

Analytical Decomposing of Labor Productivity Growth in Construction Industry of Bahrain

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Abstract

Using the growth accounting approach and applying the Divisia and Tornqvist index numbers, the paper has decomposed the labor productivity growth into factor-labor intensities (FLI) and multifactor productivity (MFP) growth in the construction industry of Bahrain for the period 2010-2014. Over the time period 2010-2014, the average annual growth rates of labor productivity, factor-labor intensities, and MFP were about -4.7%, -6.6%, and 2%, respectively. The negative growth rate of the FLI had been the main destructive contributor to the growth rate of labor productivity in Bahrain's construction industry.

Keywords: Growth accounting; Divisia and tornqvist index numbers; Bahrain

JEL Classification: O12; O47

Introduction

Bahrain is the smallest of six oil producing and exporting Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE). All economic activities of Bahrain evolve around the oil and financial sectors. Like other GCC countries it has been trying to diversify, expand, and develop in other areas. Construction, especially infrastructure investment, is in forefront of such development and expansion. With the process of development and the importance of the structural transformation, it will be very important to understand the fundamental concepts of productivity analysis and measurement, which could help to identify the most proper industry-oriented policy. It is obvious that an economic expansion would create a need for an additional requirement of production factors. Labor requirements could be satisfied by attracting and encouraging the Bahraini (indigenous population) to enter the industrial sector as a long-run solution. This is a relevant and an important issue because as of early 2010s the participation rate of Bahraini in the privately owned construction firms was about 8% only. So there is a potential of increasing the participation rate of Bahraini workers in this industry. This leads to an urgent need for more industry-oriented planning program that would encourage the Bahraini people to participate in the industrial sector.

Bahrain has a population of little more than 1 million of which about half are expatriates (foreigners). It may be noted that the total number of workers (both Bahraini and expatriates) in the construction industry was about 130,000 workers that represent more than 26% of the total private sector labor force. As in other GCC countries, foreign workers are the largest source of labor supply in Bahrain. However, a gradual restricted immigration and labor laws would see the control and diminish the foreign labors and could have a positive impact on the Bahraini participation rate in construction industry.

The recent investment in fixed capital and human capital in Bahrain has a significant and effective impact of the mix of the production factors. The importance of this factor prompts policy-makers to pay more attention to production and labor studies and especially in the measurement of the labor productivity. Fabricant [1] has stated that the differences in objectives imply that the productivity concepts and measurements most appropriate to each concern must

also differ. Failure to keep the differences in mind can, and often does, lead to the misunderstanding of what the available productivity measurements mean. In turn, this confusion can lead to the misuse of the measurements at hand, or insufficient qualification of them for the purpose in mind. Therefore, it is fundamentally important at this stage to analytically decompose the main components of the labor productivity and its use as powerful analytical tools in understanding the economic performance of the construction industry. Thus the main contribution of this paper is to provide a simple method of how to analytically decompose growth rates of labor productivity using an example of Bahrain where data are limited. Thus the main objective of this study is to measure and analytically decomposed the growth rates of labor productivity in Bahrain construction industry over the most recent time period 2010-2014.

This study is organized in the following way. Section 2 presents a review of the underlying theory of measuring labor productivity growth. In this section, the analytical decomposing model of the labor productivity which is based on an open-economy production function is also presented. Section 3 discusses the data sources and the measurement of the variables. The empirical findings are presented and analyzed in section 4. Finally, the concluding remarks that are drawn from the empirical findings are presented in section 5.

Productivity Measurement: An Overview

The recent developments in productivity measurement and analysis are based on the convexity and derivative properties of the dual cost function. In the modern approach to productivity measurement, productivity growth is measured in terms of cost saving for given level of output rather than output increasing for given level of inputs. That is, the fundamental concept underlying the cost-based measure of multi-

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factor productivity growth is that a given output can be produced with a smaller amount of inputs due to technological improvement; it implies that this level of output may be produced at a lower cost [2].

As a result of recent developments, the observed productivity growth could be decomposed into several important measures of economic performance [3]. These measures are mainly technical change, scale economies, productive efficiency, and capacity utilization. It follows that the measure of productivity should be regarded as a composed measure of a number of economic behaviors that are important pieces of the overall economic performance puzzle. Identifying and measuring these components of overall productivity help to provide a more accurate and interpretable measure of economic performance. That is, the observed change in overall productivity (residual) could be a result of various economic interactions in the production process, including technical change, scale economies, and changes in capacity utilization and inefficiency. It follows that if any of these major economic aspects of the production process is ignored, the resulting estimates of productivity are likely to have measurement bias.

However, due to unavailability of the necessary data for Bahrain, a full structural model that takes into account the contribution of the major components of the overall productivity change would not be possible to be utilized. Therefore, readers need to keep in mind the underlying assumption at which the analysis of this study has taken place. A relatively simple (restricted) model will be utilized in measuring and analyzing labor productivity growth in Bahrain construction industry. This simple method could be used in case studies of other countries given the similar data limitation. This model and its underlying assumptions are discussed next.

Productivity decomposing methodology

This section describes the framework and methodology that are used to measure and analyze the labor productivity in Bahrain manufacturing industries. The labor productivity can be seen as a compound measure of two major components:

- (1) Multifactor Productivity (MFP), and
- (2) Factor-Labor Intensities (FLI) which is a weighted average of the other inputs (production factors) used by labor.

The productivity growth modeling in an open economy (like Bahrain) must be based on a total (gross) production function that contains all primary (labor and capital) and intermediate-inputs [4,5]. Thus, the Gross Output Production function modeling for productivity growth is utilized in this study. A growth accounting method is used in deriving the analytical decomposing measurement model of labor productivity growth. The empirical model is based on the recent theoretical development in the productivity measurement in an open economy [6]. The general form of the industry-level production function can be written as: Equation 1

$$Q_t = A_t f(K_t, L_t, M_t) \quad (1)$$

Where Q_t is the real output, A_t is the index of MFP (technical change), K_t is the inputs of the capital services at time t , L_t is the labor inputs, and M_t are intermediate inputs.

The assumptions underlying the use of this model (production function) are as follows: Constant return to scale, Hicks's neutral technical change, perfect competition in the inputs and output markets, full capacity utilization of all inputs, and all production process (operations) are efficient (inefficiency does not exist). Thus,

differentiating the production function (1) with respect to time gives the growth equation, which can be written as: Equation 2

$$\frac{dQ/dt}{Q} = \frac{dA/dt}{A} + \left(\frac{\partial Q}{\partial K} \frac{K}{Q} \frac{dK/dt}{K} + \frac{\partial Q}{\partial L} \frac{L}{Q} \frac{dL/dt}{L} + \frac{\partial Q}{\partial M} \frac{M}{Q} \frac{dM/dt}{M} \right) \quad (2)$$

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. Conceptually, MFP indicates the change in output resulting from the shift of the production function. On the other hand, changes in inputs indicate that the change in output resulting from movements along the production function.

In the right hand side of equation (2) the first term in the bracket indicates the output elasticity with respect to the capital input multiplied by the percentage change in capital input. This gives the percentage change in the output resulting from the change in the capital inputs (holding other inputs constant). The second term indicates output elasticity with respect to the labor input multiplied by the percentage change in labor input, which is the percentage change in the output resulting from the change in the labor inputs (holding other inputs constant). The third term shows the output elasticity with respect to the intermediate input multiplied by the percentage change in intermediate input. This yields the percentage change in the output resulting from the change in the intermediate inputs (holding other inputs constant). The sum of these terms measures the effects (change) of all primary inputs (labor, capital) and the intermediate inputs on output, when there is no change in MFP (holding technology constant).

The third assumption is that the marginal product of all inputs is equal to the real market price (P) which implies that the elasticity of output with respect to any input is equal to the share of that input cost in the output. The share parameters are defined as $S_i = X_i/PQ$, $i=K, L, M$ and X_i is the total payment to input i . The first assumption implies that the weights (elasticities) sum up to one, that is, $S_K + S_L + S_M = 1$. By substituting these elasticities with the input shares we can rewrite equation (2) as: Equation 3

$$\frac{dQ/dt}{Q} = \frac{dA/dt}{A} + \left(S_K \frac{dK/dt}{K} + S_L \frac{dL/dt}{L} + S_M \frac{dM/dt}{M} \right) \quad (3)$$

Equation (3) is known as the Divisia index. Solow [7] was among the first to show that Divisia MFP index can be naturally derived from a simple production relationship. With an index number framework [8-11] and taking the (log) for the inputs and output index and using the average inputs share, we can get the approximation of the Tornqvist index number as: Equation 4

$$\log \frac{Q_t}{Q_{t-1}} = \log \frac{A_t}{A_{t-1}} + \left(\bar{S}_K \times \log \frac{K_t}{K_{t-1}} + \bar{S}_L \times \log \frac{L_t}{L_{t-1}} + \bar{S}_M \times \log \frac{M_t}{M_{t-1}} \right) \quad (4)$$

Where $\bar{S}_i = [S_{i,t} + S_{i,t-1}]/2$, and $i=K, L$ and M . It follows that the MFP growth rate can be presented (the differences in the growth rates of output and inputs) as: Equation 5

$$\log \frac{A_t}{A_{t-1}} = \log \frac{Q_t}{Q_{t-1}} - \left(\bar{S}_K \times \log \frac{K_t}{K_{t-1}} + \bar{S}_L \times \log \frac{L_t}{L_{t-1}} + \bar{S}_M \times \log \frac{M_t}{M_{t-1}} \right) \quad (5)$$

One of the advantages of this method is that the Hicksian parameter (A) (the growth rate of MFP) can be measured using price and quantities data. Furthermore, the MFP growth rate, however, is a valid measure of technological change (A) underlying the model's assumptions.

As for the labor productivity (LP), it can be defined as a ratio of total output (Q) to labor input (L) while its growth rate (changes) would be resulting from the changes in its main components (sources of growth): (1) the shift in production function due to the change in MFP

(technological change), and (2) the movement along the production function which it is due to the change in factor-labor intensities (FLI). Thus, the growth rate of labor productivity could be computed as the sum of the growth rate of MFP and the weighted growth rates of the inputs-labor intensities. Equation 6

$$\log \frac{q_t}{q_{t-1}} = \log \frac{A_t}{A_{t-1}} + \left(\bar{S}_K \times \log \frac{k_t}{k_{t-1}} + \bar{S}_M \times \log \frac{m_t}{m_{t-1}} \right) \quad (6)$$

Where $q_t = Q_t/L_t$ the average share of one unit of labor is in the total output $k_t = K_t/L_t$ is the average share of one unit of labor in the capital input and $m_t = M_t/L_t$ is the average share of one unit of labor in the intermediate inputs. The left-hand side of equation (6) stands for the growth rate of labor productivity, which is the sum of the growth rates of MFP and the inputs-labor intensities (ILI). Using these two factors will help us to analyze the growth rate in the labor productivity in Bahrain construction industry.

Data: Sources and Measurement

All-time series data used in this study are obtained from various publications of the Central Statistical Organization, the official data sources in Bahrain. The time period covered in this study is from 2010 to 2014. Data before 2010 are not available. The measurement of inputs and output is one of the most important issues in productivity studies. Measurement used for the variables are discussed below.

Gross output (Q)

In all sector-level productivity studies, output is measured in physical unit (real values, constant price). For products to be regarded as a homogeneous commodity (production in physical units) certain conditions should be satisfied. Physical (quantity) data are often not readily available, but the value (monetary) data usually exist. However, these value data have to be separated into their quantity and price. Then, the value of output could be adjusted for price change by using appropriate price index. In this study, output is equal to the summation of the real values (2010=100) produced and resale goods, receipts for contract (commission) work, and receipts from the non-industrial services.

Labor input (L)

The number of persons employed is defined as the total number of persons who work in the establishment, which includes working proprietors, active business partners, unpaid family workers, full-time employees, part-time and seasonal workers. Part-time and seasonal workers are reckoned according to their full-time equivalents, whereas persons on short-term leave and indefinite leave are excluded. The compensation is defined as comprising of all payments, both in cash and 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 skill among workers assuming that there is a strong relationship between wages and the workers' level of skill and experience.

Capital input (K)

The most preferred measure of capital input for productivity analysis is the flow of capital

Services used. The flow measure of the capital input reflects differences in usage and how these affect varying levels of output, which are the basis of productivity measurement and analysis. The flow of capital services, which should in principle include the value,

at current replacement cost, of the reproducible fixed assets used up during the year as a result of normal wear and tear, and the normal rate of accidental damage. Thus, the flow measures could be a good indication of the amount of capital employed to produce the current output. In practice, however, the data are generally not available in the details that are necessary for a capital flow measure. In this study the capital depreciation (in real terms) has been used as a measure of the flow of the capital service. It is known that this measure mainly refers to the capital consumed not capital services, and based on different accounting methods. However, due to many difficulties of measuring the capital flow, in productivity studies the capital depreciation is normally used.

Intermediate inputs (M)

In this study, intermediate inputs are defined as equal to the real value of the purchases of materials and supplies for production including fuels, electricity, water, and the cost of industrial services received minus the changes in their stock, plus the payments made by the establishment for non-industrial services. In other words, intermediate inputs represent the cost of all production input excluding the cost of labor and capital inputs.

The growth accounting model (discussed above) is applied to measure and analytically decompose the growth rate of labor productivity to its main components, multifactor productivity (MFP), and factors-labor intensities, using the data for Bahrain construction industry. As shown and discussed above that the two major components that contribute to the growth of labor

Empirical Results and Interpretation

As shown above that the growth rate of labor productivity (LP) can be measured by adding the two major components: (1) the growth rate of the multi-factor productivity (MFP), and (2) the growth of factor-labor intensities (FLI). Thus, the growth rate of labor productivity (LP) can be computed as: $LP = MFP + FLI$.

It is worth mentioning at this stage that the average share of each factor of production in total inputs costs. Over the sample period, the intermediate inputs share counts on average of 63% of the total inputs costs while capital and labor account for 26% and 11%, respectively. The relatively low labor share might be due to the low cost of overwhelming unskilled labor in the construction industry compared to the high capital cost. On the other hand, the capital/labor ratio (capital intensity) was only 0.056 which implies that for every one Bahraini Dinar (BD) spend on labor there was only BD0.056 spent on capital. While the ratio of intermediate inputs to labor ratio (intermediate inputs intensity) was 5.715 which imply that for every one Dinar spent on labor there was BD5.715 spent on the intermediate inputs. Thus the data show that the construction industry in Bahrain is a material-intensive industry.

Table 1 shows the annual growth rate of labor productivity and its sources of growth in Bahrain construction industry for the time period 2010-2014. It shows the two sources of labor productivity growth rate namely, growth rate of factor labor intensities (FLI) and growth rate multifactor productivity (MFP). The annual growth rate of labor productivity shows a sharp decline in the year 2011 probably due to the civil unrest during the beginning of the year.

Generally the trend of the labor productivity growth rate was negative of about 5% over the sample period. Results in Table 1 show that considerable low growth rates of the FLI over the time had been the main contributing factor for the declining or negative trend of

Year	Annual Growth Rate		
	Labor Productivity (LP)	Factor-Labor Intensities (FLI)	Multifactor Productivity (MFP)
2010	---	---	---
2011	-0.126	-0.164	0.038
2012	0.072	0.075	-0.003
2013	-0.092	-0.141	0.050
2014	-0.041	-0.032	-0.009
Time Period	Average Annual Growth Rate		
2010-2014	-0.047	-0.066	0.019

Table 1: Labor productivity and its sources of growth.

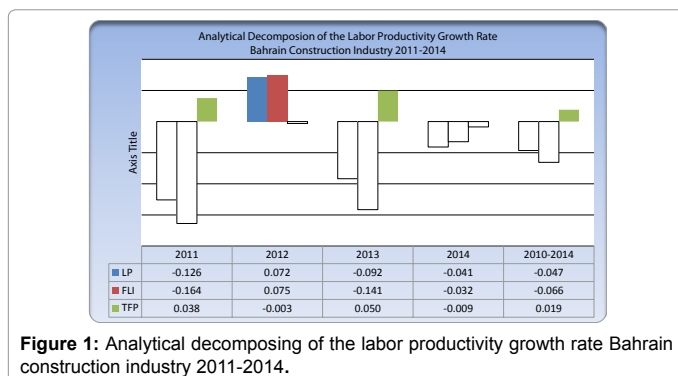


Figure 1: Analytical decomposing of the labor productivity growth rate Bahrain construction industry 2011-2014.

overall labor productivity growth. Results show that the growth rates in FLI experienced the highest decline in 2011 which is regarded, as mentioned above, the unstable time period due to civil unrest that started in February of that year. Over the time period 2010-2014, the average annual growth rates of labor productivity, factor-labor intensities, and MFP were about -4.7%, -6.6%, and about 2%, respectively. The reduction in FLI had a substantial contribution to the negative growth rates in labor productivity. The positive contribution of the growth rate of MFP was not enough to outweigh the negative contribution of the growth rate of FLI in the labor productivity growth in Bahrain construction industry.

For an easy visualization, results in Table 1 are plotted in Figure 1.

Figure 1 show clearly that only one year (2012) the annual growth rate of labor productivity was positive and the average annual growth rate of labor productivity over the sample period was negative.

Trends in factor-labor intensities

The ratio of production inputs (factors) to labor is known as factor-labor intensities. Any change in factor-labor intensities may affect the growth rate of labor productivity. The growth rate of the effect of factor intensities can be measured by (Equation 7) as shown above.

$$S_K \log(k_t / k_{t-1}) + S_M \log(m_t / m_{t-1}) \tag{7}$$

Thus, factor intensities have a direct positive effect on labor productivity growth rate. A positive growth rate of factor-labor intensities means that the capital-labor and/or intermediate inputs-labor ratios have been growing over the two time periods (years). Furthermore, an increase in capital-labor ratio may result from a more rapid growth in capital input than the growth in labor input, and the same is true for the intermediate inputs-labor ratio.

The average annual growth rate of the factor-labor intensities in Bahrain construction industry was -6.6% over the sample period. This has contributed to the negative average annual growth rate of labor

productivity in this industry. However, note that factor-labor intensities experienced a significant negative growth rate of -16.4% in 2011. This significant negative annual growth rate of factor-labor intensities had been the major factor that resulted in a negative annual growth rate of labor productivity of -12.6% in 2011. This is understandable because Bahrain experienced a civil unrest in the beginning of 2011. The factor-labor intensities again experienced a significant negative growth rate of -14.1% in 2013 and this must be due to the declining growth in capital or intermediate inputs or both relative to the growth of labor. This indicates the dependence of the construction industry on the abundance of unskilled labor with almost no human capital. The point is, in order to improve the growth rate of labor productivity in this key economic sector, one has to improve the growth rate of the FLI in this key economic industry.

Trends in Multifactor Productivity

The growth rate of MFP is defined as an increase in output that can be produced without any change in the amount of inputs (factors of production). This could be attributed to the improvement in the productive efficiency and/or capacity utilization that is considered to be the main component of the MFP growth rate (Shebeb, 2000). The MFP can be improved by mending its components as sources of growth.

Table 1 shows the annual growth rates and the average annual growth rate of the multifactor productivity (MFP) in Bahrain construction industry. The annual growth rates of the MFP in 2012 and 2014 had insignificant (small) negative effect on labor productivity growth rates of -0.3% and -0.9%, respectively. However, on average the contribution of the MFP growth rate was relatively higher (+1.9%) than the contribution of growth rate of the factor-labor intensities (-6.6%) to the growth of labor productivity over the study period 2010-2014.

Conclusion

Understanding the sources of labor productivity growth is an essential part of the evaluation of alternative cost effective policies of Bahrain construction industry. Given this in mind, the main objective of this study was to measure and analytically decompose the growth of labor productivity in Bahrain construction industry over the most recent time period, 2010-2014. Over the sample period, the annual growth rate of labor productivity ranged from a maximum of 7.2% in 2012 to a minimum of -12.6% in 2011. This negative growth rate of labor productivity in 2011 could be related directly to the civil unrest and economic instability that started in early 2011. The average annual growth rate of the labor productivity over the study period was -4.7%.

Furthermore, the growth rate of labor productivity was analytically decomposed into:

- (1) The growth rate of factor-labor intensities.
- (2) The growth rate of multifactor productivity. The annual average growth rate of factor-labor intensities was negative and only the growth of MFP had a relatively significant contribution to the labor productivity growth rate in the construction sector. The findings in the paper may help policy makers to find ways to it. The contribution of MFP to the growth of labor productivity might be improved through the improvements in productive efficiency and high-level of capacity utilization and/or the adaptation of enhanced management techniques. Further research is required to find a way to decompose MFP so that policy makers can efficiently incorporate its contribution to labor productivity.

References

1. Fabricant S (1984) Productivity Measurement and Analysis: An Overview in

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- Measuring Productivity: Trends and Comparisons from the First International Productivity Symposium, Sponsored by Japan. Productivity Center, Asian Edition co-published with the Asian Productivity Organization, Tokyo, Japan.
2. Shepard JM (1970) Functional Specialization, Alienation, and Job Satisfaction *Industrial and Labor Relations Review* 23: 207-219.
 3. Shebeb B (1998) Measuring Sources of Multi-Factor Productivity Change Using Stochastic Frontier and Non-Frontier Approaches: An Application to the Australian Mining Industries Ph.D. thesis, The University of Queensland, Australia.
 4. Gollop FM (1983) Growth Accounting in an Open Economy, in *Developments in Econometric Analysis of Productivity: Measurement and Modeling Issues*, Kluwer-Nijhoff Publishing, London, UK.
 5. Gollop FM (1987) Modeling Aggregate Productivity Growth: The Importance of Intersectoral Transfer Prices and International Trade, *Review of Income and Wealth* 33: 211-227.
 6. Shebeb B (2000) Productivity Decomposing Model: Theoretical Presentation, *Arab Economic Journal* 9: 21.
 7. Solow RM (1957) Technical Change and the Aggregate Production Function, *Review of Economics and Statistics* 39: 312-320.
 8. Tornqvist L (1936) The Bank of Finland's Consumption Price Index, *Bank of Finland Monthly Bulletin* 10: 1-8.
 9. Jorgenson DW, Griliches Z (1971) Divisia Index Numbers and Productivity Measurement, *Review of Income and Wealth* 17: 227-229.
 10. Diewert WE (1976) Exact and Superlative Index Numbers, *Journal of Econometrics* 4: 115-145.
 11. Diewert WE (1978) Superlative Index Numbers and Consistency in Aggregation, *Econometrica* 46: 83-900.