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Market Distortions and Productivity Growth with Reference to India

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Abstract

The paper studies how market imperfections distort the usual productivity growth using Indian disaggregated level of industrial data for the period of 1998-2005. A modified approach, which has dealt with the imperfections and simultaneity problems of factor choice, accounts for a lower productivity growth than the usual estimate.

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1. Introduction

The residual growth is usually considered to be the best proxy for total factor productivity growth (TFPG) to understand the technological shift of an economy. According to the production function approach, it conventionally uses either factor share (Solow, 1957) or factor elasticity (Levinsohn and Petrin, 2003) in order to subtract the factor contribution from the output growth. But, such simple calculation often ignores market imperfections and, therefore, misleads the true level of productivity growth. For example, the product market power simply inflates the residue without changing the technology frontier. Similarly, when union workers receive wage rent, the residue will essentially be lower simply because of labor market imperfections. Therefore, the simple calculation of residual change cannot provide the actual productivity growth unless one eliminates the effects of market imperfections from the residual growth. Simultaneity issue is another problem in the estimation where a part of productivity growth is usually seen, while selecting factors of production, before the actual production takes place. To the best of my knowledge, no existing study has yet dealt with these two issues together in the productivity derivation, at least in the Indian context.

Recently, Abraham et al. (2009) incorporated an approach developed by Olley and Pakes, (1996) to deal with the simultaneity issue in the decomposition analysis of cost-price margin between benefits of producer and worker for Belgium firms. In the estimation, investment is used as proxy for the simultaneity problem econometrically. But, such investment data is always under-reported by the firms and is practically zero for sizeable number of firms, causing invertibility problem in the estimation. Therefore, the intermediate input usage has been recommended as a better proxy (e.g., Levinsohn and Petrin, 2003). Incorporating the above-mentioned development, the present paper provides a modified estimate of productivity growth for Indian economy in dealing with both simultaneity and market imperfections at the three-digit industry level over fifteen Indian states during 1998-2005. The rest of the paper is organised as follows: the section 2 develops a theoretical framework. The econometric method and its results have been discussed respectively in section 3 and 4. The section 5 ends up with concluding remarks.

2. Theoretical Framework

Let us consider a Cobb-Douglas production function where value added of firm Q is produced with the use of labor L and capital K, i.e., $Q = AF(L,K)$. The function is assumed to be homogeneous of degree $1+\lambda$ for all input factors. By taking logarithmic value and total differentiating, we get:

$$(q-k)-\varepsilon_L(l-k)=\lambda k+a \tag{1}$$

Here, ε_L is labor elasticity. The left-hand expression in (1) represents the residual change which is the sum of capital growth explaining returns to scale (λk) and unexplained random term (a). This unexplained term can be used as a proxy for the traditional TFPG. Two practical problems appeared in the productivity estimation using this equation have been elasticity derivation (ε_L) and simultaneity issue between k and a. The traditional approaches (using either factor share use or elasticity estimation) of productivity derivation have been fundamentally based on the assumption of perfect competition prevailing in both product and factor markets. Under the perfect competition, we get that $\varepsilon_L = s_L$, where, ε_L and s_L are respectively labor elasticity and share. Because, wage is paid according to their value of marginal production (i.e., $w = P.MP_L$).

If the product market shows imperfect competition, the wage is paid according to their marginal revenue product (*MRP*), i.e., the product of marginal revenue (*MR*) and marginal physical product (MPP_L), where $MR = MC < P$. If P and MC are respectively price and marginal cost of production and the mark-up (μ) is defined by $\mu = P/MC$, we find that $\varepsilon_L = \mu s_L$. Assuming $\varepsilon_L + \varepsilon_K = 1 + \lambda$ and replacing in (1), we easily rewrite as follows:

$$(q-k) - s_L(l-k) = \beta(q-k) + \lambda k + (1-\beta)a \qquad (2)$$

Where, $\beta = (p - MC)/P = 1 - (1/\mu)$ is the Lerner index. Note that μ and β are directly related. The eq. (2) shows an additional term in the right-hand side and this captures the product market distortion.

Assume that the labor market is further unionised and maximises either wage or/and employment with the given bargaining power θ. If $\overline{L}$ is the total workforce in the economy and w_a is the alternative wage, the union wage can be derived from the following Nash bargaining equation,

$$\max_{w,L} \Omega = (Lw + (\overline{L} - L)w_a - \overline{L}w_a)^{\theta}(PQ - wL)^{1-\theta} \qquad (3)$$

Differentiating with respect to wage and employment, and then rearranging the terms, we get

$$\varepsilon_L = \mu s_L + \mu(s_L - 1)\theta/(1-\theta) \qquad (4)$$

Combining (2) and (4), we can write

$$(q-k) - s_L(l-k) = \beta(q-k) + \frac{\lambda}{\mu}k + \frac{\theta}{1-\theta}(s-1)(l-k) + (1-\beta)a \qquad (5)$$

The left-hand side expression is nothing but the Solow residual and this is decomposed into four terms – product market distortion (first term), returns to scale (second term), labor market distortion (third term) and productivity component (last term) in the right-hand side. Eliminating the first three effects, the estimated residual growth would provide the true level of productivity growth. Note that the product and labor market distortions work oppositely on the residual growth. If the sum of these two distortions is zero, the usual estimate could be unbiased or otherwise not. Moreover, the expression (5) is essentially a different from the one used in Levinsohn and Petrin (2003).

3. Econometric Analysis

A disaggregated information at three-digit industries for fifteen major states during 1998-2005 has been collected from the Annual Survey of Industries, Government of India. Since a major change of industrial classification is taken place on 1998, a perfect matching of industrial codes with the previous classifications has been really difficult. Hence, our sample has been confined into the period of 1998-2005 where total observarions are approximately 4536. One can write an econometric expression of eq. (5) as follows.

$$SR_{ijt} = \beta LR_{ijt} + \gamma k_{ijt} + \eta BR_{ijt} + w_{ijt} + u_{ijt};\ i = industry, j = state\ and\ t = 1998 - 2005 \qquad (6)$$

where, $SR_{ijt} = (q_{ijt} - k_{ijt}) - s_{L,ijt}(l_{ijt} - k_{ijt})$, $LR_{ijt} = (q_{ijt} - k_{ijt})$, $\gamma = \frac{\lambda}{\mu}$, $\eta = \frac{\theta}{1-\theta}$. When β is positive, μ and β are directly related and *SR* rises with *LR*. $BR_{ijt} = (\alpha_{L,ijt} - 1)(l_{ijt} - k_{ijt})$ rises with either wage share (α) or/and employment (*L*) at the *i*-th industry, *j*-state and *t*-th period. The expression (6) enables us to estimate a modified productivity growth, avoiding the effects of mark-up and wage rent without using the information on market price and alternative wage.

However, the estimation is not stright-forward. Since a firm usually observes a part of productivity change before selecting the factors of production, the simple regression results using OLS would be misleading. Therefore, the simple pooled and fixed effect panel regression techniques also cannot be applied here. As discussed, although Olley and Pakes (1996) suggested the investment proxy for the unobserved productivity shock, this is further criticised by Levinsohn and Petrin (2003) on several grounds. The investment proxy is only valid for non-zero observations. Pronounced adjustment costs force most firms in developing countries like India, Turkey, Colombia, Mexico and Indonesia to report zero-investment and therefore, it violates the invertibility condition required in the estimation process. The use of intermediate inputs would avoid such problems. Second, the adjustment costs lead to kink points in the investment demand function leaving a possibility of high correlation between regressors and error term. If it is less costly to adjust intermediate inputs it would respond more fully to the productivity term. Third, since intermediate inputs are state variables, it serves an excellent link between estimation strategy and economic theory.

According to an experiment, the intermediate inputs (like material costs and electricity usages) have been found as better proxies and both of them have been used jointly as proxy variables in the current study. These two components, in fact, sum up the total intermediate inputs of production, and we checked that the actual estimate with the use of total inputs is almost identical to that of our proxy variables. Moreover, the possibility of kink point in the input demand function would be less likely to occur in the present case.

As the proxy is used for the residual term, the derivation of the parameters from the regression model would not be straight-forward. The estimation procedure involves two steps to deal with the simultaneity problem. At first, the disturbance term of equation (6) is broken into two parts – observed and unobserved term. ω_{ijt} is the observed part and u_{ijt} is the random disturbance term. The expectation of future productivity realisation (i.e., observed term) increases in its contemporaneous values of stock (log-capital) and proxy variables (material costs and fuels, denoted as m_{ijt}). In other words, we can write an unknown function for optimal decision of m_{ijt} as $m_{ijt} = m_t(w_{ijt}, k_{ijt})$. Inverting this function, we write further as $w_{ijt} = h_t(m_{ijt}, k_{ijt})$ and therefore, $\phi_{ijt} = \lambda k_{ijt} + h_t(m_{ijt}, k_{ijt})$ where third order polynomial[1] in *m* and *k* including constant term have been used to define this unknown function. Denoting the estimated variables as $\tilde{\phi}_{ijt}$ and substituting this into (6), we find

[1] The standard assumption is that any approximation at the level lower than third order of an unknown function is considered to be gross and any level beyond this order complicates the process a lot without improving the result substantially. Therefore, our estimation is essentially based on the third order polynomial which is being widely used in such literature.

$$SR_{ijt} = \beta LR_{ijt} + \eta BR_{ijt} + \tilde{\phi}_{ijt} + u_{ijt} \tag{7}$$

At the first stage, this equation will be estimated and in order to go to the second stage, we define another variable as $V_{ijt} = SR_{ijt} - \hat{\beta} LR_{ijt} - \hat{\eta} BR_{ijt}$. Alternatively, this equation can be written as follows:

$$V_{ijt} = \gamma k_{ijt} + g(\tilde{\phi}_{ijt-1} - \gamma k_{ijt-1})_{ijt} + \nu_{ijt} + u_{ijt} \tag{8}$$

Again, *g* appears to be an unknown function and is approximated to third order polynomial for its estimation. This is a bit more cumbersome than the first-stage and the estimated ν_{ijt} provides our modified figures of TFPG. Note that the above-method of estimation from unknown non-linear specification relies on iteration process through bootstrapping with an initially specified distribution. Usually, the number iteration in this literature has been 50 times. However, a marginal improvement has been observed in standard error terms when the number of iterations is raised upto 250 times.

4. Results and Discussions

In order to run regression, the required variables like *SR, LR, BR* and *k* have been constructed and then the above-mentioned method has been applied on those. The estimated coefficients of these variables would provide the average values of mark-up, bargaining power and economies of scale in Indian industries during 1998-2005. The coefficient of *LR* has been positive and statistically significant (Table 1). From this estimated $\hat{\beta}$, we find that the average mark-up (μ) over all industries and states is 3.12. Hence, we safely infer that the product market price in Indian industries tends to be three times higher than their marginal cost of production, on an average.

Table 1: Mark-up and Bargaining power in Indian Industries during 1998-2005

Variables	Coefficient
LR	0.688***(17.02)
BR	-0.993***(-56.06)
K	0.705*** (14.26)
Obs.	4472
Wald- Statistic	70.58
Mark-up	3.12
Bargaining Power	0.50
Return to Scale	2.22

Note: *** p< 1% and figures in parentheses represent t-statistics

The coefficient of *BR* is negative and statistically significant in both regressions. The union bargaining power (θ) from the estimated $\hat{\eta}$ is found almost 0.50. Therefore, we conclude that the workers in Indian organised industries, on an average combining all industries during

1998-2005, are as powerful as employer. The estimated coefficient of *k* (i.e., log of capital) is positive and statistically significant. From the estimated $\hat{\gamma}$, we again find that the average return to scale in the Indian manufacturing (i.e., λ) is 2.26, on an average combining all industries over all regions. This result clearly suggests that Indian industries in the organised sector exhibits increasing return to scale during 1998-2005.

The results derived in the previous section suggest that both mark-up and wage bargaining power significantly affect the residual change of Indian industries. Therefore, these distortions are needed to be eliminated for the estimation of a true productivity growth. It is noteworthy to report that when the total value addition has grown on an average at 7.2% during 1998-2005 in the industrial sector, the employment growth has been less than one percent. Moreover, while the usual productivity growth (based on Solow Residual) has been found to be 1.04% for the period, the modified figure after controlling market distortions has been 0.58%, which is almost of half of the usual one (Table 2). Therefore, it can be concluded that the usual TFPG actually overstates the true level of productivity growth because of market imperfections.

Table 2: Growth of GVA, Solow Residual (SR) and the modified TFPG in Indian Industries during 1998-2005

GVA	7.2
Workers	0.76
Fixed capital	3.12
TFPG	
Usual Solow Residual growth	1.04
Modified TFPG	0.58

Note: Growth rate has been calculated by running simple trend regression after controlling industry and state effects.

5. Conclusion

The present study shows how market imperfections mislead the usual estimate of productivity growth using contemporary evidences from Indian economy. While the product market power overstates the productivity growth, the union power understates the same.

A modified version of Levinsohn and Petrin (2003) have been employed on disaggregated industrial data at the thee-digit level over 15 majors states during 1998-2005 for empirical verification in dealing with both the issues of simultaneity and market distortions. It is observed that while the usual estimate productivity growth is 1.04%, the modified estimate, after controlling market distortions, accounts for almost of half of that.

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