E C O N O M I C S B U L L E T I N

Total Factor Productivity in the Malaysian Resource-Based Industries

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Abstract

This paper will focus on the issues of total factor productivity growth (TFPG) for both 3 and 5-digit level and the performance of resource-based industries (RBIs) in Malaysia for the period 1981-1997. By using the neoclassical Cobb-Douglas production function and traditional growth accounting methodology (Solow-residual) with time discrete Tornqvist weighted value share index, the TFPG estimation for both classifications shows an interesting pattern in terms of sign and fundamental composition. The development of RBIs during the period under study is mostly input driven (moving towards a capital intensive industry), where supply effect of unskilled labour assimilates to the underlying value added growth over time.

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Introduction

This study will concentrate on the issues of TFPG and performance of selected resource-based industries (RBIs) of various sub-sectors in the Malaysian manufacturing industries using the panel data fixed effect analysis of the 3 and 5-digits Malaysian Industrial Classification (MIC) 1972 (updated 1979). The definition and classification of RBIs are broad and in this paper we only select 14 3-digits level industries involving 61 sub-industries in 5-digits level categories.

Methodology

The theoretical framework developed by Jorgenson et al. (1987) is employed to derive the indices of output, inputs and technical change. It is assumed that capital and labour inputs, as well as time are separable from intermediate input, such that productivity growth will only occur through value added. While there are several methods that can be used for computing TFP, estimates of the TFP at the different sub-sector level in RBIs are generated using traditional growth accounting methodology (Solow-Residual) with time discrete interval (Tornqvist Index) using fixed effect technique panel data analysis and allowing for time variant.

The production function for the *i*th RBIs is separable in capital K_{it} and labour L_{it}, therefore the value added Q_{it} can be represented as a function of aggregate input, say W_i:

$$Q_{it} = F^{it}\left[W_{it}\left(K_{it}, L_{it}\right), T\right] \quad \text{“(1)”}$$

Where i refers to number of cross-sectional identifier (industry)
t time period for each identifier

The production function F^i is *homothetically separable* with aggregate input W_i is homogeneous of degree one or Constant Return to Scale (CRS). Therefore the productivity growth is *Hicks neutral* and the production function can be rewrite in the form of

$$Q_{it} = A_{it}(T)W_{it}\left(K_{it}, L_{it}\right) \quad \text{“(2)”}$$

Since the productivity growth is *Hicks neutral*, the rate of productivity is independent of capital and labour inputs and depends only on time:

$$\varphi_T^{it} = \frac{d\ln A_{it}(T)}{dT} \quad \text{“(3)”}$$

The equation “(1)” can be rewritten as

$$\ln Q_{it} = \alpha_k \bullet \ln K_{it} + \beta_\ell \bullet \ln L_{it} + \varphi_T^{it} \quad \text{“(4)”}$$

Where α_k and β_ℓ are denotes marginal product of capital and marginal product of labour respectively. From equation “(4)”, the TFP can be calculated as the residual of growth after deducting the contribution of K and L. Then the equation becomes:

$$\varphi_T^{i} = \ln Q_{it} - [\alpha_k \bullet \ln k_{it} + \beta_\ell \bullet \ln L_{it}] \quad \text{(known as } \textbf{Solow-Residual}\text{)} \quad \text{“(5)”}$$

By assuming perfect competition in capital and labour market and CRS, each input factors are paid accordingly to their marginal products (i.e α_k and β_ℓ). Moreover practically, β_ℓ is more easily to find than α_k. Thus equation “(5)” can be written as:

$$\varphi_T^{it} = \lambda_{Qit} - [(1-\beta_\ell)\lambda_{Kit} + \beta_\ell \lambda_{Lit}] \quad \text{“(6)”}$$

Where β_ℓ and $(1-\beta_\ell)$ (known as **Divisia Index weighing system**)

For any two discrete points of time, T and (T-1), the growth rate of output can be disintegrated into a weighted (i.e. value shares) of the growth rates capital and labour inputs, and the rate of productivity growth, $\varphi_{(T,T-1)}^{it}$ becomes;

$$\varphi^{i}_{(T,T-1)} = \left[\ln Q_{it}(T) - \ln Q_{it}(T-1)\right] - \Theta_K\left[\ln K_{it}(T) - \ln K_{it}(T-1)\right] - \Theta_L\left[\ln L_{it}(T) - \ln L_{it}(T-1)\right] \quad \text{“(7)”}$$

Where

$\Theta_k = \frac{\alpha_k + \alpha_{k-1}}{2}$ and $\Theta_l = \frac{\beta_\ell + \beta_{\ell-1}}{2}$ (Known as **Tornqvist weighted value share index**)

Thus the estimate of the TFP is essentially the residual that is obtained after subtraction from the growth rates of output and the average growth rates of inputs viz. capital and labour. The equation “(7)” is easily to define and estimate since according to Menon (1998) all data classification needed for TFPG estimations are easily observable.

In this paper, factors that potentially determine TFPG are incorporated using panel data (pooled least square) analysis using fixed effect technique for the periods of 1982 to 1997.

The multiple regression model proposed is as follow:

$$y_{it} = \alpha_i + x'_{it}\beta_i + \varepsilon_{it} \quad \text{“(b1)”}$$

Where y_{it} is the dependent variable, x'_{it} and β_i are k-vectors of non-constant regressors and parameters for i=1,2,…..N cross sectional units. Each cross-section unit is observed for dated periods t=1,2,…..T. So total panel data set are N times T. Fixed effect techniques taking into account other variable are assumed constant although the omitted (unobserved) variable correlated with the right-hand-side variables.

And to allow us for analyze growth in dependent variable the equation transformed into Log model and the equation “(b1)” above become

$$\ln y_{it} = \alpha_i + \ln x'_{it}\beta_i + \varepsilon_{it} \quad \text{“(b2)”}$$

Where now	$\ln y_{it}$	TFP growth estimated from equation (E.6)
	$\ln x'_{it}$	k - Vectors for set of regressor, i.e
		$\ln GExp_{it}$ (percentage growth of exports)
		$\ln Gvac_{it}$ (percentage growth of value added per capital)
		$\ln Gwl_{it}$ (percentage growth of wage per unit labour)
		Zexp
		Zwl
		Zvac

Z’s values are standardized value for each set of explanatory variables which converted into probability using Standardized Normal Distribution table.

β_i	Fixed effect estimator
ε_{it}	Error terms
i	refers to ith cross-sectional unit identifier
t	refers to time period for each identifier

Data and Measurement

Study for TFPG estimation involved 17 observations from 1981-1997, which covers Fourth Malaysia Plan (1981-1985), the First Industrial Master Plan (1986-1995) that include the Fifth and Sixth Malaysia Plan as well and for the period of 1996 to 1997. Three variables involved are value added (derived as the difference between the value of gross output and the

cost of input), capital (net value of fixed assets owned as at End of each year) and labour (total number of person engaged during December or the last pay period). All data were taken from Annual Survey of Manufacturing Industries, which are quoted in nominal terms.

Since the estimation for TFPG are derived in a form of growth term, therefore all others explanatory variables will also converted to the same measurement in order for us to examine the growth effect due to percentage change in explanatory variables. All data quoted in their nominal terms and only covers for five selected 3-digit industrial classifications (due to limited data available) with 112 total numbers of observations. . Data for growth of exports adapted from Malaysia Economic Report (various issues) and Malaysian Plan (various issues), and the rest adapted from Annual Survey of manufacturing Industries, Department of Statistic Malaysia (various issues). No similar tests perform for 5-digits level since data for the desired (exports volume) variables were not available.

Results and Discussion

Table 1 and Table 2 are the output of the TFPG estimation based on the panel data analysis fixed effect technique. Whereas Table 3 present the panel data regression analysis on TFPG estimated from Tornqvist share index and involving endogenous and exogenous force factor that could determine TFPG.

The TFPG as shown in Table 1 and Table 2 exposed some interesting fundamental insights. For all industries and sub-industries (3-digits and 5-digits level), input of capital plays a substantial role. Such findings are similar of those studies done by Maisom (1981), Kruger and Tuncer (1980) and Chen (1977).

According to Table 1, average TFPG contributions to output (value added growth) for 3-digit industry are approximately 13 percent. This implied that most of the output compositions were mainly contributed by inputs factor namely labour and capital with accounted 30 percent and 56 percent respectively. In other words, there are low TFPG during the time periods 1981 to 1997 for the stipulated industries.

Table 1
Contribution Source of Growth, 1981-1997: 3-Digits Industry

Industry Code	Value Added Growth	Labour Growth	Capital Growth	TFPG	TFPG per Value Added Growth	Rank
311-312	1.0054	0.3075	0.5603	0.1377	0.1370	3
313	1.0036	0.3065	0.5600	0.1371	0.1366	7
314	1.0064	0.3088	0.5613	0.1363	0.1354	11
331	1.0074	0.3080	0.5623	0.1372	0.1362	9
332	1.0136	0.3096	0.5662	0.1379	0.1360	10
341	1.0129	0.3096	0.5666	0.1367	0.1349	12
342	1.0084	0.3079	0.5627	0.1379	0.1367	6
351	1.0166	0.3091	0.5678	0.1397	0.1374	2
352	1.0081	0.3079	0.5621	0.1381	0.1370	3
353	1.0071	0.3111	0.5678	0.1283	0.1274	13
354	0.9986	0.3134	0.5697	0.1154	0.1156	14
355	1.0076	0.3082	0.5618	0.1377	0.1366	7
356	1.0136	0.3095	0.5646	0.1395	0.1376	1
369	1.0088	0.3081	0.5625	0.1382	0.1370	3

Source: Data calculated from Department of Statistics, Malaysia: 1981-1997.
Note:

TFPG value has been rounded up to four decimal place
Rank based on TFPG per value added growth.

However, based on Table 2, the 5-digits levels show an interesting figure. For all industry labour and capital inputs contributes approximately 50 percent and 40 percent to the growth of value added respectively. Therefore in broader categories RBIs are labour intensive industries. In MIC 3-digit, the industries are classified as capital intensive. The differences of TFPG value between 3-digit and 5-digit MIC are possibly due to aggregation problem. To further investigate the duality pattern in these two different industrial levels, the regression analysis conducted at the end of this section will give the possible answer.

MIC 34190 – Manufacture of pulp, paper and paperboard articles, n.e.c show the highest TPFG per valued growth with 11.36 percent. The lowest is MIC 33190 – Manufacture of wood and cork products, n.e.c with total share in TFPG per value added counted only 8 percent. While for all other industries the TFPG per value added growth only contribute between 8 to 10 percent.

The top ten highest TFPG per value added growth (in ascending order) are MIC 34190, MIC 35111, MIC 31169, MIC 35119, MIC 31151, MIC 31131, MIC 35290, MIC 31161, MIC 35591 and MIC 31159. However, the top ten lowest TFPG per value added growth (in ascending order) are MIC 35400, MIC 33190, MIC 35300, MIC 36922, MIC 36999, MIC 35130, MIC 34110, MIC 31110, MIC 31219 and MIC 35231. The industries listed in top ten highest and top ten lowest are mostly from MIC 311-312, i.e Food manufacturing industries.

Table 2
Contribution of Source of Growth: 3 and 5 Digits Level Classification: 1981-1997

Industry Code		Value Added Growth	Labour growth	Capital growth	TFPG	TFPG per Value Added Growth	Rank
311-312 (3)	31110	1.0134	0.5089	0.4123	0.0922	0.0910	54**
	31121	1.0071	0.5027	0.4081	0.0963	0.0957	21
	31129	1.0047	0.5033	0.4077	0.0937	0.0932	45
	31131	1.0032	0.4982	0.4065	0.0985	0.0982	6*
	31139	1.0069	0.5027	0.4083	0.0959	0.0953	24
	31140	1.0068	0.5029	0.4098	0.0941	0.0935	44
	31151	0.9951	0.4948	0.4025	0.0978	0.0982	5*
	31152	1.0054	0.5034	0.4085	0.0935	0.0930	47
	31153	1.0050	0.5004	0.4080	0.0966	0.0962	19
	31159	1.0078	0.5015	0.4084	0.0979	0.0971	10*
	31161	1.0047	0.5011	0.4058	0.0979	0.0974	8*
	31163	1.0074	0.5020	0.4076	0.0978	0.0971	11
	31164	0.9995	0.4989	0.4078	0.0928	0.0928	48
	31169	1.0014	0.5006	0.4001	0.1006	0.1005	3*
	31171	1.0103	0.5043	0.4095	0.0964	0.0954	22
	31172	1.0127	0.5057	0.4111	0.0960	0.0948	32
	31180	1.0060	0.5018	0.4068	0.0974	0.0969	14
	31190	1.0095	0.5037	0.4098	0.0961	0.0952	25
	31211	1.0079	0.5035	0.4068	0.0977	0.0969	13
	31212	1.0125	0.5035	0.4128	0.0961	0.0949	30
	31214	1.0084	0.5029	0.4083	0.0971	0.0963	17
	31215	1.0149	0.5060	0.4134	0.0955	0.0941	40
	31219	1.0091	0.5063	0.4105	0.0923	0.0915	53**

	31220	1.0075	0.5017	0.4087	0.0972	0.0964	15
313	31310	1.0030	0.4996	0.4070	0.0963	0.0960	20
(7)	31340	1.0050	0.5018	0.4082	0.0950	0.0945	36
314 (11)	31400	1.0064	0.5050	0.4084	0.0930	0.0924	49
	33111	1.0035	0.5020	0.4070	0.0946	0.0943	38
	33112	1.0115	0.5054	0.4106	0.0955	0.0944	37
331	33113	1.0112	0.5058	0.4097	0.0957	0.0947	33
(9)	33119	1.0154	0.5090	0.4119	0.0945	0.0931	46
	33120	1.0082	0.5019	0.4105	0.0958	0.0950	29
	33190	1.0081	0.5109	0.4133	0.0838	0.0832	60**
332(10)	33200	1.0136	0.5063	0.4119	0.0954	0.0942	39

Source: Data calculated from Department of Statistics, Malaysia: 1981-1997.

Note: Number in brackets denotes ranking in 3-digits level.

The discrepancies of TFPG and TFPG per Value Added value are due to rounding up to 4 decimal place

* *Top Ten Highest*

** *Top Ten Lowest*

Table 2 (cont.)

Comparison Between 3 and 5 Digits Level Classification: 1981-1997

Industry Code		Value Added Growth	Labour growth	Capital growth	TFPG	TFPG per Value Added Growth	Rank
	34110	1.0162	0.5093	0.4149	0.0920	0.0905	55**
341(12)	34120	1.0135	0.5077	0.4126	0.0932	0.0920	50
	34190	1.0328	0.5045	0.4110	0.1173	0.1136	1*
342(6)	34200	1.0084	0.5034	0.4094	0.0956	0.0948	31
	35111	1.0279	0.5084	0.4154	0.1040	0.1012	2*
351	35119	1.0200	0.5059	0.4134	0.1007	0.0987	4*
(2)	35120	1.0080	0.5027	0.4099	0.0953	0.0946	34
	35130	1.0190	0.5117	0.4154	0.0919	0.0902	56**
	35210	1.0105	0.5059	0.4099	0.0946	0.0936	43
	35220	1.0098	0.5038	0.4114	0.0946	0.0937	42
352(3)	35231	1.0068	0.5053	0.4093	0.0921	0.0915	52**
	35239	1.0085	0.5053	0.4084	0.0948	0.0940	41
	35290	1.0101	0.5026	0.4089	0.0987	0.0977	7*
353(13)	35300	1.0071	0.5087	0.4131	0.0853	0.0847	59**
354 (14)	35400	0.9986	0.5126	0.4145	0.0715	0.0716	61**
	35510	1.0062	0.5022	0.4083	0.0957	0.0951	28
	35591	1.0036	0.5001	0.4059	0.0976	0.0973	9*
355(7)	35592	0.9841	0.4903	0.3985	0.0954	0.0969	12
	35593	1.0068	0.5021	0.4078	0.0969	0.0963	18
	35599	1.0149	0.5074	0.4109	0.0966	0.0952	26
356(1)	35600	1.0136	0.5062	0.4107	0.0967	0.0954	23
	36910	1.0099	0.5035	0.4104	0.0961	0.0951	27
	36921	1.0090	0.5027	0.4090	0.0972	0.0964	16
	36922	1.0151	0.5114	0.4139	0.0898	0.0885	58**
369(3)	36991	1.0096	0.5070	0.4098	0.0928	0.0919	51
	36992	1.0137	0.5056	0.4123	0.0959	0.0946	35
	36999	1.0179	0.5087	0.4182	0.0910	0.0894	57**

Source: Data calculated from Department of Statistics, Malaysia: 1981-1997.

Note: The TFPG value are rounded up to 4 decimal place

* *Top Ten Highest*

** *Top Ten Lowest*

In this paper we also consider a number of potential determinants of TFPG. The main concern of testing: (i) to discover potential endogenous (resource allocation) factor that might be determined TFPG in this industry and (ii) to look at the competitiveness of RBIs in world markets. The endogenous factors are incentives to factor of production, which is a proxy to wage per unit labour and capital-to-value added ratio as a proxy to capital utilization to value added growth. One exogenous factor to be tested is export volume of RBIs, as a proxy to competitive force in world markets. We also include three standardized variables to measure the volatility (stability) of each endogenous and exogenous factor. If the standardized value significant in the model with negative (positive) sign, we can imply that the variables are volatile (stable) within the stipulated period under study. Volatility (stability) of each variable is very much depends on its threshold level. If for example, the standardized coefficient shows a negative (positive) sign we might say that most of the variables disperse below (above) the threshold level and consequently depress (surpass) the TFPG to the some level. The selections of the explanatory variables are based on the argument of availability of the data and to prove the hypothesis made by Nishimizu and Robinson (1984).

Average export growth for all industries in 1982-1997 is around RM 1.24 million. Although the selected industries experienced positive and negative of TFPG, annual exports for all industries shows a better figure. To empirically show the correlation between TFPG and other selected explanatory variables, eight industries were selected. The industries are Food manufacturing industry (311-312), Wood and Wood products industry (331), Furniture and Fixture (332), Manufacture of Paper and Paper products (341), Manufacture of Industrial Chemical (352), Manufacture of miscellaneous products of petroleum and coal (354), Rubber products industry (355) and Non-metallic mineral products (369). The choice of the selected industries is dictated by the availability of data for the periods of 1982 to 1997 except for Furniture and Fixture industry (332) since data cover only for the period of 1988 to 1997.

Both resource allocation effect and externality effect lead to an economy-wide productivity increase as exports expanded. Study by Nishimizu and Robinson (1984) had proved the existence of a significant (positive) correlation between productivity growth and export expansion. The correlation between exports performance and productivity was also had proven statistically by Chen and Tang (1990) on their study on exports performance and productivity growth in Taiwan manufacturing sector.

Table 3

Panel Data Regression: Fixed Effect Analysis

Ln**TFPG** =	0.0393ln**Gexp** -	0.0033ln**Gwl** +	0.3842ln**Gvac** -	0.0094**Zexp** +	0.0325**Zwl** +	0.0129**Zvac**
	[2.4716]**	[-0.1936]	[10.8017]***	[-0.9181]	[3.2131]**	[1.6302]$^{+}$

Modified R^2:	0.9458
LM(2):	2.4079
Total panel observations:	112 (unbalanced)

Note: Value in bracket is t-statistic
$^{+}$ Significant at 20 percent level
* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1% level.

According to Table 3, only four coefficients are found statistically significant at least at 20 percent level. Export growth (positive sign) is significant at 5 percent level. However, stability test shows that the export volume is still volatile in the world market but there is not enough evidence to support the hypothesis. One concrete finding - low competitive in exports will lead to a slower growth of TFPG in the selected industries. Although the export growth positively affect TFPG but the performance of export expansion still below par. Therefore, to overcome the volatility in the export market it should be supported by implementing more effective strategy (containing pricing and marketing) especially for wood and wood products and rubber product industry (classified as export-orientation industry) as strongly stipulated in the Second Industrial Master Plan (Ministry of International trade and Industry, 1996).

The growths of TFPG are fundamentally contributed by input factors (endogenous factors) as we have seen in Table 1 and 2. To clarify which type of inputs mainly contributed to this selected industries can generally be explained from this model. The growth of incentive effect (ln**Gwl**) unfortunately depresses the TFPG growth in this analysis. Although the sign is different compared to many theoretical foundation, it is worth to note here that these industries might be saturated by the supply effect of unskilled labour as one percentage growth increase in incentives (ln**Gwl**) depress the TFPG growth. The evidence is further explained by stability incentive coefficient (**Zwl** - significant at 5 percent level) and this might be an indication that the industry is still under the process of shifting to more capital intensive as noted earlier. Unfortunately the exact time of such process is not traceable. To verify the statement (incentive effect and stability), capital to-value added ratio (ln**Gvac**) could give better explanation. The hypothesis of no correlation between TFPG and growth in capital to-value added ratio is rejected at 1 percent level and the stability coefficient significant (weakly correlated) at least at 20 percent level. Thus, from the evidence shown above we can imply that RBIs are characterized (at this point of study) as capital-intensive industries and were saturated by the assimilation of supply effect of unskilled labour.

Concluding Remarks

Growth pattern of average TFPG for the RBIs especially in broad categories (5-digits levels) had shown that RBIs are labour intensive industries with massive capital investment. Although all industries recorded a positive TFPG value (in 3-digits MIC levels) but in a broader categories labour contribution surpass capital contribution (TFPG per value added growth). For the variation of TFPG, although exports growths are significant in this industry, but the industries progress and development should be supported towards stabilizing exports volume in world markets and supported by concentration of effort to capitalize the industry.

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