

Modeling Industrial Growth and Agglomeration Economies in the Manufacturing Sector of Pakistan

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The uneven distribution of production and consumption is one of the several problems being faced by the less developed countries (LDCs). The governments of these countries are pursuing multidimensional policies to develop the backward areas and to put a check on overcrowded cities. For example, in Pakistan National Development Finance Corporation (NDFC) has been established to promote industries in backward areas. Moreover, tax holidays, import facilities and loans on easy terms are some of the devices which are being used to promote the backward regions. Besides, Lahore and Karachi are facing serious economic problems due to rapid urbanization. Their population is growing 1 percent to 2 percent above the national growth rate of population.¹ On the other hand, several geographical locations are still backward, despite policy measures taken by the public sector.² It is important that, if these policies fail to improve the situation, a better rationale should be explored in this respect.

The purpose of this study is to identify the sources of industrial concentration in Pakistan. Besides, we will be looking at reasons for the concentration of industries at certain locations. One way to explain this phenomena is through agglomeration economies. We will develop a model to study this event. If our model can explain the increasing returns to scale, which is a way to measure agglomeration economies,³ then, we may be able to utilize this knowledge to provide a base for policy formulation to develop the backward areas, as well as, for efficient use of public finance.

Agglomeration economies (AE) relate to those factors which produce "centralizing effects". It is the economies of size and concentration. Of course, there are

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¹The overall population growth in Pakistan is 3.1 percent. However, the largest cities are growing at a rate of 4 percent to 4.5 percent per annum.

²The public sector has introduced several economic policies to develop the backward areas by providing incentives for industrialization. These incentives include, tax holiday, tax free zones, concession in import of inputs etc. The province of Baluchistan is lagging behind other provinces. See also by the same author (1989).

³For details see Tylant (1977), Shefer (1973).

several other factors like markets, urbanization, inputs and infrastructure facilities which do lead to the clustering of manufacturing units at particular locations. However, (AE) may be one of the major sources for this event. In brief, (AE) may be decomposed as follows:

- (i) Urbanization economies (market size and inputs);
- (ii) Internal scale economies;
- (iii) Localization economies; and
- (iv) Infrastructure economies.

It is only recently that some serious attempts have been made to quantify the concentration of industrialization. Shefer (1973), classified it into internal and external economies. Positive internal economies will be realized when expansion in the scale of an enterprise leads to decreasing average cost. The external economies result from the scale of urban areas, decreasing input cost, concentration of industries, urbanization and infrastructure facilities.

The study of the above events is important for several reasons. Most LDCs industries are concentrated in a few areas, while other areas remain underdeveloped. The policies introduced to achieve balanced growth, by providing incentives like tax holidays, infrastructure facilities etc., have been unsuccessful.⁴ Since one of the goals of public policies in LDCs is to promote 'even' geographical development, it requires government intervention for the removal of bottlenecks.⁵ These objectives may be achieved by direct government intervention, regulation or through competition. Therefore, we want to study the hypothesis whether there agglomeration economies exist in the manufacturing sector which may be a source of industrial concentration. Thus, if we are able to identify the existence of agglomeration economies, the government could introduce policies to increase the peoples' welfare.

This study has been organized as follows. Section II of this paper provides a theoretical background and description of the model. The results and empirical outcomes have been discussed in Section III. Section IV conclude with a discussion on policy implications, derived from the theoretical and empirical findings.

II. THEORETICAL BACKGROUND AND THE MODEL

Most location theories are explained by using data of the developed coun-

⁴ In Pakistan, industrial units are concentrated at few locations in the each province. Most of the districts and interior of the provinces are underdeveloped. Even, the regional production activities are concentrated at few points.

⁵ There are several bottlenecks for balanced economic growth. The income inequality, monopolies in production, privileged loans, black marketing and tax evasion are some of the diseases which require public sector's interference. Still, Pakistan's economy is somewhat open.

tries which have rarely been applied to less developed countries (LDCs). Shefer (1973) and Carlino (1980) have attempted to utilize the production function approach to explain such events. Dhrymes (1965) provided empirical rationale for these events.

In applying the CES production function to identify AE in the developing countries we face the problem of restricted economies.⁶ The economies of LDCs may differ from developed economies in market competition, rigidities in the system and other bottlenecks for free growth. They may also not fulfil the conditions that the factors of production are paid according to their marginal productivities. However, we may assume these conditions for the LDCs as long as a country has an unrestricted investment environment and an open economy. Furthermore, the public sector participates in business as a competitor. Moreover, factors of production enjoy free mobility. We believe that given free mobility of the factors of production, a mixed economic system, a dominant private sector, significant size of its foreign trade, and an unrestricted investment environment in Pakistan, the neo-classical type framework may be utilized to study the above stated hypothesis.

A pioneering article by Solow, Minhas, Arrow and Chenery (SMAC) (1961), examined the invariant returns to scale. To study Agglomeration Economies (AE), we need to study increasing returns to scale which may be derived from the CES type production function.

Assume that the relationship between wages and output per worker/hour is as given below:—

$$W = A \left(\frac{Q}{L}\right)^{\beta} \quad \dots \quad \dots \quad \dots \quad \dots \quad (1)$$

and that:

$$Q = F(K, L) \quad \dots \quad \dots \quad \dots \quad \dots \quad (2)$$

Where

- W = Wages;
- Q = Output;
- L = Labour; and
- K = Capital.

If we assume constant returns to scale and perfect competition in the market, then Equation (2) can generate a functional form.

⁶For developed countries it could be assumed that their markets are close to perfect competition. However, it is relatively less logical to assume the same for developing countries.

$$Q = F(K, L) = A [\alpha K^{-e} + (1-\alpha) L^{-e}]^{-1/e} \quad \dots \quad (3)$$

Where 'A' is efficiency parameter 'α' is, ($0 \leq \alpha \leq 1$), distribution parameter, 'e' is substitution parameter. Assuming profit maximization and production function of homogenous degree 'h', Dhrymes (1965) showed that Equation (2) can be rewritten as given below:

$$W = A Q^\beta L^\alpha \quad \dots \quad \dots \quad \dots \quad (4)$$

When $\alpha = -\beta$, it includes Equation (1). Now with some modification we can generate CES type production function.

$$Q = F(K, L) = L^h F\left(\frac{K}{L}\right) = A(t) [\Theta_1(t) K^{hg} + \Theta_2(t) L^{hg}]^{1/g} \quad \dots \quad (5)$$

In this equation ' Θ_i ' is distribution parameter, 'h' stands for homogeneity and 'g' is the substitution parameter. Given this, Equation (4) can be rewritten as

$$W = A \left(\frac{Q}{h}\right)^\beta - (\alpha + \beta h) \quad \dots \quad \dots \quad \dots \quad (6)$$

Equation (6) can be rearranged as:

$$W = A Q^\beta \cdot L^{(\alpha + \beta h - \beta h)} \quad \dots \quad \dots \quad \dots \quad (6.1)$$

Let:

$$S(h) = \alpha + \beta h \quad \dots \quad \dots \quad \dots \quad (7)$$

Now if we define $S(h) = \alpha + \beta h$ then the Dhryme's model reduces to the SMAC, CES type production function, when $h = 1$ & $S(h) = 0$. Let 'S' take a simple function form:

$$S(h) = h - 1 \quad \dots \quad \dots \quad \dots \quad (8)$$

Now setting Equation (7) equal to Equation (8) and solving for (h). We have:

$$h - 1 = \alpha + \beta h \quad \dots \quad \dots \quad \dots \quad (9)$$

Thus:

$$h = \frac{1 + \alpha}{1 - \beta} \quad \dots \quad \dots \quad \dots \quad (9.1)$$

We can estimate 'h', increasing returns to scale or (AE) from Equation (4). Thus, for estimation, we transform Equation (4) into log form.

$$\text{Log } W_{ij} = \log A + \beta \log Q_{ij} + \alpha L_{ij} + U_{ij} \quad \dots \quad (10)$$

Where subscripts refer to *i*th manufacturing industry at *j*th location.

For further verification we may also adopt another model based on Solow's technological change (1957) and Arrow (1962), as follows.

$$Q/L = AW^\alpha Q^\beta \quad \dots \quad (11)$$

Where

$$\beta = Z (1 - \alpha)$$

In this model (α) is the elasticity of substitution and Q is the proxy for cumulated experience. In this model (AE) is $(1 + z)$.

For estimation purposes, we apply OLSQ to the logarithmic form of Equation (11). Let us call it model 2.

$$\text{Log } (Q/L) = \log A + \alpha \log W_{ij} + \beta \log Q_{ij} + U_{ij} \quad \dots \quad (12)$$

To estimate Equations (10) and (12), cross-sectional data may be used for a specific year. We test the hypothesis that in Equation (9.1), $h > 1$. If so, then, there exist AE, which will provide a base for government policy for industrialization of backward areas by providing AE incentives. In Equation (12) AE is $(1 + z)$, which may also be estimated from cross-sectional data.⁷

III. EMPIRICAL FINDINGS

The Equations (10) and (12) are estimated for major industries in the main industrial districts in Pakistan.⁸ The cross-sectional data for the year 1984-85, taken Government of Pakistan (1989). For estimation, ordinary least squares is applied to the logarithmic forms of the models. The results of the regressions are presented in Table 1.

⁷ Also refer to SMAC (1961). Capital and Labour Substitution and Economic Efficiency. (1961) *Review of Economics and Statistics*.

⁸ Sample size varies for each industry from 31 to 15 observations, based on heavily industrialized districts/cities.

Table 1

Agglomeration Economies in the Manufacturing Industries in Pakistan (1984-85)

Industry	Model : 1 $h = \frac{1 + \alpha}{1 - \beta}$	R^2	DW
1. Textile Manufacturing	2.49	0.98	1.30
2. Chemical, Rubber and Plastic	2.40	0.92	2.30
3. Food, Beverages and Tobacco	2.40	0.89	2.30
4. Metal Products and Machinery	3.48	0.95	1.70
5. Food Manufacturing	3.66	0.60	2.30
Model : 2 $h = 1 + z$		R^2	DW
1. Textile Manufacturing	1.56	0.88	1.20
2. Food, Beverages and Tobacco	3.80	0.85	2.30
3. Metal Products and Machinery	1.55	0.76	2.50
4. Food Manufacturing	1.40	0.53	1.40
Urbanization Economies			
All Industries			
1. Model : 1	2.59	0.98	1.80
2. Model : 2	1.57	0.89	1.80

The empirical results indicate that all the coefficients are significant at better than ninety-five percent level of confidence, for all industries, except for food manufacturing. The ' β ' coefficient for food manufacturing was also significant at the ninety-five percent level of confidence. However, ' α ' coefficient was significant at ninety percent level of confidence. All these coefficients provide an explanation of the event and the models performed well.

Table 1 indicates that for model 1, all the industries are enjoying increasing returns to scale. The values of ' h ' are greater than one, which implies that there exist agglomeration economies in all the industries. The values of R^2 are also better than 0.90 for all the industries, except for food manufacturing. The value of R^2 for food manufacturing is 0.60, which means that the variables utilized explain the event by 60 percent. However, the value of ' h ' is the highest among all the industries.⁹

⁹The Durban Watson (DW) statistics is also satisfactory. However, we may not pay much attention to DW, since we are not focusing on forecasting.

The results of model 2, show that the values of 'h' are also greater than one, which indicates that there exist agglomeration economies in all the industries and they are enjoying increasing returns to scale. It confirms our findings of the model one that there exist AE in the manufacturing industries in Pakistan.

We have also identified urbanization economies, by applying both the models, based upon the entire manufacturing sector as a unit of observation. The coefficients of the regression equations are valid at better than ninety-five percent level of significance. Thus, it seems to indicate that agglomeration, as well as, urbanization economies are sources for concentration of manufacturing units at certain locations in Pakistan. It may be noted that we have not attempted to decompose different economies which are part of AE. However, our models did identify well the AE and urbanization economies.

IV. CONCLUSION

Most of the studies have explained that AE is a phenomena of developed countries. However, our study has revealed that AE also exists in developing countries, like Pakistan. Our study seems to indicate that the increasing returns to scale is a phenomena for concentration of industries in Pakistan. There exist agglomeration, as well as, urbanization economies.

As far as policy implications for LDCs are concerned, we may suggest that public policies may be amended according to the local environment. Our findings have indicated that industrial zones may be established by providing proper industrial environment. In other words, if tax holidays, tax free zones etc., fail to develop a certain region, it may be possible to develop backward areas by industrializing that region. It could be done by generating AE at a specific location. The government may introduce public goods industrial units at a specific location and thus it may generate AE to attract other industries from the private sector. By doing so, backward areas may be brought forward into the mainstream. Besides, it could be extended for balanced growth. By similar policy actions, the public sector may also generate a competitive environment for development. Further research in these areas may strengthen these findings, which may provide further support for such public policies to develop backward areas.

Appendix

Appendix Table 1

Industry/Coefficient	α	β	R^2	DW
1. Textile Manufacturing	1.12 (8.47)	1.203 (10.06)	0.88	1.2
2. Food/Beverages and Tobacco Manufacturing	0.21 (2.11)	0.89 (5.99)	0.85	2.3
3. Metal Products and Machinery Equipment Manufacturing	0.96 (10.81)	1.07 (13.01)	0.76	2.5
4. Food Manufacturing	0.14 (1.5)	0.46 (4.8)	0.53	1.40

Model : 2 $\text{Log } (Q/L)_{ij} = \text{Log } A + \alpha \text{Log } W_{ij} + \beta \text{Log } Q_{ij} + u_{ij}$

Appendix Table 2

Industry	β	α	R^2	DW
1. Textile Manufacturing	0.32 (4.19)	0.74 (8.47)	0.98	1.30
2. Food/Beverages and Tobacco	0.21 (2.11)	0.89 (5.91)	0.89	2.30
3. Metal Products and Machinery Equipment	0.57 (3.65)	0.497 (2.89)	0.95	1.70
4. Food Manufacturing	0.42 (1.62)	0.54 (1.52)	0.55	2.21
5. Chemical/Rubber and Plastic Manufacturing	0.26 (2.4)	0.75 (4.91)	0.92	2.30

Model : 1 $\text{Log } W_{ij} = \text{log } A + \beta \text{Log } Q_{ij} + \alpha \text{Log } L_{ij} + U_{ij}$

Appendix Table 3

All Industries

	α	β	R^2	DW
1. Model : 1	1.03 (10.81)	1.18 (13.01)	0.89	1.80
2. Model : 2	0.3 (4.66)	0.81 (10.6)	0.98	1.70

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Comments on “Modeling Industrial Growth and Agglomeration Economies in the Manufacturing Sector of Pakistan”

The study addresses the important issue of industrial concentration in Pakistan. It is a well-known fact that industrialization in Pakistan has led to the emergence of a few enclaves in which industrialization has taken place while the world outside these enclaves has not changed much. This phenomenon entails a number of socio-economic problems.

Given this background the title and introduction of this paper catch the eyes of the reader as they give the impression that the study would present and estimate a model which would relate industrial concentration to industrial growth and also to some policy variables. But actually the paper does not meet all these expectations because it is primarily concerned with statistically verifying and quantifying the phenomenon of industrial concentration.

For this purpose, the author estimates two equations. From the estimated Equation (11) he calculates the value of parameter h . This parameter measures the degree of homogeneity of an extended version of the CES production function which is modified to take care of market imperfections. If we look at Equation (11), we can see that after estimation it cannot be differentiated from the standard Equation which is commonly used for indirectly estimating the elasticity of substitution of an ordinary CES production function. So I wonder how can one be definite about whether the estimated coefficients are the parameters of an ordinary CES production function or those of a Dhrymes-type extended CES production function. As far as Equation (13) is concerned, I have to take it for granted since the author has not given much explanation of its theoretical underpinnings.

On the basis of his results, the author reaches three main conclusions. One, increasing returns to scale prevail in the industries he has studied, two, he has identified urbanization economies and, three, his estimated coefficients according to him provide “strong” explanation of the phenomenon of industrial concentration. Now, even if increasing returns to scale prevail in certain industries, it is not clear how does it necessarily imply the presence of industrial concentration because other factors also influence returns to scale. It would also have added to our knowledge if the author had clarified how one could identify urbanization economies from other types of economies in such an aggregative framework. I also feel it difficult to agree

with the claim that the estimated coefficients provide “strong” explanation of industrial concentration. In my opinion they, at the most, statistically verify and quantify the presence of this phenomenon.

The last section of the paper presents some recommendations for government policy. While these recommendations may be very useful, one wonders how do they directly follow from the findings of this study. Overall, this is a commendable paper because it draws our attention to an important problem of our country.

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