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## ABSTRACT

This study is to empirically investigate the effect of real wages on labour productivity in Malaysia's manufacturing sector using annual data from 1980 to 2009. The Johansen's test suggests that real wages and labour productivity are cointegrated. Moreover, productivity and real wages have a quadratic relationship (i.e. inverted-U shaped curve) instead of linear relationship. Hence, the effect of real wages on labour productivity is not monotonic. Furthermore, the Granger causality test indicates that real wages and labour productivity is bilateral causality in nature.

*JEL Classification Codes*: C22; J24; J30
*Keywords*: Causality; Cointegration; Malaysia; Wages-Productivity

## 1. INTRODUCTION

Empirical testing of the linkages between real wages and labour productivity has long been debated in the social sciences literature. Many empirical works have been conducted to examine the relationship between real wages and labour productivity in the developed and developing economies (e.g. Wakeford, 2004; Montuenga-Gómez et al., 2007; Narayan and Smyth, 2009). They found that real wages and labour productivity are closely connected, but the direction of causality for these variables remains ambiguous. Two theories have rooted the causal relationship between real wages and labour productivity. First, the *marginal productivity theory* postulated that employers are usually practice the performance-based wages and profit-optimisation strategy. They will recruit labour force up to a level where the marginal productivity of labour equal to the marginal cost (i.e. real wages). Hence, they believe that raising labour productivity will lead to higher wages rather than reversal. Second, the *efficiency wages theory* argued that employers pay more to employees will motivate the employees to increase their productivity (Akerlof, 1982; Akerlof and Yellen, 1986). There are several reasons of why labour productivity or effort may depend on wages. In the *shirking model* of Shapiro and Stiglitz (1984) if employees receive a higher wage, the cost of losing their job becomes higher, and this acts as an incentive for employees not to shirk and risk being fired. Hence, labour productivity increase. The *gift-exchange model* of Akerlof (1982, 1984) stated that a higher wages is seen by employees as a gift from the employer, and employees will return this gift in the form of higher effort (more productive). In addition, the *fair wage-effort model* of Akerlof and Yellen (1990) documented that if employees were paid a wage below what they perceived as fair, they would not apply as much effort as when they got a "fair" wage. Therefore, the efficiency wages theory suggests that real wages induce labour productivity rather than reversal. Understanding of the causal relationship between real wages and labour productivity is utmost important for decision-makers to enhance labour productivity, maintaining international competitiveness, and long-term economic growth. For example, if the finding is in favour of wages Granger-causes labour productivity; hence increase of wages may enhance labour productivity and eventually generate economic growth. Otherwise, policy to increase wages may affect international competitiveness and ultimately deteriorate economic growth and development.

As far as Malaysia is concerned, empirical analysis of the relationship between real wages and labour productivity is relatively scarce. To the best of our knowledge, only Ho and Yap (2001), and Yusof (2008) examined the relationship between real wages and labour productivity in Malaysia using the cointegration test. Both of them found that real wages and labour productivity are cointegrated and they have a positively relationship in the long run. Ironically, there are several shortcomings correspond to these studies. First, the earlier studies in Malaysia assumed a monotonic linear positive relationship between real wages and labour productivity (e.g. Ho and Yap, 2001; Yusof, 2008). Nevertheless, the time allocation and the trade-off theories (Becker, 1965; Williams, 1970) clearly noted that the effect of real wages on labour productivity is non-monotonic (i.e. inverted U-shaped relationship). Initially, increases of wages will lead employees to be more productive because increase of wages make leisure more expensive and thus they willing to substitute working for leisure time (i.e. substitution effect outweigh income effect). While, after a turning point where the given wages is sufficiently high, further increase of wages will decrease labour productivity because employees become richer and they can afford more leisure with the present income (i.e. income effect outweigh substitution effect). Coherently, Hondroyiannis and Papapetrou (1997) and Gneezy and Rustichini (2000) also found that the relationship between real wages and labour productivity is not monotonic and offering higher wages did not always motivate labour productivity (see also Brown et al., 1976). Hence, the presumption of linear relationship between real wages and labour productivity may be biased. Second, without using formal causality tests the earlier studies for Malaysia assumed that the causal relationship is unilateral, running from labour productivity to real wages. For this reason, the studies only focused on the determinants of wages, rather than the effect of wages on labour productivity in Malaysia. However, it is also plausible to have reverse causation from wages to labour productivity as noted by the efficiency wage theory. Third, the existing studies do not considered the implication of structural break(s) in the unit root tests. Perron (1989) noted that if the series contain structural break(s), the power of conventional unit root tests decreases drastically and may lead to spurious rejection of null hypothesis of a unit root when the structural break(s) is neglected. Therefore, the estimation results of the earlier studies for Malaysia should be accepted with caution.

Motivated by the above lacuna, this study attempts to re-investigate the effect of real wages on labour productivity in Malaysia's manufacturing sector over the period of 1980 to 2009. The analysis of this study can be divided into three parts. First, we apply the conventional Augmented Dickey-Fuller (ADF) in association with the Zivot and Andrews (1992) and Lumsdaine and Papell unit root tests with one and two structural break(s) to ascertain the order of integration for each variable. Second, we implement the Johansen's cointegration test to detect the presence of long-run equilibrium relationship. Finally, we perform the Granger causality test to ascertain the causal relationship between real wages and labour productivity.

The rest of this paper is set out as follows. Data and methodology will be briefly explains in Section 2. Section 3 discusses the empirical findings and the concluding remarks will be reported in Section 4.

## 2. DATA, MODEL, AND METHODOLOGY

### *2.1 Data and model*

This study uses secondary data, consisting of the yearly data for real wages (proxied by real wages per worker paid for manufacturing sector) and labour productivity (proxied by real value added per worker). The consumer price index (CPI, 2000 = 100) is uses to adjust the inflationary effect for each variable. This study covers the annual sample period from 1980 to 2009. All data of this study are collected from *Annual Survey of Manufacturing Industries* published by the Malaysian Department of Statistics and the CEIC data.

Based on the time allocation and the trade-off theories (Becker, 1965; Williams, 1970), the relationship between real wages and labour productivity is non-linear; hence we estimate the following double-log model.

$$prod_t = \beta_0 + \beta_1 w_t + \beta_2 w_t^2 + \varepsilon_t \qquad (1)$$

Here, $prod_t$ is the labour productivity; $w_t$ is the real wages; and $w_t^2$ is the square of real wages, where following convention, lower case denotes natural logarithm. $\beta_1$ and $\beta_2$ are the coefficients of labour productivity with respect to real wages and squared of real wages. According to the time allocation and the trade-off theories, the sign of $\beta_1$ is expected be positive, while the sign of $\beta_2$ is expected to be negative. Under these conditions, the turning point is $-(\beta_1/2\beta_2)$. In this case, as real wages increases beyond this turning point, further increase of real wages does not encourage labour productivity because the income effect outweighs the substitution effect.

### *2.2 Econometric techniques*

In this sub-section, we briefly discuss the econometric techniques use to achieve the objective of this study. We start our analysis by investigating the presence of long-run equilibrium relationship using the Johansen's cointegration test. To perform the Johansen cointegration test, we estimate the following vector error-correction model (VECM):

$$\Delta z_t = \Pi z_{t-1} + \Gamma_1 \Delta z_{t-1} + \cdots + \Gamma_{k-1} \Delta z_{t-k+1} + e_t \qquad (2)$$

where, $\Delta$ is the first difference operator, $(z_t - z_{t-1})$. $z_t$ is a vector of three endogenous variables of interest $[prod_t,\ w_t,\ w_t^2]$. The errors term $e_t$ are assumed to be normally distributed and white noise and *k* is the lag structure in the VECM. The $(3\times 3)$ $\Pi$ matrix contains information of the long-run equilibrium relationships between the variables. In addition, we can decompose $\Pi = \alpha\beta'$, where $\alpha$ denotes the speed of adjustment to disequilibrium, while $\beta$ is the cointegrating vector. To test for the presence of long-run equilibrium relationship, we employ the likelihood ratio tests suggested by Johansen (1988). These tests are trace test, $LR(\lambda_{\text{trace}}) = -T\sum_{i=r+1}^{k} \ln(1-\lambda_i)$ and maximum eigenvalues test, $LR(\lambda_{\max}) = -T\ln(1-\lambda_{i+1})$, where *T* is the number of observations and $\lambda_i$ are the eigenvalues $(\lambda_1 > \lambda_2 \ldots > \lambda_k)$.

If the variables are found to be cointegrated, we estimate the following decomposed error-correction models:

$$\Delta prod_t = a_1 + \delta_{11} ect_{t-1} + \sum_{j=1}^{p-1} \lambda_{1j} \Delta prod_{t-j} + \sum_{j=1}^{p-1} \phi_{1j} \Delta w_{t-j} + \sum_{j=1}^{p-1} \varphi_{1j} \Delta w_{t-j}^2 + \varepsilon_t \quad (3)$$

$$\Delta w_t = a_2 + \delta_{21} ect_{t-1} + \sum_{j=1}^{p-1} \lambda_{2j} \Delta prod_{t-j} + \sum_{j=1}^{p-1} \phi_{2j} \Delta w_{t-j} + \sum_{j=1}^{p-1} \varphi_{2j} \Delta w_{t-j}^2 + \varepsilon_{2t} \quad (4)$$

$$\Delta w_t^2 = a_3 + \delta_{31} ect_{t-1} + \sum_{j=1}^{p-1} \lambda_{3j} \Delta prod_{t-j} + \sum_{j=1}^{p-1} \phi_{3j} \Delta w_{t-j} + \sum_{j=1}^{p-1} \varphi_{3j} \Delta w_{t-j}^2 + \varepsilon_{3t} \quad (5)$$

where $ect_{t-1}$ is the one period lagged error-correction term derive from the normalised cointegrating vector. These equations allow us to measure the short- and long-run causality. The significance of $ect_{t-1}$ represent the long-run causality, while the significance of the first difference lagged explanatory variables indicates the short-run causality. From equation (3), we can test $\Delta w_t$ and $\Delta w_t^2$ do not Granger-cause $\Delta prod_t$ in the short run by testing the null hypothesis of $H_0 : \phi_{1j} = \varphi_{1j} = 0$ using the standard Wald test. Rejection of this hypothesis implies that real wages induce labour productivity to change in the short run. While, we can also test the null that $\Delta prod_t$ does not Granger-causes $\Delta w_t$ and $\Delta w_t^2$ by estimating equations (4) and (5), and apply the Wald test on the null hypothesis of $H_0 : \lambda_{2j} = \lambda_{3j} = 0$. Similarly, rejection of this hypothesis implies that labour productivity Granger-causes real wages. Turning to the long-run Granger causality, real wages Granger-causes labour productivity if $\delta_{11} \neq 0$, while labour productivity Granger-cause real wages if $\delta_{21} \neq \delta_{31} \neq 0$.

## 3. EMPIRICAL RESULTS

Table 1: The results of unit root tests

| Unit root test without break | | Unit root tests with one and two structural breaks | | | |
|---|---|---|---|---|---|
| Augmented Dickey-Fuller | | Zivot-Andrews (ZA) – Model C | | Lumsdaine-Papell (LP) – Model CC | |
| Variables | Test statistics | Break year | Test statistics | Break year | Test statistics |
| *Levels*: | | | | | |
| $prod_t$ | –2.247 (0) | 2003 | –3.584 (0) | 1996; 2003 | –4.545 (1) |
| $w_t$ | –3.109 (1) | 1995 | –4.587 (1) | 1988; 1996 | –3.537 (1) |
| $w_t^2$ | –3.008 (1) | 1995 | –4.511 (1) | 1988; 1996 | –3.528 (1) |
| *First differences*: | | | | | |
| $\Delta prod_t$ | –5.726 (0)*** | | | | |
| $\Delta w_t$ | –4.161 (0)** | | | | |
| $\Delta w_t^2$ | –4.151 (0)** | | | | |

Note: The asterisk ** and *** denote significance at the 1 and 5 per cent levels, respectively. The figure in parenthesis ( ) represents the optimal lag order selected by the Akaike's Information Criterion (AIC).

Before we start to examine the relationship between real wages and labour productivity in the manufacturing sector of Malaysia, it is best for us to identify the order of integration for each variable to avoid spurious regression problem. We check the time series properties through three unit root tests. These tests are ADF, ZA, and LP unit root tests. The results of unit root tests are reported in Table 1. The ADF test suggests that all variables are non-stationary at level, but they are stationary after first differencing. Similarly, both ZA and LP unit root tests with one and two structural breaks cannot reject the null hypothesis of a unit root at level.[1] Therefore, the three unit root tests consistently indicate that the variables are integration of order one, $I(1)$. This finding is coherent with the notion that most of the macroeconomic series are non-stationary at level, but they are stationary after first differencing (Nelson and Plosser, 1982). Given that the order of integration for $prod_t$, $w_t$ and $w_t^2$ are uniformly $I(1)$, we can proceed to implement the Johansen's cointegration test and the results are reported in Table 2.

Table 2: The results of Johansen cointegration test

| Panel A: Multivariate Johansen cointegration test | | | | |
|---|---|---|---|---|
| Series: $prod_t$, $w_t$, $w_t^2$ | | LR tests statistics | Critical values[#] | |
| Hypotheses | | | | |
| $H_0$ | $H_1$ | | 5 per cent | 10 per cent |
| $LR(\lambda_{\text{trace}})$ | | | | |
| $r = 0$ | $r \geq 1$ | 53.906** | 31.5854 | 28.5131 |
| $r \leq 1$ | $r \geq 2$ | 6.494 | 16.3993 | 14.1873 |
| $r \leq 2$ | $r \geq 3$ | 0.021 | 4.0014 | 2.8630 |
| $LR(\lambda_{\max})$ | | | | |
| $r = 0$ | $r = 1$ | 47.412** | 22.3349 | 19.7849 |
| $r \leq 1$ | $r = 2$ | 6.473 | 15.5021 | 13.2761 |
| $r \leq 2$ | $r = 3$ | 0.021 | 4.1427 | 2.9588 |

| Panel B: Normalised cointegrating vector | | | |
|---|---|---|---|
| $prod_t$ | $w_t$ | $w_t^2$ | *constant* |
| 1.000 | 267.372*** | –13.839*** | –1279.518 |

Note: *** and ** denotes the significant level at the 1 and 5 per cent levels, respectively. # represent that the critical values were computed with the response surface procedure suggested by Cheung and Lai (1993). The Akaike's Information Criterion (AIC) was used to select the optimal lag order.

In Panel A of Table 2, the results suggest that both likelihood ratio tests (i.e. trace and maximum eigenvalues) reject the null hypothesis of no cointegrating vector at the 5 per cent significance level. However, the test statistics cannot reject the null hypothesis of one

[1] Basically, there are three models for unit root tests with structural break. Interested readers may refer to Zivot and Andrews (1992) and Lumsdaine and Papell (1997) for more details. However, we employ Model C and Model CC, which allows for one and two structural breaks in the intercept and slope, respectively because they perform better than other models (see Sen, 2003).

cointegrating vector at the same level of significance. Therefore, we surmise that there is one cointegrating rank among the variables under investigation.[2] Since the variables are cointegrated and the interest of this study is to investigate the effect of real wages on labour productivity in Malaysia, the cointegrating vector is normalised by its labour productivity. Panel B of Table 2 presents the normalised cointegrating vector. Consistent with the time allocation and the trade-off theories, $prod_t$ is positively related to $w_t$, but negatively related to $w_t^2$. The long-run coefficients of labour productivity with respect to real wages is found to be $267.37 - 13.84w_t$. Moreover, both coefficients are statistically significant at the 1 per cent level. This result provides some support for the inverted-U shaped relationship between real wages and labour productivity in Malaysia that is labour productivity first increases with real wages and declines thereafter. Therefore, our empirical results affirm that the effect of real wages on labour productivity in the manufacturing sector of Malaysia is not monotonic. Furthermore, the turning point of average real wages is RM15,679.2 per annum (i.e. around RM1,306.6 per month), meaning that for those who received real wages beyond this point, further increase of real wages is insufficient or inappropriate to motivate labour productivity. Therefore, alternative rewards should be complemented in order to promote labour productivity in Malaysia's manufacturing sector.

Table 3: The results of Granger causality test based on VECM

| Null hypotheses | $\chi^2$ - statistics | |
|---|---|---|
| | Short-run Granger non-causality test | Long-run weak exogeneity test |
| $\Delta w_t, \Delta w_t^2 \nrightarrow \Delta prod_t$ | 31.206*** | 3.970** |
| $\Delta prod_t \nrightarrow \Delta w_t, \Delta w_t^2$ | 133.030*** | 50.838*** |

Note: The asterisk *** represents the significant level at the 1 percent.

Next, we conduct the Granger causality test within the error-correction framework to verify the short- and the long-run causal relationship between real wages and labour productivity. Table 3 reports the Granger causality results. Contrary with the earlier studies, our empirical evidence suggest that real wages and labour productivity are Granger-cause each other (i.e. bilateral causality) in both the short-run and the long-run. Therefore, the marginal productivity theory and also the wages efficiency theory are vindicated in Malaysia. These results are harmonised with the findings of Alexander (1993), Millea and Fuess (2002), and Millea (2005) that real wages and labour productivity is bilateral causality in nature.

## 4. CONCLUDING REMARKS

This study attempts to examine the effect of real wages on labour productivity in Malaysia using the cointegration and Granger causality frameworks. Our empirical results

[2] Additionally, this study also performed the residuals-based cointegration test with structural breaks developed by Gregory and Hansen (1996) to confirm the cointegration result. Interestingly, we find that the variables are cointegrated, thus the Johansen's cointegration test results are robust. However, the cointegration test results for structural breaks are not reported here, but it can be obtained upon request.

reveal that real wages and labour productivity shared a common trend and thus they are cointegrated. As a value added to the earlier studies, our empirical results indicate that labour productivity and real wages have a quadratic relationship and hence the effect of real wages on labour productivity in Malaysia's manufacturing sector is non-monotonic. Furthermore, we also performed the Granger causality test within the VECM framework to examine the short- and the long-run causality between real wages and labour productivity. The Granger causality test reveals bilateral causality between real wages and labour productivity in both the short- and the long-run. Hence, real wages and labour productivity is interrelated in Malaysia.

With these findings, we could summarise that although real wages and labour productivity are interrelated, increase of real wages may not monotonically increase labour productivity in particular for high wages labour force. Therefore, decision-makers should adopt the dual strategy by offering more lucrative wages to encourage labour productivity, and also increase investment on education and training, and offer incentives for greater research and development (R&D) activities to enhance labour's skills and productivity for them to attain higher wages. In doing so, we may develop a group of international competitive and knowledgeable labour force for generating long-term productivity growth in Malaysia. In addition, Malaysian government should also set up minimum wages policy and other benefits such as medical insurance to enable the low and middle classes wages labour forces to cope with the rising cost of living in Malaysia. Ultimately, it may also help to enhance labour productivity.

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