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DETERMINANTS OF MANUFACTURING VALUE ADDED IN PAKISTAN: AN APPLICATION OF BOUNDS TESTING APPROACH TO COINTEGRATION

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Abstract. This study employed bounds test based cointegration technique using annual time series data from 1965 to 2007 for exploring determinants of manufacturing value added in Pakistan. Three determinants included in the study were: total factor productivity (TFP), price level of investment and trade openness. TFP turned out to be the most significant determinant of manufacturing value added both in the short and long run. The price level of investment affected manufacturing value added negatively and significantly. Trade openness, however, turned out to be insignificant. The study recommends enhancement of TFP and stabilizing prices of investment goods for accelerating growth of manufacturing value added in Pakistan

I. INTRODUCTION

Manufacturing sector of any economy holds the significant importance and its contribution in overall economic growth cannot be exaggerated. The importance of this sector in Pakistan, being the third largest sector of the economy, is evident from the fact that it accounted for about 18.5 percent of GDP, 13 percent of total employment and 74 percent of total exports of the country in the fiscal year 2008-09. This sector of Pakistan economy, however, shows much volatile trend of contribution in GDP growth (30 percent in 2004-05 and –58 percent in 2008-09). It also bears the declining

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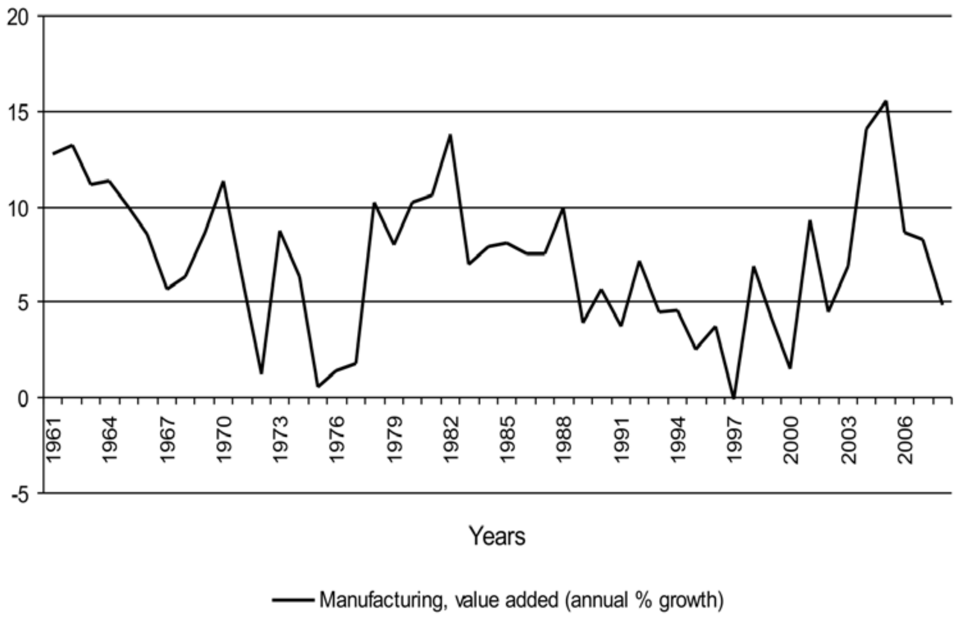
trend of fixed investment (23 percent, 22 percent and 16.2 percent in the years 2000, 2005 and 2010 respectively).[1] The growth trend of this sector, as shown in Figure 1.1, is also very fluctuating (as maximum as 15.51 percent in 2005 and as minimum as -0.07 percent in 1997). At the moment it is useful to bring evidence from the international trade behaviour. Certain Latin American and African countries have remained poor despite exporting primary and agro-based commodities like coca, banana and coffee. In the same manner none would say the oil rich Gulf countries developed despite exporting the most demanded commodity (oil and investing billions of dollars in US and Europe). In contrast to this economic miracle of Japan and Asian Tigers is the result of concentration on manufacturing and export of manufactured goods. In these circumstances an urgent, yet effective, policy is needed which could stabilize or even raise the contribution of this sector in economic growth.

FIGURE 1.1

Manufacturing Value Added (Annual Percent Growth)



Source: Generated by Authors Using Data from World Development Indicators (2010).

[1]Pakistan (2010), *Pakistan Economic Survey*.

Economics researchers are always interested in investigating the factors of sector wise GDP growth. These factors vary from sector to sector and even from country to country. Once these factors are identified, it can help to devise an effective policy to increase the sectoral growth by focusing on the main factors. In the light of above discussion, the present study aims to examine the determinants of manufacturing value added in Pakistan using an autoregressive distributed lag (ARDL) model. Rest of the study is organized as follows: Section II reviews the relevant empirical studies. Section III presents the levels accounting equation of total factor productivity. Section IV presents econometric model and data sources. Empirical results are discussed in Section V. Finally, section VI concludes the study.

II. REVIEW OF LITERATURE

The literature pertaining to the area under study in the Pakistani context is nearly non-existing. Very few studies are available and these are related to productivity of manufacturing sector not the value added thereof.

Verdoorn (1949) was the first who found the causality running from manufacturing output to labour productivity growth. This relationship is known as Verdoorn's law. This law remained ignored for thirteen years. Arrow (1962) cited this relationship in his study 'learning by doing'. But once again this law remained unnoticed till 1966 when Kaldor (1966) emphasized the said relationship and drew the attention of economists on the subject matter. To interpret this law Kaldor (1970) and Dixon and Thirlwall (1975) considered the concept of increasing returns to scale. According to this law, output growth raises labour productivity growth which reduces the unit cost of labour, and enables a country to compete globally due to lower prices. This competitive edge helps the country to export more and gain more demand for output and this reinitiates the cycle (Libanio, 2006).

Khan and Rafiq (1993) estimated substitution among capital, labour, imported raw materials and bank credit using a three-level nested CES production function for manufacturing sector of Pakistan over the period 1972-73 to 1990-91. They found that capital, imported raw materials and bank credit were complimentary whereas there was a low substitution between labour and capital (*i.e.* –0.63). This implied that there was little scope for employment generation in the manufacturing sector because of capital intensive nature of production technology. Further, it was noted that manufacturing sector of Pakistan showed decreasing returns to scale during this period.

Numerous researchers have been considering the output growth as a result of physical factors' accumulations. Supporters of this notion argue that more inputs produce more output. Young (1992, 1994, 1995), Kim and Lau (1994) and Collins and Bosworth (1996) are some of the studies which support this notion. On the other hand, many studies focused on the role of total factor productivity growth (TFPG) in output growth. TFPG is known as the growth of output due to factors other than physical inputs. These factors may include technical change, economies of scale, government policies, human capital, vintage of capital, research and development expenditures, international trade policies and remittances etc. Due to scarcity of physical inputs role of TFPG becomes more important. Atkinson and Stiglitz (1969), Kanamori (1972), Lapan and Bardhan (1997), Van and Wan (1997), Van, Park, and Ha (2003), Han (2003) and Ahmad *et al.* (2010) are some of the main studies which found the significant role of TFPG in output growth. Wizarat (2002) worked to compute TFP of the large-scale manufacturing sector of Pakistan for the period 1955-91. She found that for the period under study role of TFP in economic growth of Pakistan remained negative. IMF (2002) estimated TFPG for the period of 1961-2001. It found that TFPG remained negative in 1960s but positive afterwards. Pasha *et al.* (2002) examining TFPG in manufacturing sector of Pakistan for the period of 1973-98 found that it remained positive but showed a declining trend. In the pursuit of above literature a study is needed to investigate the role of TFPG in output growth of manufacturing sector of Pakistan rather than just finding the trend of TFPG. Present study attempts to fulfill this need.

III. LEVELS ACCOUNTING EQUATION OF TFP

This study draws upon Hall and Jones (1999) and Ozanne (2006) the levels accounting equation to calculate TFP with a slight difference. Ozanne (2006) used data on labour force unadjusted for human capital but the present study uses data on labour force adjusted for human capital in terms of education level. Assume that output in manufacturing sector is produced according to the following function:

$$Y_t = K_t^{\propto} \left(A_t L_{tec}\right)^{1-\propto} \tag{3.1}$$

Where Y_t, K_t, A_t and L_{tec} represent manufacturing value added, capital stock, labour augmenting total factor productivity and labour force adjusted for education level, respectively. Details of education level according to fractions of labour force employed in manufacturing sector of Pakistan economy are available in the *Labour Force Survey* published by Federal

Bureau of Statistics (FBS), Government of Pakistan. Present study uses the following method to adjust data on labour force for human capital:

$$L_{tec} = L_t\,(1 + \lambda e) \tag{3.2}$$

Where L_{tec}, L_t, λ and e represent total labour force employed in manufacturing sector adjusted for education level, total number of workers employed in manufacturing sector, the literate fraction of employed labour force in manufacturing sector and average education level of the employed labour force in manufacturing sector.

In order to compute TFP equation (3.1) can be written in an alternative way in terms of manufacturing value added per worker $\left(\frac{Y_t}{L_{tec}}\right)$ as follows:

$$\frac{Y_t}{L_{tec}} = \left(\frac{K_t}{L_{tec}}\right)^{\propto} A_t^{1-\propto} \tag{3.3}$$

Due to non-availability of data on capital stock we employed perpetual inventory method to construct this series. This method shows that capital stock is the accumulation of the flow of past investments as shown in equation (3.4).

$$K_t = \sum_{i=0}^{t} I_{t-i}(1-\delta)^i \tag{3.4}$$

Where K_t, I_t and δ represent the capital stock in current time period, investment level in current time period and the rate of depreciation of capital respectively. Present study uses 4 percent depreciation rate of capital as done by Nehru and Dhareshwar (1993), Collins and Bosworth (1996) and Ahmad *et al.* (2010).

IV. DATA SOURCES AND METHODOLOGY

DATA SOURCES AND VARIABLES

This study uses data on four variables — manufacturing value added (*MF*), total factor productivity (*TFP*), price level of investment (*PI*) and trade openness (*TO*) — with annual frequency for the period 1965-2007 in case of Pakistan. Data series on *TFP* was generated according to levels accounting equation as given in section III. We obtained data on manufacturing value added (in millions of Rupees at constant factor costs of 1980-81), education level according to fractions of labour force employed in manufacturing sector (in terms of years of schooling), labour force (in terms of hours worked in manufacturing sector), gross fixed capital formation (for generating data on capital stock (in millions of Rupees at constant factor costs of 1980-81)) from *50 Years of Pakistan in Statistics* (Volume I) and *Statistical Yearbook* (various issues) published by Federal Bureau of Statistics, Government of Pakistan. Data on price level of investment (PI) and trade openness (total trade as percentage of GDP) have been obtained from Penn World Tables version (6.3).

ECONOMETRIC MODEL

We specify the following equation to investigate the effects of total factor productivity, price level of investment and trade openness on manufacturing value added:

$$\ln (MF_t) = \beta_0 + \beta_1 \ln (TFP_t) + \beta_2 \ln (PI_t) + \beta_3 \ln (TO_t) + U_t \tag{4.1}$$

Where MF_t, TFP_t, PI_t and TO_t represent manufacturing value added, total factor productivity, price level of investment and trade openness. ln represents natural logarithmic form of the series. Parameters β_1, β_2 and β_3 are the long-run elasticities of *MF* with respect to *TFP*, *PI* and *TO* respectively. Engle and Granger (1987) test, maximum likelihood-based Johansen (1988, 1991) and Johansen-Juselius (1990) tests are the most widely used methods to investigate cointegration (long-run equilibrium relationship) among variables. These methods necessitate that all the variables included in the model must be stationary at first difference, *i.e.* I(1). Poor performance in the case of small sample is another limitation of these methods. Autoregressive distributed lag (ARDL) approach to cointegration avoids the said limitations. Pesaran, Shin and Smith (1996) and Pesaran and Shin (1999) developed this approach whereas Pesaran *et al.* (2001) developed it further. Due to various econometric advantages over other methods of cointegration this approach has gained wide acceptance. This approach, contrary to other approaches, does not necessitate all the variables to be integrated of the same order, *i.e.* I(1). This approach is equally good if all variables in a model are I(0) or I(1) or even fractionally integrated (Pesaran and Pesaran, 1997). Pesaran and Shin (1999) argued that ARDL approach to cointegration provides robust results and super consistent estimates of the long-run coefficients in case of small samples.

Considering above advantages of ARDL approach to cointegration, we specify the following model:

$$\Delta \ln(MF_t) = \begin{array}{l} \beta_0 \sum_{i=1}^{q} \beta_{1i} \Delta \ln(MF_{t-i}) + \sum_{i=0}^{q} \beta_{2i} \Delta \ln(TFP_{t-i}) + \sum_{i=0}^{q} \beta_{3i} \Delta \ln(PI_{t-i}) \\ + \sum_{i=0}^{q} \beta_{4i} \Delta \ln(TO_{t-i}) + \beta_5 \ln(MF_{t-1}) + \beta_6 \ln(TFP_{t-1}) \\ + \beta_7 \ln(PI_{t-1}) + \beta_8 \ln(TO_{t-1}) + U_t \end{array} \quad (4.2)$$

Where Δ is the first difference operator, q is optimal lag length, β_1, β_2, β_3, and β_4 represent short-run dynamics of the model and β_5, β_6, β_7, and β_8 are long-run elasticities. Before running the ARDL model we tested the level of integration of all variables because if any variable is I(2) or above ARDL approach is not applicable. For this we use Augmented Dickey-Fuller test (ADF) and Phillip-Perron test (PP). In order to find the long-run relationship as given in equation (4.1), we conducted bounds test of equation (4.2) using F-statistic with two bounds, *i.e.* lower bound and upper bound. The null hypothesis assumes no cointegration among variables. If the value of F-statistic is greater than the upper bound then the null hypothesis is rejected and if it is less than lower bound then null hypothesis is accepted and if it falls between the lower and upper bounds the test is inconclusive. After testing cointegration we use Schwarz Bayesian Criterion (SBC) to select the optimal lag length of variables. An error correction version of equation (4.2) is given as below:

$$\Delta \ln(MF_t) = \begin{array}{l} \beta_0 \sum_{i=1}^{q_1} \beta_{1i} \Delta \ln(MF_{t-i}) + \sum_{i=0}^{q_2} \beta_{2i} \Delta \ln(TFP_{t-i}) \\ + \sum_{i=0}^{q_3} \beta_{3i} \Delta \ln(PI_{t-i}) + \sum_{i=0}^{q_4} \beta_{4i} \Delta \ln(TO_{t-i}) + \lambda EC_{t-1} + \varepsilon_t \end{array} \quad (4.3)$$

Where q_1, q_2, q_3 and q_4 represent optimal lag length, λ is the speed of adjustment parameter and EC represents the error correction term derived from long-run relationship as given in equation (4.2).

V. EMPIRICAL FINDINGS

Before applying ARDL approach to cointegration, unit roots of all the series are tested. Table 5.1 presents the results of ADF and PP at level and at first difference. According to results of both the tests, ln (*PI*) and ln (*TO*) are stationary at first difference form at one percent significance level whereas, ln (*MF*) and ln (*TFP*) are stationary at first difference at five percent significance level according to Augmented Dickey Fuller test and at one percent significance level according to Phillips-Perron test. In this situation we can apply ARDL approach to cointegration.

TABLE 5.1

Unit Root Test Results

Variables	Augmented Dickey Fuller Test Statistic (At Level)	Augmented Dickey Fuller Test Statistic (At First Difference)	Phillips-Perron Test Statistic (At Level)	Phillips-Perron Test Statistic (At First Difference)
ln MF_t	–0.01	–3.01**	0.45	–4.65*
ln TFP_t	–0.28	–3.37**	–0.48	–5.94*
ln Pi_t	–2.11	–5.70*	–1.60	–5.76*
ln TO_t	–1.62	–4.92*	–1.07	–8.24*

* and ** show significance level at 1 percent and at 5 percent levels, respectively.

Results of long-run relationship are sensitive to lag-length selected in the model (Bahmani-Oskooee and Bohal, 2000). Table 5.2 presents the computed F-statistic to select optimal lag-length in the model. According to Pesaran *et al.* (2001), with lag of order 1 the lower and upper bound values at 95 percent significance level are 4.94 and 5.73 respectively. Table 5.2 shows that the computed value of F-statistic (5.76) is greater than the upper bound value of F-statistic which helps us to reject the null hypothesis of no long run relationship. Therefore, we conclude that there is long-run relationship among the variables.

TABLE 5.2

F-Statistic for Testing the Existence of Long-Run Relationship

Order of Lag	F-Statistic
1	5.76

The lower and upper bound values (4.94 and 5.73 at 95 percent) for F-statistic are taken from Table CI(*iii*) Case III: Unrestricted intercept and no trend given in Pesaran *et al.* (2001).

We used Schwarz Bayesian Criterion (SBC) to select the optimal lag length of variables included in the ARDL model. Table 5.3 presents the results of long-run relationship of the selected ARDL model (1, 1, 0, 0) using SBC.

TABLE 5.3

Long-Run Coefficients of ARDL (1, 1, 0, 0) Model
Dependent Variable ln (*MF*)

Regressor	Coefficient	Standard Error	t-Ratio
Constant	11.330	3.840	2.95*
ln (TFP_t)	1.089	0.264	4.118*
ln (PI_t)	–1.524	0.647	–2.357**
ln (TO_t)	–0.175	0.568	–0.308

* and ** show significance level at 1 percent and 5 percent respectively.

Table 5.3 reveals that *TFP* is the most significant factor of manufacturing value added in Pakistan. The effect of *TFP* on *MF* is significant at one percent level of significance. The coefficient (1.089) of ln (*TFP*) shows that one percent increase in *TFP* leads to over 1 percent increase in manufacturing value added in the long-run. Price level of investment is another significant factor of manufacturing value added in Pakistan. At five percent level of significance the effect of *PI* on *MF*, as expected, is negative. The coefficient (–1.524) of ln (*PI*) indicates that one percent increase in price level of investment deteriorates the manufacturing value added by 1.52 percent in the long-run. Trade openness, however, does not affect manufacturing value added significantly even with unexpected negative sign.[2] The results presented in this paper signify the importance of *TFP* and PI in manufacturing sector. These results indicate that concerned authorities should devise and implement such policies in manufacturing sector which could increase the level of *TFP* and control the price level of investment. Present study supports the findings of Atkinson and Stiglitz (1969), Kanamori (1972), Lapan and Bardhan (1997), Van and Wan (1997), Van, Park, and Ha (2003), Han (2003) and Ahmad *et al.* (2010).

[2]Imports-to-GDP ratio and exports-to-GDP ratio were also tried as separate regressors but none was found to be significantly affecting manufacturing value added in Pakistan.

Table 5.4 contains the results of error correction representation of the selected ARDL model. Coefficients of the variables with Δ sign show the short-run elasticities. Results represent that in the short-run *TFP* once again is the most significant factor (with the largest coefficient and largest t-ratio) of manufacturing value added. However, both the variables *TFP* and *PI* affect the manufacturing value added at one percent significance level. The 0.26 value of coefficient of Δ ln (*TFP*) reveals that ten percent increase in *TFP* brings about 2.6 percent addition in manufacturing value added in the short-run. Similarly, –0.08 value of the coefficient of Δ ln (*PI*) reflects that ten percent increase in PI pulls manufacturing value added down by almost one percent. Trade openness does not significantly affect the manufacturing value added even in the short-run. The coefficient of error correction term (–0.063) is significant at one percent level. Highly significant negative sign of the error correction term reinforces the existence of long-run relationship among the variables. However, the speed of adjustment from previous year's disequilibrium in manufacturing value added to current year's equilibrium is only 6.3 percent.

TABLE 5.4

Error Correction Representation of the Selected ARDL (1, 1, 0, 0) Model
Dependent Variable Δ ln (*MF*)

Regressor	Coefficient	Standard Error	t-Ratio
Constant	–0.656	0.189	–3.466*
Δ ln (TFP_t)	0.262	0.033	7.939*
Δ ln (PI_t)	–0.082	0.028	–2.928*
Δ ln (TO_t)	0.004	0.029	0.138
$ECM_t(-1)$	–0.063	0.019	–3.315*

R^2 = 0.757, Adj. R^2 = 0.723, F (4, 37) = 27.98, Prob (F-stat) = 0.000, DW = 2.120.

* denotes significance of the coefficient at 1 percent level.

We tested the stability of the selected ARDL based on error correction model using cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) stability testing technique presented by Brown *et al.* (1975). CUSUM and CUSUMSQ plots have been shown in Figures 5.1 and 5.2 respectively. Since both the plots remain within critical bounds at 5 percent level of significance, we conclude that the model is structurally stable.

FIGURE 5.1

Plot of Cumulative Sum of Recursive Residuals

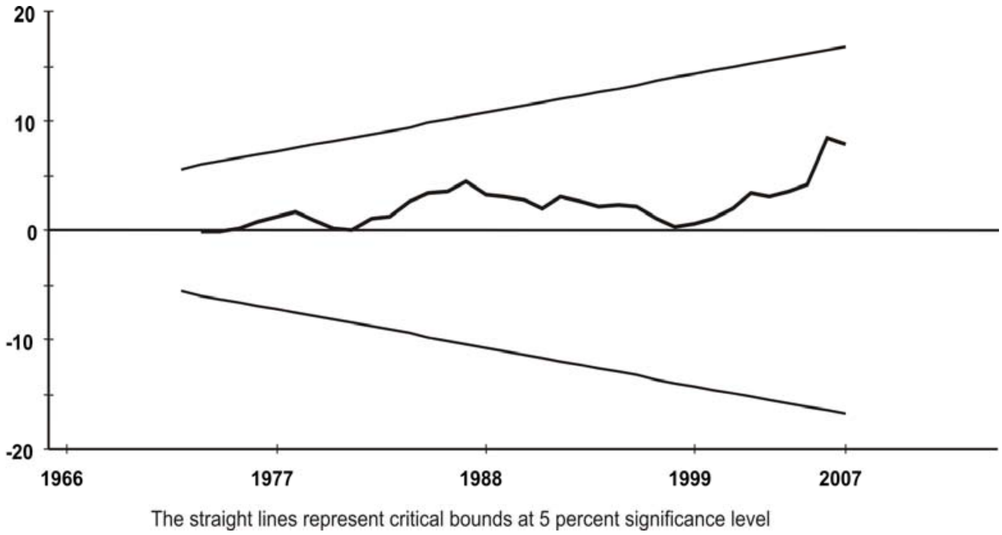
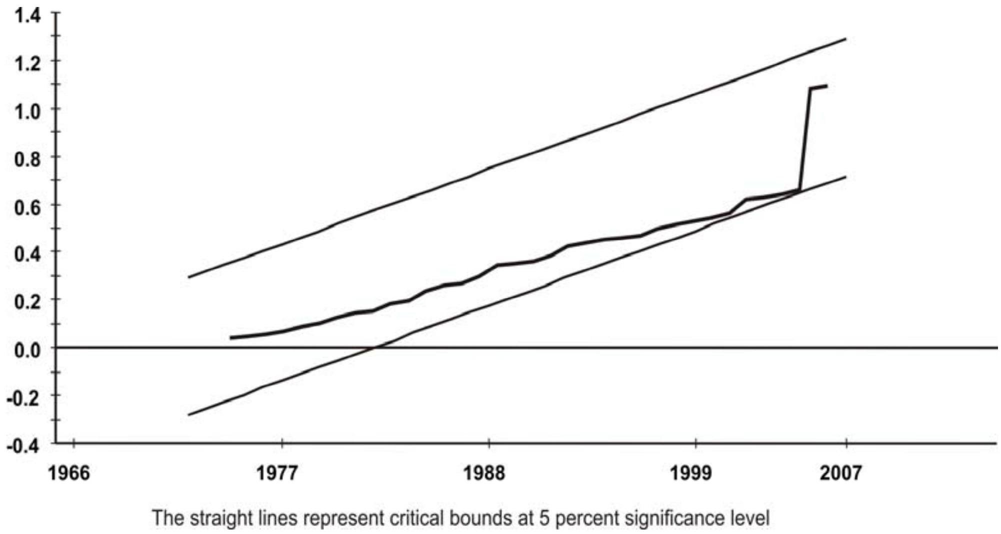


FIGURE 5.2

Plot of Cumulative Sum of Squares of Recursive Residuals



VI. CONCLUSION

This study aimed to investigate the determinants of manufacturing value added in Pakistan for the period 1965 to 2007. We considered three variables (total factor productivity, price level of investment and trade openness) as the determinants of manufacturing value added. Due to certain advantages discussed in section IV we used ARDL approach to cointegration and an error correction representation of the ARDL model. According to results of this study *TFP* is the most significant determinant of manufacturing value added in Pakistan both in the short-run and long-run. Price level of investment also affects manufacturing value added significantly both in the short-run and long-run. Trade openness, however, does not affect manufacturing value added both in the short-run and long-run. The speed of adjustment process from previous year's disequilibrium in manufacturing value added to current year's equilibrium is also very slow (only 6.3 percent).

In the light of the findings of present study we strongly recommend that the Government of Pakistan should introduce such policies which could enhance the level of *TFP* and control the price level of investment. This action would help the manufacturing sector of Pakistan to exhibit a sustainable growth. The labour augmenting total factor productivity may be increased through education and training of the labour force working in manufacturing sector.

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