Exit Friction, Firm Selection and Trade Reform

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Abstract. This paper highlights the importance of incorporating exit friction, i.e. cost upon firm closure, into the analysis of firm dynamics and trade reform. Selection of firms through entry and exit is crucial for aggregate efficiency and benefits from trade. The exit friction, however, hampers firm selection by preventing unproductive yet large firms from exiting, meanwhile, discouraging small and productive firms out from increasing size. In this paper, we build a dynamic model with heterogeneous firms and exit cost related with firm size in an open economy. Exit cost reduces firm turn rate and weakens the correlation between firm size and productivity. We estimate the model to Chinese manufacturing firm data, and find the exit cost is around 30% of annual wage per employee. Counterfactual analysis shows that if exit was frictionless, the increase in average productivity would become four times larger during the trade reform. Using Chinese manufacturing firm data, we show reduced form patterns consistent with the model predictions.

Keywords: Exit friction, firm selection, size distribution, trade reform
JEL code: L11, L25, F14, F16, J65.

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1 Introduction

The question of how the exposure to trade affects aggregate productivity is a long-established subject of both theoretical and practical import. One key channel for trade reform to affect efficiency, as well as welfare, is the trade-induced reallocation, or selection of firms, through entry and exit. An influential work, Melitz (2003) has exerted significant impact on the literature of the relationships between trade opening and aggregate productivity. From his point of view, trade opening brings about an increase in the productivity threshold for surviving firms, forcing firms with productivity below the threshold to exit, thus makes room for more productive new entrants and improves the aggregate productivity.

Based on the above findings, much literature has then studies the affecting factors towards trade-induced reallocation. Among most discussed factors are entry barrier, labor market frictions including firing cost and search cost, capital market frictions, etc. However, exit friction, i.e. cost upon firm closure, which widely exists in different economies (Johnson, 2006) has been overlooked in this realm. It is thus natural to delve into the question of whether exit cost affects the effectiveness of trade opening, by affecting firm selection.

This paper argues that to fully understand the effectiveness of trade reform through firm selection, exit friction needs to be taken into account. In an economy with large exit friction, i.e. high exit cost per worker, the firms with low productivity and large size, which should marginally exit during trade reform would stay (because they could not afford the cost to close) and consequently drive out the small productive firms. In the meantime, small productive firms would hesitate to become large to avoid the potential high exit cost in the future. Both effects hinder the productivity increase induced by trade reform.

The following questions regarding exit friction are studied in this paper. How large is the exit cost per worker? How exit cost affects firms' exiting decisions, as well as the joint distribution of firm size and productivity? When an economy opens to trade, how the aggregate productivity improvement from opening-up is related with exit cost and what is the mechanism of such relation?

To answer these questions, an open economy dynamic model is built with heterogeneous firms and size-dependent exit friction. Then we match the model to Chinese data by estimating the key parameters, and conduct counterfactual analysis of trade reforms. In the model, each firm has idiosyncratic productivity and employment size. Individual firm's decisions of exit or stay, and size adjustment are modeled as a dynamic programming problem. Export is assumed to be subject to fixed cost. The model assumes dismissal cost both to incumbents and closing firms. We use exit cost to denote the dismissal cost when a firm closes, and use firing cost for the dismissal cost when a firm still operates, in the rest of this paper. In equilibrium, the firm distribution and other aggregate variables are stationary. By investigating the model predictions, this paper has four key findings.

Firstly, we show the exit cost which is related with firm size brings about different prediction on the surviving productivity threshold with the classic theory. We find the size-dependent exit cost shifts the surviving productivity threshold to be less increasing than in a traditional model, even decreasing in firm size, and reduces the exit rate for large firms. To illustrate the mechanism, we denote the surviving productivity threshold, which depends on firm size to be $z^*(L)$. One firm with size L chooses to exit if its productivity is lower than $z^*(L)$, and to stay otherwise. In the Hopenhayn (1992) or Melitz (2003) model, this productivity threshold is a constant regardless of size. In a model with firing cost to incumbents but not to closing firms, the threshold $z^*(L)$ is increasing in size L. The intuition is that, with the existence of firing cost, the continuing value of larger firms under each level of productivity becomes lower, since they may need to pay positive amount of firing fees in the future upon bad shocks. Hence to remain a larger size, the productivity threshold needs to be higher. The intuition is confirmed in Hopenhayn and Rogerson (1993), Poschke (2009) and Samaniego (2006), etc.

However, when there is exit cost, the threshold $z^*(L)$ will be less increasing or even decreasing in size L, depending on the relative values of exit cost and firing cost. In contrast to the reallocation effect of firing cost, which shifts upward the productivity threshold curve, exit cost has opposite effect. In an economy with large exit cost per worker, the firms with low productivity and large size, which should marginally exit during trade reform would stay, since they could not afford the cost to close, i.e. exit cost lowers firm exiting rate, especially for large firms.

Secondly, we find firm size and productivity in Chinese data are slightly negatively correlated, contradictory with the predictions from classic models, in addition, provide an explanation. This empirical finding is robust when we control for industry fixed effects, firm ownership, province fixed effects and capital intensity, or when we use labor productivity instead of total factor productivity (TFP) as measure for productivity. A model with no exit cost predicts positive correlation between firm size and productivity. For example, in Melitz (2003) and Hopenhayn (1992) model, firm size and productivity are positively correlated and one-to-one matching, since firms could perfectly adjust their sizes; in a model with firing cost but no exit cost, size and productivity are positively correlated, although not one-to-one matching. The reason lies in that, the surviving productivity threshold is increasing in firm size, and that more productive firms always choose to become bigger in size. However, in a model with exit cost, as we mentioned earlier, the productivity threshold becomes decreasing in firm size, creating a force of negative correlation between size and productivity. Further, the tendency for productive firms to increase size becomes weaker than in an economy with no exit cost, since firms would choose avoid the potential high exit cost associated with large size in the future. The two effects jointly induce a much less positive correlation between size and productivity, i.e. large firms are not necessarily large.

This finding also sheds light on how exit cost affects the equilibrium firm distribution. By constructing a counterfactual analysis, we find the firm distribution in an economy with exit cost is more dispersed, i.e. more firms at the two ends of firm distribution. The intuition is two folded. First of all, since a number of less productive yet large firms do not exit the market when exit cost is large, there are more large firms than in the model where exit is frictionless. Secondly, the small firms' hesitation of becoming larger increases the density of small firms in the size distribution.

Thirdly, by structurally estimating the model and conducting counterfactual analysis, we know the magnitude of exit cost, and the impact of exit cost on the effectiveness of trade reform. We estimate key parameters including firing cost, exit cost, different fixed costs, entry cost, parameters of productivity distribution, as well as foreign demand for Chinese manufacturing firms. The estimation utilizes moment conditions of exiting, exporting, productivity and size distribution, applying estimation approachs similar with Coşar et al. (2016). The estimation finds the firing cost is around the annual wage per employee, while the exit cost is around 30% of annual wage per employee, for Chinese manufacturing firms during 2004-2008.

After estimating the model, by conducting counterfactual analysis, we find that exit cost weakens the selection effect of trade reform, and lowers the increase in average productivity. In the estimated model, a trade liberalization in 2004 which reduces import tariff to zero increases 1 percentage point of turnover. This number became 10 percentage points if exit cost was zero. When a country opens to trade, i.e. experience a tariff cut, productive firms increase the size, driving up the factor price, and driving out the inefficient firms. When there is exit cost, low productive firms' closure reduces, so the efficiency gain from trade is smaller. The efficiency improvement from trade liberalization is 2.1% in the estimated model. If there was no exit friction, the improvement would become 9.5%, more than four times of the actual improvement. If the existing exit cost doubled, the improvement would disappear.

Lastly, we empirically answer the question of what determines exit and show the effect of exit cost. To implement the analysis, we explore Chinese regional differences in exit friction, by constructing various proxies for exit cost. Two findings consistent with the model are presented. Firstly, the data pattern shows that in regions with high exit cost, the tendency of exiting for large or unproductive firm is lower. Secondly, we find opening up to trade (reduction in tariffs and raising in exports) increases the average productivity; however, in regions with larger exit cost, the increase in average productivity is smaller.

This paper contributes to the literature of factor market frictions and firm dynamics by highlighting the importance of incorporating exit cost into analysis. The literature of firm dynamics emphasizes continuous selection of firms through entry and exit, starting from early seminal works of Hopenhayn (1992) and Jovanovic (1982). Empirically, researchers find that firm turnover contributes a large share in the total growth and increase in aggregate productivity, for example, Davis et al. (2006) for the US and Brandt et al. (2012) for China. One focus of the firm dynamics literature is how factor market frictions affect firm distributions, such as Cooley and Quadrini (2001), Cooper and Haltiwanger (2006), Bloom (2009) for capital market imperfections. Hopenhayn and Rogerson (1993), Kambourov (2009), and Coşar et al. (2016) for labor market frictions (firing cost). In most of these papers, exit is of no friction. Our paper is closest related with Samaniego (2006), Poschke (2009) and Janiak (2013). Samaniego (2006) studies the impact of exit cost on aggregate employment. Poschke (2009) studies the impact of firing costs on productivity growth. Janiak (2013) models the exit cost as share of capital recovery and find its impact on unemployment. This paper differs from these three papers in that, firstly, we model the exit cost in an open economy, and show the impact of exit cost on effectiveness of trade reforms. Secondly, we structurally estimate the exit cost, while in the existing papers the models are calibrated assuming no exit cost, then used for simulations of positive exit costs.

The paper also contributes to the literature of trade reforms in an imperfect market, especially to the large literature of Chinese trade liberalization. Kambourov (2009) studies firing cost and labor reallocations across sectors, Alessandria and Choi (2007) and Das et al. (2007) study the export sunk cost and export dynamics. Coşar et al. (2016) incorporates labor search friction in an open economy firm dynamics model and studies the joint reforms of trade and labor market liberalization. Empirically, Brandt et al. (2016) finds that the pro-competitive effect of trade improves domestic productivity in China. We find in this paper that in an imperfect market with exit cost, the gain from trade from selection is lower. This paper contributes to the literature of trade reforms in an imperfect market, by looking into the friction upon exit for the first time in literature.

This paper is also related with the large literature of labor market frictions and misallocation. While most research assumes zero exit cost, this paper carefully investigate the impacts of exit cost on firm distributions and gain from trade. My finding of slightly negative correlation between firm sizee and productivity is related with the literature of misallocation. While most literature emphasize the wedges from factor price distortions, such as Hsieh and Klenow (2009), Edmond et al. (2015), Bai et al. (2018), etc, in this paper we provide another channel of misallocation through size-dependent exit cost.

The rest of paper is organized as follows. Section 2 builds a model of open economy with heterogeneous firms and exit cost. Section 3 estimates the model and shows main findings about firm dynamics and the effectiveness of trade reform. Section 4 discusses data and empirical patterns related with the findings in Section 3. Section 5 concludes.

2 Model

We build a model of firm dynamics in spirit of Hopenhayn and Rogerson (1993). The settings in open economy is built based on Coşar et al. (2016), where firm export is subject to fixed cost, but not sunk cost, i.e. export is a static decision. The difference between this model with HR and CGT is that, In HR and CGT, labor market frictions are subject to operation firms, while in this paper, labor market frictions are also subject to exiting firms.

2.1 Consumers

We assume one unit of infinitely lived representative consumer-worker in the economy, consuming final good C_t, which is a CES aggregation of intermediate inputs $c_t(n), n \in [0, N_t]$. $\sigma > 1$ stands for the elasticity of substitution.

$$C_t = \left(\int_0^{N_t} c_t(n)^{(\sigma-1)/\sigma} \right)^{\sigma/(1-\sigma)}$$

The consumer maximize her present-value life time utility $U = \sum_{t=1}^{\infty} \frac{C_t^{1-\rho_0}-1}{(1+r)^t(1-\rho_0)}$, $\rho_0 \in (0, 1]$, where r is the discount rate. In each period, the budget constraint condition is that,

$$P_t C_t = w_t L^0 + \Pi_t + T_t$$

Where $w_t L^0$ is labor income, Π_t is dividend income and T_t is the amount of lump-sum transfers received from the government (tariff revenue). This paper assumes inelastic labor supply, which suggests strong reallocation of labor across sectors.

2.2 Firms

2.2.1 Timing of Incumbents' Decisions

Before getting into detailed settings of the model, it's helpful to introduce the structure of firm dynamics. We first introduce the time line settings for incumbent firms as shown in Figure 1. At the start of period t, a firm who operates in the period $t-1$ observes its productivity z_t and employment l_t.At the beginning of each period, the firm receives revenue $G(z_t, l_t)$ and pays the labor cost wl_t.Note that the firm has a choice of whether to export. If exporting, the revenue consists of sales both to domestic and abroad markets, also, the firm pays additional fixed cost of exporting. Then, prior to receiving any new information, the firm makes a decision about whether to stay in the market or exit.

If a firm exits, it pays the dismissal cost $C_x(l_t)$, with $C'_x(l_t) > 0$. After exiting, the firm receives zero profits in the future periods.If a firm chooses not to exit, it incurs the fixed cost c_p to operate, decides its employment for the next period l_{t+1}, and incurs a firing cost $C_f(l_t, l_{t+1})$ only if l_{t+1} is lower than l_t (no cost if l_{t+1} is larger than l_t). At the end of period t, the firm draws productivity for the next period, z_{t+1}. This process is repeated next period. Since this paper studies a stationary equilibrium model, all variables are constant in each period. We suppress time subscript t in the following paper.

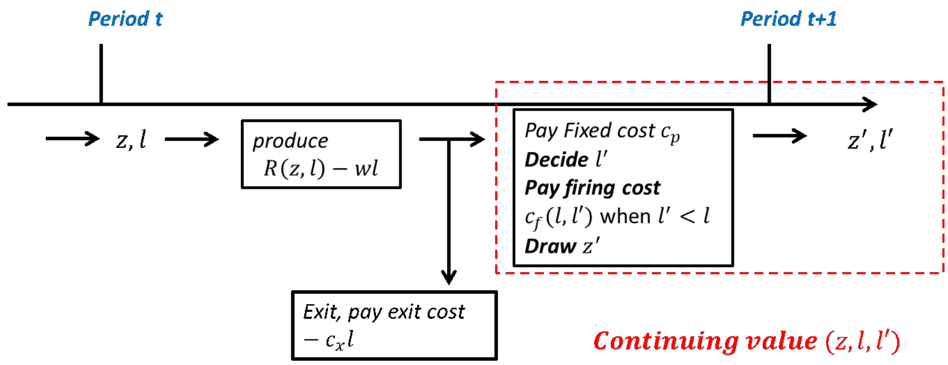

Figure 1: Timeline of Incumbent Firms

2.2.2 Technology

Each intermediate good c_n is supplied by individual firm, each of which produces a unique product. We assume the production uses one factor, labor, and the production function takes the form of $q = zl^\alpha$, where q is output and l is labor input, $0 < \alpha < 1$ stands for the output elasticity, and z captures the firm heterogeneity in productivity, or equally, quality [1].

The productivity z follows a stationary AR(1) process,

$$\ln z' = \rho \ln Z + \sigma_Z \varepsilon$$

Where $\rho \in (0, 1), \sigma_z > 0, \varepsilon \sim N(0, 1)$ is a standard normal random shock independently and identically distributed across time and firms.

[1] In this model, we assume production requires only one factor, labor, to keep the model as simple as possible. Note that including more dynamic inputs will significantly increase the computation time. Other papers often assume firms make static decisions of other factors, including material and capital, such as Samaniego (2006), Poschke (2009), etc. We implicitly assume capital as fixed and material input as flexible input. z is then a combination of TFP, capital, material input and material price.

2.2.3 Prices, Exports and Revenues

The setting of open economy is borrowed from Coşar et al. (2016). We assume the imported varieties are fixed as $[0, N_F]$, and an endogenous set of goods $[N_F, N]$ are exported by domestic producers. By assuming $\tau_x > 1$ as the export iceberg cost and $\tau_m > 1$ as the iceberg cost of imports, this model allows for asymmetric trade reforms. In this section, we introduce the price indices and revenues, and derive firms' exporting decisions.

Assume $n \in [0, N_F]$ goods are imported with the foreign currency price is $p^*(n)$. Denote $p(n)$ as the domestic price for good $n \in (N_F, N]$. Then domestic price index is $P_H = \left[\int_{N_F}^{N} p(n)^{1-\sigma} dn\right]^{1/(1-\sigma)}$. Since we assume a small open economy, the foreign price is fixed. Without loss of generosity, we assume $\left[\int_0^{N_F} p^*(n)^{1-\sigma} dn\right]^{1/(1-\sigma)} = 1$. So the domestic price index is $P = \left[P_H^{1-\sigma} + (\tau_m k)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$, where k is the exchange rate. And the exporting price index in foreign currency is $\left[\int_{N_F}^{N} I^x(n) p_X^*(n)^{1-\sigma} dn\right]^{1/(1-\sigma)}$, where $I^x(n)$ is an indicator of exporting. We assume final good to be numeral with price $P = 1$, with exchange rate k adjusts so that these two normalizations are consistent.

Firms engage in monopolistic competition. Assume consumer income to be Y, and denote $D_H = \frac{Y}{P} P^\sigma$, then the domestic demand for good n is $Q_H(n) = D_H p(n)^{-\sigma}$ for $n \in (N_F, N]$, and demand for foreign good is $Q_H(n') = D_H \left[\tau_m k p^*(n')\right]^{-\sigma})$ for $n' \in [0, N_F]$, foreign demand for domestic good is $Q_F(n) = D_F^* p_X^*(n)^{-\sigma}$ for $n \in (N_F, N]$, where D_F^* measures foreign demand, and is assumed as exogenous in this model. Then total expenditure on domestic good is $D_H P_H^{1-\sigma}$, on imported good is $D_H (\tau_m k)^{1-\sigma}$, and foreign expenditure on domestic exported good is $k D_F^* P_X^{*1-\sigma} / \tau_x$.

Note that firm production in a single period is given by the production function $q = z l^\alpha$. Given the fixed output, each firm maximizes its profit by endogenously sell η fraction of output abroad. Then the domestic sales equals to $D_H^{1/\sigma} [(1-\eta) q]^{(\sigma-1)/\sigma}$, and foreign sales equal to $k D_F^{*1/\sigma} \left[\frac{\eta}{\tau_x} q\right]^{(\sigma-1)/\sigma}$. Denote $d_H = \log D_H^{1/\sigma}$, $d_F(\eta) = \left((1-\eta)^{\frac{\sigma-1}{\sigma}} + k \left(\frac{D_F^*}{D_H}\right)^{\frac{1}{\sigma}} \left(\frac{\eta}{\tau_x}\right)^{\frac{\sigma-1}{\sigma}}\right)$, the total sales then equal to

$$G(q, \eta) = \exp\left[d_H + d_F(\eta)\right] q^{(\sigma-1)/\sigma}$$

Each firm mamimizes $d_F(\eta)$ to optimize $G(q, \eta)$. $\exp\left[d_H + d_F(\eta^o)\right] - \exp(d_H)$ measures the markup from exporting. Then the optimal $\eta^o = \left(1 + \frac{\tau_x^{\sigma-1} D_H}{k^\sigma D_F^*}\right)^{-1}$, and the export choice is captured by the dummy variables $I^x(q)$:

$$I^x(q) = \begin{cases} 1, If \left[\exp\left[d_H + d_F(\eta^o)\right] - \exp(d_H)\right] q^{(\sigma-1)/\sigma} > c_{px} \\ 0, \text{ otherwise} \end{cases}$$

i.e. there is a threshold value of output quantity q for being an exporter. A direct inference is that the productivity threshold for firms to export is decreasing in firm size. The total revenue is

$G(q) = \exp\left(d_H + I^x(q) d_F\left(\eta^o\right)\right) q^{\frac{\sigma-1}{\sigma}} - c_{px} I^x(q)$. Note that in our model, firms endogenously choose whether to export and how much to export. However, the export share η among all exporters are the same, since it is only related with the ratio of foreign to domestic demand.

2.2.4 Dynamics Programming Problem for Incumbents

Incumbent firms' problem is captured by a dynamic programming problem with two state variables and two policy functions. The two state variables are productivity z and size l. The policy functions are $l' = L(z,l)$ for next period employment, and $\chi = \chi(z,l)$, whether to exit in this period. $\chi(z,l) = 1$ if a firm stays, and $\chi(z,l) = 0$ otherwise. The dynamic programming problem is captured by the following Bellman equation:

$$\mathrm{V}(z,l) = R(z,l) - wl + \max\left\{-c_x l, -c_p + \max_{l'} -C_f\left(l,l'\right) + \frac{1}{1+r}\mathbf{E}V\left(z',l'\right) dF\left(z'|z\right)\right\}$$

In which, $-c_x l$ is the key unique assumption of this model, standing for exit cost that is increasing in firm size. Revenue function is $G(z,l) = \exp\left(d_H + I^x(q) d_F\left(\eta^o\right)\right) q^{\frac{\sigma-1}{\sigma}} - c_{px} I^x(q)$, in which $q = zl^{\alpha}$. Assume exit cost is linear in the current employment, c_x as a constant measures the size of exit cost. $C_f(l,l')$ is the firing cost, which incurs when the next period l' is lower than current l. I assume the firing cost to have the same form with citethopenhayn1993job, i.e. a tax linear in labor reductions.

$$C_f\left(ll'\right) = \begin{cases} c_f\left(l-l'\right), & \text{if } l > l' \\ 0, & \text{otherwise} \end{cases}$$

Denote $\mathbf{C}(z,l,l')$ is the maximized future value, which equals to the lager value between exit cost $-c_x l$ and continuing value $-c_p + \max_{l'} -C_f\left(l,l'\right) + \frac{1}{1+r}\mathbf{E}V\left(z',l'\right) dF\left(z'|z\right)$ [2].

2.2.5 Free Entry Condition

In each period, a number of firms endogenously exit the market, and an equal number of entrants find it optimal to pay sunk cost c_e to create new firms. We assume entrants draw initial size from distribution $\phi_e^l(l)$, and draw initial productivity from distribution $\phi_e^z(z)$ [3] . In the first period, the entrants decide their next period employment l', but do not engage in production in the current

[2] I follow Samaniego (2006) to assume fixed cost and firing cost are paid in the end of period, to ensure that the expected value is larger than zero.

[3] Coşar et al. (2016) assume all entrants have initial (minimum) employment. Hopenhayn and Rogerson (1992) allows entrants to have size distribution. We follow the latter approach. The initial size distribution is calibrated using Chinese manufacturing firm data.

period. The free entry condition implies that,

$$V_e = \iint V(z,l)\mathrm{d}\phi_e^l(l)\mathrm{d}\phi_e^z(z) \leq c_e$$

which holds with equality when there is a positive mass of entrants.

2.3 Equilibrium

Assume each consumer owns equal shares of a diversified fund that collect firms' profits. We also assume all fixed costs, firing cost, exit cost and entry cost are paid with final good. Given foreign demand D_F^*, a steady state equilibrium for a small open economy consists of policy functions $l'(z,l)$ and $\chi(z,l)$, value function, firm mass N_H, measure of entrants M, price P, domestic demand shifter D_H, total income Y, total labor demand L, exit rate μ_{exit}, export rate μ_x, wage w, exchange rate k and firm distribution $\phi(z,l)$ that satisfies the following conditions,

1.Market clear in the good market

$$N_H \iint q(z,l)\phi(z,l)dzdl = D + N_H\left(\overline{c} + c_p + \mu_x c_{px}\right) + Mc_e + Mc_x\overline{l_x}$$

The fixed cost, adjustment cost, entry and exit cost are paid by final good. The LHS of this equation stands for the total production, where N_H is the firm mass in equilibrium. In the RHS, D stands for total expenditure of consumers. $\overline{c}$ is the average firing cost, μ_x is the export rate, M stands for the entry or exit firm mass. $\overline{l_x}$ stands for the average size of exiting firms, so $Mc_x\overline{l_x}$ stands for total exit cost.

2. Market clear in labor market

$$N_H \iint l\phi(z,l)dzdl = L^0 = 1$$

Assume total labor supply L^0 is unity. The LHS stands for the total labor demand of firms.

3. Entrants equal exit firms

$$M = \mu_{exit} N_H$$

where $\mu_{exit} = \iint I_{exit}(z,l)\phi(z,l)dzdl$ is the exit rate.

4. Firm distribution over states in the interim and the end of each period, reproduces themselves through stochastic process of z and policy functions, and z draws upon entry

5. Income equals expenditure

$$D = Y = wL^0 + D_H \tau_a^{-\sigma} \left(\tau_c k\right)^{1-\sigma} \left(\tau_a - 1\right) + M\overline{\pi}$$

D stands for consumer total expenditure and Y stands for total income, which consists of three parts, wage income wL^0, tariff revenue $D_H \tau_a^{-\sigma} \left(\tau_c k\right)^{1-\sigma} \left(\tau_a - 1\right)$ and total profit $M\overline{\pi}$ in which $\overline{\pi}$is the average profit.

6. Trade balance

$$\frac{D_H \left(\tau_a \tau_c k\right)^{1-\sigma}}{\tau_a} = \frac{k D_F^* P_X^{*1-\sigma}}{\tau_c}$$

The LHS stands for expenditure for imports, and RHS stands for total export revenue, both in domestic currency.

2.4 Numerical Solution Algorithm

To compute the value function, we discretize the state space on a log scale using 300 grid points for employment and 60 grid points for productivity. The maximum firm size is set as 2000 workers (99^{th} percentile from the data). The algorithm of computation consists of four steps.

First of all, formulate guesses for w, d_f, D_H. Given w, d_f, D_H, calculate the revenue function and solve the Bellman equation, find the policy functions. Then find the equilibrium firm distribution $\phi(z, l)$ using the condition of stationary equilibrium. Then compute the value of entry V_e. Compare V_e with c_e. If $V_e > c_e$, decrease D_H and if $V_e < c_e$, increase D_H. Repeat this step until $V_e = c_e$ and D_H converge.

Secondly, given w and d_f, and converged value of D_H from step 1, solve the Bellman equation, find firm distribution $\phi(z, l)$ and compute the aggregate variables, including income, firm mass N_H, total import and export revenue. Compare export with import. If export is larger than import, lower d_f; otherwise, increase d_f. Repeat this step, until d_f converges.

Thirdly, update wage. Given w and converged values of d_f and D_H, solve Bellman equation, find the firm distribution and aggregate variables. Compute expenditure as total output minus firing cost, fixed costs, exit cost and entry cost. Use the condition income equals expenditure to infer income. Update wage as (income – tariff income)/labor supply. Repeat this step, until wage converges.

Estimation procedure

In the policy experiments, we use the complete algorithm above to compute equilibrium outcomes for the set of estimated parameters. While estimating the model, we following Coşar et al. (2016) to treat d_f as a parameter to be estimated. Also, assuming the economy is in a steady state with positive entry, we back out c_e by calculating entry value V_e. These shortcuts allow us to reduce computation time.

3 Quantitative Analysis

3.1 Institutional background

Before getting into details of estimating the model and quantitatively analysis, we first discuss the institutional background of exit friction. One widely existing source of exit friction is the employment protection legislation (EPL). In China, EPL is ensured by the Labor Contract Law, which mandates that if "the employment contract is terminated if they (employer and employee) so agree after consultations", and "employee shall be paid severance pay based on the number of years worked with the Employer at the rate of one month's wage (the employee's average monthly wage for the 12 months prior to the termination or ending of his employment contract) for each full year worked".

Although the Labor Contract Law makes clear indication of the amount of severance payment, when a firm closes. The payment is often not fulfilled, i.e. the exit cost is usually lower than the firing cost for firms who still operates (Johnson, 2006). This is due to the case of insolvency. Although the Bankruptcy Law states that, "the compensation payable to the staff and workers in accordance with laws and administrative regulations" has the first priority in dealing with the property in bankruptcy, before the taxes owned by the bankrupt and other common claims in bankruptcy. The firms often are partly exempted from paying the workers. Samaniego (2006) discusses two possible reasons, one is that the regulatory regime may grant exemptions for plant closures, such as some government-sponsored insurance funds; the second is that the firm may have no funds to cover the payment. When the severance pay go unfulfilled, the exiting cost will be smaller than firing cost, but, still be positive [4] . And the actual value of exit cost depends on the enforcement of EPL, and remains as an empirical question. Therefore, in this section, we estimate the value of exit cost for Chinese firms, by structurally estimate the model.

3.2 Data

Two data sets are used to construct the sample moments. We use the Chinese Industrial Census to construct moments related with exiting, and use Chinese manufacturing survey data to construct

[4] As Johnson (2003)Johnson (2006) states, China has the "pro-employee approach" of employer insolvency, among the four approaches, pro-employer, Bankruptcy Priority–No Insurance (e.g. Mexican), Bankruptcy Priority-Guarantee Fund (e.g. Danish), and No Priority–Guarantee Fund (e.g. Germany).

moments related with a specific group of moments of auto-correlations of firm revenue, labor and exporting status.

The Chinese Industrial Census is carried out by the National Bureau of Statistics (NBS) of China every four or five years. Our data source is the 2004 and 2008 data [5]. The data sets consist of both manufacturing and service firms. For manufacturing firms, the observations in these two years are 0.22 million and 0.33 million, respectively. The data sets cover firm level information, including main sector of business, ownership, employment, output, value added, capital stock, wages, exports, and some other information of financial reports. We apply similar approaches with Brandt et al. (2016) to make the industrial classification, prefecture code to be consistent over time. Using these two waves of census data, we will be able to identify continuing firms (exist both in 2004 and 2008), exiters (only appear in 2004) and new entrants (only appear in 2008).

When estimating the model, a specific group of moments of auto correlation coefficients of output, employment and export is used. The census data could not provide this information, so we use the manufacturing survey data. The manufacturing survey data covers all state-owned firms and other firms with sales over 5 million RMB, covering from 1998 to 2007. We follow Cai and Liu (2009) and use the General Accepted Accounting Principles as guidance to clean the data. To make the model and sample moments consistent, we use 2004-2008 data to compute the data moments, and calculate the corresponding moments for a simulated truncated sample from the model. In section 4 of this paper, to show empirical patterns of the model findings, we use firm level productivity (TFP) which are estimated following using this data. We apply Ackerberg et al. (2015) for the estimation, and eliminate outliers of productivity by dropping top and bottom 1% samples.

Table 1 shows a summary of the two data sets. Among all firms in 2004, 33.8% of them left the market in 2008. Among all firms in 2008, 56.7% of them are new entrants. Compared with the incumbent firms, the exiting firms have lower employment, value added, output, fixed asset, age, export ratio and labor productivity. However, the average TFP of exiting firms is slightly higher than the incumbent firms. In the 5^{th} and 6^{th} column of Table 1, we show the values of t test for mean comparison of variables of exiting and non-exiting firms. The differences between the mean value of the two groups of firms are all significantly away from zero.

3.3 Fitting the Model to Data

Parameters not estimated

Several parameters are not identified in the model, which we take from external sources. We set

[5] Brandt et al. (2016) uses 1995, 2004 and 2008 data of Chinese Industrial Census to study the entry barrier and growth in China.

Table 1: Data Summary

	Exit		Non-Exit		t test	
Firm Number	80,379		156,181		\	\
Share(in 2004 data)	0.34		0.66		\	\
Variables	Mean	S.D.	Mean	S.D.	t value	S.E.
Employment	4.461	1.067	4.784	1.077	0.323	0.005***
Value Added	8.202	1.290	8.651	1.299	0.449	0.006***
Output	9.604	1.164	10.060	1.183	0.456	0.005***
Fixed Asset	7.791	1.717	8.393	1.659	0.601	0.007***
Age	9.666	10.476	8.680	9.093	-0.986	0.042***
Export	0.253	0.435	0.343	0.475	0.090	0.002***
TFP	1.416	0.410	1.403	0.407	-0.013	0.002***
Labor Productivity	3.747	1.067	3.869	0.992	0.122	0.004***

$r = 0.10$ to match the annual discount rate 0.91 of Chinese manufacturing firms. Eaton and Kortum (2002) estimate that the tariff equivalent of iceberg costs falls between 123 percent and 174 percent, in this paper we choose our pre-reform value of export iceberg cost τ_x to be 1:50. We take the estimate of pre-reform nominal tariff rate, $\tau_x \tau_m - 1 = 0.21$ from Chinese tariff data in year of 2004. We take the elasticity of substitution between products from Coşar et al. (2016) that $\sigma = 6.8$.

Reduced form estimation of production function

The estimation of coefficients in productivity process $\alpha, \rho, \sigma_\varepsilon$ is independent of the structural estimation. The identification strategy is to control for productivity stochastic process, then to match the moments of exiting, in order to identify the additional exit frictions. To fix the idea, consider an economy where productivity is fixed for each firm. Then any firm with negative profit is subject to some exit cost.

To estimate the three coefficients, the first step is to conduct an OLS regression of revenue on employment, to get the estimate of α. The residual is then the productivity z_{it}. The second step is to conduct an AR(1) regression of the residual z_{it}, and find the AR(1) coefficient ρ, and the standard derivation of the residual from this AR(1) regression is σ_ε. In the Appendix we show the derivation of the production function, and how α and z are related with the capital, material input and price of material input.

The estimator

This leaves us with six parameters to estimate, which are,

$$\Omega = (D_F^*, c_{px}, c_p, c_x, c_f, c_e)$$

I estimate the parameters using method of simulated moments (Gourieroux et al., 1996). Let $\overline{m}$ be a vector of sample statistics that the model is designed to explain, and define $m(\Omega)$ as the vector of model-based counterparts to these sample statistics. The estimator is given by,

$$\overline{\Omega} = \arg\min(\overline{m} - m(\Omega))'\widehat{W}(\overline{m} - m(\Omega))$$

Where $\hat{W}$ is a bootstrapped estimate of $[var(\overline{m})]^{-1}$ with off-diagonal elements set to zero.

The sample statistics

The target moments and weighting matrix are based on Chinese manufacturing data sets. We utilize three groups of moments. The first is the annual exit ratio. In the data, the 4 year exit ratio is 0.35, resulting in a one year exit ratio of 0.09. The second group contains the quintiles of the distribution of employment sizes. The third group contains correlation coefficients of revenue, employment and export, as well as the auto covariance of these three variables.

Estimates and Model Fits

Our estimates of parameters are shown in Table 2, and the data-based and model-based moments are shown in Table 3. We follow Coşar et al. (2016) to compute the standard errors in Table 2, using the standard asymptotic variance expression. The overall model fit is well, except that the model predict higher correlation between employment size and export. This is partly due to our assumption that export is a static decision given the output quantity, and export is completely determined by firm size, as well as wage.

Table 2: Parameter Estimations

Parameter	Description	Value	S.E
Structural Estimation			
c_{px}	Fixed cost of export	32.135	0.0442
c_p	Fixed cost of operation	53.375	0.0381
c_x	Exit cost	**0.220**	0.0007
c_f	Firing cost	**0.750**	0.0007
c_e	Entry cost	622.110	0.8134
d_f	Foreign market size	475.839	1.9323
Reduced Form Estimation			
ρ	Persistence of z process	0.900	0.0005
σ_ε	Standard deviation of z process	0.526	\
α	Elasticity of output w.r.t labor	0.727	0.0007
Equilibrium			
w	Wage	0.782	\

C_{px}, C_p, C_x, C_f and C_e, as well as wage in equilibrium are measured in terms of the numeraire, the price of final good. The equilibrium wage in our model is 0.782. Given that the average wage in

2004 of 14032.8 RMB Yuan, the estimated sunk cost to start a new firm is 11.1 million, fixed cost to export is 0.57 million, fixed cost to operate is 0.96 million. The firing cost is about 96% of one year wage per worker, and the exit cost is about 28% of one year wage per worker.

Table 3: Moments

Moments	Data	Model	Moments	Data	Model
Exit Ratio	0.09	0.12	Correlation Coefficients		
EXP	0.28	0.24	Corr(Y, L)	0.62	0.98
size distribution			Corr(Y, EXP)	0.22	0.81
20% L	3.89	3.62	Corr(L, EXP)	0.28	0.72
40% L	4.44	4.51	Corr(Y, LagY)	0.16	0.21
60% L	4.98	5.42	Corr(L, LagL)	0.93	0.92
80% L	5.68	6.72	Corr(EXP, LagEXP)	0.84	0.81

3.4 Policy Functions

The estimated model enables me to do some comparative statics analysis of exit cost. In this section, we investigate the impacts of exit cost on policy functions, i.e. exit threshold and employment decisions. Later in Section 4, we show empirical patterns consistent with findings in this section.

3.4.1 Exit cost and Surviving Productivity Threshold

The first policy function, whether to exit, could be expressed as a vector $z^*(l)$, the exiting productivity threshold for firms with different sizes. Figure 2 shows a major distinction between our model and classic ones. The blue line shows the productivity threshold in a model with no firing cost or exit cost, e.g. Melitz (2003) or Hopenhayn (1992) model. Since firms could freely adjust their sizes, the productivity threshold is the same for firms with different sizes. Then in a model with firing cost, the productivity threshold will be increasing in firm size, i.e. the green line in the figure. This is confirmed by other researchs, such as Mukoyama and Osotimehin (2016), Poschke (2009), etc. The rational is that firms with larger sizes need to be more productivity to survive, since they face higher potential costs of firing workers in the future.

However, with exit cost which is increasing in firm size, the productivity threshold becomes decreasing in size. To fix the idea, consider the case when firing cost is zero, and exit cost is not. Then given the level of productivity, for firms with larger size, the higher exit costs drives down the value of exit (to negative). Then the firm with larger size will choose to wait in market for longer time than in the zero-exit cost economy. Therefore the productivity threshold is decreasing in size, i.e. the orange line. Hence, in a model with firing cost and exit cost, the productivity threshold could be increasing or decreasing in firm size, depending on relative values of the two parameters.

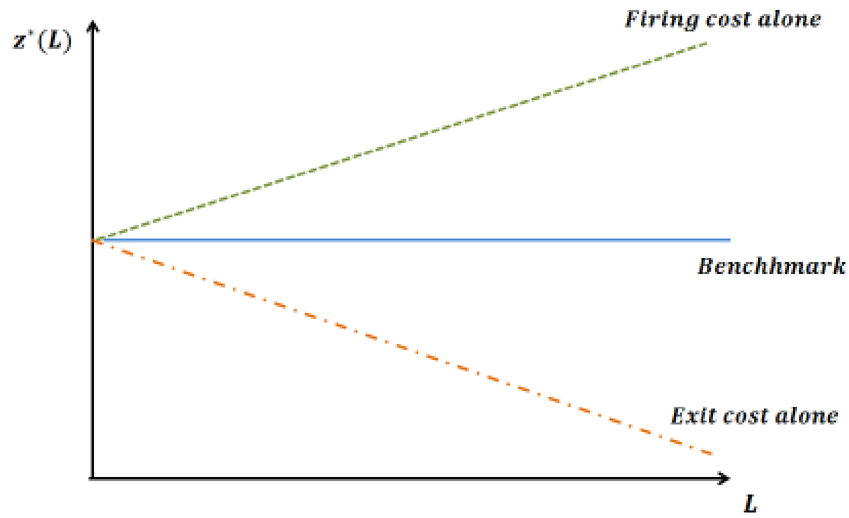

Figure 2: An Illustration of Productivity Threshold for Surviving

In Figure 3 we plot the exit threshold under different values of exit cost, while keeping the values of other parameters in the model. The blue line is the model with estimated parameters, showing that the surviving productivity threshold as an upward curve w.r.t firm size. Then we gradually increase the exit cost, and find the productivity threshold gradually becomes decreasing in firm size. With a downward sloping exiting productivity threshold curve, the correlation between exit and size is weaker, while the correlation between exit and productivity is less negative, since a lot of low productivity and large firms do not exit. That brings us with the first testable inference:**With higher exit cost, the tendency to exit for large firm is lower, for inefficient firm is lower, i.e.**

$$\frac{\partial}{\partial c_x}\frac{\partial Z^*(l)}{\partial l} < 0$$

$$\frac{\partial}{\partial c_x}\frac{\partial Z^*(l)}{\partial z} > 0$$

3.4.2 Exit Cost and Size Decisions

Next, we study how exit cost affects the other policy function, size decisions of firm. Figure 4 shows differences in the policy functions for high and low exit cost economy. The horizontal axis is the grids of size, and the vertical axis is the grids of productivity. The left panel shows the change in policy

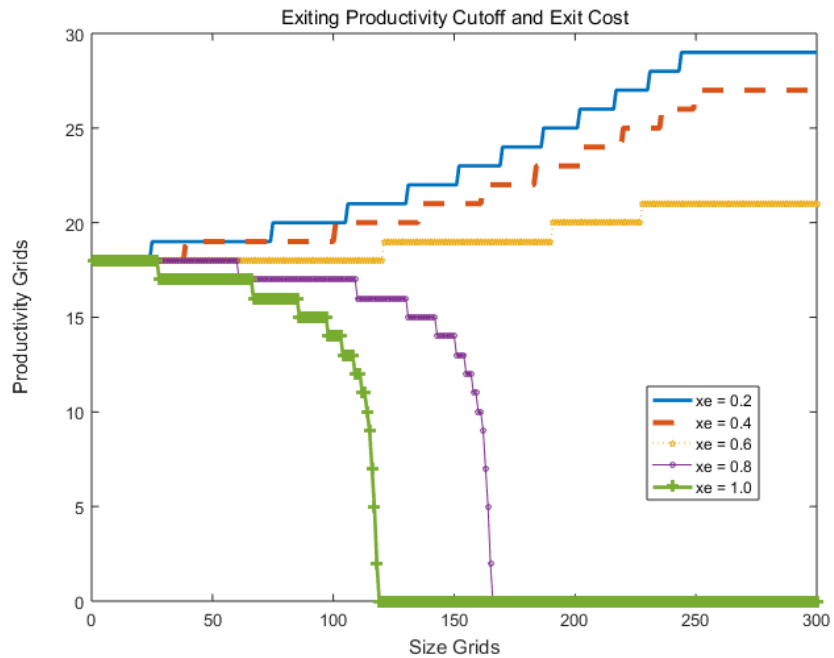

Figure 3: Exiting Productivity Threshold and Exit Cost

function "exit", from high exit cost to low exit cost economy, where blue means 0 and yellow means -1. Since exit dummy is 1 if stay, 0 if exit. The yellow area stands for the firms who would exit in a low exit cost economy, but stays in a high exit cost economy. The right panel shows the changes in size decisions. The deeper of color, the larger magnitude is the reduction of size.

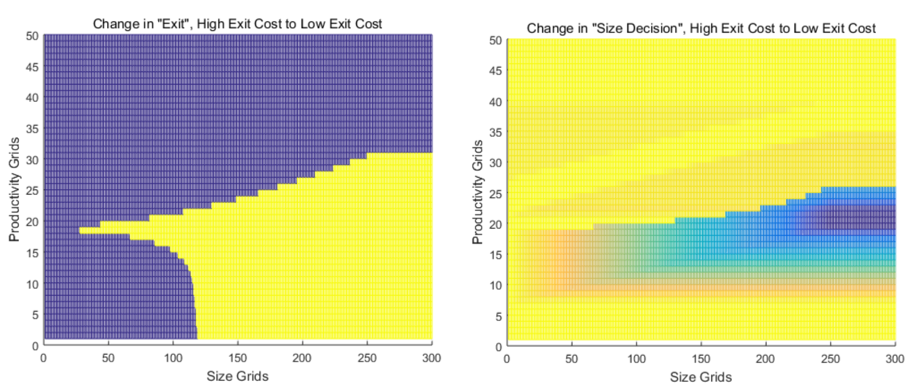

Figure 4: Changes in Policy Functions with Exit Cost

Two patterns are found in the right panel. First of all, those firms who should have exited in a low exit cost economy, stay in the market and reduce sizes. The larger is the current size, the more is the reduction. Secondly, compared with that in the low exit cost economy, some firms with median productivity reduce their size in the high cost economy. To sum up, high exit cost stops large and less productive firms exiting the market, and discourage small and productive firms to increase sizes.

The two findings have some direct inference with firm distributions. Firstly, with higher exit cost, the distribution of firm sizes will be more dispersed. Secondly, the correlation between firm size and productivity will be lower. The figure A3 in Appendix shows the distribution of firms in Melitz model and this model, where the distribution in this model is far more dispersed and the correlation between size and productivity is far less positive.

3.5 Exit Cost and Efficiency Improvement from Trade

I now examine the effects of reduction in trade frictions in the model, and investigate how exit cost affects this effect. The first experiment is to reduce the tariff τ_m to 1. The second one is to reduce the exit cost to 0, at the same time with tariff reduction. The third experiment is to double the exit cost, at the same time with tariff reduction. In Table 4, the changes in the moments are presented, where we normalize the bottom panel statistics by their baseline levels. Column 1 is the baseline model. Column 2 shows the results after tariff reduction. We find a slight increase in firm turnover rate, from 12% to 13%. The average size of firms, as well as the quintiles of firm size distribution becomes larger in size. The average level of employment increases by 10.8%. The average productivity increases by 2.1% after tariff reduction.

In Column 3, tariff reduction and zero exit cost are assumed at the same time. We find the turnover rate increased by 10 percentage point, which was 10 times of turnover rate increase in benchmark model. At the same time, the average employment size increased by 23%, and average productivity increased by 9.5%, which was more than four times of the productivity increase in the benchmark model. The results show that reducing the exit cost largely improves the effectiveness of trade.

Column 4 shows a counterfactual analysis when tariff reduced to zero, and exit cost doubled. The turnover rate decreased by one percentage point compared with the baseline model, and the average employment size only increased by 1.6%, with the average revenue decreased by 0.7%. We find the quintiles of firm sizes became more dispersed. On one hand, the 20% and 40% quintiles became smaller; on the other hand, 60% and 80% quintiles became larger. This is consistent with our finding in section 3.4.2, that small firms hesitate to grow bigger, and the large inefficient firms do not exit. The average productivity barely changes from the baseline case. It indicates that when exit cost was doubled, the productivity improvement from trade reform would disappear.

The mechanism that exit cost affects the productivity improvement from trade lies in the effects of exit cost on the selection of firms. Trade opening has two effects on firms. For those who export,

Table 4: Counterfactual Analysis of Trade Reform

	(1) Baseline	(2) Tariff Reduction	(3) Tariff Reduction Zero Exit Cost	(4) Tariff Reduction Larger Exit Cost
Exit Ratio	**0.12**	**0.13**	**0.22**	**0.11**
20% L	3.62	4.01	4.68	3.48
40% L	4.51	5.32	6.55	4.46
60% L	5.42	6.40	7.50	5.89
80% L	6.72	7.60	7.60	7.13
Average R	**1**	**1.041**	**1.131**	**0.993**
Average L	**1**	**1.108**	**1.23**	**1.016**
Export Ratio	**1**	**2.536**	**3.028**	**1.738**
Average Prod	**1**	**1.021**	**1.095**	**1.00**
Corr(Y,L)	1	0.980	0.942	1.00
Corr(L,EXP)	1	1.061	1.038	1.097
Corr(Y,EXP)	1	1.064	1.082	1.084
Corr(EXP,L.EXP)	1	1.189	1.141	1.213
Corr(L,lagL)	1	1.002	1.055	0.983
Corr(Y,lagY)	1	0.966	0.986	1.011

tariff reductions increases their demand, encourage them to raise sizes. For those who do not export, tariff reductions intensifies the competition they are faced with, making the least productive firms exit the market. A high exit cost weakens both the two channels. Firms who export, i.e. large firms, stay in the market not because they are productive, but because they have high exit cost. When tariff reduces, their increase in size is less than the in a model with zero exit cost economy. On the other hand, the firms who should be driven out of the market by foreign competition, might stay in the market and reduce size, also due to high exit cost. Therefore the two effects of trade are dampened by exit cost, leading to mild or even zero productivity improvement from trade. The analysis in this section brings us the second testable inference that, the productivity improvement from trade decreases with exit cost.

4 Suggestive Empirical Patterns

In Section 3, the model is estimated to Chinese data. The estimated parameters show the average of all Chinese manufacturing firms. However, the exit cost, and other coefficients, could have heterogeneity across different regions. From the discussion of institutional background in Section 3.1, the differences in exit cost could be captured by the enforcement of EPL. Therefore, in this section, we construct proxies for exit cost, and test the three main testable predictions in this section.

4.1 Proxies for Exit Friction

According to the institutional background we discussed in section 3.1, we construct variables for EPL enforcement as proxies for exit cost. There are papers using measures of firing cost to study the impacts of firing cost on aggregate variables, such as Autor et al. (2007) for total factor productivity, Balasubramanian and Lee (2008) for total factor productivity growth, and Mukoyama and Osotimehin (2016) for innovation. For example, Mukoyama and Osotimehin (2016) uses the OECD indicator of the strictness of dismissal regulations to stand for the firing cost. In this paper, we construct proxies for exit cost particular . Based on the institutional backgrounds, the firing cost for incumbents can be fulfilled in general, so is generally the same across provinces, but the exit cost could have large regional variations. The exit cost depends on the strictness of the enforcement of law when a firm exits. The enforcement of law, especially bankruptcy law, depends on how strong the worker claim is, as well as the local government's attitude towards unemployment.

To describe how strong the worker claims are, we use the unemployment insurance coverage as a proxy. If a worker has unemployment insurance, the probability that he /she makes a strong claim is lower. Therefore, in regions with higher unemployment coverage, the exit cost to firms is then smaller. We also use share of unskilled labor. On one hand, in a region with larger unskilled labor share, the exit cost tends to be larger, since unskilled workers are often more difficult to find the next job. On the other hand, the local government tends to value stability of employment system more than in a region with less unskilled labor. We use the average level of unskilled labor share and unemployment insurance coverage in a region to measure for exit frictions of one firm in this region. Unskilled labor share is defined as the ratio of number of workers with under high school education to the total number of workers. Unemployment Insurance Coverage is defined as the ratio of total unemployment insurance payment to total wage payment.

To describe the local government's attitude towards unemployment, we explore the variations in local government's attitudes towards unemployment compensation, to construct proxy for exit cost. We use the word frequency of employment and unemployment in government annual report (provincial level). The proxies for exit cost are summarized in Table 5. The observations of prefecture level proxies are 2,724. The average unskilled labor share is 0.52, and average unemployment insurance payment is 0.032 of wage payment. The provincial measure is the word frequency in government annual report. In a province where government cares more about unemployment, the government will ask closing firms to pay higher compensation payment . Average total word count in provincial annual report is 15,885. The average frequency for unemployment is 0.426 per 1,000 words, ranging from 0.161 to 0.873. The average frequency for employment is 1.557 per 1,000 words, ranging from 0.666 to 2.456.

Table 5: Proxies for Exit Cost

Variable	Obs	Mean	Std.Dev.	Min	Max
Prefecture Level					
Unskilled Labor Share	2,724	0.520	0.150	0.139	0.875
Unem. Insurance / Wage	2,724	0.032	0.045	0.000	0.236
Province Level					
Total	31	15885	2722	5950	22665
Count - Unemployment	31	6.581	2.306	3	13
Fre - Unemployment / 1000	31	0.425	0.155	0.161	0.873
Count - Employment	31	25.032	8.803	6	43
Fre - Employment / 1000	31	1.557	0.428	0.666	2.456

4.2 Measuring Trade Shocks

The first measurement of trade shock is the regional weighted average tariff. The weighted tariff of region c in period t is $\tau_{ct} = \sum_i w_{ict}\tau^0_{it}$, where w_{ict} is the sales share of industry i in city c in period t, and τ^0_{it} is the import tariff of industry i in period t. Figure 5 shows that the mean and standard deviation of tariffs in different sectors reduce in the same time, indicating the drop in tariffs in different industries are based on the initial tariffs, which means the tariff reduction is a uniform process, rather than endogenous choice of the government.

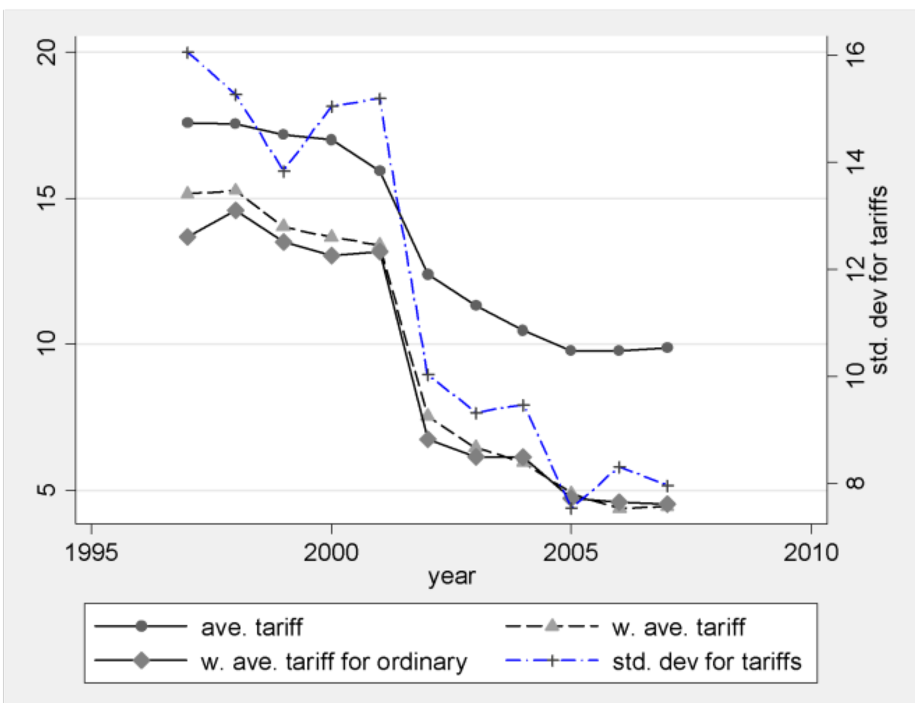

Figure 5: Reduction in Tariff

To measure the trade shock from exports, I compute the regional weighted average export ratio. The weighted export ratio in region c in period t is $xr_{ct} = \sum_i w_{ict} XR^0_{it}$, where w_{ict} is the sales share of industry i in city c in period t, and XR^0_{it} is the export share of industry i in period t in the whole nation. I also use Post 2002 dummy as the trade shock. Tariffs and export shares in each year are summarized in Table 6. It shows that the weighted tariff to be decreasing in mean, standard deviation, minimum and maximum values. At the same time, the average export ratio remains relatively stable in mean value, but increasing in the maximum value.

Table 6: Summary of Trade Shocks

	Weighted Tariff				Weighted Export Ratio			
year	Mean	S.D	Min	Max	Mean	S.D	Min	Max
1998	19.79	7.57	3.23	63.08	0.12	0.09	0.01	0.57
1999	19.45	7.66	0.68	61.58	0.12	0.09	0.01	0.56
2000	19.43	8.22	2.07	62.26	0.13	0.09	0.01	0.59
2001	17.71	7.42	1.86	60.17	0.12	0.09	0.01	0.66
2002	13.26	5.38	0.48	46.60	0.12	0.09	0.01	0.72
2003	9.50	5.53	0.00	41.00	0.12	0.09	0.01	0.70
2004	8.50	5.48	0.00	43.55	0.13	0.10	0.00	0.69
2005	7.27	3.98	0.00	28.06	0.16	0.08	0.00	0.67
2006	7.66	5.06	0.00	44.52	0.12	0.09	0.00	0.66
2007	7.75	4.92	0.00	43.95	0.11	0.09	0.00	0.67

4.3 Exit Friction and Firm Closure

In this section, I test Hyphothesis 1: With higher exit cost, the marginal derivative of exit probability w.r.t size is lower; the marginal derivative of exit probability w.r.t productivity is higher. Based on this hypothesis, I construct the following regression model:

$$\text{Prob}\left(exit_{ijc}\right) = \alpha_1 Size_{ijc} + \alpha_2 \omega_{ijc} + \alpha_3 \,\text{Size}_{ijc} * FX_c + \alpha_4 \omega_{ijc} * FX_c + \Gamma X_{ijc} + \gamma_j + \delta_c + \varepsilon_{ijc}$$

The exit regression is a cross-sectional Probit model with industry and province fixed effects, where i, jc stands for firm, industry and province, respectively. The panel data covers over 2,000 cities. $Size_{ijc}$ stands for firm level employment (in log), and ω_{ijc} stands for firm productivity (TFP). I conduct city (or province) level measures for exit friction FX_c, such that,

$$\frac{\partial \,\text{Prob}\left(exit_{ijc}\right)}{\partial Size_{ijc}} = \alpha_1 + \alpha_3 * FX_c$$

$$\frac{\partial \,\text{Prob}\left(exit_{ijc}\right)}{\partial \omega_{ijc}} = \alpha_2 + \alpha_4 * FX_c$$

I also control for firm level characteristics which affect their exit decision. The hypothesis predicts that $\alpha_3 < 0, \alpha_4 > 0$. Larger firms have lower probability to close, i.e. $\frac{\partial \operatorname{Prob}(exit_{ijc})}{\partial Size_{ijc}} < 0$; more productive firms have lower probability to exit, i.e. $\frac{\partial \operatorname{Prob}(exit_{ijc})}{\partial \omega_{ijc}} < 0$. With higher exit cost, larger firms has even lower probability to exit, i.e. $\alpha_3 < 0$. Meanwhile, the existence of exit cost weakens the selection effect, so that large firms with low productivity are less likely to exit, i.e. $\alpha_4 > 0$. All results are clustered at province and industry level. The results are shown in Table 7.

Table 7: What Determines Exit and the Effect of Exit Cost

Dependent Variable: Exit Dummy (1 for exit, 0 for stay)						
	(1)	(2)	(3)	(4)	(5)	(6)
Exit friction =	\	\	\	Unskill	1-InsCov	WordCount
Size	-0.358***	-0.232***	-0.232***	-0.138***	0.568***	-0.146***
	(-25.92)	(-15.41)	(-15.52)	(-4.10)	-3.31	(-2.68)
TFP	-0.220***	-0.186***	-0.179***	-0.387***	-1.221**	-0.177*
	(-7.16)	(-6.58)	(-6.55)	(-4.32)	(-2.54)	(-1.71)
Size*Exit Cost				-0.172***	-0.823***	-0.0429*
				(-2.66)	(-4.63)	(-1.77)
TFP*Exit Cost				0.383**	1.071**	-0.00093
				-2.24	-2.15	(-0.02)
Log k		-0.169***	-0.159***	-0.161***	-0.160***	-0.159***
		(-23.27)	(-21.36)	(-21.92)	(-21.42)	(-21.41)
Age(log)		0.193***	0.109***	0.107***	0.106***	0.109***
		(19.52)	(11.33)	(11.17)	(11.02)	(11.28)
N	236495	236224	236224	236224	236224	236224
R2	0.0343	0.0458	0.052	0.0523	0.0523	0.052

In the first column, I only include size and TFP in regression. The coefficient on size is negative and significant. In the second column I add firms' fixed asset (in log) and age. Firms with larger capital stock have higher continuing value, so are less likely to exit. Older firms have larger probability to exit. The regression shows that fixed asset has negative impacts on exit probability and age has a positive impact. After controlling for fixed asset and age, the coefficient on size is smaller in magnitude but still significantly negative. In the third column I further control for firm ownership. I find the coefficient on size is robustly negative.

In the fourth column, I add a city-level proxy for exit cost and the interaction term between this proxy and size as well as productivity. A city with more unskilled labor might face more severe social unstable risk, so the local officials have stronger incentive to maintain employment, also the workers' claims at firm closure tend to be stronger. I find the interaction term between size and unskilled labor share is negative, implying that in counties where unskilled labor share is higher, firms with larger size have lower probability to exit controlling for other firm level characteristics. Similarly, in the fifth column, I control for another city-level measure of unemployment pressure and the interaction term with firm size. The unemployment insurance coverage measures the share of total unemployment insurance in total wage. The negative coefficient on the interaction term indicates that in countries where unemployment insurance coverage is smaller, larger firms have lower probability to exit.

In the last column, I include interaction terms between firm size and the word frequency of employment and unemployment in local government's annual report, and find that the interaction term of size with employment-unemployment frequency is negative and significant at 10% level and the interaction term between TFP and word frequency has no significant coefficient.

4.4 Exit Friction and Firm Distribution

Section 3.4 states that with higher exit cost, the correlation between size and productivity is weaker (less positive). In this section, I show the empirical patterns of the correlation between size and productivity, and investigate the impact of exit cost on size-productivity correlation across different regions. Figure 6 shows a scatter point graph between firm size and productivity of Chinese manufacturing firms in the year of 2004. Each scatter point stands for a firm, and the red line is a local polynomial fitness curve. It shows that firm size and productivity are slightly negatively correlated, opposite to predictions of traditional models, including Melitz (2003), Hopenhayn and Rogerson (1993), etc.

In Table 8, I show a robustness check of this correlation. Firstly, I use TFP as a measure of productivity and control for industry, year, ownership and capital intensity when computing the correlation coefficient. In the second column, I show results when using labor productivity instead of TFP as measurement of productivity.

Table 8: Correlation between Size and Productivity

Corr(Size, TFP)	Corr(Size, Labor Productivity)	Control for
-0.0504*	-0.0323*	None
-0.0504*	-0.0323* 1.0000	Industry FE
-0.0456*	-0.0298*	Industry FE, Ownership
-0.0421*	-0.0249*	Industry FE, Ownership, Province FE
-0.0217*	-0.0838*	Industry FE, Ownership, Province FE, Capital

The slightly negative correlation between firm size and productivity could result from alternative reasons. For example, the literature of misallocation has an explanation by mapping the divergence of firm size from productivity into wedges in factor prices across firms. Another example is that the

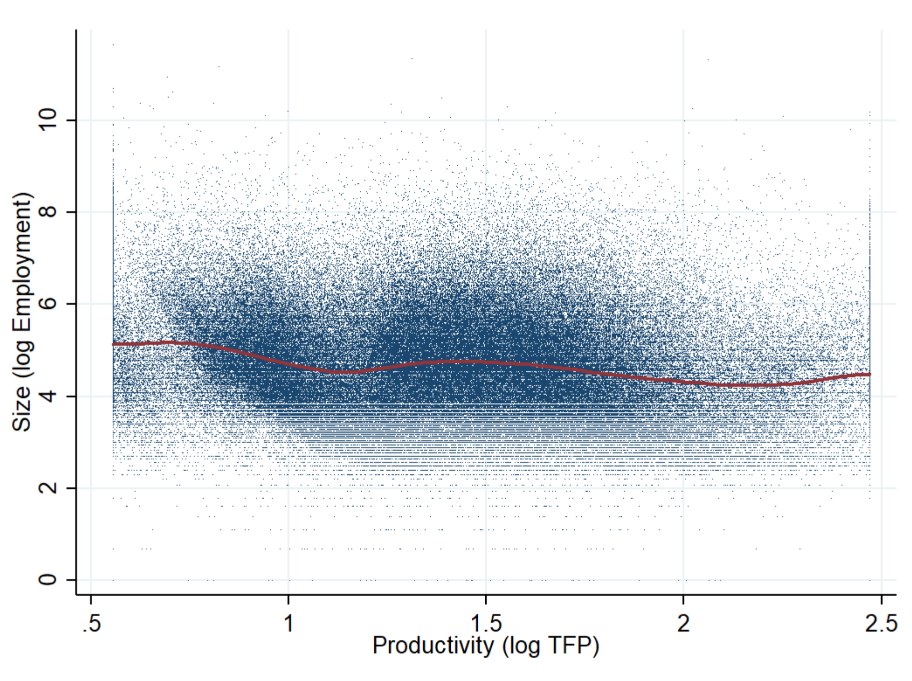

Figure 6: Firm Size and Productivity

existence of multiproduct firms might contribute, since a larger firm might produces multiple goods while a smaller firm produces single product. Due to the discount of diversification, the estimated productivity for a large firm could be lower. Therefore, to show the existence of exit cost contributes to the negative correlation between firm size and productivity, I show two suggestive patterns as in Figure 7 and 8.

In Figure 7, I further that within province size-productivity correlation is negatively correlated with exit cost. The horizontal axis is the within-province correlations between size and productivity, and the vertical axis is the within province correlation between exit and size, which stands for the exit cost. The two variables are positively correlated. It indicates that in a province where larger firms have lower probability to exit, the correlation between firm size and productivity is lower.

In Figure 8, I use the local government's attitude towards unemployment as a measure for exit cost. The horizontal axis is the word frequency of employment and unemployment in Provincial Government Annual Report, which stands for the exit cost in each province. The vertical axis is the correlation coefficient between size and productivity in each province. A fitted line between two variables has a slope of -0.029, and is significant at 10% level. It shows that in provinces where the government has strong attitude towards employment and unemployment, which indicates that the exit cost of firms are higher, the correlation between firm size and productivity is more negative. The pattern shows that the low correlation between size and productivity is at least partly contributed by the exit cost

I study in this paper.

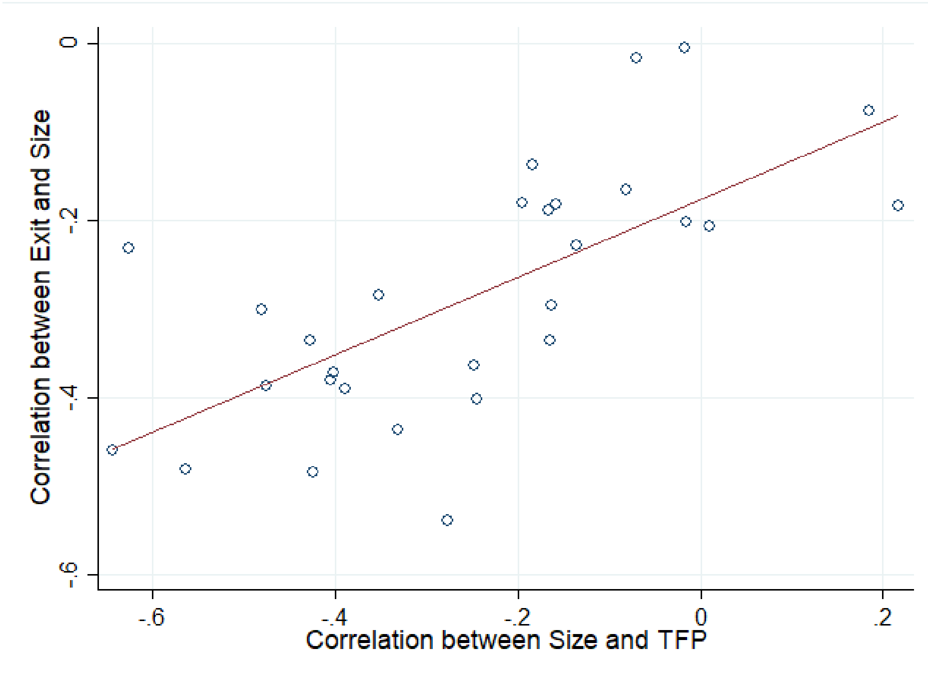

Figure 7: Size-Productivity Correlation and Size-Exit Correlation

4.5 Exit friction, Productivity and Trade Shocks

In this section, I empirically investigate the second Hypothesis: The larger is exit friction, the lower is the efficiency improvement from trade. Based on this hypothesis, I construct the following regression model:

$$\overline{\Omega}_{ct} = \beta_1 X_{ct} + \beta_2 X_{ct} * FX_c + \gamma_c + \xi_t + \varepsilon_{ct}$$

Where X_{ct} stands for the trade shock of city c in period t I introduced in section 2.3. $\overline{\Omega}_{ct}$ is the weighted average productivity of city c in period t. I control for city fixed effect γ_c and year fixed effects ξ_t. The hypothesis suggests, i.e. $\beta_2 = \frac{\partial}{\partial FX_c} \frac{\partial \overline{\Omega}_{ct}}{\partial X_{ct}} < 0$.

Table 9 shows the results. In this section, we use city level panel data regressions, instead of province level, to maintain a sizable observation. In the upper panel, I show the results of using weighted average tariff as the measurement of trade shock. Column 1 shows that a reduction in the weighted average tariff increases the average productivity. In Column 2, I include the interaction between weighted average tariff and (one minus) the unemployment insurance coverage. A negative coefficient indicates that with lower unemployment insurance coverage, which suggests a larger exit cost, the reduction in weighted average tariff will have less impact on increasing the average produc-

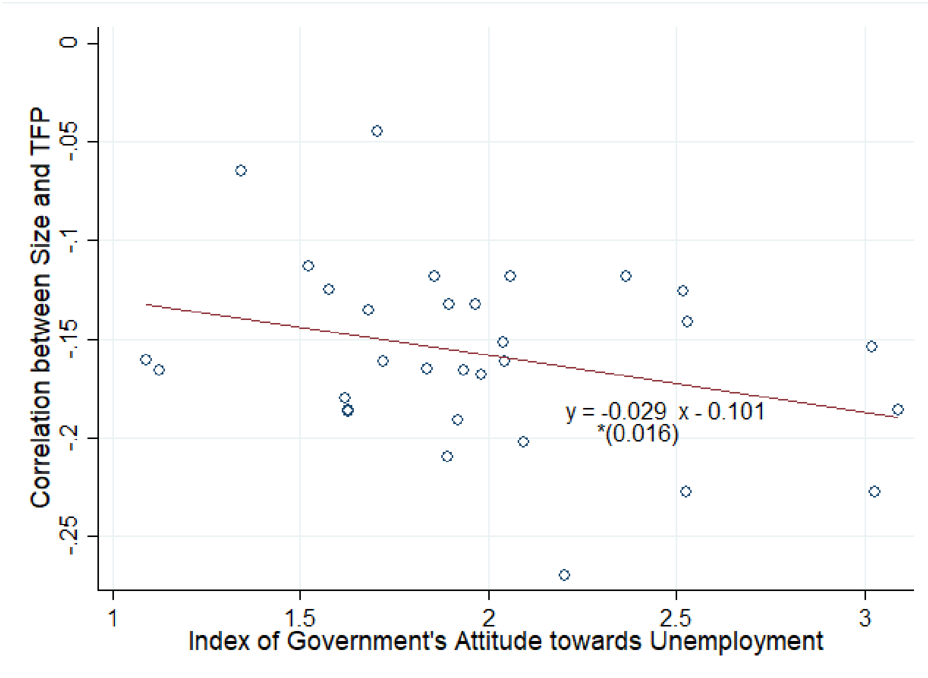

Figure 8: Size-Productivity Correlation and Government's Attitude towards Unemployment

tivity. In Column 3, I use unskilled labor share to proxy for exit cost, and the results are similar with in Column 2.

In the middle and lower panel, I use the weighted average export ratio, and post 2002 dummy to stand for trade shocks, respectively. In both panels, the interaction term between trade shocks and proxies for exit cost are included. The results are robustly consist with the hypothesis, except in Column 2 of the lower panel, the interaction term is not significant. Results in Table 9 confirms the hypothesis that the effect of tariff reductions on productivity depends on the size of exit cost.

5 Conclusion

This paper studies the crucial impact of exit cost on firm selection and the effectiveness of trade reform. Our key conclusion is that the large dismissal cost for closing firms dampers firm selection through entry and exit, weakens the response of firm size to productivity, and lowers the productivity improvement from trade reform. In this paper, I incorporate exit cost and open economy to an otherwise Hopenhayn and Rogerson (1993) model, and estimate the model to match Chinese manufacturing data during 2004 to 2008. The model shows the mechanisms for exit cost to hamper selection of firms. On one hand, high exit cost per worker stops large and inefficient firms from closing down. On the other hand, the potential cost of exiting discourages small and productive firms to raise size. Com-

Table 9: How Exit Cost Affects The Impact of Trade Shocks on Average Productivity

Dependent Variable: City Weighted Average Productivity			
Weighted Aver. Tariff	-0.542***	-3.256***	-1.036***
	(-13.81)	(-6.30)	(-12.08)
Weighted Aver. Tariff*(1-InsuCover)		2.771***	
		(5.19)	
Weighted Aver. Tariff*UnskillShare			0.917***
			(6.01)
Dependent Variable: City Weighted Average Productivity			
Weighted Aver. ExpShare	0.365***	3.778***	0.673***
	(10.27)	(4.78)	(6.25)
Weighted Aver. ExpShare*(1-InsuCover)		-3.485***	
		(-4.29)	
Weighted Aver.ExpShare*UnskillShare			-0.545***
			(-2.77)
Dependent Variable: City Weighted Average Productivity			
Post2002	0.434***	0.366***	0.484***
	(83.40)	(5.40)	(40.28)
Post2002*(1-InsuCover)		0.0728	
		(1.04)	
Post2002*UnskillShare			-0.0923***
			(-4.45)

bining the two effects, large exit cost lowers firm turnover rate, and weakens the correlation between firm size and productivity. When a country opens to international trade, exit cost slows down the reallocation across firms and lowers the productivity improvement from trade reform. I then show empirical patterns consistent with the model predictions using Chinese manufacturing firm data.

This paper contributes to the literature of firm dynamics and trade reforms by studying how exit cost, a form of market imperfection that trade literature has overlooked, affects the effectiveness of trade through the firm selections. To my knowledge, this paper is the first in literature to structurally estimate exit cost and firing cost in the same model. We find the exit cost for Chinese manufacturing firms in 2004 is around 30% of annual wage per employee. It's also the first paper to discuss trade reform in an economy with exit cost. I find that if there was no exit friction, the improvement in productivity from trade opening up would become 9.5%, more than four times of the actual improvement. If the existing exit cost doubled, the improvement would disappear.

This paper sheds light in the recent heated discussions about the issue of zombie firms and excess capacity in some Chinese industries, such as steel industry, concrete inductry, etc. In this paper I show that the employment protection could bring large aggregate inefficiency through the reduction in the exit rate of unproductive large firms. The model in this paper could be extended to include other forms of exit frictions, such as interventions from local government, imperfect capital recovery, etc, to discuss the effects of different exit frictions on the efficiency loss.

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Appendix 1. Derivation of the production function

Assume capital k is fixed, material input m is variable input, and labor l is the dynamic input, and is taken as given at the beginning of each period. Then the output is,

$$y = \mathrm{z}_0 l^{\alpha_l} m^{\alpha_m} k^{\alpha_k}$$

Where z_0 is the productivity. One firm's static optimization problem then is,

$$\max_{\mathrm{m}} P\mathrm{z}_0 l^{\alpha_l} m^{\alpha_m} k^{\alpha_k} - P_m m$$

With the optimal solutionm^*, the revenue function is then,

$$r = Pz_0 k^{\alpha_k} \left[\frac{P_m}{\alpha_m P z_0 k^{\alpha_k}}\right]^{\frac{\alpha_m}{\alpha_m - 1}} \frac{\alpha_l}{l^{1-\alpha_m}}$$

Then I denote $\mathrm{z} = Pz_0 k^{\alpha_k} \left[\frac{P_m}{\alpha_m P z_0 k^{\alpha_k}}\right]^{\frac{\alpha_m}{\alpha_m - 1}}$, $\alpha = \frac{\alpha_l}{l^{1-\alpha_m}}$, I have the production function in the paper.

Appendix 2: Exceptional exporter performance and firm size

Related with the finding of downward sloping surviving productivity threshold curve, my model offer a prediction of exporters' productivity premium, defined as average productivity gap between exporters and domestic firms is increasing in firm size. I combine the exiting productivity threshold with the export productivity threshold, and look into the exporter productivity premium of firms with different sizes in Figure A1. The black line in the above is the export productivity threshold. Export is assumed to be a static decision and subject to a fixed cost in our model, such that, only firms with revenue larger than a threshold value could export. Since revenue depends on productivity and size, for firms with larger sizes, the productivity threshold is lower. So the average productivity of exporters is decreasing in size. Further, the exporter productivity premium is ONLY possible to increase in size when the productivity threshold is decreasing in size, with the slope of domestic productivity threshold having a larger absolute value than the exporter productivity threshold. This finding is also consistent with empirical pattern. In Figure A2, I separate firms into 20 groups, according to their sizes. It shows that in regions with larger exit friction, the exporter premium is more increasing in firm size.

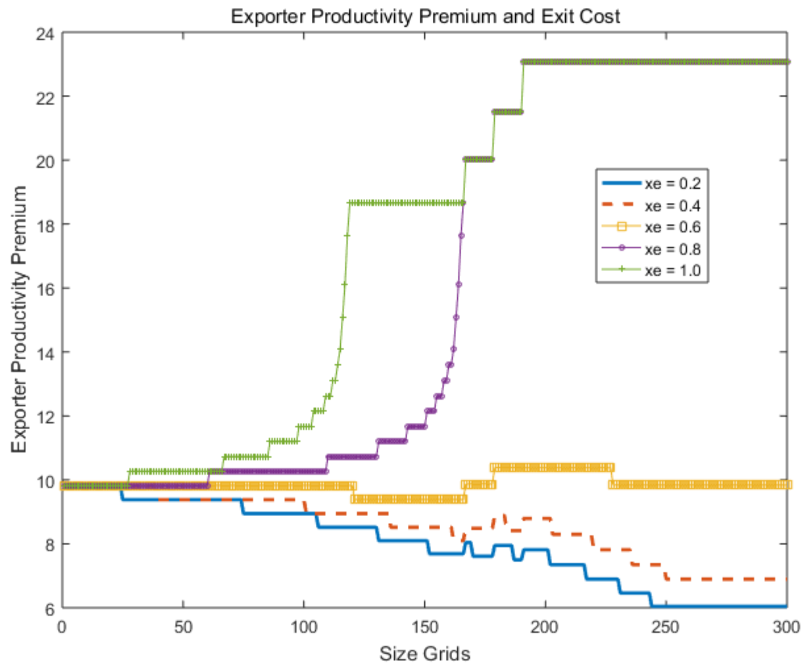

Figure 9: *
Figure A1: Exporter Productivity Premium and Exit Cost

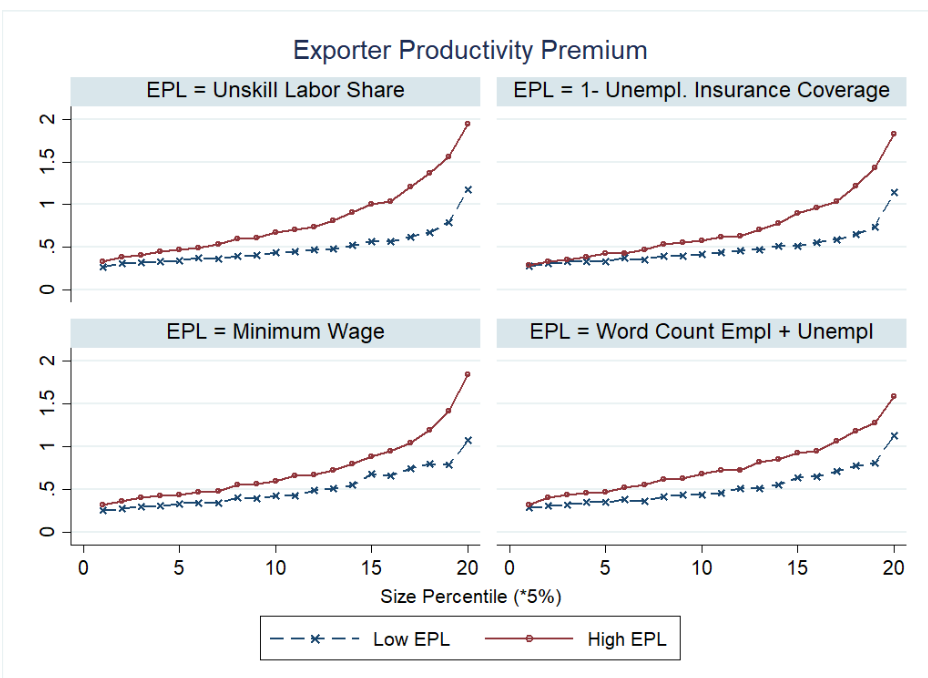

Figure 10: *
Figure A2: Exporter Productivity Premium in Data