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Abstract

In this paper, we build a dynamic game model of quantity competition to explain the price difference between continuing exporters and exits. Continuing exports are forward looking and they may intentionally set a lower price in the export market at current stage to crowd out the competitors to maximize the overall expected profit in their total life period. Using a large sample of matched panel data of Chinese firms from firm-level production data and product-level trade data, we find that after controlling the most important determinants of export price as well as the firm-year-specific effects, continuing exporters charge a price 42.4%-54.0% lower than the price level charged by future exits in China.

Keywords: Export prices · Dynamic game · Quantity competition
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1. Introduction

Trade models with firm heterogeneity generate rich predictions for not only firm productivity but also export prices. Continuing exporters are expected to charge less than occasional exporters who sometimes exit from international market, since continuing exporters are more productive and have lower mark up (Aw, Chuang and Roberts, 1999; Melitz, 2003; Eaton, Eslava, Kugler and Tybout, 2007). For instance, Aw et al (1999) show that average productivity is highest for continuing exporters followed by the group of entrants, exits, and non-exporters. In addition to productivity, market share and product quality are also key determinants driving export prices (Atkeson and Burstein; 2008; Manova and Zhang, 2012; Fan, Li and Yeaple, 2014; Bas and Strauss-Kahn, 2015). For example, Fan, Li and Yeaple (2014) show that trade liberalization induce China's producers to upgrade the quality of the goods and raise its export price. But such effect is evident in industries where the scope for quality differentiation is large, which is consistent with their model. Bas and Strauss-Kahn (2015) also show that input trade liberalization in China raise the export price, but such effect is specific to firms sourcing inputs from developed economies and exporting output to high-income countries. This is consistent with the observation in Manova and Zhang (2012).[1] Such export price effect caused by market share and product quality during trade liberalization can only be effective for continuing exporters since exits from export market will not make use of the trade liberalization.

[1] In addition, there are other studies to investigate the within-exporter price variation from other perspective. For instance, Johnson (2012) show that export prices are increasing in the difficulty of entering the destination market in the majority of sectors. Ge, Lai and Zhu (2015) show that foreign-owned firms charge about 28 percent higher prices than Chinese exporters in export market, which is the multinational price premium.

The mechanism above to explain the systematic price differentiation between continuing exporters and exits is from static setting and comparative static analysis by assuming that firm care about current profit. However, from dynamic point of view, continuing exports are forward looking and they may intentionally set a lower price in the export market at current stage to crowd out the competitors to maximize the overall expected profit in their total life period. Thus, in this paper, we build a simple dynamic model of quantity competition to show such price pattern, in which, other things equal, when a firm observes its productivity level and foresees its exit from the export market next period, it will charge higher prices this period to maximize the current profit. On the contrast, once a firm which will continue to stay in a market, it has the incentive to reduce its current price to foreclose some competitors from this market in order to increase its profit in the future periods.

China offers an ideal setting to test our model's predictions. The Chinese Custom office collects the transaction level data of Chinese exporting firms. We can observe the price of each product produced by each firm exported to particular market in specific year. The comprehensive information enables us to make comparison of the price difference between continuing exporters and exit exporters. Using a large sample of matched panel data of Chinese firms from firm-level production data and product-level trade data, we find that after controlling the most important determinants mentioned above of export price as well as the firm-year-specific effects, continuing exporters charge a price 42.4%-54.0% lower than the price level charged by future exits in China.

Besides the huge export price literature we discussed above, our paper is also closely related to the dynamic game literature. For example, Gallant et al. (2012)

document that in the pharmaceutical industry, the generical drug firms tend to enter some currently unprofitable markets to gain competitive advantage in the future drug markets. Amisano and Gioretti (2013) emphasize the important role of a firm's early market entry behaviors on its profit in the following periods. Rodrigue and Tan (2015) also claim that when an exporting firm penetrate into a new export market, it tends to charge a lower price in the early periods to attract more consumers and build its reputation and increase its profit in the following periods. These papers underscore the impact of dynamic consideration on the firm-level behaviors. Different from these papers, in our model a firm's price and quantity choice not only affect its own current profit but also the profit of other firms. As such the benefits for continuing firms to reduce their price is to decrease the profit of their competitors and force them to exit the market. This will decrease the market competition in the future periods and hence increase the continuing firms' profit.

The rest of paper will proceed as follows, in section 2 we introduce the dynamic model of quantity competition. Section 3 describes the data sets and the empirical results. The last section concludes.

2. The Model

2.1 Basic set up

Following Atkeson and Burnstein (2008), we assume the representative consumer's preference is given by

$$E_0 \sum\nolimits_{t=0}^{\infty} \beta^t u(c_t, 1 - l_t)$$
$$u(c_t, 1 - l_t) = \ln \left[c_t^u (1 - l_t)^{1-u} \right]$$

where c_t denotes the consumption of final good, and l_t denotes the working hours at time t. The final good is produced by a competitive firm using a continuum input y_{jt} for $j \in [0, 1]$ taking a Constant Elasticity of Substitution (CES) form:

$$c_t = \left[\int_0^1 y_{jt}^{1-\frac{1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

Therefore, the price index P_{it} for the final consumption is given by $P_t = \left[\int_0^1 P_{jt}^{1-\eta} \right]^{\frac{1}{1-\eta}}$ and the inverse demand function of products in sector j is given by $\frac{P_{jt}}{P_t} = \left(\frac{y_{jt}}{c_t} \right)^{-\frac{1}{\eta}}$. P_{jt} is the price of y_{jt}. In each input sector, there are only K firms, as such the output in each input sector is given by: $y_{jt} = \left[\sum\nolimits_{i=1}^{K} (q_{ijt})^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$, where q_{ijt} is sales of firm i in sector j at time t. The corresponding price index in sector j can be written as $P_{jt} = \left[\sum\nolimits_{k=1}^{K} (P_{ijt})^{1-\rho} \right]^{\frac{1}{1-\rho}}$ and the inverse demand function for product i within sector j is given by $\frac{P_{ijt}}{P_{jt}} = \left(\frac{q_{ijt}}{y_{jt}} \right)^{-\frac{1}{\rho}}$. Thus, we have the demand function of product i, which is obtained by multiplying the demand function of products in sector j and the demand function for product i within sector j:

$$\frac{p_{ijt}}{P_t} = \left(\frac{q_{ijt}}{y_{jt}} \right)^{-\frac{1}{\rho}} \left(\frac{y_{jt}}{c_t} \right)^{-\frac{1}{\eta}}. \tag{1}$$

Upon above basic set up, we also have the following market structure assumptions:

(1) Goods are imperfect substitutes: $\rho < \infty$.

(2) Goods within a sector are more substitutable than goods across sectors: $1 < \eta < \rho$.

(3) Firms play a dynamic game of quantity competition. In particular, each firm picks its quantity at each period to maximize its discounted profit. We further assume that firm i cannot observe q_{kjt} at period t if firm k does not exit, instead, it can observe q_{kjt} at period $t+1$. In addition, firm i can observe a zero quantity of firm k if it generates a negative profit in period $t-1$ and exit at period t.[2] Each firm uses the total sales of other survived firms in the last period to proxy the total output of the other firms in the current period.[3] Mathematically, $E\sum_{k\neq i} q_{kj,t} = \sum_{k\neq i} q_{kj,t-1}$.

Different from a static setting, firm i needs to balance the pain in the current period and the gain in the future if it does not exit from the market. In particular, firm i can increase its quantity in period t intentionally which reduces the price index P_{jt} in sector j, and as such, some least productive firms will be crowded out of the market, thus, firm i can make more profit in the next period and increase the overall discounted profit.

(4) At each period, firm i suffers a bad shock with probability $(1-\beta)$, and for any firms suffering the bad shock are forced to exit the market. At the meanwhile, some new firms born in each period, and they enter the market to replace the

[2]Here we require that any firm generating a negative profit in a period has to exit the market at the end of the period.

[3]We call this assumption as bounded rationality, and this assumption implies that firm i does not consider the response of firm k to its quantity choice at current period. One explanation could be in the reality it is costly to find all other firms' response to the firm its own quantity choice.

firms suffering bad shocks. In the equilibrium, the number of exit firms equals the number of entrants, and they have the same productivity distribution. [4]

(5) Firm i needs to pay a fixed cost, f in each period.

2.2. Equilibrium of continuing exporting firms.

With all the above assumptions, firm i with productivity level φ_{ijt} maximizes the following discounted profit which contains current profit and the value of future profit subject to the inverse demand functions for product i described in equation (1), which is the optimization of continuing exporting firms (with wage normalized to 1):

$$\max_{q_{ijt}}(p_{ijt}-\frac{1}{\varphi_{ijt}})q_{ijt}-f+\beta V\left(E_t\sum\nolimits_{k\neq i}q_{kj,t+1}\right)$$
$$\Leftrightarrow\max_{q_{ijt}}(p_{ijt}-\frac{1}{\varphi_{ijt}})q_{ijt}-f+\beta V\left(\sum\nolimits_{k\neq i,\pi_{kj,t}\geq 0}q_{kj,t}\right)$$
$$s.t.\frac{p_{ijt}}{P_t}=\left(\frac{q_{ijt}}{y_{jt}}\right)^{-\frac{1}{\rho}}\left(\frac{y_{jt}}{c_t}\right)^{-\frac{1}{\eta}}$$

Where, the first order condition(FOC) is:

$$\left(1-\frac{1}{\rho}\right)q_{ijt}^{-\frac{1}{\rho}}\widehat{y}_{jt}\widehat{y}_{jt}^{\frac{1}{\rho}-\frac{1}{\eta}}c_t^{\frac{1}{\eta}}P_t+\left(\frac{1}{\rho}-\frac{1}{\eta}\right)\widehat{y}_{jt}^{\frac{1}{\rho}-\frac{1}{\eta}-1}\widehat{y}_{jt}^{\frac{1}{\rho}}q_{ijt}^{-\frac{1}{\rho}}c_t^{\frac{1}{\eta}}P_t$$
$$-\frac{1}{\varphi_{ijt}}+\frac{\partial V}{\partial A_{t+1}}\frac{\partial A_{t+1}}{\partial q_{ijt}}=0$$
$$\Rightarrow\left[\left(1-\frac{1}{\rho}\right)+\left(\frac{1}{\rho}-\frac{1}{\eta}\right)\widehat{s}_{ijt}\right]p_{ijt}=\frac{1}{\varphi_{ijt}}-\frac{\partial V}{\partial A_{t+1}}\frac{\partial A_{t+1}}{\partial q_{ijt}}$$

[4] In the steady state, $\sum_{j\neq i}q_{j,t}$ is constant as all firms, incumbents or new entrants, at period $t+1$ will behave as in period t. Therefore, the prediction of each firm about other firms' total quantity is correct.

where $\widehat{s}_{ijt}$ is firm i's conjectural market share in sector j at period t, which is defined as $\widehat{s}_{ijt} = \frac{q_{ijt}^{1-\rho}}{\sum_k q_{kjt}^{1-\rho}}$.[5] Similarly, $\widehat{y}_{jt}$ is firm i's conjecture of the total output in sector j at period t, which is defined as $\widehat{y}_{j,t} = \left(q_{ij,t}^{\frac{\rho-1}{\rho}} + \sum_{k \neq i, \pi_{kj,t} \geq 0} q_{kj,t-1}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}$. Lastly, $A_{t+1} = E_t \sum_{k \neq i} q_{kj,t+1}$, which is used to simplify the notation.

2.3. The cutoff equilibrium of exits

The least productive firms who know they will exit the market, only maximize the current profit without considering the impact of its price or quantity on the future discounted profit subject to the its demand function, thus we name this condition as static setting.[6]

$$\varphi_{j,t}^{*} = \inf \left\{ \varphi : \max \left(p_{ij,t} - \frac{1}{\varphi} \right) q_{ij,t} = f \right\}$$

$$\text{where } q_{ij,t} = \Phi_{jt} p_{ij,t}^{-\rho}$$

$$\Phi_{jt} = P_t^{\rho} \widehat{y}_{jt}^{1-\frac{\rho}{\eta}} c_t^{\frac{\rho}{\eta}}$$

Assume firm i is the firm with the least productivity, and the optimization of

[5] Note that as assumed above, firm i cannot observe its competitors' current output levels when it decides its own quantity. As such, firm i speculate its market share by assuming all other firms' output in period t is identical to that in period $t-1$.

[6] The least survived firms have to maximize its current profit to obtain zero profit to stay in the market.

$\left(p_{ijt} - \frac{1}{\varphi}\right) q_{ijt}$ implies that

$$\begin{aligned}
\left(1-\frac{1}{\rho}\right) p_{ij,t} + \left(\frac{1}{\rho}-\frac{1}{\eta}\right) p_{ij,t} \frac{q_{ij,t}^{\frac{\rho-1}{\rho}}}{\widehat{y}_{j,t}^{\frac{\rho-1}{\rho}}} &= \frac{1}{\varphi^*} \\
\Rightarrow \left(1-\frac{1}{\rho}\right) p_{ijt} + \left(\frac{1}{\rho}-\frac{1}{\eta}\right) p_{ijt}\widehat{s}_{ijt} &= \frac{1}{\varphi^*} \\
\Rightarrow p^s_{ijt} = \frac{\frac{1}{\varphi_{ijt}}}{\left[\left(1-\frac{1}{\rho}\right) + \left(\frac{1}{\rho}-\frac{1}{\eta}\right)\widehat{s}_{ijt}\right]} & \qquad (3)
\end{aligned}$$

where p^s_{ijt} is the optimal price for firm i if it will exit in period $t+1$. This price maximizes firm i's current profit, and it referred to as the static optimal price. With the equation (**??**), we reach the following lemmas:

Lemma 1. *The profit of firms with cutoff productivity is increasing in other firms' price level (Proof of Lemma 1 is in the appendix),*

$$\frac{\partial \pi_{kj,t+1}}{\partial p_{ijt}} > 0$$

Lemma 2. *The cutoff at period t+1 is decreasing in firm i's price level, which implies that firm i can increase its quantity in period t to squeeze out some firms in period t+1.*

$$\frac{\partial \varphi^*_{j,t+1}}{\partial p_{ijt}} < 0$$

Proof. This result can be derived directly from Lemma 1 that other firm cannot stay in the market after the decreasing of p_{ijt}. □

Lemma 3. *The expected total output in period t+1 is increasing in firm i's current* *price:*

$$\frac{\partial \sum_{k\neq i,\pi_{kj,t}\geq 0} q_{kj,t}^{\frac{\rho-1}{\rho}}}{\partial p_{ijt}} > 0$$

Proof. It can be derived directly from the implication of Lemma 2 that the number of other surviving firms will increase when p_{ijt} increases, so the total output. □

Lemma 4. *The value function given the state variable A_t, $V(A_t)$, is a decreasing function of A_t (Proof of Lemma 4 is in the appendix), where $A_t = \sum_{k\neq i,\pi_{kj,t}\geq 0} q_{kj,t}^{\frac{\rho-1}{\rho}}$*

$$\frac{\partial V(A_t)}{\partial A_t} < 0$$

Combing these lemmas, we can get the following Proposition:

PROPOSITION: The price in the dynamic setting (continuing exporters) is strictly lower than that in a static setting (exits), given other things equal.

$$p_{ijt}^{d} = \frac{\frac{1}{\varphi_{ijt}} - \frac{\partial V}{\partial A_{t+1}}\frac{\partial A_{t+1}}{\partial q_{ijt}}}{\left[\left(1-\frac{1}{\rho}\right)+\left(\frac{1}{\rho}-\frac{1}{\eta}\right)\widehat{s}_{ijt}\right]}$$

$$p_{ijt}^{s} = \frac{\frac{1}{\varphi_{ijt}}}{\left[\left(1-\frac{1}{\rho}\right)+\left(\frac{1}{\rho}-\frac{1}{\eta}\right)\widehat{s}_{ijt}\right]}$$

$$\Rightarrow p_{ijt}^{d} < p_{ijt}^{s}$$

Proof. From Lemma 4, we know $\frac{\partial V}{\partial A_{t+1}} < 0$ and from Lemma 3 which is based on Lemma 1 and Lemma 2, we know $\frac{\partial A_{t+1}}{\partial q_{ijt}} = \frac{\partial A_{t+1}}{\partial p_{ijt}}\frac{\partial p_{ijt}}{\partial q_{it}} < 0$. In addition, the equation (2) and (3) which show the price of continuing exporting firms and exits, respectively. Thus, we can easily reach an inequality through simple comparison: $p_{ijt}^{d} < p_{ijt}^{s}$. □

The inequality tells that continuing exporters (dynamic setting) charge lower than the exits (static setting) in the export market. As a final remark, although the simple dynamic game of quantity competition that relies on a numerous assumptions, can explain such price pattern, there could be other channels in place which themselves are interesting to explore further for future research.

3. Price difference between continuing exporters and exits: An empirical investigation

3.1. Data

We mainly rely on two disaggregated, large panel data sets in this paper, which are firm-level production data and product-level trade data over period 2000-2006. Firm-level data comes from annual surveys of manufacturing firms, which is collected and maintained by the China's National Bureau of Statistics (NBS). The dataset covers all state-owned enterprises (SOEs) and non-SOEs with annual sales more than RMB 5 million (which is equivalent to around 770,000 US Dollar under current exchange rate).[7] Detailed information on financial variables such as out-put, value added, labor input, fixed capital, intermediate inputs etc is available. It is the data source for measuring TFP, which we used as one of the control variables in the estimation. The advantage of rich information makes the dataset very popular in research focusing China, but it has been noticed that lots of samples are quite noisy and are therefore misleading. Brandt, Biesebroeck and Zhang (2012), Upward, Wang and Zheng (2013), as well as Feenstra, Li and Yu (2014) summarize these problems and provide the necessary procedure to resolve.

[7] Aggregated data on the industrial sector in the annual China's Statistical Yearbook by the National Bureau of Statistics are compiled from this data set.

We follow their work to clean the sample before estimation. After applying this rigorous clean work to guarantee the quality of the production data, the filtered firm data are reduced by about 50 percent in each year, as shown in columns I and II in Table 1.

The product-level transaction data are obtained from China's General Administration of Customs (GAC). It contains information of product at the 8-digit The Harmonization System Code (HS code) level for each trading firm, including price, quantity and value. We rely on this dataset to construct our export price variable and firm-product continuation dummy variable and other control variables such as market share and intermediate input price. Therefore, it is necessary to merge these two different sourced data sets. Since each firm has a unique numerical ID (registration code) in these two separate dataset, linking them by firm ID is straightforward. However, the firm IDs is coded in the two datasets according to different coding system. Thus, to increase the number of qualified matching firms as many as possible, we follow Upward, Wang and Zheng (2013), using each firm's Chinese name and the year of establishment as a bridge to match, which is deemed as the most effective way because firm names are less likely to be missing or changed during the relatively short time period 2000-2006 (7 years) than other information. As described in Table 1, After matching, the remaining observations accounts for nearly 15% of the original firm-level production dataset and about 25% of the original transaction dataset, and more than half in terms of export value. By way of comparison, our matching success rate is highly comparable to that in other studies, such as Ge, Lai, and Zhu (2011) and Yu (2014).

Table 1: The number of firms of two data sets before and after matching

	NBS Sample		GAC Sample		Merged Sample
	Raw firms	Filtered firms	Transactions	Firms	Firms
	I	II	III	IV	V
2000	162,883	83,868	10,586,696	61,900	15,539
2001	169,031	100,279	12,667,685	67,360	19,072
2002	181,557	110,706	14,032,675	75,431	21,871
2003	196,222	129,659	18,069,404	90,664	26,721
2004	277,004	199,289	21,402,355	112,823	41,822
2005	271,835	198,945	24,889,639	123,437	44,821
2006	301,960	224,908	16,685,377	164,822	47,102

3.2. Specification and TFP

To investigate the price difference between continuing exporters and exits, we use the following estimated equation:

$$P_{ijt} = c + \beta D_{it} + \delta X_{ijt} + \sigma_i + \sigma_j + \sigma_t + \varepsilon_{ijt} \tag{2}$$

where i denotes to firm, j is the product index, and t is the year. The continuing exporting dummy variable for firm i, D_{it}, is our main causal variable. It is defined as that if a firm exports in year t and year $t+1$, then in year t it is treated as an continuing exporter.[8] For the robustness check, we also define the continuing exporter in year t as that if a firm exports in year t year $t+1$ and year $t+2$.[9] Readers will find later that our results are not sensitive to the definition of an continuing exporter.

X_{ijt} includes our control variables such as firm level total factor productivity (TFP), firm-level imported intermediate input price to control for the quality of

[8]Thus, only the 2000-2005 period sample enters the equation.

[9]Thus, in this case only the 2000-2004 period sample enters the equation.

imported material, and firm-product-destination level market share measured by firm-product sales divided by the total sales of all Chinese firms producing the same product in the same market. Since continuing exporters are more productive and thus have lower mark up (e.g.,Eaton, Eslava, Kugler and Tybout, 2007). In addition, market share and product quality are also key determinants driving export prices(Etkeson and Burstein; 2008; Fan, Li and Yeaple, 2014).

Firm level TFP is always deemed as the contribution to output other than labor and capital or intermediate material. According to features of the data used in the paper, there are different estimation methods. We adopt TFP estimated by two methods. The first follows Foster, Haltiwanger and Syverson (2008) method to estimate the firm-product level TFP:

$$\ln TFP_{ikt} = \ln q_{ikt} - \alpha_k \ln k_{ikt} - \alpha_l \ln l_{ikt} - \alpha_m \ln m_{ikt} \tag{3}$$

where q_{ikt} is the physical units of output i exported by firm k in year t across all destinations. k_{ikt}, l_{ikt} and m_{ikt} represent the firm-product-year measures of capital, labor and materials, respectively. α_k, α_l, and α_m are the input share for capital, labor and intermediate materials, respectively.

We assume that the output of each product is produced by a Cobb-Douglas function. To compute firm-product level productivity, we need to calculate input shares for labor, materials and capital, α_l, α_m and α_k, respectively, for each product. Let $\tilde{\omega}_{kt}$ denote firm k's total nominal wage payments in year t. Hsieh and Klenow (2009) suggest that the wage bill, $\tilde{\omega}_{kt}$ tends to underestimate the labor share in the Chinese manufacturing data. Following their approach, we multiply each firm's wage bill by a constant parameter, $\tilde{\rho}$, to inflate the wage bill in each firm. We determine the size of the constant parameter by choosing the parameter so that the aggregate labor compensation in the manufacturing sector matches the labor share in national accounts (roughly 50 percent).

Specifically, we denote the total, observed payments to workers as

$$t\omega = \sum_k \sum_t \tilde{\rho}\tilde{\omega}_{kt} = \tilde{\rho} \sum_k \sum_t \tilde{\omega}_{kt} = \tilde{\rho}\widetilde{t\omega}$$

where $\tilde{\rho}$ is the unknown inflation parameter we need to determine and $\widetilde{t\omega}$ denotes the total observed labor compensation. We denote total revenues tr and total intermediate materials tm. Hsieh and Klenow (2009) suggest that the ratio of total wage payments to value-added is roughly 50% from the Chinese national accounts and input-output tables. This implies that

$$\frac{t\omega}{tr - tm} = 0.5 \Rightarrow \frac{\tilde{\rho}\widetilde{t\omega}}{tr - tm} = 0.5 \Rightarrow \tilde{\rho} = 0.5\frac{tr - tm}{\widetilde{t\omega}}$$

After $\tilde{\rho}$ is determined, we calculate the labor share in each of exporting industries we focus on as:

$$\alpha_l = \frac{1}{\tilde{N}} \sum_t \sum_k \frac{\tilde{\rho}\tilde{\omega}_{kt}}{\tilde{r}_{kt}}$$

where $\tilde{r}_{kt}$ are the firm k's nominal revenues, and $\tilde{N}$ is the total number of firm observations in each year. Similarly, we calculate the intermediate materials share as the average share of intermediate inputs in total revenues,

$$\alpha_m = \frac{1}{\tilde{N}} \sum_t \sum_k \frac{\tilde{\rho}\tilde{m}_{kt}}{\tilde{r}_{kt}}$$

where $\tilde{m}_{kt}$ is the total value of intermediate materials firm k used in year t. Finally, in the absence of reliable capital share information, we follow Hsieh and Klenow (2009) and assume constant returns to scale so that $\alpha_k = 1 - \alpha_l - \alpha_m$. We have alternatively tried estimating the input shares, and productivity, using control function methods (De Loecker and Warzynski, 2012). We find very similar measures of input shares and productivity.

The second is OP method, which was first proposed by Olley and Pakes (1996) and has been widely used in the literature (e.g., De Loecker, 2007, 2011; De Loecker and Warzynski, 2012; Feenstra, Li and Yu, 2014; Yu, 2014). The essence of this approach is to use investment as proxy for unobservable productivity. Compared with OLS, it can overcome the problems of simultaneity and selectivity bias. In considering that technology varies across industries and production function is estimated sector by sector based on 2-digit Chinese industry code. When estimating the productivity, value added of firms is used as explained variable, the number of employees is treated as labor input, and investment is deducted according to perpetual inventory method with data of net fixed assets and the depreciation rate. The measured TFP is expected to capture the firm's true technical efficiency. However, here measured TFP might also reflect price heterogeneity across firms (De Loecker, 2011; De Loecker and Warzynski, 2012). The ideal way to solve this problem is to remove price difference by using firm-specific price deflator (Foster, Haltiwanger, and Syverson, 2008). Unfortunately, these price deflators are unavailable, therefore, as many other studies, e.g., De Loecker and Warzynski (2012) and Yu (2014), we use industrial output price to deflate the firm's value added. It is much more difficult to get real capital and investment for two reasons: first, firms do not report fixed investment; and second, firms report information on the value of their fixed capital stock at original purchase prices. We follow the procedures provided by Brandt, Biesebroeck and Zhang (2012), estimating capital stock with real values based on the information of industrial capital stock growth rate and price index.

3.3. Empirical results

Table 2 and 3 report the estimation results of empirical specification. Table 2 defines a firm to be continuing exporter in year t when this firm exports in both year t and year $t+1$ and Table 3 defines a firm to be continuing exporter in year t when this firm exports in years t, $t+1$ and $t+2$. Column (1)-(4) uses firm-product TFP and Column (5) uses TFP by OP method. After controlling firm and year fixed effects, we add the controls one by one for continuation dummy, productivity, market share and intermediate input price. The main message is that in each regression, continuing exporters charge a price lower than the price level charged by future exits no matter what continuation is used or TFP is used. After controlling the most important determinants of export price as well as the firm-year-specific effects, we still find that continuing exporters charge a price 42.4%-54.0% lower than the price level charged by future exits in China.[10]

[10]The figure is calculated by $[Exp(\beta) - 1]$.

Table 2: The Impact of Continuation on Firms' Exporting Price-First definition of continuation

	1	2	3	4	5(OP)
D_cont	-0.7142***	-0.4719***	-0.4745***	-0.5511***	-0.7759***
	(0.0423)	*(0.0398)*	*(0.0398)*	*(0.0536)*	*(0.0554)*
TFP		-4.3581***	-4.3584***	-4.8137***	-0.6236***
		(0.0115)	*(0.0115)*	*0.0149*	*0.0258*
m_share			0.3901**	0.8342***	0.3441**
			(0.1283)	*(0.1600)*	*(0.1677)*
Mprice				1.47e-06***	2.24e-06***
				(1.90e-07)	*(2.09e-07)*
Firm fixed effect	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes
R^2	0.1016	0.1239	0.1240	0.1306	0.1039
# of obs	1,075,189	1,075,189	1,075,189	709,411	709,411

Notes: *D_cont* equals to 1 in year t when a firm export in both year t and year $t+1$, otherwise *D_cont* takes value 0. Standard errors are in parenthesis, *** and ** , respectively, denoting significance at the 1%, and 5% levels.

Table 3: The Impact of Continuation on Firms' Exporting Price–Second definition of continuation

	1	2	3	4	5(OP)
D_cont	-0.9094***	-0.6784***	-0.6793***	-0.7352***	-0.6916***
	(0.0515)	*(0.0489)*	*(0.0489)*	*(0.0655)*	*(0.0673)*
TFP		-3.9150***	-3.9151***	-4.3104***	-0.6712***
		(0.0139)	*(0.0139)*	*0.0179*	*0.0325*
m_share			0.2089	0.6884***	0.2189
			(0.1744)	*(0.2082)*	*0.2164*
Mprice				3.97e-07*	8.19e-07***
				(2.28e-07)	*(2.47e-07)*
Firm fixed effect	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes
R^2	0.1022	0.1078	0.1078	0.1139	0.1039
# of obs	692,150	692,150	692,150	462,298	462,298

Notes: *D_cont* equals to 1 in year t when a firm export in year t, $t+1$ and $t+1$, otherwise *D_cont* takes value 0. Standard errors are in parenthesis, *** and ** , respectively, denoting significance at the 1%, and 5% levels.

4. Conclusion

In this paper, we build a simple dynamic game of quantity competition to show that continuing exporters (dynamic setting) could charge a lower price than the exits (static setting) in the export market intentionally. Using a large sample of matched panel data of Chinese firms from firm-level production data and product-level trade data, we find that after controlling the most important determinants of export price as well as the firm-year-specific effects, continuing exporters charge a price 42.4%-54.0% lower than the price level charged by future exits in China. The results are robust to using different firm TFP measures and continuing export definition. As a final remark, although there could be other channels which can explain the price pattern, our simple dynamic model provide a new perspective to explain the observed price disparity between continuing and exit exporters.

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Appendix

Proof to Lemma 1

Given all other firms price unchanged, only the price of firm i changes. When all firms optimally choose their price and firm i chooses p_{ijt}^{a}, the optimal price and profit of firm k in period $t+1$ are $p_{kj,t+1}^{a}$ and $\pi_{ij,t+1}^{a}$, respectively. If firm i decreases its price to p_{ijt}^{b} at period t, and all other firms keep prices unchanged, the optimal price and profit of firm k in this situation are $p_{kj,t+1}^{b}$ and $\pi_{kj,t+1}^{b}$, respectively. If firm k charges $p_{kj,t+1}^{b}$ when firm i charges p_{ijt}, we denote the profit of firm k is $\pi_{kj,t+1}^{c}$.

Obviously, $\pi_{ij,t+1}^{a} > \pi_{kj,t+1}^{c}$ because $p_{kj,t+1}^{a}$ is the optimal price at p_{ijt}. Now we need to show that $\pi_{kj,t+1}^{c} > \pi_{kj,t+1}^{b}$. As firm k does not change its price level, its unit profit keep the same in both cases, which is:

$$q_{kj,t+1} = \chi \widehat{y}_{jt+1}^{1-\frac{\rho}{\eta}}$$
$$\chi = P^{\rho} c_{t+1}^{\frac{\rho}{\eta}} p_{kj,t+1}^{-\rho}$$

Thus,

$$\frac{\partial q_{kj,t+1}}{\partial p_{ijt}} = \chi \left(1 - \frac{\rho}{\eta}\right) \widehat{y}_{jt+1}^{-\frac{\rho}{\eta}} \left[\frac{\partial \widehat{y}_{j,t+1}}{\partial q_{kj,t+1}} \frac{\partial q_{kj,t+1}}{\partial p_{ijt}} + \frac{\partial \widehat{y}_{j,t+1}}{\partial q_{ijt}} \frac{\partial q_{ijt}}{\partial p_{ijt}}\right]$$
$$\Rightarrow \left\{1 + \chi \left(\frac{\rho}{\eta} - 1\right) \widehat{y}_{j,t+1}^{-\frac{\rho}{\eta}} \frac{\partial \widehat{y}_{j,t+1}}{\partial q_{kj,t+1}}\right\} \frac{\partial q_{kj,t+1}}{\partial p_{ijt}} = \chi \left(1 - \frac{\rho}{\eta}\right) \widehat{y}_{j,t+1}^{-\frac{\rho}{\eta}} \frac{\partial \widehat{y}_{j,t+1}}{\partial q_{ijt}} \frac{\partial q_{ijt}}{\partial p_{ijt}}$$

The coefficient for the $\frac{\partial q_{kj,t+1}}{\partial p_{ijt}}$ is positive because $\rho > \eta > 1$ and $\frac{\partial \hat{y}_{j,t+1}}{\partial q_{kj,t+1}} > 0$. Meanwhile the right hand side is also positive as $\left(1 - \frac{\rho}{\eta}\right) < 0$, and $\frac{\partial q_{ijt}}{\partial p_{ijt}} < 0$ (demand rule). These imply that $\frac{\partial q_{kj,t+1}}{\partial p_{ijt}} > 0$. This result indicates that when p_{ijt} changes: $q_{kj,t+1}^{c} > q_{kj,t+1}^{b}$, the profit $\pi_{kj,t+1}^{c} = uni\_prof \cdot q_{kj,t+1}^{c} > uni\_prof \cdot q_{kj,t+1}^{b} = \pi_{kj,t+1}^{b}$. Since $\pi_{kj,t+1}^{c} < \pi_{kj,t+1}^{a}$, we directly have $\pi_{kj,t+1}^{b} < \pi_{kj,t+1}^{a}$.

Proof to Lemma 4

This is solved based on the optimization of continuing exporting firms above where the FOC is:

$$\left[\left(1-\frac{1}{\rho}\right)+\left(\frac{1}{\rho}-\frac{1}{\eta}\right)\widehat{s}_{ijt}\right]p_{ijt}=\frac{1}{\varphi_{ijt}}-\frac{\partial V}{\partial A_{t+1}}\frac{\partial A_{t+1}}{\partial q_{ijt}}$$

Now we are going to show that $\frac{\partial V}{\partial A_{t+1}}<0$. Denote the optimal price choice of firm i at A_t^a is p_{ijt}^a, and $q_{ijt}^a=P_t^\rho C_t^{\frac{\rho}{\eta}}\left(p_{ijt}^a\right)^{-\rho}\widehat{y}_{jt}^{1-\frac{\rho}{\eta}}$. If when firm i faces A_t^b, but deviate its price to p_{ijt}^a, it will have the same unit profit as facing A_t^a. However, now its sales, $q_{ijt}^b>q_{ijt}^a$. This inequality is because, $\frac{\partial A_{t+1}}{\partial q_{ijt}}=\frac{\partial A_{t+1}}{\partial p_{ijt}}\frac{\partial p_{ijt}}{\partial q_{ijt}}$. From Lemma 3 we can get $\frac{\partial A_{t+1}}{\partial p_{ijt}}>0$ and demand rules tells that $\frac{\partial p_{ijt}}{\partial q_{ijt}}<0$, thus, $\frac{\partial A_{t+1}}{\partial q_{ijt}}<0$ and $\frac{\partial q_{ijt}}{\partial A_t}<0$. This result guarantee

$$q_{ijt}^b=q_{ijt}(A_t^b)>q_{ijt}(A_t^a)=q_{ijt}^a$$

Therefore, we conclude that when firm i deviate its price from its optimal price to p_{ijt}^a when it faces A_t^b, its discounted profit is higher than $V(A_t^a)$. However, this contradicts with the fact that $V(A_t^a)>V(A_t^b)$.