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Abstract

This paper reviews a recent paper by De Loecker and Warzynski (AER, 2012), which developed a method (so-called DLW method) to estimate markups (market powers) using plant-level production data. Although DLW aimed to explore the relationship between markups and export behavior, its core value is the estimation method of firm-level markups. However, this paper finds that the DLW method still has some errors, one is the disadvantages of supply-side model, the other is that they used an identical equation to estimate markup.

Key words: Market power; DLW method; Supply-side model; Parameters identification

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1 INTRODUCTION

Market power (or markup) is an old topic in the fields of industrial organization and international trade; many prestigious economists have researched it, such as Chamberlin (1933), Lerner (1934, 1972), Samuelson (1964), Bresnahan (1989), and Tirole (2015). With the rapid development of empirical methods, this problem has been studied in more depth (e.g., Berry, Levinsohn, and Pakes, 1995), but to date, there is still no authoritative method to measure market power (or markup) and accompanying welfare loss.

A recent paper by De Loecker and Warzynski (AER, 2012), henceforth DLW, develops a method to estimate markups using plant-level production data. The paper has been cited by a lot of scholars, because the method (so-called DLW method) is relatively easy to operate. Although this paper aims to explore the relationship between markups and export behavior, its core value is the estimation method of firm-level markups. However, we find that the DLW method still has some errors. Because cannot obtain the primitive data, we just give a theoretical explanation.

2 MEARURING METHODS OF MARKUP

There are two types of models to estimate markup: One is the supply-side model, and the other is the demand-side model. The former is more convenient (De Loecker and Warzynski, 2012; Berry and Haile, 2015), but the latter is more popular in academia (for example, Berry, Levinsohn and Pakes, 1995; Nevo, 2000, 2001). Of course, as shown in Table 1, each method has advantages and disadvantages. For example, estimation of the demand-side model is relatively difficult, especially when facing serious endogenous problems[1], but its premise conditions are more tolerant.

Relies on the first order condition (FOC) of cost minimization, DLW gave the expression of

[1] The endogenous problem is caused by the interaction of price and market share (demand).

	Supply-side methods	Demand-side methods
Markup	$markup = P/MC$	$markup = P - MC$
Literature	Hall (1988); Roeger (1995); Klette (1999); Ellis and Halvorsen (2002); DeSouza (2009); De Loecker (2011); De Loecker and Warzynshi (2012)	Berry (1994); BLP (1995); Goldberg (1995); Nevo (2000, 2001); Capps et al. (2003); Davis (2006); Zhelobodko et al. (2012); Berry and Haile (2015); Pakes (2015)
Advantages	(1) Less micro data requirements. (2) Do not consider endogenous and instrumental variables. (3) Do not consider product characteristics. (4) Be easy to calculate.	(1) Do not require that every plant has realized cost optimization. (2) Can estimate demand system, is convenient to analyze price competition. (3) Can estimate some other parameters in addition to markup.
Disadvantages	(1) Assume at least one input factors are free to adjust. (2) Assume that every plant has realized cost optimization. (3) Assume a special production function. (4) Need to control TFP.	(1) Endogeneity and instrumental variables selection. (2) Need abundant product-level micro data, and long-panel data structure. (3) Assume a special utility function, and simulate the market share.

Note: P defines price, MC defines marginal cost. In order to remain consistent with DLW, this paper uses the division-form markup (P/MC), which can also be derived straightforwardly from Lerner index and has no unit.
Source: Summarized by the authors.

Table 1: Supply-side and demand-side methods of markup estimation

markup as follows:

$$\mu_{it} \equiv \frac{P_{it}}{MC_{it}} = (\frac{\partial Q_{it} X_{it}}{\partial X_{it} Q_{it}})/(\frac{P_{it}^X X_{it}}{P_{it} Q_{it}}) = (\frac{\partial Q_{it} X_{it}}{\partial X_{it} Q_{it}})/(\frac{P_{it}^X X_{it}}{R_{it}}) = \frac{\theta_{it}^X}{\alpha_{it}^X}. \tag{2.1}$$

where θ_{it}^X denotes the output elasticity on input X, α_{it}^X denotes the share of expenditures on input X, and P, Q, R denote product price, quantity, and sales revenue, respectively. To be specific, the DLW method estimates markups as follows:

1. *Estimate θ_{it}^X and random disturbance term using ACF method*[2]*;*

2. *Correct α_{it}^X using the random disturbance term obtained in the step 1;*

3. *Calculate markups (μ_{it}) using equation (2.1) and steps 1-2.*

[2] If the input-output data are observable, some other parametric or nonparametric methods in addition to the ACF method are also feasible in the first step.

3 PROBLEMS OF DLW METHOD

According to the three steps of DLW method, in order to estimate markups, researchers must first estimate the output elasticity (θ_{it}^{X}) and expenditure share (α_{it}^{X}). It is relatively easy to obtain the data on α_{it}^{X}, but very difficult to estimate θ_{it}^{X}. Even DLW used the famous ACF (Ackerberg, Caves, and Frazer, 2015) method to estimate θ_{it}^{X}, there are still at least two serious problems.

3.1 Disadvantages of Supply-Side Model

As summarized in Table 1, DLW method belongs to a typical supply-side method. Table 1 mentioned four disadvantages of supply-side methods: First, this kind of model assumes that at least one input factor is free to adjust; second, assumes cost-minimizing producer, so factor price is equal to its value of marginal product ($P^X = \partial R/\partial X$); third, assumes a special production-function form, for example, translog form, so there may be specification bias[3]; fourth, estimating the output elasticity of a given factor should control the inputs of other factors, productivity level and the random disturbance term, but productivity and random disturbance term are unobservable, and productivity is endogenous.

If employ ACF method to estimate production function and θ_{it}^{X}, the latter two disadvantages could be solved partially, but it is still hard to avoid the first two disadvantages. Inputs, in fact, are difficult to freely adjust, especially DLW chose labour factor, which has adjustment costs obviously.[4] Additionally, factors markets are not necessarily in equilibrium level, so producers maybe do not realize cost optimization, leading the FOC of cost minimization does not satisfy.

[3]If employ a translog or high-degree polynomial production function, the estimate of marginal output (and output elasticity) of a certain factor may be negative, which is caused by the inherent defects of parametric methods. When the estimate of output elasticity (θ) is negative, the DLW method loses efficacy.

[4]DLW gave some discussions about adjustment costs, but did not solve the problem. In other words, DLW assumed free of any adjustment costs when derived the FOC, but this assumption is very strict.

3.2 Unobtainable Production Data

According to equation (2.1), DLW gave the estimation formula of markup as $\mu_{it} = \theta_{it}^X (\alpha_{it}^X)^{-1}$, where θ^X denotes output elasticity of factor X, i.e., $\theta^X = \partial lnQ/\partial lnX$ (for simplicity in notation, the subscripts are omitted; the same below). However, in reality, researchers often cannot obtain the specific data of output (Q), even for producers themselves, because a firm could produce a variety of products. Generally, researchers can only obtain the data of operating income (or added value), i.e., $R = PQ$. Therefore, most researchers use R instead of Q to estimate output elasticity.[5]

After using R instead of Q, the markup estimated by DLW method is $\hat{\mu} = (\partial lnR/\partial lnX)/\alpha^X$, where $\partial lnR/\partial lnX$ satisfies

$$\frac{\partial R}{\partial X}\frac{X}{R} = \frac{\partial P}{\partial X}\frac{X}{P} + \frac{\partial Q}{\partial X}\frac{X}{Q} = \frac{\partial P}{\partial Q}\frac{Q}{P}\frac{\partial Q}{\partial X}\frac{X}{Q} + \frac{\partial Q}{\partial X}\frac{X}{Q} = (1 + \frac{1}{\eta})\frac{\partial lnQ}{\partial lnX}. \tag{3.1}$$

where η denotes price elasticity of demand, $\partial lnQ/\partial lnX = \theta^X$ is the real output elasticity on input X; because Q is unobservable, it is also difficult to estimate the real θ^X. According to the relationship between markup and market power, $\mu = 1/(1 - \upsilon)$, where υ denotes Lerner Index. And through $MR = MC$,[6] there exists $\upsilon = -1/\eta$. Therefore, $\mu = \eta/(1 + \eta)$, which is equivalent to $1/\mu = 1 + 1/\eta$. Substituting it into equation (3.1), obtain

$$\frac{\partial R}{\partial X}\frac{X}{R} = \frac{1}{\mu}\frac{\partial Q}{\partial X}\frac{X}{Q}. \tag{3.2}$$

By equation (3.2), using $(\partial lnR/\partial lnX)/\alpha^X$ to estimate markup in the DLW method is equivalent to $\hat{\mu} = (\partial lnQ/\partial lnX)/(\alpha^X \mu)$, and because the real markup satisfies that $\mu = (\partial lnQ/\partial lnX)/\alpha^X$,

[5] DLW wrote that"The estimation of the production function requires information on plant-level output (revenues deflated with detailed producer price indices), (deflated) value added, input use: labor as measured by full time equivalent production workers, raw materials and a measure of the capital stock." Thus they used revenues instead of outputs, but revenues have included price information while output only represents quantity.

[6] No matter in a perfect competition, monopolistic competition, oligopoly, or monopoly market, rational producers always make decisions based on this principle, so $MR = MC$ is not very strict. If we do not impose this condition, it is almost impossible to analyze the supply-side model or demand-side model.

have $\hat{\mu} \equiv 1$ theoretically. From the above derivation, if researchers use operating revenue or added value or similar income indices instead of output quantity to estimate markup, the theoretical estimate of markup should equal to 1. If the actual estimate results are not equal to 1 (such as DLW's results), the main reason is that the premise of cost minimization is not satisfied, i.e., $\partial lnR/\partial lnX \neq \alpha^X$. Therefore, no matter the estimated markups of DLW method equal to 1 or not, the results do not reflect the real markups.

According to equation (3.2), the real markup satisfies[7]

$$\mu = \frac{\partial Q}{\partial X}\frac{X}{Q}/\frac{\partial R}{\partial X}\frac{X}{R}. \tag{3.3}$$

But, estimated markup of DLW method is

$$\hat{\mu} = \frac{\partial R}{\partial X}\frac{X}{R}/\alpha^X. \tag{3.4}$$

If actual data satisfies the assumption of DLW method, i.e., cost-minimizing producers, the equation, $\partial lnR/\partial lnX = \alpha^X$, holds. At this case, from equation (3.4) there exists $\hat{\mu} = 1$, which is a paradox[8]. As mentioned above, inputs are difficult to freely adjust, and producers are also hard to make decisions in strict accordance with cost minimization, so in fact factor price is often lower than its value of marginal product, i.e., $\partial R/\partial X \geq P^X$, so $\partial lnR/\partial lnX \geq \alpha^X$. On the other hand, because the markup of ordinary goods tends to be greater than 1, by equation (3.3) we know $\partial lnQ/\partial lnX \geq \partial lnR/\partial lnX$. Therefore, compare equation (3.4) to equation (3.3), both numerator and denominator are smaller, so DLW overestimating or underestimating markup is not sure, but obviously the estimation is not correct.

[7] From equation (3.3), if use operating income (R) instead of output quantity (Q) to estimate output elasticity of factor ($\partial lnQ/\partial lnX$), it is equivalent to assume that $markup = 1$.

[8] According to the assumptions of DLW method, if firms are cost-minimizing producers, then $\partial lnR/\partial lnX = \alpha^X$. Substitute it into equation (3.3), we can obtain $\mu = (\partial lnQ/\partial lnX)/\alpha^X$, which is the calculating formula of markup given by DLW. However, because Q is unobservable, DLW and a lot of other papers that cited the DLW method used $\partial lnR/\partial lnX$ to replace $\partial lnQ/\partial lnX$, then $\hat{\mu} = (\partial lnR/\partial lnX)/\alpha^X = 1$ because $\partial lnR/\partial lnX = \alpha^X$. Therefore, DLW method is a paradox, using an identical equation to estimate markup.

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