Analysis of Market Demand Change in the Export Destination, Innovation and Cost Addition Based on Experimental and Mathematical Statistics Analysis

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Abstract— It is difficult to measure the change of market demand through the micro mechanism that affects enterprise cost addition through innovation. Based on the mathematical operation, this paper constructs a general formula for the impact of innovation on mark-up pricing through the consumer optimization model, the enterprise optimization model and the choice of innovation behavior. Moreover, to avoid the collinearity problem, the production function is estimated by ACF's method. The export impact function is constructed with the change of the market share of the export destinations, the initial export density of the enterprises, the total export and the total sales revenue, and the intermediary effect model is used to estimate it. By constructing a mathematical model, it provides a perfect model framework for scholars to conduct an empirical analysis of market demand changes, innovation and cost addition in export destinations.

Keywords-innovation; intermediary effect; theoretical model

1 INTRODUCTION

Cost addition (mark-up) defined as the ratio between enterprise pricing and marginal cost, and it is an important concept of industrial economics and of microeconomics, it reflects both the degree of market competition, the competitive power of enterprises, and the existence of excess production capacity in the industry. However, the "three low problems" which include the low price, the low quality and the low profit of export products have not been effectively alleviated for a long time, behind the phenomena, China's export enterprises are gradually falling into the "low addition rate trap"[1]. Exports are believed to help developing countries enter international markets and learn foreign advanced knowledge and technologies, thus enhancing enterprise productivity and market competitiveness (Huang Xinhai et al., 2018) [2]. Much of the literature currently supports the existence of the effect, and it can be called "learn from export"(Aghion et al.; 2017, 2018) [3][4]. This paper provides a theoretical framework for analyzing the changes of export destinations, innovation and the cost addition.

The main reason for the low-price products which Made in China is the low-cost addition of export companies (Sheng Dan, Wang Yongjin; 2012) [5]. A large number of enterprises into the export market bring the "competitive effect", but the division of the domestic market and subsidy policy distortion makes the "choice effect" can not effectively play, leading to the export market "competitive effect" is greater than the "Selective effect", and the higher the

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export density the lower enterprise bonus rate (Liu Qiren, Huang Jianzhong, 2015) [1]. Further analyzing the competition effect, the competition effect forces the export enterprises to reduce the cost addition, and raise the price of factors, and as a result the marginal export cost rise. The excessive competition in the product market and the factor market makes the export enterprises fall into the trap of low addition (Xu Ming, Li Yifei; 2018) [6]. In addition, exporters face additional costs in the export market, enterprises will charge higher prices in foreign markets to cover sinking costs and charge high cost addition; On the other hand, enterprise pricing ability in foreign markets also depends on foreign competitors, so it facing fierce competition in the export markets, enterprises tend to charge lower cost addition to keep its export competitive (Zhu Shujin, Zhang Penghui; 2015) [7].

Aghion and Howitt (1992) argue that the main goal of corporate investment innovation is to obtain monopoly rents, and the companies can set higher bonus rates at their marginal costs before their new products are imitated [8]. Innovation can promote the production of new products, indicating that innovation can reduce the marginal cost of enterprises, thus increasing cost addition. Innovation not only improves the cost advantage from inside of the enterprise, but also obtains greater market share from outside of the enterprise, and it helps enterprises to improve the market competitiveness, thus enterprise can set a higher cost addition (Liu Qiren, Huang Jianzhong; 2016) [9]. The increasing market demand of export destinations indicates that the increasing of market size, enterprises can obtain more profit in the export destinations' market, so it can invest more in R & D which lead the product higher technical content and stronger competitiveness, thus increasing the cost addition of enterprises indirectly (Li Shengqi, Xu izhang; 2016) [10]. The effect of demand change in export destinations' market on enterprise cost addition is divided into direct effect and indirect effect. In terms of direct effects, Melitz et al (2008) pointed out that market size expansion directly increases the product competition, thus curbing the ability of enterprises to charge higher cost addition [11]; The indirect effect means that while the destinations' market is increasing its market competition, enterprises with higher initial productivity are more likely to conduct high-level of R & D activity (Aghion, 2018) [4]. Innovation affects the mark-up pricing through two channels, one is the price channel. R & D activities can improve the quality of products and thus create higher cost addition. The other is the cost channel, and the innovation has the scale effect. The technological innovation of the enterprise is spread within the enterprise. Therefore, the larger the scale of the enterprise, the lower the marginal cost after the innovation, so as to increase the enterprise cost addition (Nie et al.; 2012) [13].

The above literature deepens the understanding of mark-up pricing in this article. The problem to be solved in this article is: How can scientifically measure the cost bonus of export? How to build a theoretical model including the demand change of the export destinations' market, enterprise heterogeneity, innovation and cost addition under the framework of the new trade theory, and analyze whether investment innovation can inhibit the negative effect of competition effect on cost addition?

This paper uses the intermediary analysis method: to test whether the intermediary effect exists between the changes in the export destinations' market demand and the cost addition according to the process summarized by Wen Zhonglin (2014) [12].

$$Y = cX + e_1 \tag{1}$$

$$M = aX + e_2 \tag{2}$$

$$Y = bM + e_3 \tag{3}$$

$$Y = c'X + dM + e_4 \tag{4}$$

In Equation (1), c is the total effect of the variable X on Y. The a,b in formula (2) and formula (3) means the mediation effect.

c' of the equation (4) is the direct effect after controlling the mediation variable. According to the test procedure, the total effect in formula. (1), if significant, can be argued according to the mediation effect. Next, a,b at least one is not significant requires a bootstrap test. Further validation to equation (4) will need if the product of ab is significant not zero. Finally, according c' on whether it is significant, it is the intermediary effect or the partial mediation effect; If c' and ab have the same sign, it is an intermediary effect, otherwise it is a masking effect.

2 THEORETICAL MODELS

In this part, we use a parameterized model to analyze the effect of the demand change of export destinations' market on the mark-up pricing of the market size expansion. We mainly explore the reasons for this result and generalize it to more general functional forms. Consumer count L as an exogenous variable is used to represent market size. The diversity of destinations' markets is represented by the continuous variable i with an interval of [0, M]. M represents the measure of product diversity. Assuming that the demand for diversity is q_i , and the representative consumer utility of regional D is

$$\mathrm{u}(\mathrm{q}_i) = \alpha \mathrm{q}_i - \frac{\beta q_i^2}{2}, \quad \alpha > 0,\ \beta > 0 \tag{5}$$

Consumers have no difference in the diversity of products, and the expression of output and profit is not related to product diversity.

2.1 Consumer Optimization Model

Demand variable q_i are generated by consumers λ , and representative consumer prices are the solution to the following optimization problem:

$$\max_{q_i \geq 0} \int_0^M u(q_i)di,\ \ s.t. \int_0^M p_i q_i di = 1 \tag{6}$$

Standardize consumer spending on diversified products to 1 and meet the following assumptions:

(A1) $u(q_i) \geq 0;\ u'(q_i) \geq 0;\ u''(q_i) \geq 0;\ q_i \geq 0$

Its counter-demand function is:

$$p(q_i)=\frac{u'(q_i)}{\lambda}=\frac{\alpha-\beta q_i}{\lambda} \tag{7}$$

$\lambda=\int_0^M u'(q_i)di$ is the Lagrange operator, it is also equivalent to the marginal utility of the income. Under the assumption of consumer homogeneity M, with the help of the representative consumer utility function, we can get the marginal utility of income is the only endogenous aggregate demand steering variable λ, it make the consumption curve move inward. λ is the competition parameter (Melitz,2018) [4].

2.2Enterprise Maximum Optimization Model

Consider the company having a marginal cost c as well as the competition parameters λ. The needs of the unit consumer are recorded $q(c,\lambda)$, the enterprises' profit is $\pi=L(p(q_i)q_i-cq_i)$.

Based on the optimized first order conditions, obtained $q(c,\lambda)=\frac{\alpha-c\lambda}{2\beta}$, in order to determine the above equation solution exists and is unique, further set:

(A_2) $\varepsilon_p(0)<1$.

Among them $\varepsilon_p(q_i)=-{p'(q_i)q_i}\big/{p(q_i)}$, this setting ensures that the marginal return curve is diminishing at all output levels and is positive at a given output level. Under the optimal output level, the mark-up pricing of the product q_i is calculated:

$$\mu(q_i)=\frac{q+c\lambda}{2c\lambda} \tag{8}$$

It can be seen from the above expression that under the condition of short-term equilibrium and constant competition, the increase of market size has no impact on the mark-up pricing. In the long term, changes in mark-up pricing depend on market competition effects.

2.3 Selection of Innovative Behavior

The productivity level of enterprises is determined by their benchmark costs $\tilde{c}$. Enterprises reduce the marginal costs of enterprises through innovative investment. The hypothesis is

$$c=\tilde{c}-\varepsilon k \tag{9}$$

The k refers to R & D investments, and $\varepsilon>0$. The innovation cost of the enterprise is $\frac{1}{2}c_I k^2$, that the company optimizes investment is $k(\tilde{c},\lambda)$, to maximize profits, we can get equation (10).

$$\prod(\tilde{c},k;\lambda)=L\prod(\tilde{c},k;\lambda)-\frac{1}{2}c_I k^2 \tag{10}$$

If the R & D investment is positive, we can get equation (11).

$$\varepsilon L[\alpha - (\tilde{c} - \varepsilon k)\lambda] / 2\beta = c_I k \tag{11}$$

Direct calculation is:

$$k = \frac{\alpha - \tilde{c}\lambda}{\frac{2\beta}{\varepsilon L} c_I - \varepsilon\lambda} \tag{12}$$

2.4 Influence of Innovation on Mark-Up Pricing

1. The higher the founding productivity of an enterprise, the more increase in innovation investment as the market demand increases.

Derivation of (12) can get (13).

$$\frac{dk}{dL} = 2\beta c_I (\frac{\alpha}{\lambda} - \tilde{c}) + \varepsilon^2 L^2 \frac{d\lambda}{dL} (\varepsilon L - \frac{2\beta}{\varepsilon L} c^2{}_I) + \varepsilon^2 L^2 \frac{d\lambda}{dL} \frac{2\beta}{\varepsilon L} c_I (c_I - \tilde{c}) \tag{13}$$

Enterprises with higher initial productivity, their mark-up pricing increases with innovation investment.

Substitute formula (9) into formula (8), derivation of (8), obtain:

$$\frac{d\mu}{dL} = \frac{\alpha}{2(c\lambda)^2} [\varepsilon\lambda \frac{dk}{d\lambda} - (\tilde{c} - \varepsilon k) \frac{d\lambda}{dL}] \tag{14}$$

When the initial productivity is sufficiently high, the second term of equation (13) tends to be zero, and $\frac{d\mu}{dL} > 0$. This proposition shows that innovation promotes the improvement of mark-up pricing.

2.5 Plus up Pricing Estimation Method

This paper calculates the mark-up rate following De Loecker and Warzynski (2012) [14]. Existing studies usually use the OP method or semi-parametric methods which represented by LP to control the productivity impact by controlling the monotonic relationship between enterprise investment and intermediate product investment and productivity, but may still produce collinearity problems, and this problems will lead the failure of estimation. Therefore, if the production function is estimated by ACF's method to avoid possible collinearity problems. This paper assumes that:

$$m_{it} = m_t (k_{it}, \omega_{it}, Z_{it}) \tag{15}$$

Among them, m_{it} represents the intermediate input of enterprise i in year t, k_{it} represents the capital input and ω_{it} represents the enterprise productivity, Z_{it} is the control variable vector affecting enterprise input demand, including some enterprise level eigenvectors such as enterprise export status; Adding Z_{it} makes it unnecessary to consider the characteristics at the enterprise level when calculating the output elasticity of subsequent input factors. This paper uses the inverse function $\omega_t = h_t(m_{it}, k_{it}, Z_{it})$ of intermediate input m_t to substitute productivity into production function. In the setting of the production function, using a more flexible transcendental logarithmic production function, the equation is:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l^2{}_{it} + \beta_{kk} k^2{}_{it} + \beta_{mm} m^2{}_{it} + \beta_{lk} l_{it} k_{it} \\ + \beta_{lm} l_{it} m_{it} + \beta_{mk} m_{it} k_{it} + \beta_{lmk} l_{it} m_{it} k_{it} + \omega_{it} + \varepsilon_{it.} \tag{16}$$

Among them y_{it} , l_{it} , k_{it} , m_{it} respectively are the total enterprise output, number of employees, capital investment and intermediate product investment after taking the natural logarithm. The above lowercase letters indicate the factor input after the price reduction and the logarithmic taking. β_l β_{lkm} respectively are the parameter to be estimated, ω_{it} represents enterprise productivity, and ε_{it} represents residual terms.

In the first step, we substitute the surrogate equation of productivity into the production function and obtain the following equation:

$y_{it} = \phi_t(l_{it}, k_{it}, m_{it}, Z_{it})$.

Then we obtain the estimate of the expected output $\hat{\phi}_t$ and the estimate of the residual term ε_{it} . The expected output is:

$$\hat{\phi}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l^2{}_{it} + \beta_{kk} k^2{}_{it} + \beta_{mm} m^2{}_{it} + \beta_{lk} l_{it} k_{it} \\ + \beta_{lm} l_{it} m_{it} + \beta_{mk} m_{it} k_{it} + \beta_{lmk} l_{it} m_{it} k_{it} + h_t(m_{it}, k_{it}, Z_{it}) \tag{17}$$

In the second step, we assume that the productivity changes obey the first-order Markov properties:

$$\omega_{it} = g_t(\omega_{it-1}) + \xi_{it} \tag{18}$$

The corresponding parameter estimation in the production function is obtained by GMM estimation, and then the output elasticity of intermediate material input factors at the enterprise level is obtained according to $\hat{\beta}_m + 2\hat{\beta}_m m_{it} + \hat{\beta}_{lm} l_{it} + \hat{\beta}_{km} k_{it} + \hat{\beta}_{lmk} \mathrm{k}_{it}$.

Based on De Loecker and Warzynski (2012), we obtain the mark-up rate μ formula as:

$$\mu_{it} = \theta_{it}{}^M (\alpha_{it}{}^M)^{-1} \tag{19}$$

3 WAY ANALYSIS FRAMEWORK

3.1 Firm-level Export Demand Shocks

In order to establish the export demand impact indicators, consider the enterprise f export product s to the destination j at the initial moment t. Let M_{jst} indicate the total import value of product s excluding China's export value of export destination j. When $t \geq t_0$, M_{jst} reflects the change of market share of export destinations. For M_{jst} , we use the initial time of enterprise f to weight the export volume of the country in the total export volume of the enterprise. The reason is that the potential import change of the destinations' country is a good approximation to the change of the export situation faced by the enterprise. The initial export density of enterprises refers to the ratio of export delivery value at the time of first export to the sales revenue of the current year, which is used as the weighting of export demand impact. When the export density of enterprises is zero, the ratio of enterprises' exports to destination' countries to their total exports is close to zero, and enterprises are also least affected by the export impact of destination countries.

Note X_{fjt} as the export of enterprise f to the destination country j at the time t. This refers to the first observed export value of the data entering the sample. At time t, export demand impact is

$$D_{ft}^{M_s} = \frac{X^*_{\mathrm{ft}_0}}{S^*_{ft_0}} \sum_{j,s} \frac{X_{\mathrm{fjst}_0}}{X_{ft_0}} \log M_{jst} \tag{20}$$

Among them, $X_{ft_0} = \sum_{j,s} X_{fjst_0}$ refers to the enterprise level of export at the moment of the aggregate. Weighted $\frac{X^*_{ft_0}}{S_{ft_0}^*} \; \frac{X_{fjst_0}}{X_{ft_0}}$ represents the initial share of product sales revenue at the export destination. The enterprise asterisk segment represents the initial export density, which $X^*_{ft_0}$ represents the total export, $S_{ft_0}^*$ represents the total sales revenue from the product s.

In this paper, the time variables $D_{ft}^{M_s}$ arise only from demand impact exit flow, regardless of the weighted term, which depends only to the initial period of the export t_0. This paper expects that the impact of export demand at time t will lead to the change of time t plus pricing and the marginal effect of cost addition. Endogenicity from export demand shocks was excluded by weighting at the fixed enterprise level (including the wide extension margin of product and destination).

This paper uses another measure of export demand impact, namely using an aggregate of industrial-level data. By adding the export destinations' market (excluding the industrial level data of Chinese export to the country), utilization

$$D_{ft}^{M_I} = \frac{X^*_{\mathrm{ft}_0}}{S^*_{ft_0}} \sum_{jI} \frac{X_{\mathrm{fjIt}_0}}{X_{ft_0}} \log M_{jIt} \tag{21}$$

Measurement $M_{jIt} = \sum_{s \in I} M_{jst}$ here is the aggregate import of industrial I from the destination j. The measure $X_{\mathrm{j}It_0} = \sum_{s \in I} X_{\mathrm{jst}_0}$ is the aggregate of the number of industrial I that enterprise f exported to the destination j at time t_0.

3.2 Main Estimates

3.2.1 Mediation effect model

To test the assumptions proposed in this paper, tests of mediation effects can be given using the Bootstrap method. Mediation effect research method has been widely used in the empirical study of influence mechanism analysis. To avoid the absence of intercept terms in the regression equation, all variables can be decentralized, and the data is subtracted and the sample mean is zero (Wen Zhonglin et al., 2014) [12]. The mediation model used in this paper contains four equations, equation (22) used to test the impact of different initial productivity enterprises on enterprise cost addition under conditions of changes of market demand of the export destination.

$$makrup_{ft} = \alpha_{10} D_{ft}^{M_s} + \alpha_{11} D_{ft}^{M_s} \times df + \gamma_1' Z_{ft} + \chi_f + \chi_t + \varepsilon_{ft} \tag{22}$$

Equation (23) is used to test the change in market demand of the export destination, and the impact of different initial productivity enterprises on intermediary variables.

$$\mathrm{new}_{ft} = \alpha_{20} D_{ft}^{M_s} + \alpha_{21} D_{ft}^{M_s} \times df + \gamma_2' Z_{ft} + \chi_f + \chi_t + \varepsilon_{ft} \tag{23}$$

Equation (24) is used to examine the effect of intermediary variables (new product output value) on the enterprise addition rate.

$$makrup_{ft} = \alpha_{30} + \alpha_{31} \mathrm{new}_{ft} + \gamma_3' Z_{ft} + \chi_f + \chi_t + \varepsilon_{ft} \tag{24}$$

Equation (25) is used to examine the impact of intermediary variables on enterprise cost addition under the change of market demand of the export destination.

$$makrup_{ft} = \alpha_{40} D_{ft}^{M_s} + \alpha_{41} D_{ft}^{M_s} \times df + \alpha_{42} \mathrm{new}_{ft} + \gamma_4' Z_{ft} + \chi_f + \chi_t + \varepsilon_{ft} \tag{25}$$

Among them, here $makrup_{ft}$ refers to the measurement of mark-up pricing enterprise f on time, and $D_{ft}^{M_s}$ depicts the export demand index. This indicator is completely exogenous for the decision-making of enterprises. χ_t Controls for temporal heterogeneity, and χ_f for individual enterprise heterogeneity. ε_{ft} Refers to the random error term.

3.2.2 Endogenous issues

In the above intermediary model, the relationship between market demand changes of the enterprise export destinations, innovation and cost addition may be causal to each other, thus causing endogenous problems and leading to bias in OLS estimates. To solve the endogenous problem of the causal inversion of the variables mentioned above, the generalized moment estimation can be used. Although unbiased estimates can be obtained, they can also cause the sample loss and the large variance of the estimation coefficient. Therefore, the existing literature mostly uses the OLS estimation intermediary effect model. OLS estimation results can be used as a benchmark result and using GMM estimation results as a test of robustness.

4 CONCLUSIONS

Based on the quantitative operation, this paper builds a general formula for the influence of innovation on mark-uo pricing through the choice of consumer optimization model, the enterprise optimization model, and the innovation behavior. The export impact function can be constructed with the change of the market share of the export destinations, the initial export density of the enterprises, the total export and the total sales revenue. The intermediary effect model can be used to estimate it. This paper builds a mathematical model and provides a perfect model framework for scholars' empirical analysis of the change of market demand, innovation and cost addition in the export destinations.

REFERENCES

[1] Liu,Q.R., Huang,J.ZH.(2015) Suphibiting export propensity, learning effects and "low addition rate trap" .Economic Research.,12:143-157.

[2] Huang, X., J, Z.CH., Yu, L.H.(2018) Export, innovation and entrepreneur add-up rate: based on factor density .The World Economy, 5:125-143.

[3] Aghion, P.; Bergeaud, A.; Lequien, M.and Melitz.(2017) “The Impact of Export on Innovation: Theory and Evidence."NBER Working paper.

[4] Aghion, P.;Bergeaud,A.;Lequien,M.and Melitz.(2018) “The Impact of Export on Innovation: Theory and Evidence."NBER Working paper.

[5] Sheng, D., Wang, Y.J.,(2012) Chinese enterprise low-price export mystery —— is based on the perspective of enterprise bonus rate. Managing the World, 5: 8-23.

[6] Xu, M., Li, Y.F.,(2018) Mystery of low Chinese export bonus rate: competition effect or selection effect. The World Economy, 41: 77-102.

[7] Zhu, S.j., Zhang, P.H., (2015) Do exporters have higher cost addition: evidence of Chinese manufacturing. The World Economy, 4:3-24.

[8] P Aghion, P Howitt. A model of growth through creative destruction Econometrica, 1992(60):323-351.

[9] Liu, Q.R., Huang, J.ZH.(2016) How the product innovation affects the enterprise markup rate. The World Economy, 39 (11): 28-53.

[10] Li, Sh.Q., Xu, J.ZH., (2016) Study on Influects of Manufacturing Export Enterprises on Add markup Rate. Exploration of economic problems, 9: 101-109.

[11] Melitz, M.J. (2018) “Competitive effects of trade: theory and measurement." Review World Economics, 154, 1–13.

[12] Wen, Zh.L., Ye, B.J., (2014) Intermediation effect analysis: Methods and model development. Progress in Psychology, 22: 731-745.

[13] Nie, H.H., Jiang, T., Yang, R.D., (2012) Current status and potential problems of industrial enterprise database in China. The World Economy,5:14-158.

[14] De Locker, F.Warznski. (2012) “Markup and Firm-Lever Export Status," American Economic Review, 102(6):2437-2471.