f$, (17) is more stringent than (18). That is, the firm can borrow whenever it wants to borrow. In this case the credit market imperfections do not affect the borrowing decision. On the other hand, $\Pi_d(z) - wc_d < (1-\lambda)\, wc_f$, borrowing constraint (18) is more stringent. This means the credit market imperfection may affect borrowing.

At the beginning of each period, each existing firm has the probability δ of exiting; corresponding to $1-\delta$ probability they will survive to enter the next period. With the borrowing constraints imposed on the exporters the value of the firm V satisfies

$$V_t(z) = \max\left(\Pi_t(z) + (1-\delta)\, V_{t+1}(z), 0\right). \tag{19}$$

Potential entrants will consider the expected profit. The sunk cost for entry c_e is also denominated in terms of domestic labor. The productivity of new firms is drawn from distribution G. With the free entry, the expected firm value equals the entry cost; that is,

$$wc_e = \frac{1}{r}\int V_{t+1}(z)dG. \tag{20}$$

We assume the mass of entrants is F_{et} in the period t. The labor market clearing condition is given by

$$\int l_t dF(z) + \int (c_d + x_t(z)c_f)dF(z) + F_{et}c_e = L. \tag{21}$$

4. DISCUSSION

4.1. Characterization of exporters

To simplify our analysis we remove firm dynamics from the original model, that is we do not consider the entry cost c_e and we assume the number of potential incumbent firms is proportional to the population L. Moreover the price index in each country is assumed not to be affected by foreign firms. According to these assumptions the price index in the home country is

$$P = \left(p_a(z)^{1-\sigma} L dF_z(z) \right)^{\frac{1}{1-\sigma}} \tag{22}$$

where $F_z(z)$ is the productivity distribution of firms in the domestic economy.

With the price index we can analyze the firms behavior in its domestic setting. Following the analysis in section 3.3 we can have the following productivity thresholds for the domestic firm:

$$\Pi_d(z_d) = wc_d \tag{23}$$
$$\Pi_d(z_1) = wc_d + (1-\lambda) wc_f \tag{24}$$
$$\Pi_f(z_2) = (1+r) wc_f \tag{25}$$
$$\lambda \Pi_f(z_3) = (1+r)\left(wc_f - (\Pi_d(z_3) - wc_d) \right). \tag{26}$$

Productivity level z_d determined by (23) is the level below which the firm exits the market. This endogenous exit is caused by operation cost c_d. The high operation cost c_d makes the inefficient firms with low productivity exit the market, while the high productivity firms stay in the market and continue to produce.

We only impose credit constraints on the firms who are willing and able to export. The levels, z_1, z_2 and z_3 determine the firms' decision to export.

Productivity level z_1 from (24) determines if the firm is affected by credit market imperfection. With the productivity level above z_1 the firm is not restricted by the credit constraint. The profit made by their high productivity derived from the domestic sales can help the firm overcome the imperfections of the credit market. In other words, the bank does not worry about the firms' loss in the foreign market, since a profit in the domestic market could be used for the repayment. Under the assumptions we have made, it is clear high operating cost c_d forces a high value of z_1. High operating cost causes the firm to struggle in the domestic market and reduce its domestic profit margin. Therefore, fewer firms are not restricted by the credit market. However the effect from λ is just the opposite. Higher λ means all the firms can use a larger portion of total domestic profit to

repay their debt; that is, the country has a relatively better credit market than other countries. Clearly higher λ can help lower the productivity requirement z_1 and more firms can borrow without restrictions. The interest rate has the same effect as λ. As the interest rate increases, productivity level z_1 decreases. The increase in the interest rate helps the firm raise the value of its existing assets and increase available funds in banks as savers respond to the incentive of higher returns. The increased asset value allows the firm to borrow with fewer restrictions in the credit market. A higher interest rate in the home country should cause producers to seek profits in export markets. For the fixed export costs c_f, higher export costs increases the value of z_1.

The trade-off between the export profit and the opportunity cost of borrowing generates z_2. The firm has to balance the expected profit and opportunity cost of borrowing before entering the foreign market. If the future profit in the foreign market does not cover the opportunity cost of borrowing, clearly exporting is not a good deal. z_2 is one of the thresholds to determine whether to exit or stay in the foreign market. According to Π_f and P^*, z_2 is determined by c_f, c_d^*, τ, r and $\frac{w}{w^*}$. Clearly c_f and τ have a positive impact on z_2. Higher fixed and variable export costs are two disadvantages of the firm in the foreign market. Only the high productivity firm could afford the high export cost. c_d^* also has a positive effect on z_2. Since c_d^* is the operating cost in the foreign country, a higher c_d^* means that a higher average productivity is required in the foreign market and that the low productivity firms will be forced to exit the market. The exporters are faced with a fiercely competitive foreign market. This will have a negative effect on the profits from foreign sales. Therefore, the increase in c_d^* will raise z_2. Unlike the effect on z_1, interest rate has a positive effect on z_2. The increase in the interest rate raises the opportunity cost of borrowing, so the higher interest rate means higher z_2 and funds can only flow into the most profitable export deals. As for relative wage $\frac{w}{w^*}$, a higher domestic wage relative to the foreign wage creates a disadvantage for the exporter in the foreign market, leading to higher z_2.

From (26) we can see z_3 is determined jointly by Π_d and Π_f. The most important thing about z_3 is that z_3 will not be affected by the interest rate because the borrowing constraint is presumed to be not related to the interest rate. Like the effect of c_f and c_d on z_d, z_1 and z_2, c_f and c_d have the same positive effect on z_3. Moreover λ exerts a negative effect on z_3. If the country has a better credit market with high λ, the productivity level z_3 is lower. High λ reduces the productivity requirements for exporters.

In summary, z_d gives us information about the necessary productivity levels for survival or expansion in the domestic market; z_1 is the productivity level to determine if the firm is affected by credit market imperfections; z_2 is the productivity level that the firm without credit constraints should

achieve in order to export; z_3 is the productivity level at which the firm with credit constraints can overcome their borrowing constraints.

Proposition 1 helps us identify which firms will enter the foreign market given different financial market imperfection.

PROPOSITION 1. *If λ is large enough, then $z_1 \leq z_3 \leq z_2$, the firm with productivity above z_2 will export; otherwise, If λ is low, then $z_2 \leq z_3 \leq z_1$, the firm with productivity above z_3 will export.*

When λ is large enough, we have $z_1 \leq z_3 \leq z_2$, where z_1 is the lowest productivity level which means the firms with low productivity could possibly overcome the difficulty caused by the credit market. In this relatively good credit market, no firm with a productivity below z_2 could profitably export. Clearly z_2 is the most important cutoff point for exporters. The firms with productivity below z_2 can not generate enough profit in the foreign market to cover the fixed export cost. When λ is low, we have $z_2 \leq z_3 \leq z_1$, where z_1 is the highest productivity level which means the credit market is tough for the firms that want to export. The firms with productivity between z_2 and z_1 could generate the enough profit from their exports to cover the fixed export cost, but they are restricted by the imperfect credit market. In this case z_3 is the important level to identify for the potential exporter. The firms with productivity below z_3 exit the foreign market since the future repayment is more than they can afford. The firms with productivity above z_3 will export since they can both satisfy the borrowing constraint and afford to finance the fixed export cost because they are able to generate enough profit in the foreign market.

4.2. Cutoff levels, trade flow and interest rate

In the following section, we first show how these cutoff levels change with respect to the change in interest rate, and then we study how the trade flow changes with the interest rate. To simplify the investigation we assume the two countries have the same wage rates, operating costs and fixed export costs.

The following proposition shows how the extensive margins respond to the movement of the interest rate.

PROPOSITION 2. *An increase of domestic interest rate has the following effects:*

1. The effect on z_2 is given by

$$\frac{\partial z_2}{\partial r} = \frac{wc_f}{\frac{\partial \Pi_f}{\partial z}}. \tag{27}$$

2.The effect on z_3 is given by

$$\frac{\partial z_3}{\partial r} = \frac{wc_f - (\Pi_d(z_3) - wc_d)}{\lambda \frac{\partial \Pi_f}{\partial z} + (1+r)\frac{\partial \Pi_d}{\partial z}} < \frac{\partial z_2}{\partial r}. \tag{28}$$

Proof.

1. We solve z_2 from (25) and imply $\frac{\partial z_2}{\partial r}$ by taking first order derivative with respect to r.

2. We solve z_3 from (26) and imply $\frac{\partial z_3}{\partial r}$ by taking first order derivative with respect to r.

∎

In a perfect financial market, equation (27) shows higher interest rates reduce export competitiveness by increasing the opportunity cost of borrowing. Higher opportunity cost of borrowing impedes entries to the foreign market. In a less developed financial market, the firm with borrowing constraints mainly depends on internal finance to invest and export. Equation (28) shows an increase of domestic interest rates raises the domestic asset return which relieves productivity requirements for exports. Therefore an increase of domestic interest rates has a smaller effect on extensive margin in a country with an imperfect financial market.

If the firm exports, we have the revenue from export $r_f(z)$ using consumer's expenditure on this good (11).

$$r_f(z) = \sigma w^* c_d^* \left(\frac{w^*}{\tau w}\frac{z}{z_d^*}\right)^{\sigma-1}. \tag{29}$$

And the total trade flow T of exports is given by,

$$T = \int_{\tilde{z}} L r_f(z) dF_z(z). \tag{30}$$

Clearly total trade flow depends on the exporter's cutoff levels $\tilde{z}$, interest rate and λ for the imperfect credit market. Following proposition 2 we can imply the impact of interest rates on trade flows.

PROPOSITION 3. *In the country with a good credit market, an increase in the interest rate will have a negative impact on trade flow; moreover, an increase in the interest rate will have smaller impacts on the trade flow in the country with severe credit market imperfections than in the country with a good credit market.*

The movement of the domestic interest rate leads to exit and entry of firms into the foreign market, which is the effect on extensive margin. In a developed financial market most firms borrow to export. An increase of domestic interest rates causes negative impact on exports by reducing potential exporters. In a less developed financial market most firms can not borrow. In this case $\frac{\partial z_3}{\partial r}$ determines the effect on extensive margins. Proposition 2 shows the movement of domestic interest rate would have only a small effect on potential exporters and most firms in this market would find easier to enter the foreign market with higher interest rates. Therefore the negative impact on extensive margin from the movement of the interest rate is smaller in a less developed financial market.

5. CONCLUSION

This paper has shown how the interaction of financial markets and interest rates can impact the aggregate exports in a country. Based on a heterogeneous firm model we study individual firm behavior under different degrees of financial market development. We find that in developed financial markets the strong dependence on external finance sourcing causes interest rate changes to generate a significant effect on aggregate exporting, while in less developed financial markets the threshold to borrow is high and firms find it hard to obtain external financing, so credit market deterioration generates a less significant effect on exporting than in the more developed financial markets.

However, in our model we do not consider the individual tailored rates the firms may be offered in the credit market. Clearly, lenders can measure the lending risk and change the interest rate to the firm based on banking experience, expectation, firm level accounting details and local conditions. Aggregate shock and dynamic framework analysis probably could predict more specific outcomes regarding individual firms' behavior and aggregate macroeconomic variables, but for our aggregate investigation, these assumptions should affect neither the overall accuracy nor the basic trends and relationships developed here.

APPENDIX: PROOFS

PROOF OF PROPOSITION 1

PROPOSITION 1. *If λ is large enough, then $z_1 \leq z_3 \leq z_2$, the firm with productivity above z_2 will export; otherwise, If λ is low, then $z_2 \leq z_3 \leq z_1$, the firm with productivity above z_3 will export.*

Proof. The export decision depends on both (25) and (26). If λ is large enough, $\Pi_d > wc_d + (1-\lambda)\, wc_f$, (25) is more stringent than (26). That is, the firm is not affected by borrowing constraints. In this case the borrowing decision is determined by z_2. On the other hand, when $\Pi_d < wc_d + (1-\lambda)\, wc_f$, borrowing constraint (26) is more stringent. This means the firm with productivity above z_3 will export.

Next we show z_3 is neither larger nor smaller than z_1 and z_2.

First we prove z_3 cannot be smaller than z_1 and z_2. Let's suppose $z_3 < z_1 < z_2$ or $z_3 < z_2 < z_1$. When $z_3 < z_1 < z_2$, according to the cutoff levels (24) (25) and (26), Π_d and Π_f is increasing in z, clearly if $z \in (z_3, z_1)$,

$$\Pi_d(z) < wc_d + (1-\lambda)\, wc_f$$
$$\lambda \Pi_f(z) > (1+r)(wc_f - (\Pi_d\,(z) - cw_d)).$$

We can imply $\Pi_f(z) > (1+r)wc_f$ if $z \in (z_3, z_1)$. However when $z = z_2$, $\Pi_f(z) = (1+r)wc_f$. Clearly this case is impossible, since $z_2 > z_3$ and Π_f is increasing in z. For the second case $z_3 < z_2 < z_1$, the proof is nearly the same.

Similarly, we can show z_3 cannot be bigger than z_1 and z_2 using the same logical sequence.

From the above argument, when λ is large enough, we have $z_1 \leq z_3 \leq z_2$; when λ is low, then $z_2 \leq z_3 \leq z_1$. ∎

PROOF OF PROPOSITION 3

Proposition 3. *In the country with a good credit market, an increase in the interest rate will have a negative impact on trade flow; moreover, an increase in the interest rate will have smaller impacts on the trade flow in the country with severe credit market imperfections than in the country with a good credit market.*

Proof. If we know the productivity level that separates out the exporters from all the other firms in the country, We have the following aggregate trade flow T

$$T = \int_{\tilde{z}} Lr_f(z) dF_z(z),$$

where $\tilde{z}$ is the productivity level that determines the exporters. From proposition 1, $\tilde{z}$ could be z_2 and z_3. Differentiating T with respect to r,

$$\frac{\partial T}{\partial r} = -r_f(\tilde{z})\frac{\partial F(\tilde{z})}{\partial z}\frac{\partial \tilde{z}}{\partial r}$$

When financial market imperfection is high, λ is low, $\tilde{z}$ is z_3. When financial market imperfection is low, λ is high, $\tilde{z}$ is z_2.

According to (27) and (28), we can imply $\frac{\partial z_2}{\partial r} > 0$ and $\frac{\partial z_3}{\partial r} < \frac{\partial z_2}{\partial r}$. ∎

REFERENCES

Beck, T., 2002. Financial development and international trade: Is there a link? *Journal of International Economics* **57(1)**, 107–131.

Beck, T., 2003. Financial Dependence and International Trade. *Review of International Economics* **11(2)**, 296–316.

Bernard, A., J. Jensen, and P. Schott, 2009. *Importers, exporters and multinationals: A portrait of firms in the US that trade goods*. University of Chicago Press.

Chaney, T., 2005. Liquidity constrained exporters. *University of Chicago mimeo*.

Do, Q. and A. A. Levchenko, 2007. Comparative advantage, demand for external finance, and financial development. *Journal of Financial Economics* **86(3)**, 796–834.

Eaton, J., S. Kortum, and F. Kramarz, 2004. Dissecting Trade: Firms, Industries, and Export Destinations. *American Economic Review* **94(2)**, 150–154.

Eaton, J., S. Kortum, and F. Kramarz, 2011. An Anatomy of International Trade: Evidence From French Firms. *Econometrica* **79(5)**, 1453–1498.

Ju, J. and S. Wei, 2005. *Endowment versus finance: a wooden barrel theory of international trade*. No. 2005-2123. INTERNATIONAL MONETARY FUND.

Kletzer, K. and P. Bardhan, 1987. Credit markets and patterns of international trade. *Journal of Development Economics* **27(1-2)**, 57–70.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. W. Vishny, 1997. Legal Determinants of External Finance. *Journal of Finance* **52(3)**, 1131–50.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. W. Vishny, 1998. Law and Finance. *Journal of Political Economy* **106(6)**, 1113–1155.

Manova, K., 2013. Credit Constraints, Heterogeneous Firms, and International Trade. *The Review of Economic Studies* **80(2)**, 711–744.

Matsuyama, K., 2008. Aggregate Implications of Credit Market Imperfections. NBER chapters, National Bureau of Economic Research, Inc.

Melitz, M. J., 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* **71(6)**, 1695–1725.

Svaleryd, H. and J. Vlachos, 2005. Financial markets, the pattern of industrial specialization and comparative advantage: Evidence from OECD countries. *European Economic Review* **49(1)**, 113–144.