Pertanika J. Soc. Sci. & Hum. 13(1): 95-102 (2005) ISSN: 0128-7702
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Relationships Among Output, Wages, Productivity and Employment in the Malaysian Electronic and Electrical Sub-sector

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Keywords: Output, wages, productivity, electronic and electrical industries, employment

ABSTRAK

Industri elektrik dan elektronik Malaysia telah menjadi komponen paling penting dalam sektor pembuatan negara. Seperti yang diketahui umum, sektor tersebut memainkan peranan penting dalam eksport negara, guna tenaga sepertimana pertumbuhan ekonomi. Memikirkan kepentingan subsektor tersebut, adalah mustahak supaya kita memastikan pertumbuhan subsektor itu berterusan dan persaingan dikekalkan atau dipertingkatkan. Kajian ini secara khususnya bertujuan untuk menyelidik pertalian antara output, produktiviti, gaji dan buruh. Seperti yang diketahui umum, gaji boleh meningkat selagi ia setara dengan peningkatan tinggi dalam produktiviti. Walau bagaimanapun, perubahan gaji sebenarnya boleh mempengaruhi guna tenaga. Ujian punca unit menunjukkan bahawa semua pemboleh ubah gaji tersebut adalah I (1). Prosedur Johansen dikendalikan untuk melihat hubungan jangka panjang dan jangka pendek dengan pemboleh ubah tersebut. Keputusan ujian kointegrasi Johansen menampakkan bahawa hubungan jangka panjang keseimbangan wujud di kalangan pemboleh ubah tersebut. Daripada analisis dinamik jangka pendek, kami dapati bahawa kecuali gaji sebenar, produktiviti buruh dan guna tenaga secara statistiknya signifikan dalam mempengaruhi output.

ABSTRACT

The Malaysian electronic and electrical sub-sector has been the most important component of the nation's manufacturing sector. As is widely known, the sector has played a vital role in the nation's export, employment as well as overall economic growth. Considering the importance of the sub-sector, it is imperative that we ensure sustainable growth of the sub-sector and that competitiveness is maintained or even improved. This study is particularly aimed at investigating the linkages between output, productivity, wage and labour. As is widely acknowledged, wages may increase as long as it is commensurate with a higher increase in productivity. However, changes in wages can actually affect employment. Unit root tests indicate that all of the above variables are I(1). Johansen's procedure was conducted to see the long run and short run relationships between the variables. The Johansen cointegration test results revealed that a long-run equilibrium relationship exists among the variables. From the short run dynamic analysis, we found that except for real wages, labour productivity and employment are statistically significant in influencing output.

INTRODUCTION

Since the early 1980s, the Malaysian economy has relied heavily on the manufacturing sector. About 27% of the working population is engaged in the sector (Table 1). The manufacturing sector is currently the major contributor to the nation's GDP (about 30% of the total) and it accounts for about more than 80% of the nation's total merchandise export.

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TABLE 1
Malaysian manufacturing sector: annual growth of output, exports, value added, percentage share of GDP and employment

Year	Output Growth	Exports Growth	Percentage Share of GDP	Percentage Share of Employment
1988	17.0	31.97	21.1	15.29
1989	20.3	36.21	23.3	15.94
1990	15.3	28.07	24.6	19.94
1991	14.0	30.91	25.6	21.33
1992	7.0	16.53	25.1	23.10
1993	14.6	25.52	26.2	23.55
1994	11.4	34.11	26.7	24.89
1995	11.4	22.41	27.1	25.92
1996	18.2	7.66	29.1	26.68
1997	10.1	12.87	29.9	27.50
1998	-13.4	32.80	27.9	26.50
1999	13.5	14.34	30.	27.10
2000	17.0	20.61	33.4	27.6
2001	12.0	24.9	30.2	26.7
2002	4.0	29.3	30.1	21.7
2003	6.5	26.6	30.6	21.7

Source: Malaysia Economic Report

Within the manufacturing sector, the electronic and electrical (E&E) sub-sector has played a leading role in the nation's growth, exports and employment. In 2003, the sub-sector contributed 61% of the total manufacturing output, about 35% of the total manufacturing value added, and accounted for 34% of total manufacturing employment. The E&E sub-sector also contributed 68% (worth of RM223 billion) of the total manufactured exports in year 2003. Major export products include electrical machinery, apparatus, appliances, electrical parts, office machines and automatic data processing equipment. In terms of value added, much of it has been contributed by semiconductors and other electronic components and communication equipment and apparatus, radio and TV sets, sound reproducing, and reproducing and recording equipment.

Obviously, the country's exports are heavily dependent on manufactured products while manufactured exports are narrowly based on E&E products. Thus, our exports would be very sensitive and vulnerable to changes in world supply and demand for electrical products. Should there be any severe drop in the demand for electronic and electrical products in the world market, the country's economy would be adversely affected in terms of growth and employment. The world electronic industry did experience severe doldrums in the middle of the 1980s in the aftermath of a massive supply expansion in anticipation of increased demand which did not materialise. The effects of the doldrums were severely felt by many producers, exporters and workers in the electronic sector. As such, it is important to understand the relationship or interdependence between certain important variables in the sub-sector i.e. output, productivity, employment and wage.

A very first question here is whether wage, labour productivity and employment significantly affect the real output of the Malaysian electronic sub-sector? It is also of interest to examine the multi-directional linkages among the real output, wages, productivity growth and employment in the electronic sub-sector. The establishment of causal dynamic linkages among these variables has important implication for Malaysia. If the wage rate leads to a higher productivity, then increasing it can increase the manufacturing output and competitiveness in the international market. However, if the increase in wage rate leads to a significant reduction in employment, then the objective of reducing unemployment may contradict that of reducing poverty and improving the living standards of the workers.

Numerous studies have been conducted to examine the relationship among wages, productivity, employment and output. Huh and

Trehan (1995) found that Granger causality runs from prices and productivity to wages but not the other way round in the United States by using a simple dynamic labour demand model. Parker (1995) had shown that increase in the United States wage rate increased the labour productivity, but it reduced the level of employment by about 2%. Hostland (1996) supported the neoclassical view of a long run equilibrium relationship between the real wage rate and labour productivity in the case of Canada. Deviations between the real producer wage rate and average labour productivity are large and persistent but are not found to be permanent. Growth in the real producer wage growth in excess of average labour productivity has generally had relatively minor implications on the employment rate.

The effect of productivity growth on wages has been carried out by Carneiro (1998) in Brazil using time series data for 22 manufacturing sub-sectors for 1985-1993. He found changes in sectoral productivity to be a relevant explanation for the changes in sectoral nominal wages. Paus and Robinson (1997) demonstrated that economic growth, investment share growth and productivity growth are the determinants of real wage growth. They also concluded that governments who want to promote growth and living standards of their workers have to focus explicitly and primarily on increasing investment and productivity growth. On the other hand, Pehkonen (1995) found that there are considerable differences across the different sectors of the economy and inter-country differences of productivity growth.

This paper is divided into several parts. The next section explains the sources of data and the econometric methodology employed followed by discussion on the estimated results. The last section provides the conclusion and policy implication.

THE DATA AND METHODOLOGY

The Data

This study involves annual data spanning from 1973 to 1997 of the E & E sub-sector real output (RO), employment (EMP), labour productivity (LP) and real wages (W). They were collected from various issues of the Malaysia Year Book of Statistics, published by Department of Statistics and Annual Productivity Report by National Productivity Corporation (NPC).

Value-added is used as a proxy for output of E&E sub-sector. The value added output is gross ex-establishment values minus cost of inputs and is deflated by the producer price index (PPI) to achieve real terms at the base year 1990. Value-added reflects the true economic activity of the industry and it also tended to yield results that are more closely associated with business changes. The nominal wages is derived by dividing the labour costs (salaries and wages paid, including bonuses, cash allowances, etc) by the number of paid employees. The real wage is then obtained by deflating the nominal wage with consumer price index (CPI). The number of paid employees comprises both full time and part-time workers, where two part-time workers are made equivalent to one full-time worker. Labour productivity (LP) is defined as value added per employee in nominal terms.

Vector Autoregressive (VAR) Model

For the purpose of this study, a vector autoregressive (VAR) model was set up to investigate the relationship among output, labour productivity, employment and real wages in the E&E sub-sector.

$$\begin{bmatrix} RO_t \\ LP_t \\ EM_t \\ W_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \begin{bmatrix} \beta_{1,1}(L) & \cdots & \beta_{1,4}(L) \\ \vdots & \cdots & \cdots \\ \vdots & \cdots & \cdots \\ \beta_{4,1}(L) & \cdots & \beta_{4,4}(L) \end{bmatrix} \begin{bmatrix} RO_t \\ LP_t \\ EM_t \\ W_t \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \end{bmatrix} \quad (1)$$

where RO denotes the real output; LP is labour productivity; EM is employment and W is real wages.

The long-run relationships amongst the variables are investigated by the Johansen-Juselius (1990) multivariate cointegration test. The short-run relationships, on the other hand, are analyzed by the Granger-causality analysis with the vector error-correction model (VECM) (1988).

Multivariate Cointegration Test

Before conducting the multivariate cointegration test, it is necessary to establish whether the relevant variables are stationary and to determine the order of integration of the variables. This can be achieved by employing unit root tests, namely the Augmented Dickey-Fuller (ADF) (1979) and unit root tests in the levels and first

differences of the variables. After having the order of integration of each series or stationary properties of each individual series, maximum likelihood multivariate cointegration test is then utilized to determine the number of linearly independent cointegrating vectors in the system. In the case of non-stationary data, a cointegration analysis will then be conducted in a vector autoregression (VAR) model:[1]

$$\Delta X_t = \prod X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \mu + \Theta t + \varepsilon_t, \qquad (2)$$

where $\prod = -\left(I - \sum_{i=1}^{k} \Pi_i\right)$ and $\Gamma_i = -\left(I - \sum_{j=1}^{i} \Pi_j\right)$,

for $i = 1, \ldots, k-1$.

X_t is a vector of p variables (or $p = 4$ for this study), μ are the intercepts, t are deterministic trends and ε_t is a vector of Gaussian random variables. The coefficient matrix $\prod$, also referred to as the long-run impact matrix, contains information about the stationarity of the four variables and the long-run relationship amongst them. The rank (r) of the matrix determines the number of cointegrating vectors in the system. In the absence of cointegration, $\prod$ is a singular matrix (its rank, $r = 0$). Hence, in a cointegrated case, the rank of $\prod$ could be anywhere between zero and four. If = 1, there is a single cointegrating vector, whereas for $1 < r < 4$, there are multiple cointegrating vectors. This is an indication that the variables in the system are cointegrated in the long run with r cointegrating vectors. In other words, these variables possess a long-run equilibrium relationship, and are moving together in the long run. The $\prod$ matrix can be factored as, $\prod = \alpha\beta^T$, where the α matrix contains the adjustment coefficients and the matrix contains the cointegrating vectors. (Johansen and Juselius 1990) approach uses two likelihood ratio statistics, the trace and the maximum eigenvalue statistics, to test for the possible number of cointegrating vectors in the system. Critical values for these statistics are tabulated in Osterwald-Lenum (1992). The optimal lag structure of the system is determined by using the Likelihood ratio test.

Vector Error-Correction Model (VECM)

If cointegration is detected amongst the variables, then the short-run Granger-causality analysis on these variables must be conducted in a vector error-correction model (VECM) to avoid problem of misspecification (see Granger 1988).[2] Otherwise, the analysis may be conducted as a standard vector autoregressive (VAR) model.[3] The direction of Granger-causal effect running from one variable to another can be detected using the vector error-correction model (VECM) derived from the long-run cointegrating vectors. The VECM model employed for the testing of Granger-causality across various variables in the system can be represented by:

$$X_t = \begin{pmatrix} \Delta RO_t \\ \Delta LP_t \\ \Delta EM_t \\ \Delta W_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{pmatrix} + \begin{pmatrix} \beta_{11}(L) & \beta_{12}(L) & \cdots & \beta_{14}(L) \\ \beta_{21}(L) & \beta_{22}(L) & \cdots & \beta_{24}(L) \\ \vdots & & & \\ \beta_{41}(L) & \beta_{42}(L) & \cdots & \beta_{44}(L) \end{pmatrix} \begin{pmatrix} \Delta RO_t \\ \Delta LP_t \\ \Delta EM_t \\ \Delta W_t \end{pmatrix} + \begin{pmatrix} \gamma_1 z_{1,t-1} \\ \gamma_2 z_{2,t-1} \\ \vdots \\ \gamma_4 z_{4,t-1} \end{pmatrix}$$

$$+ \begin{pmatrix} \Phi(L) & 0 & \cdots & & 0 \\ 0 & \Phi(L) & 0 & \cdots & 0 \\ \vdots & & & & \\ 0 & \cdots & 0 & & \Phi(L) \end{pmatrix} \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \vdots \\ \varepsilon_{4,t} \end{pmatrix} \qquad (3)$$

where X_t is an (4 x 1) vector of the variables in the system, α's represent a vector of constant terms, β's are estimable parameters, Δ is a difference operator, L is a lag operator, $\beta(L)$ and $\Phi(L)$ are finite polynomials in the lag operator, z_{t-1}'s are error-correction terms, and ε_t's are disturbances.

The Granger causality test is applied by calculating the F-statistic based on the null

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1 A variable that is found to be stationary at level, or is I(0), is treated as an exogenous variable in the system.

2 If the variables in a system are cointegrated, then the short-run analysis of the system should incorporate the error-correction term (ECT) to model the adjustment for the deviation from its long-run equilibrium.

3 When an ECT is added to the vector autoregressive model (VAR), the modified model is referred to as the vector error-correction model (VECM). VECM is thus a special case of VAR.

hypothesis that the set of coefficient for the lagged values of independent variables are not statistically different from zero. If the null hypothesis is not rejected, then it can be concluded that the independent variable does not cause the dependent variable. For instance, if the F-statistic of the real wages (W as an independent variable in the equation) is significant at a 5% level (i.e. H_0: $\beta_i(L) = 0$, for i refers to W, is rejected at a 5% significance level), and the employment (EM) is the dependent variable of the equation, then we can say that there is a short-run causal effect running from W to employment. Besides the detection of the short-run causal effects, the VECM also allows us to examine the effective adjustment towards equilibrium in the long run through the significance or otherwise of the *t*-test of the lagged error-correction terms (ECT) of the equation.

ESTIMATED RESULTS AND INTEPRETATIONS

Unit Root and Cointegration Tests

Table 2 presents the result of the ADF and Phillip-Perron (P-P) unit root tests of real output, labour productivity, employment and real wages. The results support the presence of a unit root at the level of all variables and the absence of any unit root after first differencing; in other words, all variables are I(1). This reveals that all variables are nonstationary in the levels, but stationary in the first differences.

The Johansen cointegration test is performed to a system of four I(1) variables for the E&E sub-sector and the estimated results are reported in Table 3. The results reveal that there is one cointegrating vector in the system.

This indicates that there a long-run equilibrium relationship exists in the four variables, namely real output, labour productivity, real wages and employment.

It is assumed that there is no deterministic trend in data, no intercept and trend in the cointegrating equation. Outputs of the Johansen's test suggest that one cointegrating vector exists based upon the λ_{max} and trace statistics at 1 % level (Panel I). Both of the tests suggest rejection of zero cointegrating vector in favour of one. The cointegrating equation was estimated with a provision for three lags and no serious serial correlation or normality problem was found with the inclusion of this number of lags (Panel III). The estimated cointegrating vector has theoretically plausible coefficients. The long run relationship may be written as:

$$LRO_t = 3.11*LLP_t + 1.85*LEM_t - 1.717*LWAGE_t$$

The equation indicates that higher labour productivity and employment yield positive influence on the real output of the industry in the long run with estimated elasticities of 3.11 and 1.85 respectively. On the contrary, real wage increase seems to cause a decrease in the E&E industry real output with estimated elasticity of

TABLE 2
Results of the unit root tests

	Augmented Dickey Fuller Test		P-P Test	
	Constant with Trend	Constant without Trend	Constant with Trend	Constant without Trend
		Level		
RO	-2.7138(1)	-0.8549(1)	-2.5292(2)	-1.2715(2)
LP	-1.0618(0)	0.8572(1)	-0.6678(2)	1.6605(2)
EM	-1.4506(0)	-0.8852(0)	-2.0031(2)	-0.8645(2)
W	-3.3737(0)	-1.2608(0)	-3.4764(1)	-1.3725(1)
		First Difference		
RO	-5.9108(1)**	-6.0524(1)**	-3.7785(2)*	-4.0262(2)**
LP	-5.1127(0)**	-4.3324(1)**	-6.0199(2)**	-4.9233(2)**
EM	-3.0697(0)	-3.0725(0)*	-3.2019(2)	-3.1561(2)*
W	-6.1585(0)**	-6.3436(0)**	-6.3505(2)**	-6.5678(2)**

Notes: RO = real output; LP = labor productivity; EM = employment; W = Real wages. The asterisk * and ** indicates the level of significance at a 5 % and 1 % level respectively. The number in each parenthesis indicates the optimal lag length used in the regression, which is determined by the Akaike information criterion (AIC), to ensure the whiteness of the residual.

TABLE 3
Results of Johansen and Juselius multivariate procedure, VAR with 3 lags
sample period: 1973-1997 (25 observations)

I. Eigenvalue

0.942627	0.587569	0.281412	0.0019842

Hypothesis Ho:rank=p	Maximum Eigenvalue -Tlog(1-\mu)	using T-nm	95%	Trace -T\Sum log(.)	using T-nm	95%
p == 0	62.88**	40.01**	27.1	89.68**	57.07**	47.2
p <= 1	19.49	12.4	21.0	26.8	17.05	29.7
p <= 2	7.27	4.627	14.1	7.314	4.654	15.4
p <= 3	0.0437	0.02781	3.8	0.0437	0.02781	3.8

II. Estimated Cointegrating Vector

LRO	LLP	LEM	LW
1.0000	-3.1105	-1.8496	1.7167

III. Test for Appropriate Lag Length (3)

	LRO	LLP	LEM	LW
i)	Serial Correlation			
	$\chi^2(1)$ 2.0147 [0.1558]	0.25286 [0.6151]	8.656 [0.0342]*	0.0827 [0.7736]
	F(1, 12) 1.2097 [0.2930]	0.13953 [0.7153]	0.1976 [0.6645]	0.0453 [0.8350]
ii)	Normality: $\chi^2(2)$			
	5.5816 [0.0614]	0.96614 [0.6169]	5.2299 [0.0732]	0.5446 [0.7617]
iii)	Vector AR 1-1 F(16, 18)	= 2.0802 [0.1870]		
iii)	Vector normality χ^2 (8)	= 11.826 [0.1591]		

Note:
** indicates significance at 1% level.
* indicates significance at 5% level.
Figures in square parentheses [] refer to marginal significance level.

TABLE 4
Causality results based on vector error correction model for electrical and electronic sub-sector (lag 3)

	Estimated F-Statistic (joint Wald test) D(LRO)	D(LLP)	D(LEM)	D(W)	ECT Coefficient / (t-Statistic)
D(LRO)	-	2.689***	0.9398	4.348***	-0.8302 / (-2.15)**
D(LLP)	2.030*	-	2.593**	2.194**	-0.894 / (-14.34)***
D(LEM)	2.880**	2.456**	-	1.1109	-0.0306 / (-1.1867)
D(LW)	2.014*	0.882	1.6238	-	-0.545 / (-3.101)**

Note: * , ** and *** denote statistically significant at 10%, 5% and 1% respectively.

-1.717.

The Short Run Dynamic Relationship

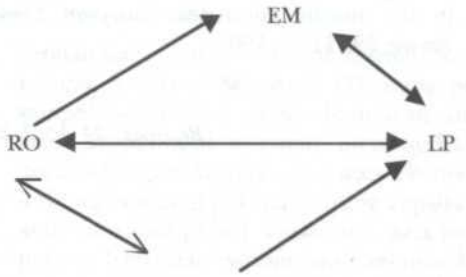
The short run interaction among the four variables are estimated using the vector error correction model. The results of the VECM are reported in Table 4. Following the Johansen multivariate cointegration test, one error-correction term is incorporated in the VECM. The error correction coefficients are significant in three of the equations i.e. that of real output, labour productivity and real wage suggesting that real output, labour productivity and real wage are adjusted to divergence from long-run equilibrium steady state.

The results in Table 4 imply that RO, LP and W are endogenous while EM is weakly exogenous. The estimated results also reveal that there is a unidirectional causal effect running from labour productivity and employment to real output. Both labour productivity and real wage significantly cause real output at 1% level of significance. We could also see a unidirectional causal effect from real wage to labour productivity

and from real output to employment. Bi-directional causal effect seems to prevail between employment and labour productivity.

The summary of the short run dynamic relationship between the variables may be illustrated using the following diagram:

Results of diagnostic tests (Table 5) indicate that the estimated short run dynamic models are quite robust as they generally pass all the tests of LM for auto-correlation, J-B for normality, and the Ramsey general specification test for specification (except for the LLP which is significant barely at 5%).



CONCLUSION AND IMPLICATIONS

Global development and the domestic developments in the Malaysian manufacturing scenario which is basically highly dependent on E&E sub-sector provides justification for a thorough understanding of the short run and long relationship between real output, labour productivity, employment and wage in the sub-sector. As is widely known, manufacturing as a whole sector is positioned as the main engine of growth for the nation's development and has been experiencing fundamental changes in technology and liberalization of competition. Among all industries, the E & E sub-sector has absorbed the highest number of employment. Therefore, changes in wage rate in order to influence productivity growth may amplify fluctuations in employment rate. This study attempted to investigate the linkages between these variables over the 1973 - 1997 period in order to provide a historical perspective on this issue using the VAR model.

TABLE 5
Diagnostic checking for the VECM

Test	LM(4)	ARCH(4)	J-B	RESET(1)
LRO	0.528	0.082	1.77	2.62
LLP	0.332	0.239	0.571	4.897*
LEM	0.832	0.169	0.815	0.08
LW	0.750	0.155	3.304	1.35

Note: *and ** denote statistically significant at 5% and 1% respectively.

The estimated results indicate that there is a long run equilibrium relationship among real output, labour productivity, employment and real wages of the E&E sub-sector. The short-run dynamic interaction shows that productivity and real wage are quite significant factors affecting the output. In the meanwhile, changes in productivity are associated with changes in real wage, employment and real output. Real output and labour productivity are also responsible for changes in employment and finally, real output does indeed affect real wage.

An important implication from this study is that productivity can indeed play an important role in the real output of the E&E sub-sector in the long run as well as short run. Our long run model reveals that availability of more labour is associated with an increase in output while a real wage increase can adversely affect the real output. Thus, it is imperative that policy makers intensify efforts to improve the level of productivity in the sub-sector, and at the same time ensure that the increase in level of real wage reflects the productivity of labour.

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(Received: 24 April 2002)