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Considering Impacts of Short-Term and Long-Term Production Capacity Utilization Rate on Manufacturing Total Factor Productivity Growth Rate in Iran

Farzad Karimi,
Assistant Professor of Economics,
Islamic Azad University,
Science and Research Branch of Isfahan, Iran.

Mohamad Reza Ghasemi,
Assistant Professor of Economics,
Isfahan Management and Planning Organization, Iran.

Fatemeh Amiri,
AShrafi Esfahani University, Iran.

Abstract

Economists often emphasize on the use of manufacturing capacity utilization ratein order to increase industrial productivity rate. The purpose of this study was to examine the impacts of short- and long-term productive capacity utilization rate on manufacturing total factor productivity growth in the period of 1986-2011 (1365-1390) using Co-integration method in Iran. The manufacturing productivity growth was calculated by Cobb-Douglas production function and by deterministic frontier production function of manufacturing capacity utilization rate.The Results revealed a positive effect on the long-term production capacity utilization rate; also Error Correction Model was shown in short- termproduction capacity, the amount of 0.25 of long-term error was corrected in each period. It also reflected the positive impact of capital expenditures and the quality of human resources and the negative impact of exchange rate on manufacturing total factor productivity growth in the long termproduction capacity.

Keywords: *Manufacturing productivity growth, total factor productivity growth, manufacturing capacity utilization rate, co-integration method*

1. Introduction

Nowadays, in an effort to the industry growth, there is a high tendency to promote productivity, because over time, the relative decline of natural resources and the control of population growth, which can be meant the reduction of production capacities, the only way to the growth of production is to achieve a higher productivity. This matter has been important so far that even productivity is known asa factor ofnation's wealth creation in the new field. Hence, discussing themanufacturing productivity has entered into the literature of industrial organization (Mehrabani, 2012).

According to the theory of production, production growth will be achieved in two ways: in the first methodan increase in production byusing more manufacturing factors whiletechnology is constant will happen. In the second method, the main contribution to the increase in production, by using advanced and efficient methods of production withhigh productivity and byusingall the production capacity will happen.

(Bamikole, 2012).

Due to the attainment of high economic growthand increasingly important industry sector for the economy in developing countries, it is necessary to clearly identify factors affecting industrial growth.So it will be possible to develop a comprehensive policy for industrial and economic fields.

Since Productivity is the most important channel to achieve economic growth, in the Medium-term and long-term planning in the countries, it is taken into consideration, and it is referred to as creating real wealth. In fact, the assessment of industrial productivity in comparison with other sectors of the country can facilitate moving toward competitive actions and planning short and long-term comparative advantage in industry (Ray, 2012).

In general, factors that increase the productivity can be an efficient use of productive capacity due to special technology, technology growth, technology development, and optimal allocation of economic resources which are based on the returns to scale in production (Ray and Mihir, 2011). The significance of productivity and its relationship with capacity utilizationmade the researcher to investigate the impact of capacity utilization on industry productivity growth.

2. Theoretical Framework

Capacity utilization is a concept in economics which refers to the extent to which an enterprise or a nation actually uses its installed productive capacity. Thus, it refers to the relationship between actual output that 'is' produced with the installed equipment and the potential output which 'could' be produced with installed equipment, if capacity was fully Used (Ihejirika and Warri,2012).

Due to Cassels, 1937, economic capacity output of the firm is the level of production where the firm's long-run average cost curve reaches a minimum. Since long-run average cost is considered, no input is held fixed. So, the economic measure pertains to capacity utilization of all inputs. For a firm with a typical U-shaped average cost curve, at this capacity level of output, economies of scale have been exhausted but diseconomies have not yet set in Ray, (Mukherjee, and Wu, 2006). If the technology exhibits constant returns to scale, the long-run average cost curve is horizontal and does not have a minimum. So the capacity level of output is not defined. Klein, 1960 proposes the output level where the short-run average cost curve is tangent to the long-run average cost curve as a measure of the capacity output (Deb , 2011).

Most of the authors agree that capacity utilization is a sine-qua-non to the productivity growth of the manufacturing sector. Anyawu (2000) opines that an economy with a poor performing manufacturing sector faces shocks internally from inflation, unemployment and externally from price distortions of oil at the international market. Adenikinju (2005), Oloni and Oshodi (2008), Ogunleye and Ayeni (2008), Adeniknju and Chete (2002) and others agree that manufacturing productivity growth can never be accelerated without a high absorptive capacity and high capacity utilization rate (Bamikole , 2012).

One of the important criteria by which one can realize the strength of industrial activity in order to achieve a comparative advantage in the inner and outer surface is the amount of productivity rateof factor production. Productivity is "the degree of using each of the factors of production".Enhancing the productivity factors of production can increase their efficiency in various industries and thereby, improving manufacturing activity and industrial production growth.Productivity growthof factor production in an industry which causes the reduction of price levels and level of prices including factors of production, leading to lower average cost of production of goods and services in the market but it increases the amount of production capacities in the final products profitability of industry. Consequence of these developmentwillhave a significant effect on the increase in demand and most importantly, increase the competitiveness of domestic products in foreign markets. Consequently, the volume of new industrial investmentsis increased and subsequently use of innovations and new technologies is extended and thiswill be an important factor to increase the efficient use of resources (Mowla'ii and et al., 2002).

Using old technology, inability to use the full capacity, insufficient consideration of maintenance, lack of specialist and efficient force in using capital and management weaknesses are among the factors that play a vital and determining the role in low investment returns and other manufacturing capacities; consequently, production is less and productivity is lower. If production factors are managed through appropriate techniques and are used by scientific methods, output of the firm or company will be increased, thereby productivity gets increased (Victoria, 2003).

The growth of physical capital and accumulation of new capital increase the capital in terms of any labor. If the system has the ability of qualitative and quantitative changes of the inputs and outputs and if it can allocate this capital to firms that have capital-intensive production technology, this system will be able to increase the efficiency of capacity utilization in order to generate more products (Baltagiand Rich, 2005).

Competition has also factors affecting capacity utilization. With extension of competition, business management is better and allocation factors of production and their combination is more efficient. In other words, for a certain amount of inputs, more products will be obtained (Mehrabani, 2012).

Baldwin et al. (2011), in a study of the Canadian manufacturing sector through an alternative strategy, have concluded that the decomposition of productivity growth into its components shows that aggregated labor productivity growth was declined further due to the decrease in labor productivity growth within factories rather than the effect of restructuring and reallocation of more resources. This reduction was due to a rise in excess capacity. Because non-immediate adjustment of production inputs such as capital and labor, leads to excess capacity and lower estimate productivity. The difference between the effects of excess capacity in various sectors shows that this effect particularly for companies and industries serving export markets, has been intensive.

Using Johanson-Joseliusco integration method, Bamikole (2012) in the study of the impact of capacity utilization rate and manufacturing productivity growth in Nigeria between the years 2007 to 1975 concluded that contrary to the belief of economists, capacity utilization rate has a negative effect on manufacturing productivity growth, which in his opinion it was due to frequent power cuts. Additionally, the exchange rate has a positive relationship with manufacturing productivity growth. If currency in Nigeria has an increasing value against Dollar, imports of capital goods will be cheaper, thus productivity will be increased. The government's capital expenditure has a positive impact on manufacturing productivity growth, but statistically it is not significant. According to Bamikole, the reason of this is that investment projects has a long return period and may also mean that politicians allocate a part of capital budget into non-productive activities.

3. Model

Economists have observed that over these years, compared to the past, the amount of manufacturing capacity utilization has been accelerated, such companies can produce more products, and in order to supply the products for domestic consumption, they export some of their products (Bamikole, 2012).

The production capacity can be increased in different ways and it affects the total factor productivity. Tremendous impact of technological developments on the optimal use of production capacity, which reduces the amount of wasting production resources, has a direct relation with the economic growth and total productivity (Bakhshali and Mojtahed, 2004).

However, government can have direct and indirect impacts on increasing productivity and economic growth. The direct impacts include benefits through investment in employment and welfare programs. Indirect impacts occur when the growth of the agricultural and non-agricultural sectors through government investments in infrastructure, research related to each sector and health and education are increased and lead to creation of job opportunities and also income generation for public especially low revenue segments (Torkamzni and Jamalimoqadam, 2008).

The role of exchange in economy systems, especially in underdeveloped countries is undeniable. The reason is clear, developing countries in most sectors of the economy are dependent to industrialized countries and need more foreign exchange for importing goods.

Most manufacturing enterprises in order to purchase raw materials, technology and machinery proceed to import. If under the effect of changes in economic and several other factors effective, the exchange rate rises, firms are forced to pay more for imports.

Increase in the exchange rate on the one hand, increases debt levels, and on the other hand increases the cost of products and services provided by these companies. Increased debt leads to lack liquidity of and lack of liquidity of the enterprises have a negative impact on the use of resources, production, productivity, profits and distribute cash returns of shares (Madsen, 2002).

Simon Kuznets, the winner of the Nobel Prize in Economic in 1971, believed that the concept of capital that only involves physical and commodity capital is a deficient and incomplete concept. Therefore, both human capital and physical capital should be taken into consideration.

Relating to this, he says: 'human capital of an advanced industrial country, is not industrial tools and equipments, they even are knowledge obtained from the experiments and the experienced individuals to apply this knowledge". He believed that investment in education is an important source for the formation of human capital, such as enabling the labor and advancement of technical knowledge production; he also considered human capital as an important factor in development of economy (Sobhani, 2011).

Education, strengthen the quality of human capital is regarded as an important factor along with physical capital and labor, in the production process. Training can affect growth through different mechanisms (Emadzadeh and et al., 2009) :

First, training increases human capital in the labor, which leads to increase in productivity and promoting economic growth (neoclassical theory).

Second, training can increase the power of innovation in the economy and contribute to the creation of new knowledge and technologies and improve the growth and manufacturing process (endogenous growth theory).

Third, training helps the dissemination and transfer of knowledge which is needed for knowing the new process of information and successful applying the new technologies which leads to economic growth.

According to the theoretical fundamentals of this study and given explanations, the model used in this study, following Bamikol (2012), is stated as follows:

GMPI GMPI = f (CPU, EXR, GCE, EIG) (1-3)

It specifies a functional relationship in a linear form (with an error term u)

$GMPI = \beta_0 + \beta_1 CPU + \beta_2 EXR + \beta_3 GCE + \beta_4\ EIG + u$ (2-3)

Where GMPI is Growth-Manufacturing Productivity Index, CPU is Capacity Utilization, EXR is Exchange rate, GCE is Government Capital Expenditure, EIG is Employed Industry Graduate. In this study, the proportion of highly educated people who are employed in the industry to the total people employed in the industry is used.

There are several indexes to calculate the total factor productivity of which the most important ones are: basic index, Solo, Kendrick, Divisia, Tourniquet Index and Heinz model. In this study, in order to calculate manufacturing productivity growth the neoclassical growth theory has been used. The Solow growth-accounting technique (Solow, 1957) requires only the assumption of constant returns to scale in the production functionand perfect competition. We estimated production function to obtain the respective weights of inputs through Ordinary Least Square (OLS). We can specify an aggregate production function as:

$Y_t=A_t f(K_t,L_t)$ (3-3)

Where 'Y', 'K' and 'L' are value added, physical capital stock and labor force respectively, and 'A' is total factor productivity (TFP). Taking the logarithmic form of function and differentiate the function (3-3) it transforms into equation (3-4):

$$\frac{\hat{Y}}{Y} = \frac{\hat{A}}{A} + \frac{Af_k K}{Y}\frac{\hat{K}}{K} + \frac{Af_L L}{Y}\frac{\hat{L}}{L} \qquad (4\text{-}3)$$

And obtain the growth rate of output decomposed into sources of growth:

Improvement in productive efficiency $(\frac{\hat{A}}{A})$ and increase in factor inputs $(\frac{\hat{K}}{K})$, $(\frac{\hat{L}}{L})$.

The $(\frac{Af_k K}{Y})$،$(\frac{Af_l L}{Y})$ are the shares of capital (α_k) and labor (α_l) in total output respectively. Since the share of capital one minus the share of labor under the assumption of constant returns to scale, the growth rate of output is decomposed into TFP growth and the weighted sum of the growth of capital and labor is as follows:

$$\frac{\hat{Y}}{Y} = \frac{\hat{A}}{A} + (1 - \alpha_l)\frac{\hat{K}}{K} + \alpha_l \frac{\hat{L}}{L} \quad (5\text{-}3)$$

Given the above discussion, the total factor productivity growth based on the production function of Cobb - Douglas production and logarithmic shape variables are calculated. With a growth rate of data input and output, along with the contribution factor, the equation above can be TFP growth as output growth remains after subtracting the measurement of the input measure of output growth. Therefore, the above equation can be expressed as follows:

$$\frac{\hat{A}}{A} = \frac{\hat{Y}}{Y} - (1 - \alpha_l)\frac{\hat{K}}{K} + \alpha_l \frac{\hat{L}}{L} \quad (6\text{-}3)$$

In this study, the rate of capacity utilization is equal to the ratio of actual output to potential output multiplied by 100. To obtain potential output, the Cobb - Douglas production function based on the deterministic frontier production function with assumption of constant return to scale was used and it is done as follows (Bamikol, 2012):

$$Ln(Y) = (a_0 + |u|) + (1 - \beta)Ln(K) + \beta Ln(L) \quad (7\text{-}3)$$

Where a_0 represents the intercept, u is residues, β is production function elasticity with respect to labor and (1-β) is production function elasticity with respect to capital stock in the ordinary least squares estimation function. Placement of the labor force and capital stock in constant prices can be obtained from the rate of potential output.

3.1. Introduce the long-term pattern

3.1.1 The Johanson-Joselius cointegration test

To determine the cointegration of long-run equilibrium relationships between variables, Johansson test which is the most complete test of the cointegration test, is applied. Procedure is such that at first using the maximum value test and trace test (Trace) presented by Johansson, which is known as the likelihood ratio statistics, the number of integrated vectors between the variables are determined (Noferesti, 2012).

3.2 Pattern of short-term

3.2.1 - vector error correction model (VECM)

The co-integration existence between a set of economic variables provides the statistical basis of using error correction models. These models have become increasingly popular in empirical work. The main reason of popularity of error correction models is that they relate short-term fluctuations of variables to their long-run equilibrium values. The Error correction model suggests that variation of dependent variable is a function of the deviation from long-run equilibrium relationship (expressed by error correction part) and changes in the other explanatory variables. This pattern relates the short-term and long-term behavior of two variables (Noferesti, 2012).

4. Experimental Results

4.1. The Test of Dtermination the degree of Cointegration

In order to estimate by vectors of auto-regression method it is necessary to consider the degree of cointegration between pattern variables. In this study Durbin- Watson co-integration regression test (CRDW) is used to determine the degree of integration between the variables.

To conduct this test, the model (4-1), by OLS is estimated. According to the results, the statistic Durbin - Watson test (DW) is larger than the coefficient of determination R^2, (1.59>0.31), The possibility of spurious regression is rejected. To test the hypothesis d = 0, the calculated Durbin-Watson statistic in estimated regression are compared with critical quantities provided by Sargan and Bargava. The results show that D.W = 1.59 is greater than the provided critical quantities even in the 10% level. Thus the null hypothesis is rejected. It means the disturbing statements are stable. As a result, it can be inferred that there is a long-run equilibrium relationship between the variables of the given pattern so that explained in this model.

Table (4-1) Critical values of the test CRDW

Critical quantity	The level of significance
0.511	1%
0.386	5%
0.323	10%

Source: Calculations research

Table (4-2) The results of estimating equation (3.2) by OLS

Statistics	value
Durbin-Watson	1.596178
R-Squared	0.317654
Adjusted R-Squared	0.187673

Source: Calculations research

4.2. Calculating long-term relationship

The model used in this study is to evaluate the long-term dynamics of compliance Bamikol (2012) which is mentioned below:

$$GMPI = \beta_0 + \beta_1 CPU + \beta_2 GCE + \beta_3 EXR + \beta_4 EIG + u \quad (1\text{-}4)$$

Before estimating the model, it is required to investigate the stability (stationary or static) of variables. Although the stability condition of variables of a time-series regression correlation can be provided by subtracting, for long-term retention of information in relation to the level of variables no particular job can be done. Therefore, the convergence procedure (co-integration) can help estimate a regression without fear of being spurious based on time-series variables level.

4-2-1 Determining Degree of Variables stationary

Unit root test is one of the most commonly used tests, which today it is applied for the detection of stability of a time-series process. In this study, argumented Dickey - Fuller test for the stability of variables is used through Eviews 7 software, the results are shown in Table (4-3).

Table (4-3) Dickey - Fuller Test at level (5%)

Variables with intercept and trend

GMPI	CPU	GCE	EXR	EIG	Variable name	
-3.19	-3.16	-4.26	-1.50	-2.12	Statistics Dickey - Fuller	
0.1	0.11	1.00	0.79	0.5	Probability	
-4.37	-4.39	-4.39	-4.37	-4.37	Level 1%	The critical values
-3.60	-3.61	-3.61	-3.60	-3.60	Level 5%	
-3.23	-3.24	-3.24	-3.23	-3.23	Level 10%	
Non-Stability	Non-Stability	Stability	Non-Stability	Non-Stability	Evaluation Stability	

Source: Calculations research

According to the findings, the variable of government capital expenditure is stable at 95%. To investigate the stability of other variables their first difference, (D1CPU, D1GMPI, D1EXR, D1EIG) and argumented Dickey - Fuller test is used. The results have been reported in table (4-4).

Table (4-4) Dickey - Fuller Test at first differences (5%)

Variables with intercept and trend					
D1GMPI	D1CPU	D1EXR	D1EIG	Variable name	
-4.98	-6.14	-5.06	-4.39	Statistics Dickey - Fuller	
0.00	0.06	0.00	0.01	Probability	
-4.41	-4.49	-4.39	-4.39	Level 1%	The critical values
-3.61	-3.65	-3.61	-3.61	Level 5%	
-3.24	-3.26	-3.24	-3.24	Level 10%	
Stability	Stability	Stability	Stability	Evaluation Stability	

Source: Calculations research

As it can be seen, the test statistic is greater than the absolute critical quantities, the hypothesisH_0 is rejected. It means that with 95% probability it can be accepted that the first order difference of all variables are stable.

4.2.2 Determination of integrated vectors

To determine the long-run relationship the maximum eigenvalue test and trace test is used. The results of these tests are summarized as follows:

Table (4-5) test of determine the number of integrated vectors

Trace test	The maximum eigenvalue test

Nnull	Alternative	test statistic	Critical value at 95%	Alternative	test statistic	Critical value at 95%
r = 0	r ≥ 1	113.6043	79.34145	r = 1	55.20670	37.16359
r ≤ 1	r ≥ 2	58.39679	55.24578	r = 2	30.59511	30.81507
r ≤ 2	r ≥ 3	27.80250	35.01090	r = 2	16.02368	24.25202
r ≤ 3	r ≥ 4	11.77882	18.39771	r = 3	8.969223	17.4769
r ≤ 4	r ≥ 5	2.809596	3.841446	r = 4	2.809596	3.841466

Source: Calculations research

The results of the trace test confirm the existence of 1 integrated vector and maximum value does not endorse any of the integrated vector.

4.2.3. Johanson-Joselius cointegration test and long-term relationship

After specifying the number of integrated vectors, the next step is Johansson - Joselius test to obtain long-run coefficients. Table (4-6) shows the integrated vector obtained by Johansson –Joselius Test and its normalized coefficient with respect to manufacturing productivity growth variable.

Table (4-6) Normalized integrated Coefficients

EIG	EXR	GCE	CPU	GMPI	Normalized coefficient of variable
-0.2683	0.00039144	-0.00000986	-0.0712	1	Vector 4

Source: Calculations research

Considering the results in Table (4-6), since it is based on trace test only one integrated exist, based on the theoretical fundamentals of this study, among 5 integrated vector obtained from test, vector 4 is selected. Then the long-run relationship between the variables are as follows:

$$GMPI = 0.0712CPU + 9.86e\text{-}5GCE - 3.914e\text{-}4\ EXR + 0.2683\ EIG \qquad (2\text{-}4)$$

Vector obtained by the Johansson – Joselius method, shows that productivity growth in the Iranian industry is directly related to capacity utilization rate of production and government capital expenditures and the proportion of highly educated employed to total employed in industry, while in long-term the variable of exchange rate has declining effects on the total factor productivity growth.

4.3. Vector error correction model (VECM) to investigate the speed of adjustment of short-term bias towards long-run equilibrium values

What is essential and noticeable in the short-term equation VECM, the coefficient of ECM is (-1) indicates the speed of the short-run disequilibrium process adjustment towards long-run equilibrium. (Sajjadi and others, 2007).

Table (4-7) The Result of vector error correction mechanism

ECM (-1)	Statistics t	coefficient of determination	Adjusted coefficient of determination
-0.2517	-2.2499	0.2672	0.0086

Source: Calculations research

The error correction factor equals to 0.25 and as expected it is negative, indicating long-term relationship between the variables. According to the amount of statistic t, this coefficient is different from zero level and suggests a short-term relationship between the model variables. This coefficient implies that the manufacturing productivity growth in each period is adjusted by 25% towards the long-run equilibrium.

5. Conclusion

As observed, during the period of this study, the rate of capacity utilization in the industrial sector in Iran, long-term has positive impact on manufacturing productivity growth. This conclusion is justified based on the neoclassical model which believes that the technological changes has a determinant role in explaining economic growth because the technology has increased optimum use of production capacity and efficiency of resources, which results in higher production and growth of productivity. Also, considering that the error correction coefficient is negative, it could be said that the long-run relationship between manufacturing productivity growth and capacity utilization rate is established. The error correction coefficient is equal to 0.25, which implies that in each period the amount of long-term error is corrected by this amount and the relation between two variables is adjusted by this amount. Considering the important role of government in creating and developing infrastructure of growth, it could be said that the relationship between government capital expenditure and productivity growth in the industrial sector is positive. This relation in the equation (4.2) is also positive but its numerical value is low. In this case it could be said that according to endogenous theory of growth, the innovation resulted from research and development is considered as a endogenous technology advance and it has a positive and significant impact directly through increasing return and productivity factor of production and indirectly through capital accumulation on productivity growth. But since many industries in Iran are dependent on the government , and considering the important role of research and development in progress and upgrading industries, but the share of costs related to research and development from government spendings is very low, about 10 % (UNESCO , 2010), so it could be concluded that more government spending in the industrial sector belongs to payroll rather than costs related to the advancement of technology and promoting productivity factors of production. That's why government spendings in the studied period have not a significant effect on manufacturing productivity growth.

Exchange rate has an expected long-term relationship (negative) with manufacturing productivity growth in Iranian studied period. Because the increase in the exchange rate makes imported capital goods be more expensive and this reduces capital productivity which makes TFP in the manufacturing sector be reduced. In addition, the Iranian economy due to a variety of exchange policies - which subsequently various currency systems isused –causes improper adjustment of the real exchange rate and its deviation from the equilibrium path, which can inhibit the economy and slow it's growth in the industrial sector through mechanisms such as reducing the level of competitiveness in the global market, non-optimal allocation of production factors and speculation. So Iran's central bank and other financial institutions in the country must implement a strategy that will protect the country's foreign reserves because these reserves prevent unprecedented depreciation of the domestic currency and makes import of capital goodsaffordable.

Based on the results of the long-run equilibrium relationship, the quality of manpower is the most important and most critical variable affecting manufacturing productivity growth, such that increasing 1 percent in the quality of labor results in increasing 0.268 percent in productivity growth. Despite the capital that its maximum gain is equal the nominal capacity, if labor productivity is increased the efficiency will be increases significantly, and unlike investment it is a limit for inconceivable.

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