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## Abstract

With the process of expansion and the structural transformation taking place in Bahrain, it is crucial to measure and analyze the growth rates of gross domestic product (GDP), gross output and multifactor productivity (MFP) to develop proper policies that are in line with the new economic vision of Bahrain, known as *Vision 2030*. Thus, this paper comes with two main objectives: first, to provide explainable estimates for the growth rate of the gross output in the Bahraini economy and secondly to identify the main sources of the growth. The main findings of this study show that the annual growth rate of the gross output in Bahrain ranged from a maximum of about 11.7% in the year 2006 to a minimum of about 7.7% in the year 2002. The average annual growth rate of gross output over the time period 2002–2008 was 9.43%. The empirical findings also show that the MFP's annual growth rate was relatively low over the study time period. Consequently, it could be concluded that the relatively high growth rate of gross output in the Bahraini economy was mainly due to the high growth rate of other inputs (M) over the last few years. The study concludes that there is an urgent need to improve MFP in Bahrain to contribute significantly to the output growth rates. Therefore, the study calls for further research to identify the main components that contribute to the growth of MFP in Bahrain and its decomposition.



## ملخص

في ضوء عملية التوسع و التحول الهيكلي الذي يحدث الآن في دولة البحرين، فإن قياس وتحليل معدلات النمو لإجمالي الناتج القومي وإجمالي الإنتاج و إنتاجية العوامل المتعددة يعتبر أمرا مهما وحاسما لتطوير السياسات المناسبة التي سوف تساير الرؤية الاقتصادية للبحرين والمعروفة بـ "رؤية 2030". وبالتالي فان هذا البحث يحقق غرضين رئيسيين، يتمثل الأول منهما في توفير تقديرات يمكن تفسيرها بشأن معدل نمو الإنتاج الإجمالي لاقتصاد البحرين، بينما يتمثل الغرض الثاني في تحديد الموارد الرئيسية للنمو. وقد أظهرت النتائج الرئيسية لهذه الدراسة أن معدل النمو السنوي لإجمالي إنتاج اقتصاد البحرين تراوح بنسبة 11.7% كحد أقصي في عام 2006 إلي حوالي 7.7% كحد ادني في عام 2002. وقد كانت نسبة متوسط معدل النمو السنوي لإجمالي الإنتاج 4.43% في خلال الفترة من عام 2002 الى عام 2008. كما أظهرت أيضا النتائج التجريبية أن معدل النمو السنوي لإنتاجية العوامل المتعددة كان منخفضا نسبيا خلال فترة هذه الدراسة. وبالتالي فقد وجُد أن السبب الرئيسي وراء الارتفاع النسبي لمعدل نمو إجمالي إنتاج الاقتصاد البحريني كان متمثلا في معدل النمو المرتفع للمدخلات الأخرى علي مدار السنوات القليلة الأخيرة. وقد توصلت الدراسة إلى أن هناك حاجة ملحة لتحسين إنتاجية العوامل المتعددة في الاقتصاد البحريني من اجل المساهمة بطريقة مهمة في معدلات نمو الإنتاج. ولذلك فان الدراسة تدعو لإجراء بحث إضافي من اجل تحديد العنصر الرئيسي الذي يساهم في نمو إنتاجية العوامل المتعددة للاقتصاد البحريني وتحليلاته.

## 1. Introduction

Bahrain's first economic and social development plan (1982–1986) came with main emphasis on having stronger economic and social relationships among various economic and social sectors in exploiting the available resources. In subsequent plans, however, most of the government agencies shared the same objective—providing and upgrading the economic and social infrastructure. In addition, to be in line with the new economic vision of Bahrain, known as *Vision 2030*, the main activities are concentrated on the high growth rate of the gross domestic product (GDP), gross output and multifactor productivity (MFP), and achieving a stronger regional and international competitive position by attracting foreign investment, which began with several joint ventures.

With the process of development and the importance of the structural transformation taking place in Bahrain, it is important to measure and to analyze the growth rates of GDP, gross output and MFP to develop proper policies that are in line with V*ision 2030*. For that to happen it is crucial to comprehend the fundamental concepts of measuring and analyzing the growth rate of GDP, gross output, and MFP as the major sources of growth, to help in the identification of the best economic policy. In particular, the study's main focus is to measure and analyze the growth of output and the contribution of the MFP to its growth over the time period 2002–2008.

Over the last few years, however, and with no rigorous and clearly stated economic expansion plan, Bahrain's economy has accomplished a relatively high rate of growth of gross output. Table 1 shows the annual and average annual growth rate of the GDP and the gross output over the recent years. It can be noticed that the average annual growth rate of the gross output over the time period 2002-2008 was about 9.43%.

Figure 1 gives a clear picture of the annual growth rate of Bahraini GDP and gross output. It is noticeable that in 2008 the growth rate of GDP was more than 9.7% which was the maximum annual growth recorded for the Bahraini economy over the study time period. On the other hand, the maximum annual growth rate in terms of gross output (11.7%) was recorded 2006. The minimum growth rate of gross output was about 7.7% for the year 2002.

Given the growth rate of gross output in Bahrain, the questions that this paper is trying to answer are: What are the sources of the gross output growth? And more precisely, what is the contribution of MFP growth to the gross output growth in Bahrain? To answer these questions, we employ the growth accounting model by which the growth rate of the gross output could be decomposed into the growth rate of the inputs and the growth rate of the MFP.

In addition, to meet the theoretical consideration underlying the measurement and analysis of the economic growth in an open economy like Bahrain, a production function that includes the primary inputs (labor and capital) as well as the intermediate inputs should be utilized, Gollop (1983) and Shebeb and Al-Saleh(2009). Given the openness of the economy, the growth rate of the gross output is considered a more precise measure for the economic growth than that based on the growth rate of the value added, GDP.

This paper is organized as follows. Section 2 presents a review of the underlying theory of productivity measurement. The model and methodology used in estimating the growth rates of gross output, inputs, and MFP in Bahrain economy are then established. Furthermore, Section 2 presents the relationships between gross output growth rate and the growth rates of the MFP and inputs. In Section 3, the data used in the empirical investigation is defined. The empirical findings are presented and analyzed in Section 4. Finally, an overall summary of the study and the concluding remarks are presented in Section 5.

## 2. Productivity Growth: Underlying Measurement Model

In this section the theoretical framework and methodology used to measure and analyze the contribution of the multifactor productivity to the gross output growth in Bahrain economy is presented.

In general, improvements in MFP reflect the contribution to output as a result of the more efficient use of resources or the adoption of new production technologies. Thus, multifactor productivity (technological change, given the model's underlying assumptions) can be defined either by an increased output holding the level of inputs unchanged, or a reduced cost of production holding the level of output unchanged, assuming that all inputs are optimally utilized and the production process is efficient. These definitions can, however, be presented empirically either by an upward shift of the isoquant or by a downward shift in the average cost function. Thus, the production and/ or cost function can be used to represent the underlying technology and to develop the theoretical linkage between productivity growth and its main components.

Applied economists have realized that the fundamental issues of isolating the contribution of scale economies, change in capacity utilization, and the level of inefficiency to productivity growth remain unsolved, Kopp and Diewert (1982), Grosskopf (1993), Brendt and Fuss (1989), and Coelli et al (1998). However, as a result of the recent developments, the observed productivity growth could be decomposed into several important measures of economic performance (Shebeb, 1998). These measures are technical change, economies of scale, productive efficiency and capacity utilization. It follows that the measure of productivity should be regarded as a composite measure of many economic behaviors all of which are important pieces in the overall economic performance puzzle. Identifying and measuring these components would provide a more accurate and interpretable measure of economic performance. In short, the observed change in productivity (residual) could be a result of various economic interactions in the production process, including technological change, economies of scale, and changes in capacity utilization and inefficiency.

However, a relatively simple (restricted) model will be utilized in measuring and analyzing economic growth in Bahrain. In this paper the growth accounting model is utilized, thus readers need to keep in mind the model's underlying assumptions on which the analysis of this study is based. Furthermore, considering the openness of the economy, we chose to use the Deliveries to Final Demand (gross output) modeling for productivity growth in this study. This complies with the fact that an analysis of productivity growth in an open economy like Bahrain should be based on a gross output production function that includes all primary and intermediate inputs consistent with the characteristics of an open economy, Gollop (1983). A growth accounting model is used to measure the growth rate of gross output and the sources of its growth (the MFP growth rate and the growth rate of inputs)[2], Norsworthy (1984) and Disney et al. (2003).

In this paper the growth rate of aggregate production is represented as a combination of the contributions of growth rates of the respective production factors—physical capital (*K*), labor (*L*), other-materials (*M*), and MFP (technological change). Solow (1957) used the following specification of a production function with Hicks-neutral technology:

$$Q_t = A_t \psi (X_{it}) \qquad (1)$$

where $Q_t$ is the real output, $A_t$ is the index of MFP, $X_i$ is the amount of input (i), and $i = K, L,$ and $M$, all in time period t.

[2] For detailed methodology of growth accounting approach, see Gollop (1983), and Norsworthy (1984).

Conceptually, MFP growth indicates the change in output resulting from the shift of the production function. It follows that equation (1) can easily be transformed to growth equation (2) below by differentiating it with respect to time, which can be expressed as:

$$\frac{dQ/dt}{Q} = \frac{dA/dt}{A} + \sum_i \frac{\partial Q}{\partial X_{i,t}} \frac{X_{i,t}}{Q} \frac{dX_{i,t}/dt}{X_{i,t}} \tag{2}$$

The growth equation above decomposes the growth of output in the economy into the growth rate of inputs and the growth rate of MFP (the unexplained part of the output growth). Equation (2) shows the rate of change of output as a sum of the rate of change in the MFP [(*dA*/*dt*)/*A*] and the weighted average of the rate of change in use of inputs. Exploiting the model's underlying assumptions, equation (2) can be reproduced as:

$$\frac{dQ/dt}{Q} = \frac{dA/dt}{A} + \sum_i S_i \frac{dX_{i,t}/dt}{X_{i,t}}, \text{ and } S_i = C_i/P_Q Q, \tag{3}$$

where $C_i$ is the total payment to the $i^{th}$ input, and $i = K, L,$ and $M$, and $P_Q$ is the price of output ($Q$). The model's assumptions also imply that the weights (shares) sum up to one.

Equation (3) is known as the Divisia index. With an index number framework[3] and taking the (ln) for the inputs and output index with using the average inputs share. It follows that MFP growth rate can be presented as:

$$\ln \frac{A_t}{A_{t-1}} = \ln \frac{Q_t}{Q_{t-1}} - \sum_i \overline{S_i} \ln \frac{X_{i,t}}{X_{i,t-1}}, \text{ where: } \overline{S_i} = (S_{i,t} + S_{i,t-1})/2 \tag{4}$$

This shows that MFP can be viewed as the divergence of the growth rate of output from the growth rate of inputs. One of the advantages of this method is that the Hicksian parameter (*A*) or (the growth rate of MFP) can be measured using price and quantity data. The MFP growth rate, however, is a valid measure of technological change (*A*) only under the model's assumptions.

Thus, the economy-wide MFP growth is estimated using gross output measured at fixed prices as a measure of output. However, the computation of the share of labor input in total factor payments is derived by expressing national accounts estimates of total compensation as a fraction of gross output at current factor cost, and the share of other inputs is derived by expressing national accounts estimates of value of other inputs as a fraction of gross output at current factor cost with the share of capital input taken to be the complement of the shares of labor and other inputs. Computing factor shares on the basis of the current market prices straightens the relative contributions of labor, other inputs, and capital.

### 3. Data: Measurement and Sources

The data for most aggregate productivity studies usually includes as many outputs and inputs as possible in order to reflect all outputs and inputs. Output is usually measured as an aggregate of all types of outputs while inputs are generally identified as capital (*K*), labor (*L*), energy (*E*), other materials (*M*), and in short these inputs are known as KLEM. No separate data was available for the energy input, however, it was included in the other materials (*M*).

All time-series data used for this research are obtained from various publications of the Central Statistical Organization, the official data source in Bahrain. The time period covered

[3] Divisia index number and the Tornqvist index number, which is an approximation of Divisia index, see Tornqvist (1936), Jorgenson (1971) and Diewert (1976, and 1978).

in this study is from 2001 to 2008. However, it is worth noting that the growth rates of gross output, inputs, and MFP are not reported due to lag-operation of the measurement model.

### *3.1 Measurement of gross output (Q)*

Output data should be adjusted by output-net-inventory change. In other words, the correct output series should be obtained by adding the value of production to inventory change. It follows that for most productivity studies, output is measured in physical or real values. As physical (quantity) data is often not available, the value data has to be separated into quantity and price. Following that, the value of output could be adjusted for price changes by using the appropriate price index. The adjusted value is usually known as constant price output. In this study, output is equal to the summation of real values produced, resale goods and receipts from all services.

### *3.2 Measurement of labor (L)*

Data on labor input is widely available in terms of wages, number of workers or work-hours. The number of persons employed is defined as the total number of persons, which in turn includes working proprietors, active business partners, unpaid family workers and full-time, part-time and seasonal workers. Part-time and seasonal workers are treated as their full-time equivalents, whereas persons on short-term leave and indefinite leave are excluded.

The compensation is defined as comprising all payments, both in cash and in kind, and the supplement to wages and salaries. In this study the real value of compensation is used as a measure of labor input to take into account the difference in skills among workers assuming that there is a strong relationship between wages and the worker's skill-level and experience.

### *3.3 Measurement of capital input (K)*

Measuring the capital input is the most challenging. The flow measure of the capital input reflects differences in usage and how these differences influence the different levels of output. Thus, the flow measures of capital could be a good indication of the amount of capital employed to produce the current output. However in practice, the data is generally not available in the details that are necessary to construct and measure a capital flow. To overcome such difficulties of measuring the capital flow in productivity studies the capital depreciation is normally used. Following that we use capital depreciation (in real terms) as a measure of the flow of capital in this study.

### *3.4 Other intermediate inputs (M)*

Other inputs are defined as equal to the real value of the purchases of materials and supplies for production including all inputs other than labor and capital. In other words, other inputs represent the cost of all production input excluding the cost of labor and capital inputs.

## 4. Empirical Findings: Output and Productivity Growth Rates

The growth rate of output in the Bahraini economy is estimated and its sources are identified. As shown in the measurement model above, the sources of the gross output growth are the growth of the inputs and the growth of MFP. In the model above, the MFP growth is defined as the difference between the growth of gross output and the growth of inputs, as a combination of all inputs (capital (K), labor (L) and other inputs (M)).

Table 2 shows the annual growth rates of the gross output, inputs, and MFP for Bahrain during the period 2002–2008.

The annual growth rate of the gross output in Bahrain ranged from a maximum of about 11.7% in 2006 to a minimum of about7.7% in 2002. The average annual growth rate over the time period was approximately 9.4%.

Table 2 also shows that for the years 2006 and 2007, the annual growth rate of the gross output in Bahrain was lower than the growth rate of inputs. This was due to the negative impact of the MFP growth rate in these two years. Table 2 also shows that MFP had a very low contribution to the average annual growth of output over 2002–2008 of 0.03 percentage points. In the years 2000, 2006 and 2007, the MFP contributed negatively to the annual growth rate of output. However, in the year 2008, the Bahraini economy started to gain from the positive growth rate of the MFP. In the year 2002, the MFP reached its maximum annual contribution to the annual growth of output of about 3.6 percentage points to the annual growth rate of output. Figure 2 illustrates these changes clearly. It is noticeable in Figure 2 that relationships between the trends of the MFP and inputs growth rates could be seen as mirror images.

Table 3 presents the estimated contributions of the growth rate of each individual input (capital, labor, and other inputs) to the growth of the gross output in Bahrain. In the years 2002, 2005 and 2008 capital input contributed negatively to the growth of gross output. In 2007, the annual contribution of capital to the annual growth of output reached its maximum of 8.55 percentage points out of 10.47 percentage points in that year. The average annual contribution of capital to the average annual growth of gross output over 2000–2008 was 2.82 percentage points out of 9.43 percentage points.

As shown in Table 3, the average annual contribution of labor to the average annual growth of output over the time period 2002–2008 was about one percentage points out of 9.43 percentage points. However, in 2004, the labor input contributed negatively to the annual growth rate of output. In 2008, the annual contribution of labor reached its maximum of about 2 percentage points to the annual growth rate of output.

The average annual contribution of the other inputs (M) to the average annual growth of output over the time period 2002–2008 was 5.5 as shown in Table 3. In the year 2006, the annual contribution of other inputs to the annual growth of output reached its maximum of 8.45 percentage points while it reached its minimum contribution in 2005. This reduction in the contribution of the other inputs over these two years (2005 and 2006) could be attributed to the reallocation of the production inputs.

Figure 3 shows the annual and average annual contributions (in percentage points) of capital, labor, other inputs and MFP to the growth of the gross output in Bahrain. Figure 3 also demonstrates the contribution (in percent) of the growth rates of each input and the MFP to the growth rate of the gross output over the period 2002–2008.

The average annual contribution of MFP was 0.03, which represents about 3.2 percent of the average annual growth of output. This clearly shows that MFP contributed insignificantly to the growth of output in most years. Thus, with the model's underlying assumption of constant returns to scale, possible explanations of this phenomenon are the occurrence of capacity non-utilization, non-positive technological change and/or the existence of economic inefficiency in the Bahraini economy**.**

The capital and labor inputs showed considerably steady contributions to the average annual growth rate of output over the study time-period. However, it is noticeable that the other inputs had the lion's share (about 58 percent) in the average annual growth rate of the gross output. Thus, it follows that the relatively high growth rate of output in Bahrain has been mainly due to the growth rate of other inputs (M) over the last years.

## 5. Summary and Concluding Remarks

In this study the methodology of measuring the growth rates of the gross output, MFP and inputs in the Bahrain economy is outlined. In theory, the methodology is based on the growth accounting approach.

The findings of this study are expected to provide practical and informative insights to policy and decision makers. The study addressed several critical questions such as: (1) In which year did the Bahraini economy experience high (low) MFP growth rate? (2) Was the high annual growth rate of output due to the high annual growth rate of the MFP? and (3) What is the proportion of the annual growth rate of the gross output that is a result of the annual growth rate of the MFP and/ or of the other inputs?

The findings of the study showed that the MFP's annual growth rate was relatively low over the study time period (2002–2008). This could be attributed to the high annual growth rate of the inputs with low improvements in level of capacity utilization, the high level of inefficiency and/or non-positive technological change. Generally, the MFP's growth rate pattern in Bahrain tends to be in the opposite direction from the high annual growth rate of inputs.

The MFP growth rate is considered a composite measure of the overall economic performance (i.e. the observed change in the MFP growth rate can be a result of various economic interactions in the production process, including scale economies, changes in capacity utilization, and inefficiency). If any of these contributors to the production process is assumed to be held unchanged, the resulting estimates of the MFP growth would only reflect the technological change. It follows that a full structural model is needed to decompose productivity growth into its main components in Bahrain so that better policy decision could be made.

In short, identifying and measuring the components of the MFP growth would make it easier to obtain accurate and interpretable measures of economic performance. Therefore, it is advisable to conduct more detailed studies on the decomposition of the MFP growth across Bahrain's economic sectors. Such studies would help identify the causes behind the low (or negative) growth rates of MFP in the Bahraini economy.

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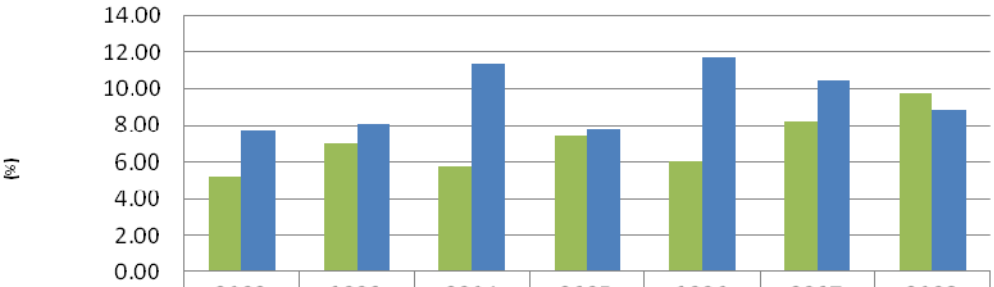
**Figure 1: Growth Rate of the GDP and Gross Output**




| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|
| GDP | 5.21 | 7.05 | 5.79 | 7.40 | 6.03 | 8.21 | 9.75 |
| Gross Output | 7.72 | 8.07 | 11.38 | 7.82 | 11.70 | 10.47 | 8.84 |

**Figure 2: The Growth Rates of Output, Input, and MFP (%)**

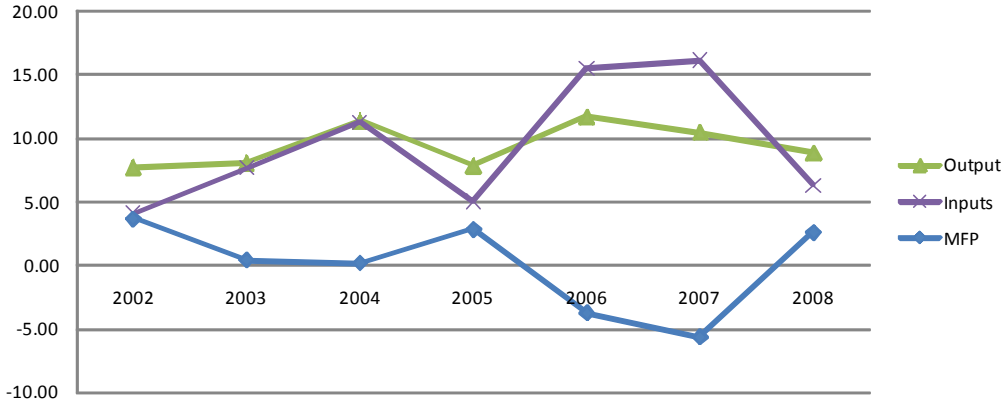
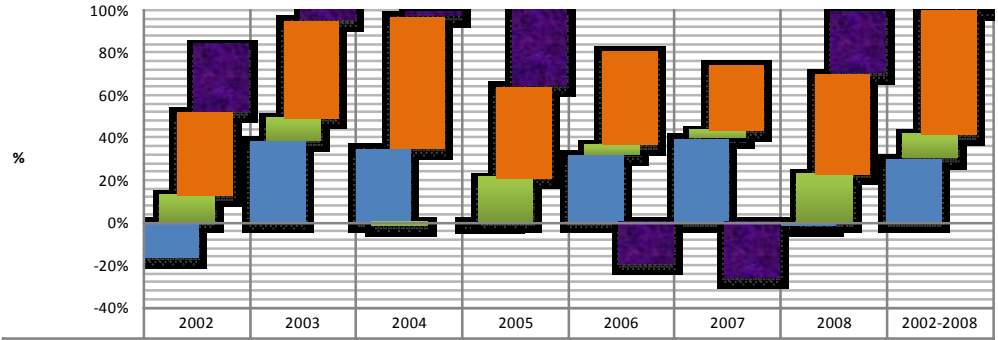


**Figure 3: The Average Annual Contributions (in Percent) of Inputs and MFP to the Growth Rates of Output**




| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2002-2008 |
|---|---|---|---|---|---|---|---|---|
| MFP | 3.64 | 0.42 | 0.17 | 2.81 | -3.76 | -5.64 | 2.58 | 0.03 |
| Other-Inputs (M) | 4.54 | 3.71 | 7.33 | 3.40 | 8.45 | 6.76 | 4.32 | 5.50 |
| Labour (L) | 1.44 | 0.87 | -0.21 | 1.64 | 0.88 | 0.81 | 2.08 | 1.07 |
| Capital (K) | -1.89 | 3.07 | 4.08 | -0.03 | 6.14 | 8.55 | -0.14 | 2.82 |

**Table 1: Growth Rates of GDP and Gross Output**

| year | GDP | Gross Output |
|---|---|---|
| 2002 | 5.21 | 7.72 |
| 2003 | 7.05 | 8.07 |
| 2004 | 5.79 | 11.38 |
| 2005 | 7.40 | 7.82 |
| 2006 | 6.03 | 11.70 |
| 2007 | 8.21 | 10.47 |
| 2008 | 9.75 | 8.84 |
| Minimum | 5.21 | 7.72 |
| Maximum | 9.75 | 11.70 |
| 2002-2008 | 7.06 | 9.43 |

**Table 2: Bahrain Economy: The Growth Rates of Gross Output, Inputs and MFP.**

| Year | Output | Inputs | MFP |
|---|---|---|---|
| 2002 | 7.72 | 4.09 | 3.64 |
| 2003 | 8.07 | 7.65 | 0.42 |
| 2004 | 11.38 | 11.21 | 0.17 |
| 2005 | 7.82 | 5.01 | 2.81 |
| 2006 | 11.70 | 15.46 | -3.76 |
| 2007 | 10.47 | 16.12 | -5.64 |
| 2008 | 8.84 | 6.25 | 2.58 |
| Minimum | 7.72 | 4.09 | -5.64 |
| Maximum | 11.70 | 16.12 | 3.64 |
| 2002-2008 | 9.43 | 9.40 | 0.03 |

**Table 3: The Annual Contributions of Inputs and MFP to the Growth Rate of Output**

| Year | Capital (K) | Labor (L) | Other-Inputs (M) |
|---|---|---|---|
| 2002 | -1.89 | 1.44 | 4.54 |
| 2003 | 3.07 | 0.87 | 3.71 |
| 2004 | 4.08 | -0.21 | 7.33 |
| 2005 | -0.03 | 1.64 | 3.40 |
| 2006 | 6.14 | 0.88 | 8.45 |
| 2007 | 8.55 | 0.81 | 6.76 |
| 2008 | -0.14 | 2.08 | 4.32 |
| 2002-2008 | 2.82 | 1.07 | 5.50 |
| Minimum | -1.89 | -0.21 | 3.40 |
| Maximum | 8.55 | 2.08 | 8.45 |