

## **Scale Economies and Returns to Variety of Local Government Expenditures in Korea\***

Sung Tai Kim\*\*

In this paper the effects of local government expenditures on the manufacturing sector output is studied using the public infrastructure model developed by Holtz-Eakin and Lovely (1996). Data from thirteen local governments in Korea for the period 1985-2000 is used to estimate the industry-level returns to a variety of equations as well as the firm-level returns to scale equation.

Strong empirical evidence shows that local government expenditures increase both the number of establishments and the output per firm in the manufacturing sector. Local government expenditures are seen to help increase the output of firms in the manufacturing industry through both industry-level returns to variety effect and firm-level returns to scale effect. The elasticity of the total manufacturing sector output with respect to local government expenditures is calculated at 0.620 and found to be statistically significant. Our empirical findings are very different from earlier empirical studies for most developed countries including the U.S.A. in which the direct effects of local public infrastructure on the manufacturing sector output were absent.

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\*\* Division of Economics and International Commerce, Cheongju University, 36 Naedok-dong, Sangdang-gu, Cheongju, Chungbuk, Republic of Korea, E-mail: stkim@cju.ac.kr

## 1. INTRODUCTION

The local autonomy system in Korea has steadily settled down particularly since 1995 which coincides with the first election for local government presidents. Fiscal decentralization should go along with political decentralization for the successful implementation of the local autonomy system in Korea. There are, however, several conditions to be satisfied for successful fiscal decentralization. Most important is the optimal allocation of functions and roles of the governments at the central and the local levels, where the optimal allocation of resources between the two levels of government should closely follow in accordance with their respective functional allocation.

The government regardless of its level has the duty to provide public goods such as national defense, police protection, roads, harbors, and information highways, etc. The central government should provide the national minimum public capital, while the local governments provide the local public capital for local residents. The local governments use their expenditures as part of local public capital, which consist of investment expenditures and consumption expenditures. The local government's investment expenditures are mostly spent on forming infrastructure in the region, while its consumption expenditures are spent on public services. For optimal allocation of resources of the public sector, it is important that consideration is made to figure out the impact of local government expenditures on the private sector in the regional economy.

Recently the impact of publicly-provided infrastructure capital on private sector productivity has attracted considerable attention.<sup>1)</sup> Before Holtz-Eakin

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<sup>1)</sup> See for example Aschauer (1989) and Munnell (1990a, b) where estimated social returns to infrastructure are found to be far in excess of those for other investments. In response to these arguments a series of econometric studies have focused on the estimated return to public capital. Among others Evans and Karras (1994), Garcia-Mila, McGuire and Porter (1993), Holtz-Eakin (1994), Hulten and Schwab (1991), and Tatom (1993) found that infrastructure did not play a special role in boosting aggregate productivity.

and Lovely (1996) set up a formal theoretical model of the productivity effects of infrastructure, there had been few studies that used a solid theoretical model from which estimation equations were derived. Moreno *et al.* (2002) has recently provided a rigorous theoretical framework for determining the short- and long-run effects of infrastructure and also presents a thorough survey of the literature on the productivity of public infrastructure.

In the case of Korea, very few studies analyze the productivity of local public infrastructure or government expenditures. Lee (1981) indicated the regional gap in infrastructures as a source of regional economic gap. Kim (1987) studied the regional growth impact of infrastructure in Korea for 1970-1986. Kim *et al.* (1991) estimated the regional production function including local public capital in the inputs and found that the regional economic gap in Korea could be explained by differences in productivity of inputs. Yoo (1993) found that local infrastructure played an important role in regional economic development using principal component analysis. Kim (1997) analyzed the role of local public sectors in regional economic growth in Korea.

The purpose of this paper is to examine the effect of local government expenditures on private sector at the regional level in Korea. Using the Holtz-Eakin and Lovely (1996) model we analyze the scale economies and the returns to variety of local government expenditures for the thirteen upper level local governments in Korea for the period 1985-2000.

As pointed out by Holtz-Eakin and Lovely (1996) there are two forms of scale economies in the model: internal scale economies in the production of intermediaries, and returns to variety that act as external economies in the production of finished manufactures. These scale economies provide an explicit rationale for considering public infrastructure provision through local government expenditures.

The remainder of the paper is organized as follows. In section 2 we sketch our theoretical model following Holtz-Eakin *et al.* (1996). In section 3 we estimate the effect of local government expenditures on the regional

economy in terms of scale economies and returns to variety. In section 4 we interpret the empirical results. The final section is a summary with policy implications.

## 2. THE HOLTZ-EAKIN AND LOVELY MODEL OF LOCAL GOVERNMENT EXPENDITURES

We employ the Holtz-Eakin and Lovely (1996) model as a theoretical model for empirical analyses. In this section we sketch how local government expenditures affect the private sector outputs.

In the small open economy there are two goods, the agricultural good ( $A$ ) in primary industry and the manufactured good ( $M$ ) in secondary industry. There are two factors of production – labor ( $L$ ) and capital ( $K$ ). Capital and labor are intersectorally mobile and factor markets are perfectly competitive. Good  $A$  is supplied by perfect competitors using capital and labor combined in a constant-returns-to-scale technology. Alternatively, capital and labor may be used in another constant-returns-to-scale technology to form factor bundles. Factor bundles ( $m$ ) are inputs into the production of components, intermediate goods ( $x_i, i=1, K, n$ ). There are  $n$  intermediate goods. Intermediate goods are used as inputs into the production of finished manufactured good ( $M$ ).

Finished manufactured good has a following production function

$$M = n^\alpha \left[ \sum_{i=1}^n \frac{x_i^\beta}{n} \right]^{\frac{1}{\beta}}. \quad (1)$$

In the production function described by equation (1),  $\alpha$  is a measure of scale economies with respect to the range of intermediates.  $\alpha > 1$  indicates increasing returns to variety, while  $\alpha < 1$  indicates decreasing returns to variety. The parameter  $\beta$  ( $0 < \beta < 1$ ) measures the degree of differentiation

between any two  $x_i$  and  $x_j$  ( $i, j = 1, K, n$ ). The elasticity of substitution between any pair is  $1/(1-\beta)$ . Higher values of  $\beta$  indicate greater ease of substitution of components in the assembly process implying less differentiation among components.

In equilibrium of the model there are  $n$  varieties of components and identical quantity ( $x_0$ ) will be supplied of each variety from the symmetry of components production. Thus, equation (1) is simplified to following equation (2).

$$M = n^\alpha x_0. \quad (2)$$

Local governments expenditures affect finished manufactures ( $M$ ) by two channels, through  $n$  and  $x_0$ . Local government expenditures are used for providing local public goods to reduce private sector resources needed for production of  $x$ . More specifically the presence of local public goods reduce the fixed cost as well as variable cost in production of  $x$ .

Total differentiation of equation (2) gives us equation (3) which may well explain the effect of local government expenditures on the output level of manufactured good ( $M$ ).

$$\frac{dM}{M} = \alpha \frac{dn}{n} + \frac{dx_0}{x_0}. \quad (3)$$

In equation (3) an increase in  $n$  and an increase in  $x_0$  will increase  $M$ .

The first channel by which local government expenditures affect the output of  $M$  is as follows. Increases in local government expenditures are used for supplying more local infrastructures that will increase the number of component producers ( $n$ ) enhancing external economies of finished manufacturing industry. Eventually increases in local government expenditures increase  $M$ .

The second channel by which local government expenditures affect the output of  $M$  is as follows. Increases in local government expenditures increase the supply of local public goods which will change the cost structure

of component production,  $x_0$ . Theoretically the net effect of local government expenditures on  $x_0$  as well as  $M$  is ambiguous.<sup>2)</sup>

### 3. EMPIRICAL ANALYSES

#### 3.1. Estimation Equation and Model Specification Tests

##### 3.1.1. Industry-level Returns to Variety Equation

Our theoretical model suggests that local government expenditure affects manufacturing output through two channels. The first major channel by which local government expenditures operate is through the equilibrium number of firms ( $n$ ). Controlling for the resources available to the manufacturing sector, private capital ( $K$ ) and labor ( $L$ ) in the region, we may regress local government expenditures ( $G$ ) on the number of firms ( $n$ ). Taking the logarithm of the dependent variable ( $n$ ) and explanatory variables ( $K, L, G$ ) the following equation is estimated:

$$\log n_{it} = \beta_0 + \beta_1 \log L_{it} + \beta_2 \log K_{it} + \beta_3 \log G_{it} + u_{it}, \quad (4)$$

where  $i = \text{Seoul, Busan, K, Jeju,}$  and  $t = 1985, K, 2000$ .

In the case of panel data, the disturbance term  $u_{it}$  may be decomposed as follows,  $u_{it} = \eta_i + \varepsilon_{it}$ , where  $\eta_i$  represents the individual effects and  $\varepsilon_{it}$  represents the residual term. Two alternative specification of the model are possible in their treatment of the individual effect: (i) a fixed-effects model that treat  $\eta_i$  as fixed but unknown component differing across individual cross-section units; and (ii) a random-effects or variance component model in which  $\eta_i$  is assumed to be drawn from i.i.d. distribution. Since our study covers thirteen different regions across the country,  $\eta_i$  may include the characteristics and specific management style of the president of local

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<sup>2)</sup> See Holtz-Eakin and Lovely (1996).

governments and regional specific cultures or climates, etc.

### 3.1.2. Firm-level Returns to Scale Equation

The second channel by which local government expenditure operates is through the preferred scale of production  $x_0$  for each firm in the manufacturing sector. We have already shown that the net effect of local government expenditures on  $x_0$  is theoretically ambiguous. Since data on intermediate output per firm is unavailable, we examine the impact of local government expenditures on output per firm in the manufacturing sector,  $M/n$ .

Rearranging equation (2) gives:

$$\frac{M}{n} \equiv x'_0 = n^{\alpha-1} x_0. \quad (5)$$

Thus,  $M/n$  does not directly yield an estimate of  $x_0$ . Instead, if we control for the variance in  $n$ , the effect of  $G$  on  $x'_0$  and  $x_0$  will coincide. Adopting this strategy, we regress the logarithm of output per firm in the manufacturing sector on the logarithms of the number of firms ( $n$ ) and local government expenditures ( $G$ ).

However, it is quite possible that an increase in the number of firms does not represent a rise in the variety of activities. Therefore, we use a measure of the dispersion of manufacturing establishments across activities. For each province, we compute the coefficient of variation (c.v.) of the number of manufacturing and mining establishments across the two-digit Standard Industrial Classification Codes.<sup>3)</sup> In order to control for the variety of activities in manufacturing sector more precisely, we interact  $n$  with the c.v. measure,  $\sigma$ , thereby introducing the variable  $\log(\sigma \cdot n)$  as an explanatory variable. We easily note that a larger value of  $\sigma$  is associated with a lower variety so that the sign of interaction term is expected to have a

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<sup>3)</sup> If there are the same number of firms in each SIC code and hence a great variety of manufacturing activity, the coefficient of variation will be equal to zero. On the other hand if firms are concentrated in a few industries, the c.v. will be larger.

negative sign. The final estimation equation for returns to scale of local government expenditures will be

$$\log \frac{M}{n_{it}} = \gamma_0 + \gamma_1 \log n_{it} + \gamma_2 \log(\sigma \cdot n)_{it} + \gamma_3 \log G_{it} + u_{it}. \quad (6)$$

In equation (6) the expected signs of coefficients are as follows. Since the variety of activity in the manufacturing sector helps to increase output per firm, the expected sign of  $\gamma_1$  is positive. As explained earlier, the expected sign of  $\gamma_2$  is negative. The sign of coefficient  $\gamma_3$  is theoretically ambiguous.

### 3.2. Hausman Model Specification Test

Based on the panel data specification we set up an estimation equation (7)

$$y_{it} = \mu + \beta'x_{it} + \eta_i + \varepsilon_{it}, \quad (7)$$

where  $i = 1, \dots, N$  (the number of cross-section units),  $t = 1, \dots, T$  (the number of periods). In the linear regression framework, when  $\eta_i$  is correlated with  $x_i$ ,  $E[\eta_i | x_i] \neq 0$ , we call (7) a fixed-effect model, while on the other hand, when  $\eta_i$  is uncorrelated with  $x_i$ ,  $E[\eta_i | x_i] = 0$ , we call (7) a random-effect model.

Hausman (1978) suggested using the statistic shown in equation (8) to test the null hypothesis  $E[\eta_i | x_i] = 0$  against the alternative  $E[\eta_i | x_i] \neq 0$ ,

$$m = \hat{q}' \hat{\text{var}}(\hat{q})^{-1} \hat{q}, \quad (8)$$

where  $\hat{q} = \hat{\beta}_F - \hat{\beta}_R$ ,  $\hat{\text{var}}(\hat{q}) = \text{var}(\hat{\beta}_F) - \text{var}(\hat{\beta}_R)$ , and  $\hat{\beta}_F$  and  $\hat{\beta}_R$  denote the estimates from a fixed effect model and a random effect model respectively. Under the null hypothesis, the test statistic (8) is asymptotically a central chi-square distribution, with  $K$  degrees of freedom (where  $K$  is the number of coefficients).

### 3.3. Data

#### Output of Manufacturing Sector: $M$

We measure  $M$  as output of the manufacturing and mining sector.

#### Labor Supply: $L$

$L$  is measured by yearly total number of employees in the manufacturing and mining sector.

#### Private Capital: $K$

Estimates of  $K$  for each province are measured by the amount of tangible assets at the end of year in the manufacturing and mining sector.

#### Number of Establishments: $n$

We use data on the number of manufacturing and mining establishments as a proxy for the range of varieties contributing to industry productivity. We compute the coefficient of variation of  $n$  across the two-digit Standard Industrial Classification Codes in Korea. The data source of variables  $M$ ,  $L$ ,  $K$ , and  $n$  is the Report on Mining and Manufacturing issued by the Korea National Statistical Office.

#### Local Government Expenditures: $G$

Total local government expenditures ( $G$ ) for thirteen local governments consists of investment expenditures ( $G_I$ ) and consumption expenditures ( $G_C$ ).  $G_I$  is measured by the sum of industry, economy and regional development expenditure as well as fisheries, forestry and regional economy expenditures. Regional development expenditures include urban development, road construction, flood control and other various regional development expenditures, while local government consumption expenditures are measured by the sum of general administration, social welfare and other expenditures including civil defense and physical education expenditures. The source for data is the Yearbook of Local Public

Finance in Korea issued by the Ministry of Government Administration and Home Affairs.

## 4. EMPIRICAL RESULTS

### 4.1. Industry-level Returns to Variety of Local Government Expenditures

We begin with the effect of marginal increase in local government expenditures on the number of firms. Table 1 presents the estimation results for equation (4).

**Table 1 Estimation Results for Industry-level Returns to Variety**

$$\log n_{it} = \beta_0 + \beta_1 \log L_{it} + \beta_2 \log K_{it} + \beta_3 \log G_{it} + u_{it}$$

Explanatory Variables	Dependent Variable : $\log n$		
	(1) OLS	(2) Fixed Effect Model★	(3) Random Effect Model
$C$ : Constant	-9.969*** (21.37)	-	-6.987*** (9.93)
$\log L$ : Labor Supply	0.849*** (29.00)	0.368*** (5.44)	0.567*** (11.71)
$\log K$ : Private Capital	-0.272*** (8.58)	0.131*** (2.91)	0.043 (0.99)
$\log G$ : Local Govt' Expenditures	0.603*** (19.16)	0.294*** (6.89)	0.380*** (9.32)
$\overline{R^2}$	0.9463	0.9843	0.9844
F - Statistic	1217.154	6500.782	4376.154
# of Observations	208		

Note: Absolute t-values are in parentheses.

★ denotes the optimal model specification.

\*\*\*: 1%, \*\*: 5%, \*: 10% significance levels respectively.

In table 1 the OLS (Ordinary Least Square) estimation result is in column (1), the fixed effects model estimation result in column (2), and the random effects model estimation result in column (3).<sup>4)</sup>

The Hausman model specification test tells that the chi-square test statistic value is 44.399, which exceeds 13.277 at the 1 percent critical value with 4 degree of freedom. Hence, we reject the null hypothesis,  $E[\eta_i | x_i] = 0$ , and explain our estimation results based on the fixed effect model.

First, the marginal increase in local government expenditures appears to contribute to the growth of the number of manufacturing firms, since the coefficient for variable  $\log G$  is positive and statistically significant.

Second, the estimate of the elasticity of the number of firms with respect to the local government expenditures is 0.294 implying that with a 1% increase in  $G$ , the number of firms  $n$  rises by 0.294%.

Our estimation, statistically significant, coincides with theoretical expectations that the effect of a marginal increase in  $G$  on the number of firms in the manufacturing sector is positive. Therefore, we may conclude that local government expenditures expand the industry-level returns to variety in Korea. Furthermore, the estimate of the elasticity of  $n$  with respect to  $G$  for Korea is 0.294, which is greater than that for U.S.A. which stands at 0.169.<sup>5)</sup>

#### 4.2. Firm-level Returns to Scale of Local Government Expenditures

We estimate equation (6) using three different methods as before. The estimation results are shown in table 2. The Hausman model specification test calculates the chi-square test statistic at 0.090, which is less than 13.277, the 1 percent critical value with 4 degree of freedom. We cannot reject the null hypothesis,  $E[\eta_i | x_i] = 0$ , and therefore proceed to explain the estimation results with the random effects model.

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<sup>4)</sup> Estimation methods for the fixed effects model and the random effects model are now very popular. See Hsiao (1986) for reference.

<sup>5)</sup> The elasticity for U.S.A. is estimated by Holtz-Eakin and Lovely (1996).

**Table 2 Estimation Results for Firm-level Returns to Scale**

$$\log \frac{M}{n_{it}} = \gamma_0 + \gamma_1 \log n_{it} + \gamma_2 \log(\sigma \cdot n)_{it} + \gamma_3 \log G_{it} + u_{it}$$

Explanatory Variables	Dependent Variable : $\log \frac{M}{n}$		
	(1) OLS	(2) Fixed Effect Model	(3) Random Effect Model★
<i>C</i> : Constant	4.255*** (3.62)	-	3.658*** (7.68)
$\log n$ : # of Firms	1.245*** (8.98)	0.655*** (3.15)	0.711*** (3.79)
$\log(\sigma \cdot n)$	-1.487*** (9.88)	-0.903*** (5.78)	-0.943*** (6.45)
$\log G$ : Local Govt' Expenditures	0.308*** (4.15)	0.332*** (8.63)	0.326*** (8.98)
$\overline{R^2}$	0.3284	0.9330	0.9369
<i>F</i> - Statistic	34.741	1449.283	1025.881
# of Observations	208		

Note: Absolute *t*-values are in parentheses.

★ denotes the optimal model specification.

\*\*\*: 1%, \*\*: 5%, \*: 10% significance levels respectively.

In table 2 the estimation results indicate a large and correct impact of local government expenditures (*G*) on output per firm ( $M/n$ ). Recall that theory depicts that the effect of marginal increase in *G* on  $M/n$  is ambiguous. Empirically, however, it is proved that marginal increase in *G* raise output per firm significantly through reduction in variable costs. The estimate of the coefficient for variable  $\log G$  is 0.326. A 1% increase in *G* will increase output per firm by 0.326%.

The estimation results also show that the number of firms in the manufacturing sector has a positive and statistically significant effect on the output per firm. The estimate of the coefficient for variable *n* is 0.711

implying that a 1% increase in the number of firms increases output per firm by 0.711%. Also, the estimate of coefficient for interaction variable  $\log(\sigma \cdot n)$  is negative and significant indicating that there is a positive relationship between the variety of manufacturing sector and output per firm.

Thus far we have found strong empirical evidence that local government expenditures increase both the number of establishments ( $n$ ) and the output per firm ( $M/n$ ) in manufacturing sector. Hence local government expenditures increase the output of manufacturing industry ( $M$ ) through both an industry-level returns to variety and a firm-level returns to scale. As a matter of fact we can estimate the elasticity of the output of the manufacturing industry by adding the elasticity of the number of firms with respect to  $G$  and the elasticity of the output per firm with respect to  $G$ . From our estimation results in sections 4.1 and 4.2, the elasticity of  $n$  with respect to  $G$  is 0.294 and the elasticity of  $M/n$  with respect to  $G$  is 0.326, thus the elasticity of  $M$  with respect to  $G$  is calculated at 0.620.

### 4.3. Estimation Results by Period

The next question is whether the scheme change of local public sector in 1995 in Korea systematically influenced the impact of local government expenditures on the output of manufacturing industry. In order to obtain an plausible answer to this question we classify the whole sample period (1985-2000) into two sub-periods, 1985-1994 and 1995-2000, where year 1995 is the starting year of the local autonomy system. As shown in the table A1 and A2 in the Appendix, the estimate of the elasticity of  $n$  with respect to  $G$  is 0.309 for 1985-1994 period and 0.109 for 1995-2000 period. Both estimates are statistically significant. This implies that industry-level returns to variety of local government expenditures had been reduced since 1995 and that the local autonomy scheme did not help variety of manufacturing industry grow.

On the other hand, the estimate of the elasticity of  $M/n$  with respect to  $G$  is 0.095 for 1985-1994 period and 0.639 for 1995-2000 period, as shown

in the Table A3 and A4 in the Appendix. Hence a firm-level returns to scale of local government expenditures had increased since 1995. The local autonomy scheme enhanced firm-level returns to scale significantly.

Considering the fact that the effect of local government expenditures on industry output can be influenced by both  $M/n$  and  $n$ , and given that the elasticity of  $M/n$  with respect to  $G$  is the sum of the elasticity of the number of firms with respect to  $G$  and the elasticity of the output per firm with respect to  $G$ , the elasticity of  $M$  with respect to  $G$  is 0.404 for 1985-1994 period and 0.748 for 1995-2000 period. Therefore, we may conclude that the local autonomy system in one way or another enhances the productivity of local governments so that its expenditures raise private sector output more with the implementation of local autonomy system.

## 5. CONCLUSION

In this paper we analyzed the effects of local government expenditures on the manufacturing sector output using the model of public infrastructure model developed by Holtz-Eakin and Lovely (1996). The model identified two channels by which local government expenditures affect the total output of manufacturing sector, (i) through industry-level returns to variety of local government expenditures, and (ii) through firm-level returns to scale. We use the data from thirteen local governments in Korea during 1985-2000 periods to estimate the industry-level returns to variety equation and the firm-level returns to scale equation.

Using the Hausman model specification test for panel data we correctly specified the model to be estimated. Estimation results are: (i) strong empirical evidence that local government expenditures increase both the number of establishments and the output per firm in manufacturing sector. That is, local government expenditures increase the output of manufacturing industry through both industry-level returns to variety and firm-level returns to scale. (ii) The elasticity of the total manufacturing sector output with

respect to local government expenditures is 0.620 and statistically significant.

These empirical results are very different from that of the U.S.A. for which Holtz-Eakin and Lovely (1996) found the absence of direct effects of local public infrastructure on the manufacturing sector output. One of the reasons for the high productivity of local government expenditures is that in the case of Korea local public infrastructure has not been accumulated enough compared to developed countries like U.S.A. Furthermore, the productivity of local government expenditures has been strengthened since 1995 following the implementation of the local autonomy scheme. A direct policy implication of our study is that the central government should allocate higher budgets to local governments to vitalize the private sector.

## APPENDIX

**Table A1 Estimation Results for Industry-level Returns to Variety: 1985-1994**

$$\log n_{it} = \beta_0 + \beta_1 \log L_{it} + \beta_2 \log K_{it} + \beta_3 \log G_{it} + u_{it}$$

Explanatory Variables	Dependent Variable : $\log n$		
	(1) OLS	(2) Fixed Effect Model <sup>★</sup>	(3) Random Effect Model
$C$ : Constant	-9.632 <sup>***</sup> (13.32)	-	-7.048 <sup>***</sup> (7.89)
$\log L$ : Labor Supply	0.795 <sup>***</sup> (17.10)	0.253 <sup>**</sup> (2.39)	0.512 <sup>***</sup> (7.67)
$\log K$ : Private Capital	-0.241 <sup>***</sup> (5.03)	0.180 <sup>***</sup> (3.12)	0.086 (1.57)
$\log G$ : Local Govt <sup>7</sup> Expenditures	0.594 <sup>***</sup> (12.20)	0.309 <sup>***</sup> (5.55)	0.382 <sup>***</sup> (7.12)
$\bar{R}^2$	0.9369	0.9867	0.9873
$F$ - Statistic	640.108	4819.990	
# of Observations	130		

Note: Absolute  $t$ -values are in parentheses.

★ denotes the optimal model specification.

\*\*\*: 1%, \*\*: 5%, \*: 10% significance levels respectively.

**Table A2 Estimation Results for Industry-level Returns to Variety: 1995-2000**

Explanatory Variables	Dependent Variable : $\log n$		
	(1) OLS	(2) Fixed Effect Model★	(3) Random Effect Model
$C$ : Constant	-5.680*** (7.89)	-	-5.649*** (6.65)
$\log L$ : Labor Supply	1.226*** (29.92)	0.795*** (12.79)	0.876*** (20.43)
$\log K$ : Private Capital	-0.506*** (15.02)	0.064 (1.26)	-0.121** (2.63)
$\log G$ : Local Govt <sup>?</sup> Expenditures	0.369*** (9.14)	0.109** (2.38)	0.269*** (5.61)
$\bar{R}^2$	0.9823	0.9985	0.9984
$F$ - Statistic	1428.341	25865.22	
# of Observations	78		

**Table A3 Estimation Results for Firm-level Returns to Scale: 1985-1994**

$$\log \frac{M}{n_{it}} = \gamma_0 + \gamma_1 \log n_{it} + \gamma_2 \log(\sigma \cdot n)_{it} + \gamma_3 \log G_{it} + u_{it}$$

Explanatory Variables	Dependent Variable : $\log \frac{M}{n}$		
	(1) OLS	(2) Fixed Effect Model	(3) Random Effect Model★
$C$ : Constant	6.733*** (3.96)	-	6.698*** (12.55)
$\log n$ : # of Firms	1.159*** (7.61)	1.028*** (4.84)	1.007*** (5.40)
$\log(\sigma \cdot n)$	-1.312*** (8.05)	-1.044*** (6.81)	-1.037*** (7.43)
$\log G$ : Local Govt <sup>?</sup> Expenditures	0.146 (1.33)	0.089* (1.95)	0.095** (2.21)
$\bar{R}^2$	0.3326	0.9682	0.9712
$F$ - Statistic	22.431	1974.624	1477.234
# of Observations	130		

Note: Absolute  $t$ -values are in parentheses.

★ denotes the optimal model specification.

\*\*\*: 1%, \*\*: 5%, \*: 10% significance levels respectively.

**Table A4 Estimation Results for Firm-level Returns to Scale: 1995-2000**

Explanatory Variables	Dependent Variable : $\log \frac{M}{n}$		
	(1) OLS	(2) Fixed Effect Model	(3) Random Effect Model <sup>★</sup>
$C$ : Constant	1.769 (0.52)	-	-1.754 (1.07)
$\log n$ : # of Firms	1.681 <sup>**</sup> (5.58)	0.768 (1.60)	0.953 <sup>**</sup> (2.40)
$\log(\sigma \cdot n)$	-2.010 <sup>***</sup> (6.02)	-1.120 <sup>**</sup> (2.51)	-1.307 <sup>***</sup> (3.36)
$\log G$ : Local Govt' Expenditures	0.471 <sup>**</sup> (2.37)	0.641 <sup>***</sup> (9.37)	0.639 <sup>***</sup> (9.81)
$\overline{R^2}$	0.3041	0.9825	0.9853
$F$ - Statistic	12.219	2179.010	1727.721
# of Observations	78		

Note: Absolute  $t$ -values are in parentheses.

★ denotes the optimal model specification.

\*\*\*: 1%, \*\*: 5%, \*: 10% significance levels respectively.

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