Exploring Determinants of Productivity in Pakistani Manufacturing Firms

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Abstract

This study examines the determinants of productivity among manufacturing firms in Pakistan using firm level data gathered in the World Bank Enterprise Survey of 2007. The research econometrically investigates the impact of various structural, organizational and technological characteristics of firms on the level of Total Factor Productivity (TFP).

Findings of The study suggest that factors which enhance the firms' performance and level of productivity include; foreign ownership, use of information and communication technology, schooling of production workers, presence of labor welfare programs, access to international market and use of innovative production process. In contrast, unionization of workforce and power outages are negatively associated with TFP.

Keywords: Manufacturing firms; TFP; Pakistan

JEL Classification: L60; D24

1. Introduction

Partial productivity indices of labor and capital are simply the average products of labor, or capital, while Total Factor Productivity (TFP) or multifactor productivity index is defined as the output per unit of labor and capital combined. TFP is often referred to as the 'residual' or the index of technological progress and represents the portion of output not explained by the amount of inputs used. Thus the level of TFP denotes how efficiently and intensely the inputs are utilized in the production process.

A rich empirical literature highlights the determinants that either affect or are associated with multifactor productivity. Based on national or macro data, various studies explored determinants that have an impact on TFP growth. Of these, education, health, infrastructure, imports, institutions, openness, competition, financial development, geographical predicaments, absorptive capacity and capital intensity appear to be the most important (Isaksson, 2007).

In contrast, other studies use firm level data to identify inter-firm differences in TFP with the help of institutional, technological, locational and other heterogeneous characteristics of firms. Syverson (2010) has classified explanations for productivity differences into two categories;

1. Factors that operate primarily within businesses; be it at the firm, plant, or even production line level. These are potentially under the control of management or other economic actors inside the firm. These determinants include; managerial practice/talent, higher-quality labor and capital inputs, information technology, research and development, learning-by-doing, product innovation and decision structure of firms.

2. The second set contains elements external to the firm. The impact of these "environmental" factors might not always be direct, but they can affect producers' willingness and ability to harness factors in the first set. Productivity spillovers, competition, deregulation and flexible input markets are some of the environmental determinants of productivity.

The World Bank's Enterprise Surveys (ES) provide a unique source of information, especially in developing countries that can be used to measure TFP and its determinants across countries or within a country across firms. Micro data are obtained through the surveys which are administered to a representative sample of firms in the non-agricultural formal private economy. These surveys collect qualitative and quantitative information regarding the business environment and the firms' performance through face to face interviews with firm managers or owners. The topics covered in the ES include infrastructure, trade, finance, regulations, taxes and business licensing, corruption, crime and informality, finance, innovation, labor, and perceptions about obstacles to doing business[1].

[1] Visit http://www.enterprisesurveys.org for detail information on sampling methodology and other aspects of the World Bank enterprise survey.

This research is based on ES data and attempts to statistically explore organizational factors associated with multifactor productivity or TFP. The sample distribution across location and sectors are described in the next section, while the methodology for deriving firms' TFP as well as how the characteristics are econometrically related with the estimated TFP is discussed in section 3. The selected factors or determinants of TFP for this study are described in section 4; while results are discussed in section 5. The last section is reserved for few concluding remarks.

2. The Sample

This research is based on the ES 2007 survey with a sample of 1183 manufacturing firms. However, due to item no-response on variables crucial for the productivity analysis, a number of observations had to be excluded from the data set, reducing the number to 808. The un-weighted and weighted[2] sample distribution across cites and sectors are furnished in Exhibits 2.1 and 2.2 respectively[3].

The graph in the Exhibit 2.2 indicates minor distortions in the overall sample distribution and the sample selected for the productivity analysis; however the problem of selectivity bias remains. The weighted sample for productivity analysis reveals that close to 60 percent firms belong to Karachi and Faisalabad, while 13 and 14 percent of sample firms are from Gujranwala and Lahore cities respectively.

The sectoral distribution is quite skewed. Textile firms dominate in the sample with close to 41 percent followed by 9 percent food and machinery each. About 34 percent sample is pooled in 'other manufacturing' category due to small number of firms. Regarding to size of firms chosen for the productivity analysis, close to 72, 21 and 7 percent firms are small (10 to 19 employees), medium (20 to 99 employees) and large (100 or more employees) respectively (Exhibit 2.3).

[2] As World Bank adopts stratified random sampling for the Enterprise Surveys, the sampling weights take care of the varying probabilities of selection across different strata. The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country. Firm size levels are 5-19 (small), 20-99 (medium), and 100+ employees (large-sized firms). Since in most economies, the majority of firms are small and medium-sized, Enterprise Surveys oversample large firms since larger firms tend to be engines of job creation. Sector breakdown is usually manufacturing, retail, and other services. However, specific manufacturing sub-sectors are selected as additional strata on the basis of employment, value-added, and total number of establishments. Geographic regions within a country are selected based on which cities/regions collectively contain the majority of economic activity. For further detail visit http://www.enterprisesurveys.org/~/media/GIAWB/EnterpriseSurveys/Documents/Methodology/Sampling_Note.pdf

[3] Seven manufacturing firms are surveyed in HUB city which lies on the outskirts of the Karachi; however these are merged with Karachi due to small numbers as well as enterprises in HUB face almost similar environment and conditions to those faced by firms in Karachi.

Exhibit – 2.1
Un-Weighted Sample of Manufacturing Firms – Cities and Sectors

	Firms Interviewed		Sample for Productivity Analysis	
	Number	Percentage	Number	Percentage
Karachi	240	20.3	136	17.3
Lahore	165	13.9	103	12.7
Sheikhupura	42	3.6	39	4.8
Sialkot	114	9.6	69	8.5
Faisalabad	164	13.9	152	18.8
Gujranwala	132	11.2	90	11.1
Wazirabad	40	3.4	15	1.9
Islamabad/Rawalpindi	87	7.4	63	7.8
Sukkur	39	3.3	30	3.7
Hyderabad	45	3.8	24	3.0
Quetta	43	3.6	28	3.5
Peshawar	72	6.1	55	6.8
Food	211	17.8	140	17.3
Garments	124	10.5	80	9.9
Textiles	256	21.6	190	23.5
Machinery & equipment	68	5.7	48	5.9
Chemicals	45	3.8	22	2.7
Electronics	16	1.4	9	1.1
Leather & Leather products	36	3.0	23	2.8
Other Manufacturing	427	36.1	296	36.6
Overall Sample	1183		808	

Source: World Bank Enterprise Survey database, 2007

Note: The Enterprise Survey data is available in the pre-coded format, thus it is not feasible to identify the type of firms included in the category of 'Other Manufacturing Firms'. It's a residual category.

Exhibit – 2.2
Weighted Sample Distribution – Percentage of Firms

	Overall Sample	Productivity Sample
Karachi	33.7	29.1
Lahore	13.6	14.3
Sheikhupura	0.8	1.1
Sialkot	2.4	1.7
Faisalabad	22.9	29.4
Gujranwala	13.0	12.9
Wazirabad	0.9	0.5
Islamabad/Rawalpindi	4.6	5.0
Sukkur	0.4	0.4
Hyderabad	3.9	2.4
Quetta	0.4	0.4
Peshawar	3.3	2.9

Source: World Bank Enterprise Survey database, 2007

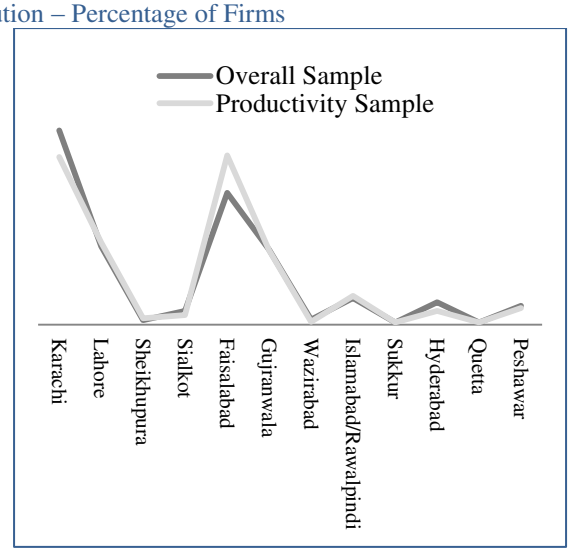
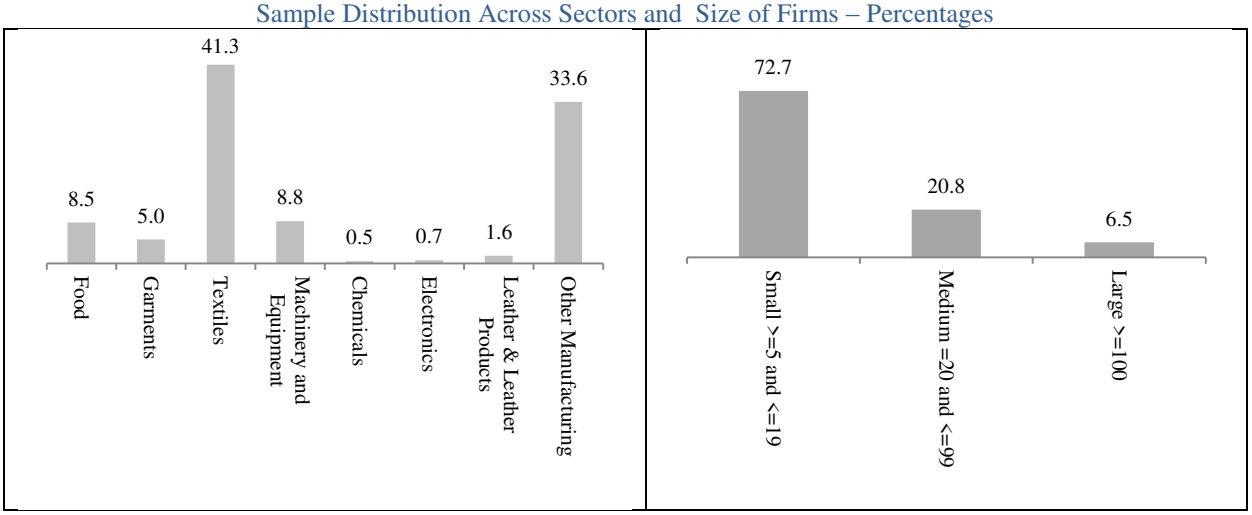


Exhibit – 2.3
Sample Distribution Across Sectors and Size of Firms – Percentages



Source: World Bank Enterprise Survey database, 2007

3. The Methodology

For the purpose of this study, it was assumed that the production function takes a simple Cobb-Douglas form and then calculates TFP as Solow residual[4]. The following specification was used to symbolize production framework and allowing non-constant return to scale.

$$Y_i = A(Z_i)K_i^{\alpha}L_i^{\beta}e^{\omega_i} \qquad [3.1]$$

According to the equation 3.1, the value added (Y) of firm is a function of the traditional factors of production, physical capital (K) and labor (L). The symbols α and β denote marginal productivities of capital and labor respectively. The term $A(Z_i)$ in the equation represents set of other factors which explain differences of productivity across firms. It was also assumed that these factors affect only total factor productivity, but not the marginal productivities of capital and labor.

A firm's value added is estimated from the ES data as the value of total sales minus material purchases and cost of energy (fuel and electricity expenses), whereas the labor productivity is measured by the value added per employee. The capital represents the firm's capital stock which is ascertained from the replacement value of machinery and equipment plus the net book value of land and buildings, while the labor input is measured by the value of the total number of permanent full-time employees.

[4] In the alternative methodology, non-parametrical index of productivity is constructed; whereby each firm's level of output and inputs are compared to those of a hypothetical firm, whose input and output values take the arithmetic mean values of output, input, and the respective input cost shares over all firms in the industry.

The equation 3.1 can be rewritten in terms of labor productivity as follows; the coefficient of $\ln(L_i)$ in the equation measures the deviation from constant returns to scale.

$$\ln(Y_i / L_i) = \ln A(Z_i) + \alpha \ln\left(\frac{K_i}{L_i}\right) + (\alpha + \beta - 1)\ln L_i + \varepsilon_i \qquad [3.2]$$

An important contribution to output is the rate of capacity utilization. Reasonably, when firms operate at higher capacity, they can produce more with the same amount of inputs. Thus following Goedhuys et al (2008), capacity utilization is explicitly introduced in the equation 3.2 expecting a positive and significant relationship with the labor productivity.

$$\ln(Y_i / L_i) = \ln A(Z_i) + \alpha \ln\left(\frac{K_i}{L_i}\right) + (\alpha + \beta - 1)\ln L_i + \gamma \ln CU_i + \varepsilon_i \qquad [3.3]$$

In analyzing with productivity differences across firms, empirical researchers have generally followed two methodological approaches; the 'extended specification approach' and the 'two-stage' approach. Under the 'extended specification' approach, variables that are assumed to proxy for $A(Z_i)$ are added directly to the right hand side of equation (3.3). Whereas in the two-stage exercise, productivity is estimated first with the help of basic growth regression and the second stage focuses on analyzing the productivity estimates obtained in the first stage with the help of explanatory variables.

The relevant literature, however, indicates several problems with the 'extended specification' approach. Most importantly, it is argued that despite extension of the specification, it is usually not possible to include all the variables that influence productivity in a growth-regression. Hence these left out variables, because of their correlation with the included variables, results in the omitted variable bias to the estimated parameters. In contrast, the two-stage approach has some advantages. First and foremost, it retains the essential distinction between the basic variables of growth and the conjectural variables that are thought to be proxy of productivity. Second, this approach brings productivity differences to the forefront of the analysis rather than relegating them to a 'nuisance' status. Third, it obtains estimates relatively free from omitted variable bias and endogeneity bias (Islam, 2008)[5].

This research also follows two-stage approach to analyze the impact of various institutional, business environmental and technological variables on firm's productivity. Thus the residuals from the first stage growth regression (equation 3.3) are used as dependent variable in estimating equation 3.4. X_{ik} in the equation is a vector of explanatory variables which are described below.

$$\varepsilon_i = TFP_i = f(X_{ik}) \qquad [3.4]$$

[5] Islam (2008) also cited two examples of researchers who have been used residuals from cross-section growth regression as dependent variable for explaining productivity differentials; Young (1994) and Feder (1985).

4. Variables Addressing Productivity of Firms

Heterogeneity across firms is controlled through age, size and legal status. It is hypothesized that older firms are relatively more efficient due to learning by doing and thus a positive relationship with the productivity is expected. Nonetheless, nature of relationship of size of firms in terms of permanent employees and legal status with the TFP is an empirical question. After preliminary econometrical investigation, the significant relationship is observed for medium sized firms having 20 to 99 employees and privately limited companies. Thus, these two variables are included in the equation.

To capture the potential effect of foreign ownership on productivity, a dummy variable indicating whether the firm has a positive share of foreign ownership is introduced in the equation. Moreover, the gender effect is also tested by incorporating a dummy variable which denotes that the principal owner of firm is female.

A direct relationship between the experience of executive manager or owner and firm's productivity may be hypothesized. Thus this variable in the equation would control variation in the years of manager's experience across firms.

Firm's technological orientation is captured with the help of two variables. It is assumed that firms having ISO certification have an edge over non-certified firms with respect to technological and organizational levels. Similarly, firms that can use technology through licensing from foreign company are better placed in terms of productivity. Consequently, a positive relationship between these two dummy variables and firm's productivity is expected.

The use of computer in the production technology signifies efficient use of input resources. Thus firms which reported having more than 20 percent computer controlled production process are included in the productivity equation in the form of binary (1,0) dummy variable. The importance of information and communication in technology for ascertaining advancement and knowledge is well recognized. The ES data provides two relevant variables for communicating with clients and suppliers; use of email and having firm's own website. However, due to collinearity problem only a dummy variable for firms having their own website is incorporated in the productivity equation.

Quality of human resources in terms of education and training is an important determinant for explaining productivity. From the ES data two variables are included to capture the link between education and training of workforce and productivity; average years of schooling of production workforce and a dummy variable representing firm which offer formal training to permanent employees. It was expected that these two variables would be linked positively with TFP.

Various measures of social security of workforce are obligatory for manufacturing firms. However, often management offers various schemes and facilities besides these compulsory provisions to increase labor productivity. From the ES data, the relevant variables chosen for the inclusion in the productivity equation include; firms having unionized workforce, provision of Gratuity of Provident Fund and having scheme of Workers Profit Participation Fund.

From the competition perspective, firms exporting products to the international market have to be more efficient than firms which are producing goods for the local or national market. To test this assertion, a dummy variable is introduced in the equation for exporting firms with the expectation of a positive relationship with the productivity.

The ES questionnaire also includes a module on firm's attempt to innovate. Two variables form this module are considered for the productivity analysis; firms which have introduced a new or significantly improved product in the market and firms which have implemented new or improved production process in firms during last three fiscal years. It is however difficult to suggest a priory the nature of relationship of these two dummy variables with TFP in the absence of any empirical research in Pakistan.

Electricity is a major obstacle to the business operations in Pakistan; the intensity however may vary across firms and across locations. Thus to control for the impact of this constraint on firm's productivity, a variable denoting average monthly hours of load shedding is included in the productivity analysis.

The Exhibit 4.1 gives average values of the determinants which are included in the final specification of Equation 3.4, besides dummy (binary) variables for cities and sectors.

Exhibit 4.1
Mean Values of Variables Included in the Equation 3.4

Age of Establishment (Years)	20.7
Firm Size – Medium (%)	21.2
Privately Held Limited Company (%)	10.2
Firms with Foreign Ownership (%)	0.3
Female Owner (%)	3.6
Experience of Executive Manager (Years)	20.0
Firms Having ISO Certificate (%)	5.9
Firms Having Technology Licensed from Foreign Owned Company (%)	2.3
Firms Having Computer Controlled Production (%)	7.1
Firms Having Own Website (%)	14.1
Schooling of Production Worker (Years)	4.2
Firms Which Offer Training Programs (%)	1.7
Firms Which Have Unionized Workforce (%)	1.0
Firms Which Facilitate Gratuity or Provident fund (%)	11.4
Firms Which Facilitate Workers Profit Participation Fund (%)	6.6
Main Product are Sold in International Market (%)	5.2
Firms Introduced significantly Improved Products (%)	5.0
Firms Introduced significantly Improved Production Process (%)	5.8
Load Shedding (Average Hours per Month)	76.8

Source: World Bank Enterprise Survey database, 2007

5. Results and Discussion

The estimated results of simple labor productivity regression (equation 3.3) are displayed in the Exhibit 5.1. The equation is estimated through Ordinary Least Square (OLS) method. The summary statistics of the Exhibit reveal good fit of the specification with statistically significant F-value and adjusted R^2 of 0.78. The elasticity of output with respect to capital is estimated at 0.44, while the estimated scale elasticity of 1.34 indicates increasing returns to scales. The

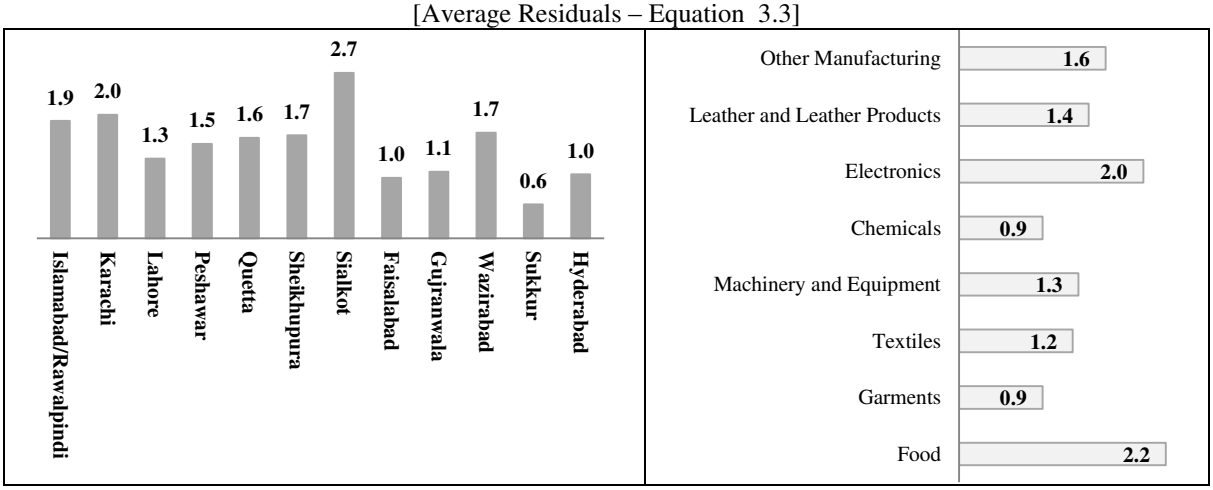
positive relationship of capacity utilization with productivity is also statistically significant denoting increase in productivity with the increase in capacity.

Exhibit – 5.1
Results of Estimated Equation – 3.3
Dependent Variable = LN (Value Added/Labor)

	Coefficients	t-Value	P-Value
LN (Capital/Labor)	0.45	16.67	0.00
LN (Employees)	1.34	46.81	0.00
LN (Capacity Utilization)	0.24	2.31	0.02
(Constant)	4.38	7.52	0.00
Adjusted – R^2		0.78	
F-Value		903	
Number of Observations		747	

The residual of each observation obtained from the estimated regression represent productivity or TFP of each firm. Average TFPs across cities and sectors are compiled and collated in the Exhibit 5.2.

Exhibit – 5.2
Total Factor Productivity Across Cities and Sectors
[Average Residuals – Equation 3.3]



The highest productivity is estimated for the City of Sialkot, followed by Karachi and Islamabad-Rawalpindi. Surprisingly, the magnitudes of TFP are significantly low for Lahore and Faisalabad as compared with Sheikhupura and Wazirabad in Punjab; even the estimated magnitudes of Lahore and Faisalabad are less than Peshawar and Quetta which are less-industrialized cities. However, the evidence of low productivity in Hyderabad and Sukkar of Sindh province is a priory expected. The sectoral productivity picture highlights food sector on the top in terms of TFP magnitude which is followed by electronics sector.

The econometrical results of the second stage regression (Equation 3.4) are displayed in the Exhibit 5.3. Few observations emerge from these findings which merit describing.

Barring the load-shedding or power outages variable, it was a priory hypothesized that all explanatory variables of the regression have positive relationship with the productivity (TFP). However, the coefficients associated with ISO certification, foreign technology license, training

program for workers, unionization of workforce and introduction of improved product do not support the hypothesis of direct relationship. The quality of management reflected by the firms' technological competence as revealed through ISO certifications is not resulting an increase in the productivity of manufacturing firms in the case of Pakistan. Similarly, the licensing technology from foreign companies is inversely related with the productivity. In contrast, the coefficient associated with foreign ownership is positive and highly significant; indicating the access to foreign technology mainly runs through foreign ownership linkage.

Exhibit – 5.3
Results of Estimated Equation – 3.4
Dependent Variable = (Residual of Equation 3.3)

	Coefficients	t-Value	P-Value
Age of Establishment (Years)	0.013	18.196	0.000
Firm Size – Medium (%)	0.143	7.636	0.000
Privately Held Limited Company (%)	0.103	3.688	0.000
Firms with Foreign Ownership (%)	0.995	7.266	0.000
Female Owner (%)	0.448	9.754	0.000
Experience of Executive Manager (Years)	0.003	3.577	0.000
Firms Having ISO Certificate (%)	-0.265	-6.297	0.000
Firms with Technology Licensed from Foreign Owned Company (%)	-0.487	-8.943	0.000
Firms Having Computer Controlled Production (%)	0.131	3.821	0.000
Firms Having Own Website (%)	0.736	26.529	0.000
Schooling of Production Worker (Years)	0.006	1.707	0.088
Firms Which Offer Training Programs (%)	-0.717	-10.015	0.000
Firms Which Have Unionized Workforce (%)	-0.279	-3.083	0.002
Firms Which Facilitate Gratuity or Provident fund (%)	0.179	5.862	0.000
Firms Which Facilitate Workers Profit Participation Fund (%)	0.062	1.703	0.089
Main Product are Sold in International Market (%)	0.436	8.884	0.000
Firms Introduced significantly Improved Products (%)	-0.339	-8.368	0.000
Firms Introduced significantly Improved Production Process (%)	0.089	2.039	0.042
Load Shedding (Hours per Month)	0.001	-6.366	0.000
Constant (Intercept)	-0.591	-13.317	0.000
Adjusted R^2		0.25	
F-Value		136	
Conditionality Index		21.9	
Number of Observations		747	

Note: All explanatory variables are statistically significant at least at 10 percent level of significance. The binary (1, 0) dummy variables for cities and sectors are also included in the OLS estimated regression.

Although adjusted R^2 is low (0.25) but it is accepted in the cross-section regression. More important is the magnitude of conditionality index which confirms the absence of multicollinearity. All explanatory variables appeared in the Exhibit are statistically significant; in fact majority of variables are significant at one percent level of significance

The Exhibit reveals that medium sized (20 to 99 employees) firms have an edge over small and large with respect to productivity. Further, the private limited firms are more efficient as compared with sole proprietorship and partnership. An interesting finding of this research is the positive and statistically significant coefficient associated with 'female owner'. Nonetheless, the ES data do not provide enough information regarding possible arguments and links between governance by female and firm's productivity.

Both variables (computer controlled process and own website) which are representing the extent of use of Information and Communication Technology (ICT) are positive and highly significance. Further, the magnitude associated with the 'website' variables is quite large indicating its large share in the contribution of productivity.

Although quality of human resources represented by average years of schooling shows the direct and significantly relationship with productivity, the inverse relationship in firms offering formal training programs is surprising. The ES data is not sufficient to establish positive link between formal training[6] and TFP. Goedhuys et al (2008) also found similar results in case of Tanzanian manufacturing firms. They observed that "In contrast to most findings in the literature, the skills level and training activities of the labor force do not produce any measurable effect on productivity".

A notable finding of this empirical work is the positive and statistically significant relationship between productivity (TFP) and measures of labor welfare schemes. Firms which offering Gratuity, Provident Fund or Workers' Profit Participation schemes relatively are more productive as compared with other firms. Nonetheless, the coefficient associated with the variable "unionization of workforce" is showing an inverse relationship with productivity.

The study also validates the presence of market competition and productivity. The econometrical results of the Exhibit 5.3 confirm the positive and statistically significant relationship between firms that are selling their products in the international market and the productivity (TFP). Thus competition, especially international motivates firms to adopt measures of using resources efficiently.

The relevant literature suggests that in the context of developing countries, innovations and R&D expenditure do not have any impact on productivity. For instance, Goedhuys et al (2008) finds that "innovations successfully introduced to the market or successfully implemented in the firm do not raise productivity". In contrast, this study however confirms a positive and statistically significant coefficient associated with firms which have introduced improved production process in their organization. However, the incidence is low; about 6 percent firms in the sample of this study verified the adoption of innovation in production process.

[6] More information are required to improve the results regarding training and innovation; for instance, duration of training, type of training, ability or skill level of participants etc. Unfortunately, these details are not available in the survey. Further, indicator representing innovation is vaguely and naively enquired by asking "During the last three years, did this establishment introduce onto the market any new or significantly improved products? (Yes/No)" However, to empirically assess the relation between TFP and innovation, information such as impact (change) on sales or on profit are needed.

Lastly, this empirical exercise confirms the inverse relationship of power outages and firm's productivity or TFP after controlling possible factors of firms' heterogeneity. Thus the uninterrupted power supply is a major channel for firms' profitability as well as productivity.

6. Concluding Remarks

Based on the data of World Bank Enterprise Survey of 2007, this study attempts to establish econometrical links of various structural, organizational and technological characteristics of firms with the productivity.

Backed with the firm level data on value added, physical and human capital and extent of capacity utilization, a production function is estimated to develop Total Factor Productivity (TFP) index for each sample firm. The level of TFP across cities stands out Sialkot with the highest average, followed by Karachi and Islamabad/Rawalpindi. The sectoral productivity analysis highlights food sector on the top in terms of TFP magnitude followed by the electronics sector.

At the second stage of the research, an econometrical analysis is carried out to explore the determinants of productivity of manufacturing firms in Pakistan. The estimated productivity at the first stage is regressed on various heterogeneous characteristics of firms. Besides controlling factors in terms of age, size, legal status of firms and executive manager's experience, various policy relevant variables are also included to determine the nature and extent of statistical relationship with productivity.

The analysis reveals that currently, possession of ISO certificate and technology license from foreign enterprise are not resulting in an increase in the productivity, while technology obtained through the channel of foreign ownership is positively affecting the productivity level. Role of information and communication technology is statistically verified through positive and significant coefficient of computer controlled production process and having firm's own website.

The study also highlights the significant role of schooling of production workers as well as the presence of welfare programs (Gratuity, Provident Fund or Workers' Profit Participation schemes) in enhancing the level of productivity of firms. However, unionization of workforce is negatively impacting on firm's productivity.

Gaining efficiency in production through international competition and change of production process through innovative improvements are also significant factors for boosting productivity of firms.

Finally, the significant negative impact of power outages on efficient utilization of available human and capital resources is a matter of concern for government as well as for entrepreneurs.

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