Short-Term Employment Functions in Manufacturing Industries of Pakistan

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The manufacturing sector has played an important role in the economic development of Pakistan. The main indicator of industrial growth—the percentage share of manufacturing in Gross National Product—has been increasing. However, the percentage of employment in manufacturing has decreased. "The share of manufacturing in GNP has increased from 8.1 percent in 1950 to 16.0 percent in 1968. But employment in manufacturing sector declined from 15.0 percent of total employment to 14.3 percent in 1965 [5, p.212].

Keeping in view that industrial development is taking place at an increasing rate and its share in national product is increasing but its share in total employment has declined, it is essential to know the exact extent of the relationship between them. The relationship between productivity and wage rate has been the subject of some studies. In this paper an attempt is made to estimate employment demand directly using data published in the Census of manufacturing industries for former West Pakistan (now Pakistan) during 1954 to 1970. The study estimates the impact of output, wages, lagged-employment and time trend (substitute for such non-measurable factors as technological change) on employment. The other important questions explored in the study are related to returns to scale and adjustment of employment to its desired level. The estimates of these relationships are compared with similar estimates for other countries.

The relationship between productivity, output and wage rate in manufacturing sector of Pakistan has been estimated by Ishrat Hussain. The equation estimated is:

$$\log V = a + b \log W + C \log Q$$

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where V = Percentage change in labour productivity

W = Percentage change in wages/labour

Q = Percentage change in output (value added at factor costs).

The results of the regression equation indicated that "the output variable was tried in both log and unlogged form and was not significant in either. The important result is that regression coefficients for W/L, *i.e.*, w is significantly different from zero at the five percent level and is less than unity. The elasticity of substitution of value added per labour (V/L) with respect to W/L is 0.73. Thus if output is held constant, then 1 percent relative change in wages (W/L) causes a 0.73 percent change in value added per worker (V/L). The implication of this regression equation is that significant substitution between capital and labour does exist. As a consequence, for any given level of output, an increase in wages leads to an increase in productivity and therefore a decline in employment" [5, pp.211-15].

Meekal Ahmed, [1, p.144] after making required and necessary adjustments in the data, estimated the following equation for exploring these relationships.

$$\text{Log } (V/L)_i = a + b\,(W/L)_i + C \text{ Log } V_i$$

where V/L = Index of real net output per head,

W/L = Index of total wage and salary compensation per head,

V = Index of real net output,

i = 1, 2, 3 — — — — — — — 28.

On the basis of the results of the above equation Meekal concluded that output-induced technical progress and realization of potential scale economies are the important variables leading to changes in productivity. It is not the substitution of capital for labour which explains the difference of productivity growth between industries but other factors such as unequal incidence of rates of technical progress, scale economies, the differential growth of labour and management skill are important in this respect.

The conclusions of these studies are different but both are estimating effects of different variables on employment through productivity. Employment demand directly has not been estimated. Direct effects of wages on employment needs to be estimated. Moreover, questions such as: How does the level of employment move and adjust over time; what is the direct effect of technological change on employment; and what are the returns to scale, have not been explored. The results presented in this paper suggest answers to the above questions.

MODEL

The models to be applied in this study have been used in advanced and developing countries to estimate relationships between employment, production, technology and wages in the manufacturing sector. A log-linear equation of the following form is estimated:

$$\log E_t = a_o + a_1 \log Q_t + a_2{}^t + a_3 \log E_{t-1} + u_t \quad .. \quad .. (1)$$[1]

where

E_t = Employment in year t (number of employees in thousands),

Q_t = Output (value added in '000' Rs. deflated by General Wholesale price Index) in year t,

t = Time trend variable,

E_{t-1} = Employment in year t-1,

a_1 = Elasticity of output with respect to labour

Equation (1) can be derived in two alternative ways. The basic assumption behind the first way is that the growth rate for capital is constant and output is determined by the level of employment, prevailing technology and capital. A short-run production function with these specifications is:

$$Q_t = Ae^{pt} (Eh_t)\alpha \quad .. \quad .. \quad (2)$$

where

Q_t = Production in time t,

E = Employment (in number of persons),

h = Hours worked at time t,

Ae^{pt} = Capital and technology parameter at time t.

Minimizing cost with respect to the number of employees, the desired number of employees are:[2]

$$E^*t = b_o e^{-b_1 t} Q_t{}^{b_2} \quad .. \quad .. \quad (3)$$

where b_o, b_1 and b_2 are constants.

Adjustment of employment over a period of time to the desired level can be of the form:

$$\frac{E_t}{E_{t-1}} = \left[\frac{E^*_t}{E_{t-t}}\right]^{\lambda} \quad o < \lambda < 1 \quad E^*_t \neq E_t \neq E_{t-1} \quad .. \quad (4)$$

where

E^*_t = Desired number of employees.

λ = Coefficient of ajustment

[1][2, pp. 179-80; 3, pp. 278-79; 7, pp. 70-71; 12, pp. 537-38].

[2]For the derivation see Ball and Cyr, and Smyth and Ireland, [2, pp. 179-80 12, pp. 537-38].

Combining (3) and (4) and taking logarithms, equation (1) can be derived, which is:[3]

$$\log E_t = a_0 + a_1 \log Q_t + a_2 t + a_3 \log E_{t-1} + U_t \quad .. \quad (5)^{4}$$

Following values can be derived from the coefficients of above equation:

$\lambda = 1 - a_3$ = Adjustment coefficient of employment to its desired level,

$\alpha = \dfrac{1 - a_3}{a_1}$ = Short-run returns to labour,

$P = - a_2/a_1$ = Annual rate of technical progress.

The main features of the model as described by Brechling and O'Brien can be summarized as follows:[5]

The desired labour services (Es) can be written as a function of the exogeneous variables, namely output (Q), capital (K) and techniques of production (T) which can be expressed as:

$$Es = f(Q,K,T) \quad .. \quad .. \quad (6)$$

The desired level of employment (E*) depends upon the desired labour services (Es), normal hours of work (H) and the ratio of overtime to standard pay (W_2/W_1). The functional relationship between desired level of employment and its determinants can be expressed as follows:

$$E^* = F(Es, H, W_2/W_1) \quad .. \quad .. \quad (7)$$

The desired level of employment is directly related to the desired labour services, however the relation between E* and H and W_2/W_1 cannot be determined a priori.

Assuming that (1) capital (K) and technology (T) can be approximated by a time trend (t), (2) normal working hours (H) and the ratio of overtime to standard pay (W_2/W_1) are either constant or vary very smoothly over time, (3) entrepreneurs adjust to their desired level of employment with lag, (4) labour supply conditions and other factors are quantitatively unimportant, and (5) the functional forms of equations are log-linear, equation (8) and (9) reduce to:

$$\log E_t^* = a + a_1 \log Q_t + a_2 t \quad .. \quad .. \quad (8)$$

Using a stock adjustment lag structure according to which:

$$\log E_t - \log E_{t-1} = (1 - a_3)(\log E_t^* - \log E_{t-1}) \quad .. \quad (9)$$

or

$$\log E_{t-1} = (1 - a_3) \log E_t^* + a_3 \log E_{t-1} \quad .. \quad .. \quad (9a)$$

[3]For details see Ball and Cyr, and Smyth and Ireland [2, pp.197-80; 12, pp. 537-38].
[4]Ireland and Smyth have derived equation (5) from a constant elasticity of substitution (CES) production function. For more details of derivation see D.J. Smyth and N.J. Ireland [12., pp. 537-38]
[5]For details see Brechling and O'Brian [3, pp. 278-79].

and combining equation (9) and (9a), we get the equation to be estimated in this paper:

$$\log E_t = a_0 + a_1 \log Q_t + a_{2t} + a_3 \log E_{t-1} + U_t \quad .. \quad .. \quad (10)$$

The relationship between employment and output is important in order to know whether the rate of increase in output and rate of absorption of employment in manufacturing sector are compatible. The variable "t" is used as time trend for taking into account the effects of technology and capital on employment. The variable "E_{t-1}" is used for estimating the coefficient of adjustment of employment with its desired level.

The adjustment coefficient (λ) indicates the percentage of any difference between the logarithms of desired and actual employment is made up during the year. The desired level of employment is the optimal number of men employed to minimize the total labour cost and this is determined by three factors. First is the desired labour services which are dependent on output, capital and techniques of production. Desired labour services have a positive relationship with output and a negative relationship with capital and intensive techniques of production. Second is the normal or standard hours of work and third is the ratio of overtime to standard pay.

The value of α or ν are interpreted as short-run returns to labour or short-run returns to scale. The latter interpretation seems more reasonable. The value of P indicates the annual rate of technical progress.

This equation has many limitations and problems. The basic assumptions, made for deriving the equations, can be questioned. Are labour supply conditions and other factors quantitatively unimportant. Does normal working hours and ratio of overtime to standard pay are constant or vary smoothly in Pakistan? Not only that assumption can be questioned, there are problems of identification, statistical problems and problems of interpretation. The main statistical problem is the possibility of multi-collinearity between t and lagged employment, *i.e.*, E_{t-1}. This can lead to underestimation or overestimation of the coefficients.

Some of the other problems are related to the interpretation and specification. It is really difficult to justify that "t" which is time trend represents the effects of technology and capital variable only on employment. It can be all other variables which are not specified in the equation and can be taken into account by using time trend. The coefficient of variable "t" may be an overestimation of the effects of capital and technology. But as most of the economists have used time trend for the variables which cannot be taken into account or cannot be precisely specified, one can use time trend in spite of its limitations. It is also difficult whether to interpret α or ν as returns to scale or returns to labour. Moreover, it is difficult to identify demand relationship and to ascertain that one has achieved that in this study can be questioned. Smyth and Ireland while pointing out these difficulties were justified in concluding that these "difficulties should be borne in mind while policy implications are drawn from the results [12, pp.543-44].

The most serious problem of the equation is that an important variable *i.e.*, e, wages have not been taken into account. As one objective of the study is to know the relationship between wages and employment, the following equation which can be derived in the framework of Cobb-Douglas' production function, has been estimated:

$$\log E_t = a_0 + a_1 \log Q_t + a_2 \log W_t \quad \ldots \quad \ldots \quad (11)$$ [6]

where

E_t = Employment in year t (number of employees in thousands).

Q_t = Output (value added in '000' Rs. deflated by General Whole Sale price Index) in year t.

W_t = Wages per employee (in Rupees deflated by General Whole Sale price Index) in year t.

This equation although very basic and simple, is useful for drawing certain conclusions and does not have some of the problems and limitations as pointed out for equation (1). The estimation of equation 1 facilitates the comparisons of the result of this study with similar studies conducted for advanced industrial countries and developing countries. Such comparisons will help one understand the differences, similarities and implications of the problem being explored.

THE DATA

The time period considered in this study is 1954 to 1969-1970. There are various problems in using the time series data published in the "Census of Manufacturing Industries" [8, 9, 10].

The first problem is that the time series data are not available for 1956, 1960-1961, 1961-1962 and 1968-1969. In order to calculate data for these years, "Lagrange's formula of interpolation for unequal intervals,"[7] has been used.

The second problem is that the "Census of Manufacturing Industries" pertain to calendar years up to 1958 but starting in 1959-1960, the period covered is the fiscal year, *i.e.*, from July 1 to June 30. Adjustments have been made in this respect also.

Another problem is that the data for 1967-1968 is for only one province and necessary inflation in figures according to the trend has been made.

There is also a problem of different definitions of terms for different years used in the Census. But these are the problems which one has to face

[6]David W. Dunlop, [4, p. 252.]

[7]Lagrange's formula of interpolation for unequal interaval is:

$$f(x) = \frac{(x-x_1)\ (x-x_2)}{(x_0-x_1)\ (x_0-x_2)} fx_0 \quad \frac{(x-x_0)\ (x-x_2)}{(x_1-x_0)\ (x_1-x_2)} fx_1 \quad \frac{(x-x_0)\ (x-x_1)}{(x_2-x_0)\ (x_2-x_1)} fx_2$$

where

fx = frequency to be calculated for missing years;

x = missing year; x_0, x_1, x_2 = years around missing years;

fx_0, fx_1, fx_2 = frequencies of years around missing years.

while using statistics from a developing country like Pakistan. These minor inconsistencies and inaccuracies should be kept in mind while conducting a study based on such data and drawing certain conclusions.

Twenty industries were aggregated for estimating the equations. Industries included are: sugar factories and refining, edible oils and fats, chemical and chemical products, food, beverages, rubber and rubber products, transport equipment, textile, basic metal, footwear, electrical machinery, non-metallic mineral products, printing and publishing, furniture and fixture, tobacco manufacturing, metal products, cotton ginning and pressing, machinery except electrical, leather manufacturing and miscellaneous.

EMPIRICAL RESULTS

The estimated equation (1) is presented below:

$$\log E_t = 1.4352 + \underset{(2.168^{**})}{0.4742} \log Q_t - \underset{(-1.399^{*})}{0.0355t} + \underset{(3.201^{***})}{0.3772} \log E_{t-1} \quad \ldots (1)$$

$\bar{R}^2 = 0.928$ [8]h $= .065$ no. $= 15$

* significant at the 0.10 level.
** Significant at the 0.05 level.
*** Significant at the 0.01 level.

Matrix of Zero Order Correlation Coefficients

	E	Q		E_{t-1}
E	1.0	0.936	0.911	0.944
Q	—	1.0	0.991	0.894
t	—	—	1.0	0.880
E_{t-1}	—	—	—	1.0

The value of $\bar{R}^2 = 0.928$ which indicates that nearly 93 percent variation in employment is explained by variations in output, lagged-employment, and the time trend. The computed value of "h"-statistic is 0.065. As "h"-statistic is distributed normally with mean zero and variance unity, one can use the

[8]"h" test is an alternative test for serial correlation where Durbin-Watson cannot be used when there is lagged-dependent variable as independent variable.

$$h = (1 - 1/2\, d) \sqrt{\frac{T}{1 - T - \hat{V}(\hat{\beta}_1)}}$$

where

d = Durbin-Watson Statistic
T = Sample Size

$\hat{V}(B_1)$ = Estimate of variance of $\hat{B}_1$

$\hat{B}_1$ = Coefficient of lagged variable

For details see [11, pp.121-26].

standard normal distribution tables for testing the null hypothesis. For 95 percent level of confidence the critical value is ± 1.645. Since computed value of h-statistic (0.065) is in acceptance region, one can accept the null hypothesis that residuals are serially independent.

The results suggest several important findings. There is negative relationship between the time-trend and employment. As the time trend is a proxy variable for capital and technology, the results indicate negative relationship between capital, technology and employment. The result is as expected. The capital-intensive techniques of production used in the manufacturing sector of developing countries cause less absorption of labour force in this sector. The findings of the study confirm this hypothesis. Little, Scitovsky and Scott are of the view that "most developing countries tend to import highly capital-intensive and labour saving manufacturing equipment, which undoubtedly contributes to their employment problem" [6, p. 86].

The coefficient of "t" is significant at the 0.10 level using one tail test. As we are testing a prior hypothesis, that capital intensive techniques of production are negatively related to employment, one tail test is to be used. The trend coefficient is significant and confirms the above hypothesis.

Another result of the estimated relationship shows the positive effect of output on employment. The coefficient of log Q_t is the output elasticity of employment. The elasticity of employment with respect to output is positive but inelastic (0.47). The result indicates that although increase in output leads to increase in employment, this increase is not proportionate. A one percent increase in output leads to 0.5 percent increase in employment. The reason for a less than proportionate increase in employment as a result of an increase in output is due to more use of capital-intensive techniques of production which can increase output in significant proportion without increasing employment significantly.

The two results are consistent with each other and support the idea that choice of automated and labour saving manufacturing methods and equipments have been the reason for less absorption of labour force in manufacturing sector of developing countries like Pakistan and created the problem of urban employment.

The other result drawn from the analysis is that lagged employment (E_{t-1}) has positive relationship with present employment. The coefficient of log E_{t-1} is positive, as expected, and indicates that elasticity of employment with respect to lagged employment is positive and inelastic (0.37). The level of previous years employment increases the present years employment, but this increase is not proportionate. The positive relationship betwen lagged employment and present employment may be interpreted as follows: as manufacturing sector earns profit and there is demand for manufactured goods in the market, output also expands and expansion in output leads to creation of more jobs in this sector.

The derived values of λ, P, and α or V are:

$$\lambda = 1 - a_3 = 1 - 0.377 = 0.623$$

$$P = -a_2/a_1 = 0.36/0.474 = 0.076$$

$$\alpha \text{ or } V = \frac{1-a_3}{a_1} = \frac{0.623}{0.474} = 1.31$$

The high adjustment coefficient (λ) indicates a fast speed of adjustment of actual employment to its desired level (0.623), which is feasible in the labour surplus economy of Pakistan.

The derived value of P indicates the annual percentage rate of technical progress. The derived value of P for the manufacturing sector of Pakistan is 0.076 and it can be interpreted that the annual rate of technical progress in Pakistan approximates 7.6 percent which seems reasonable.

The value of α or V interpreted as short-run returns to labour (1.32) seems unreasonably high. If it is interpreted as short-run returns to scale, the interpretation seems more reasonable. The derived value of α or V suggests increasing returns to scale in manufacturing sector of Pakistan. This parameter can also be interpreted as the elasticity of output with respect to labour. Given this interpretation, one can say that elasticity of output with respect to labour in Pakistan is positive and elastic.

The employment function applied for estimating the different parameters for the manufacturing sector of Pakistan appears to give reasonable results.

The other estimated equation (11) is:

$$\log E_t = \underset{}{5.5199} + \underset{(11.517^{***})}{0.5191 \log Q_t} - \underset{(-4.057^{***})}{0.8312 \log W_t} \quad \ldots (11)$$

$\bar{R}^2 = 0.939$ D.W $= 0.98$ no. $= 15$

***Significant at the 0.01 level.

Matrix of Zero Order Correlation Coefficients

	E	Q	W
E	1.0	0.936	0.944
Q	—	1.0	0.986
W	—	—	1.0

The value of $\bar{R}^2$ is as high (0.94) as for the previous equation (0.93). The Durbin-Watson statistics is low (0.98). In order to verify whether there is autocorrelation, the calculated value can be compared with the upper (1.25) and the lower (0.70) critical values for Durbin-Watson for 0.01 significance level from Durbin-Watson table. The comparison indicates that there is no positive and negative autocorrelation and if there is autocorrelation, it is indeterminate. As the Durbin-Watson statistics value falls in the inconclusive region, one can interpret that there may be autocorrelation but it is not significant to lead to any biases.

This equation is estimated to determine the relationship between wages and employment. The elasticity of employment with respect to wages is negative (—0.83). The variations in wages leads to a significant variation in employment in the manufacturing sector of Pakistan.

The coefficient of log Q_t, as expected, indicates that elasticity of employment with respect to output is positive and inelastic (0.52). The estimated elasticity is similar to that obtained in the regression equation 1 (0.47) and can be interpreted in the same way.

COMPARISON OF RESULTS WITH OTHER COUNTRIES

The values of derived parameters in U.K., Australia, Kenya and Pakistan are shown in Table 1.

Table 1

Comparison of Parameters in U.K., Australia, Kenya and Pakistan's Manufacturing

Country	λ	α or V	P
U.K.	0.48	1.14	2.40
Australia	0.71	1.34	2.66
Kenya	0.94	1.11	8.44
Pakistan	0.62	1.31	7.60

Source: For U.K., Australia, Kenya: J.K. Maitha, [7, p. 17]. For Pakistan: Derived Values are given on p. 340 of this paper.

Comparisons of these results indicate that the results obtained in the study are reasonable. The employment adjustment coefficient (λ) is higher than that of U.K. and lower than that of Australia and Kenya. The value of adjustment coefficient is reasonable in a labour surplus economy like Pakistan. The higher employment adjustment coefficient in Australia compared to the one in Pakistan may be due to migration of labour from other countries to Australia. Australia has been attracting labour from other countries by providing job opportunities at relatively high wage levels. It is interesting to note that adjustment coefficient for Kenya is higher than that for Pakistan, suggesting that the speed of adjustment of employment to its desired level is higher in Kenya. As both the economies are having labour surplus in the rural areas such adjustment is possible by migration of rural population to urban areas where industry is located. In a broad sense, the adjustment coefficient can also be interpreted as an indicator of the rural-urban migration. In this sense, it is obvious from the coefficients that the migration of rural population to urban areas is higher in Kenya as compared with Pakistan. The main reasons for lower migration in Pakistan can be related to various economic and non-economic factors. Traditional pattern of family, love for land and religious view of contentment are the main non-economic factors. Reasonable profits in agricultural commodities, under-developed transport and communications and high living cost in urban areas are the main economic factors.

The derived value of α or V (interpreted as returns to scale) is higher in Pakistan than in the U.K. and Kenya. Returns to scale in Australia and Pakistan are approximately the same. The main reason for higher returns to scale in Australia's and Pakistan's manufacturing sectors as compared to those in the U.K. and Kenya, is that this sector on the one hand is more developed and progressive in these countries as compared to Kenya but on the other hand is not as mature as of the U.K.

The technical progress parameter, *i.e.*, P is also higher in Pakistan as compared to that of Australia and U.K. But it is lower than that of Kenya. It indicates that Kenya is experiencing a more rapid technical change than Pakistan. The technical progress parameter is normally higher in a developing economy than in a mature economy. Pakistan's manufacturing sector is more mature than that of Kenya. As the manufacturing sector of the U.K. and Australia are more well-established, mature and advanced than that of Pakistan, the technical progress parameter is lower in these countries as compared to that of Pakistan.

CONCLUSIONS

There are several significant findings emanating from this study. First, although output is positively related to employment for the manufacturing sector, the output elasticity of employment is low (0.47) in equation (1) and (0.52) in equation (11).

Second, the rate of technological progress (P) is high for the manufacturing sector (7.6 percent per year) and technology is negatively related to employment in manufacturing sector of developing countries like Pakistan as indicated by the coefficient of "t" in equation 1 (—0.035).

Third, the coefficient of adjustment of employment to its desired level (λ) is high (0.623). In economies with surplus labour, it is expected that the coefficient of adjustment will be high.

Fourth, the wage elasticity of demand for labour is negative and high (—0.831) as estimated in equation (11). It implies that substitution does exist between capital and labour in manufacturing sector of Pakistan.

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