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Measuring Labour Productivity through Labour Requirement Approach: The Malaysian Experience

ZAKARIAH ABDUL RASHID and CHAN KHAI YEW*
Economics Department
Universiti Putra Malaysia
Faculty of Economics and Management
43400 Serdang, Selangor, Malaysia

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ABSTRAK

Kertas kajian ini mengukur produktiviti buruh dengan menganggar keperluan langsung buruh dan keperluan tidak langsung buruh bagi setiap unit output yang dihasilkan. Anggaran keperluan buruh ini diperolehi dengan menggunakan kaedah input-output. Kajian ini juga menggunakan dua jadual input-output untuk dua tahun yang berasingan supaya hasil kajian ini menjadi lebih mantap. Hasil kajian kemudian diuji dengan membandingkannya dengan indikator produktiviti buruh yang biasa digunakan seperti nilai ditambah setiap buruh, upah dan gaji setiap buruh dan output kasar setiap buruh. Hasil kajian ini menarik kerana walaupun keperluan langsung buruh memberikan ukuran yang mantap bagi keseluruhan ekonomi namun sektor-sektor tertentu menunjukkan pentingnya peranan keperluan tidak langsung buruh dalam mengukur produktiviti buruh.

ABSTRACT

The present paper measures labour productivity by estimating direct and indirect labour requirements per unit of output. Labour requirements are estimated by using an input-output technique. The paper uses two input-output tables for two different periods to ensure the results are more consistent. The results of the study were then tested by comparing them with the ordinary measures of labour productivity such as value-added per labour, salaries and wages per labour and output per labour. It is interesting to note that although for the whole economy direct labour requirement appears to be the consistent measure of labour productivity, for some sectors of the economy indirect labour requirement is also important.

INTRODUCTION

In many production processes, labour costs represent a substantial proportion of total cost, with costs of materials. A rise in labour cost ordinarily alters many economic decisions with respect to technological changes and obsolescence of techniques (Zakariah 1989). An economy experiencing a rapid increase in its labour cost would lose its competitive edge in the world market unless its rate of increase in labour productivity at least compensates the increase in the labour cost. Improvement in labour productivity is measured as the amount of output per unit of labour which leads to a more competitive production process. Rising labour productivity, therefore, seems to be the only way to solve the problems of a tight labour market, which is normally found in a progressive economy.

In Malaysia, present labour shortages began in the plantation sectors of oil palm and rubber and have spread to other sectors such as construction and manufacturing. The crisis is felt most acutely in the manufacturing sector, the economy's engine of growth, which accounts for 23.9% of total employment. As indicated in the Economic Report 92/93 (Ministry of Finance 1992), the manufacturing sector continued to achieve double digit growth of 13% in 1992. In terms of employment, the manufacturing sector still led other sectors in generating 74,000 new jobs in 1992. With a projected deficiency in the rate of growth of the labour force (2.9% per year) compared to the rate of job growth (3.1% per year), the current labour crisis will be persistent, at least in the short term.

Labour productivity, measured by added value per worker, has improved in recent years.

In 1991, it amounted to RM25,021 with a growth rate of 9.54% during (MITI 1994). Labour productivity in the manufacturing sector grew by 4.5% over the 1988-1992 period, compared with 3.4% in agriculture, and 3.1% in mining sectors, but slower than the construction and services sectors which registered 5.1 and 5.5%, respectively (Table 1).

Oshima (1989) shows that labour productivity grew at 3.8% in Malaysia in the period 1960–1980. The growth rate was higher than the average productivity growth of 2.7% for Southeast Asian countries as a whole during the same period, but lower than the average for the newly industrializing economies (NIEs).

Many studies on labour productivity describe average productivity of the whole economy or broad sectors of the economy. Maisom and Mohd Ariff (1994), however, computed labour productivity by sector (3-digit Malaysian Industrial Classification) to explain the contribution of labour productivity to total factor productivity growth of the Malaysian economy. By using traditional two-factor production function, the study does not take into account the inter-industrial relationships that may influence labour productivity in a particular sector. An initial attempt of incorporating direct and indirect labour requirements to fulfil final demand by sectors was made by Zakariah (1991).

DATA AND METHODOLOGY

In this paper, industries in Malaysia are classified based on input-output classification, which has been reduced to 40 industries. The input-output tables published by the Department of Statistics are aggregated to 60 x 60. The present study adopts the input-output industrial classification of the Department of Statistics except the service sectors (sectors 39, 40, 42–60) which have been aggregated to a single "service" industry. The input-output tables used in the study are for the years 1983–1987. Data on the amount of labour engaged, value-added, and salary and wages were collected from the *Survey of Manufacturing Industries*, published by the same department. Labour is defined as the number of persons engaged and classified according to Malaysian Industrial Classification (MIC) at 3-digit level. The conversion from MIC to input-output classification was done by information given by the Department of Statistics.

Labour coefficient may be defined as the quantity of labour per unit of output and is calculated by dividing the amount due to labour by its total output. It thus shows how much should be contributed directly to labour for each ringgit of output. It is the most widely used index of labour productivity. An increase in input of an industry will increase the demand for labour directly and other industries' demand for labour indirectly. Through the input-output relations, the direct and indirect labour requirements per unit of output, which show a comprehensive picture of labour productivity, can be obtained.

Each element in the matrix of Leontief inverse, $(I-A)^{-1}$, represents direct and indirect requirements of intermediate inputs for one unit increase in final demand. Labour coefficient, on the other hand, represents the amount due to labour for each unit of output. Therefore, pre-multiplying the row vector of labour coefficient by the Leontief inverse yields the direct and indirect labour requirements per unit of output.

TABLE 1
Productivity in the various sectors, 1988-1992

Sector	1988	1989	1990	1991	1992	*Growth rate 1988-1992
Manufacturing	15.9	15.9	16.6	17.7	18.5	4.5
Agriculture	7.3	8.0	8.1	8.1	8.4	3.4
Mining	183.9	194.3	198.9	203.9	202.0	3.1
Construction	6.0	6.2	6.6	7.1	7.5	5.1
Services	4.9	3.3	7.4	6.9	4.9	5.5

Note: *Compounded average annual growth rate
Source: MITI, Malaysia, Ministry of International Trade and Industry, Report 1994, p 278, Table 7.27

Now, we can distinguish two concepts of labour productivity. First, direct labour, I, measures labour inputs required per unit of output of a sector. Second, given a complete structural description of the economy, the total (direct and indirect) labour content of structural deliveries to final demand, may be derived:

$$\left[I_1, I_2 \ldots I_n\right] \begin{bmatrix} b_{11} & b_{12} \ldots b_{in} \\ b_{21} & b_{22} \ldots b_{2n} \\ b_{n1} & b_{n2} \ldots b_{nn} \end{bmatrix} = \begin{matrix} \sum_j I_i \; b_{in} \\ \sum_j I_i \; b_{i2} \\ \sum_j I_i \; b_{in} \end{matrix} \quad (2)$$

where the row vector in the left hand side of equation (1) shows the sectoral labour coefficients while the matrix shows the Leontief inverse matrix, $(I\text{-}A)^{-1}$. Since bij of the matrix represents the inter-dependence coefficients, the first column of the matrix shows the amount of sectoral output directly and indirectly required to fulfil one unit of final demand of the first sector; and the interpretation is accordingly applied to second and nth columns. The product of the above matrix multiplication, shown in the right hand side, thus can be interpreted as follows:

$\Sigma_i I_i b_{i1}$ as the amount of labour directly and indirectly required to fulfil one unit of final demand of the first sector. Similarly, $\Sigma_i I_i b_{i2}$ and subsequently $\Sigma_i I_i b_{in}$ are, respectively, the amount of labour directly and indirectly required to fulfil a unit increase in final demand of the second and nth sectors. And the grand total $\Sigma_i \Sigma_j I b_{ij}$, therefore, represents the total amount of labour directly and indirectly required to fulfil one unit increase of final demand.

The above expression can be compactly written as:

$$I^* = 1(I\text{-}A)^{-1} \quad (2)$$

Aij: element in the Leontief inverse is the direct and indirect increase in output of sector i for each increase in final output of sector j

$I_i A_{ij}$: direct and indirect labour to produce one unit of sector j output

where I* is vector of man-years required to deliver a unit of labour of each sector's product to final demand. Changes in 1 measure changes in the overall labour requirements of an economy in delivering various kind of final outputs. Such changes are the net result of changes in direct and indirect labour coefficient of many sectors and of shifting division of labour among sectors. Concurrent analysis of changes in direct and in total labour requirement for particular output gives some notion of the importance of shifting industrial specialization in the changing productivity picture.

Since direct requirements of labour describe the amount of labour required in a particular industry to produce a unit of output, whereas its indirect requirements are the amount of labour required as a result of expansion of other industries, the latter is a result of inter-industrial relationships among industries.

RESULTS AND DISCUSSION

Table 2 shows the results of simple regressions of each of the direct and indirect requirements of value-added per labour cost and value-added per employee for 1990. The direct requirements of labour appear to be a better measurement of labour productivity compared to the indirect requirements of labour. The adjusted R square is higher and the coefficient of the independent variable is highly significant in the first measurement, whereas the coefficient in the second measurement is insignificant.

TABLE 2
Direct and indirect labour requirements as measurement of labour productivity, 1990

	Value-added per labour cost			Value-added per employee		
	R-Square	Coefficient	P-Value	R-Square	Coefficient	P-Value
Direct	0.354	-1.835	0.0002	0.262	-0.00006	0.0018
Indirect	0.043	-0.169	0.135	0.063	-0.000007	0.0934

Note: data on independent variables are compiled from Industrial Survey, 1990.

The present study examined which of the two independent variables, value-added per labour cost or value-added per employee, explained better the direct requirements of labour. Both variables show the expected negative sign of the coefficients, implying that as labour productivity increases less labour is required directly. Table 2 reveals that the value-added per labour cost explained better the variation in the direct requirements of labour. The adjusted R square for value-added per labour cost is 0.354, compared to value-added per employee of 0.262. Both variables have highly significant coefficients.

Changes in the number of persons engaged and in salary and wages can be used to detect productivity changes. Since the former does not take into account differences in skill levels whereas the latter varies directly with skill levels, changes in salary and wages will capture productivity differences better among different categories of workers. This may be the explanation behind the different values of the adjusted R-square shown in the Table 2.

The size of the coefficients explains the sensitivity of value-added per labour cost, and value-added per employee variables (exogenous) on the labour requirements variable (endogenous). Given an increase in the labour productivity, as measured by a decrease in the amount of labour required per unit of output, a relatively larger increase in value-added per labour cost than those in value-added per employee would be expected.

Since direct requirements of labour describe the amount of labour required in a particular industry to produce a unit of output whereas indirect requirements are the amount of labour required as a result of an expansion of other industries, the latter is a result of an inter-industrial relationships among industries.

Results of our analysis show that in the manufacturing sector, direct requirements are larger than indirect requirements of labour. About 70% of its total requirements represent direct requirements. However, some industries' indirect requirements are greater than their direct requirements. The industries which indirectly require more labour include dairy products, oils and fats, animal feeds, beverages, industrial chemicals, paints, petroleum products, cements, and basic metals. These industries are resource-based industries and linked significantly with the rest of the sectors, their backward linkage indices are generally higher than the average (Zakariah 1994). The direct influence of labour requirements tends to deteriorate, perhaps due to the non-improvement in the economy's inter-industrial linkages (UNIDO 1992).

Table 3 shows the indirect labour requirements in 1971, 1981 and 1990 to fulfil final demand in resource-based and non-resource-based industries. The results show that resource-based industries indirectly require larger amounts of labour than non-resource-based industries do. However, the difference in the average indirect requirements of labour between the industries is non-significant. The weighted average (Lespeyres indices sectoral gross outputs as weights) of the indirect requirements of labour in the resource-based industries in 1971, 1981 and 1990 are, respectively, 27.218, 7,941 and 5,601 while those in the non-resource industries based are 22.119, 7.594 and 5.468.

The above results imply that improvement in labour productivity in the resource-based industries is more a result of an expansion of other industries, whereas improvement in labour productivity in the non-resource-based industries is a result of an expansion in its own industries.

The indirect requirements of labour in the non-resource based industry of electrical machinery is particularly low, about one-half the average requirements of the non-resource based industries. The industry produces amongst the largest output, but has amongst the lowest backward linkages. The indirect requirements of labour in the resource-based industry of furniture and fixtures, on the other hand, are particularly high, about twice the average requirements of the resource-based industries. The industry has a fairly high backward linkage with the rest of the economy.

From the above analysis, resource-based industries have higher-backward linkages and large indirect requirements of labour whereas non-resource based industries have lower backward linkages and smaller indirect requirements of labour. Testing the above hypothesis, the Spearman rank correlation coefficients between backward linkage indices and indirect requirements of labour for 1983 indices against 1981 requirements and 1987 indices against 1990 requirements of 0.208 (n=31) and 0.056 (n=31), respectively; were,

TABLE 3
Indirect requirements of resource-based and non-resource based industries

Sectors	(1) 1971	(2) 1981	(3) 1980
Resoure-based			
1 Dairy Foods	26.476	9.853	7.605
2 Vegetables and Fruit	22.806	7.773	5.884
3 Oils & Fats	24.100	7.776	5.404
4 Grain Milling	12.252	3.874	2.828
5 Bakery and Confectionery	24.855	8.916	6.599
6 Other Foods	18.761	9.446	4.823
7 Animal Feed	17.439	6.316	4.780
8 Beverages	27.322	9.336	6.582
9 Tobacco	16.857	6.456	4.786
10 Sawmills	19.833	6.681	4.993
11 Furniture and Fixtures	42.822	14.766	10.153
12 Rubber Process	8.663	2.799	2.159
13 Rubber Production	22.470	7.213	5.608
14 Textiles	38.061	12.359	7.759
15 Industrial Chemicals	37.122	6.150	4.007
16 Paints, etc	23.628	7.273	5.456
17 Other Chemical Products	28.824	8.960	6.403
18 Petrol Production	62.284	5.847	3.117
19 Plastic Production	20.107	6.681	5.086
20 Glass Production	28.015	7.614	5.685
21 Cement	25.707	7.546	6.106
22 Non-Metallic	29.235	8.283	6.015
23 Basic Metals	43.666	10.731	6.254
24 Other Metals	31.934	10.942	6.337
Total	653.241	190.591	134.429
Average	27.218	7.941	5.601
Non-resource-based			
1 Wearing Apparel	27.558	9.014	6.265
2 Paper and Printing	26.112	9.167	6.517
3 Non-electrical Machinery	26.234	8.312	5.508
4 Electrical Machinery	11.487	4.113	3.252
5 Motor Vehicles	19.558	7.323	4.993
6 Other Transport	24.822	8.562	6.567
7 Other Manufactured Products	19.059	6.668	5.173
Total	154.830	53.159	38.275
Average	22.119	7.594	5.467

Source: Computed from equation (1)
Note:(1) and (2) calculated by using 1983 input-output tables while (3) used 1987 input-output tables.

however, found to be insignificant at 5%. This may be explained by (i) the earlier finding that the indirect requirements of labour in resource based industries is not significantly larger than those in the non-resource based industries; and (ii) the correlation coefficients are calculated from different years (the linkage indices can only be calculated in the years in which input-output tables are published).

CONCLUDING REMARKS

Labour productivity is usually measured by value-added (or output) per unit of labour cost or per unit of employee, but it can also be estimated by labour requirements to fulfil a given final demand. The advantage of using the latter is not, it captures both the direct and indirect requirements, incorporating the inter-industrial relationships of an increase in final demand,

whereas the former captures only the direct requirements of labour. The element of indirect requirements of labour on labour productivity changes is particularly important in resource-based industries. We may conclude that measuring labour productivity changes by looking only at the direct requirements of labour may grossly underestimate the "true" changes in labour productivity.

The results of our analysis show that, in general, direct requirements of labour are a better description of labour productivity of the whole economy than to its indirect requirements, thus affirming such studies. However, the role of indirect requirements of labour should not be overlooked, especially when studies are focused on resource-based industries. Although the results are statistically inconclusive as they are limited by the given input-output tables, they certainly provide a clear understanding of the extent of indirect requirements of labour, particularly in the strong resource-based backward linkage sectors.

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