A note on the nonlinear wages-productivity nexus for Malaysia

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ABSTRACT

This study is to empirically investigate the effect of real wages on productivity in Malaysia using monthly data from January 1983 to November 2009. The Johansen's test suggests that wages and productivity are cointegrated. Moreover, productivity and real wages have a quadratic relationship in the long run (i.e., inverse-U shape curve) instead of linear relationship. Hence, the effect of real wages on productivity is not monotonic. Furthermore, the Granger causality test indicates that real wages and productivity is bilateral causality in nature.

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

1. INTRODUCTION

The connection between real wages and productivity has long been debated in the social sciences literature. Ample of empirical works have been conducted to examine the relationship between real wages and productivity in the developed and also developing economies (e.g., Wakeford, 2004; Montuenga-Gómez et al., 2007; Narayan and Smyth, 2009). They found that real wages and productivity is closed connected, but the causality direction for these variables remains ambiguous. Two theories have rooted the causal relationship between real wages and productivity. First, the *marginal productivity theory* stated 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 marginal cost (i.e., real wages). Hence, they believe that raising productivity will lead to higher wages. Second, the *efficiency wages theory* argued that employer pay more to employee will motivate the employee to increase their productivity (Akerlof, 1982; Akerlof and Yellen, 1986). Contrary to the earlier argument, the efficiency wages theory suggests that wages induce productivity to change. Understanding of the causal relationship between wages and productivity is utmost important for decision-makers to formulate effective growth strategies. For example, if the finding is in favour of wages Granger-causes productivity, hence increase of wages will enhance productivity and eventually generate economic growth.

As far as Malaysia is concerned, empirical analysis of the relationship between wages and productivity is relatively scarce. To the best of our knowledge, only Ho and Yap (2001), and Yusof (2008) examined the long run relationship between wages and productivity in Malaysia using the cointegration test. Both of them found that wages and 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 wages and productivity (Ho and Yap, 2001; Yusof, 2008). Nevertheless, economic theories noted that the initial increase of wages will lead employee to be more productive (i.e., substitution effect outweigh income effect) because increase of wages make leisure more expensive, while further increase of wages will decrease productivity because employee become richer and enable them to afford more leisure (i.e., income effect outweigh substitution effect). Moreover, Gneezy and Rustichini (2000) also found that the relationship between wages and productivity is not monotonic and offering higher wages did not always motivate productivity. Second, the earlier studies also assumed that the causal relationship is unilateral, running from productivity to wages. For this reason, the Malaysian studies only focused on the determinants of wages, rather than the effect of wages on productivity. However, it is also plausible to have reverse causation from wages to productivity as noted by Akerlof (1982) and Akerlof and Yellen (1986). 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 contained structural break(s), the power of conventional unit root test decreases drastically and may lead to spurious rejection of null hypothesis of a unit root when the structural break(s) is neglected.

Motivated by the above limitations, this study attempts to investigate the effect of real wages on productivity in Malaysia over the period of 1983 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 Lagrange Multiplier (LM) unit root tests (Lee and Strazicich, 2003; 2004) 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 productivity in Malaysia.

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. MODEL, DATA AND METHODOLOGY

2.1 Model and data

Based on the above discussion real wages and productivity have a quadratic relationship, hence we estimate the following double-log model.

$$\ln PROD_t = \beta_0 + \beta_1 \ln W_t + \beta_2 \ln W_t^2 + \varepsilon_t \quad (1)$$

Where, ln denotes the natural logarithm; $\ln PROD_t$ represents productivity; $\ln W_t$ is the real wages; and $\ln W_t^2$ is the square of real wages. β_1 and β_2 are the long-run coefficients of productivity with respect to real wages and squared of real wages. The sign of β_1 is expected be positive, while the sign of β_2 is expected to be negative. If β_2 is statistical significance implies that the effect of real wages on productivity is not monotonic.

This study covered the monthly data from January 1983 to November 2009 that can be obtained from DataStream 4.0. The data used in this study include real wages and productivity (proxy by real Industrial Production Index, IPI, 2000=100).[1] The inflationary effect was adjusted by using Consumer Price Index (CPI, 2000=100). The advantages of using higher frequency data is that it will enhance the statistical power and also avoid the size distortion problem (Zhou, 2001).

2.2 Econometric techniques

In this sub-section, we briefly discuss the econometric techniques use to achieve the two main objective of this study. The first objective is to investigate the effect of wages on productivity in the long run. The second objective is to verify the causal relationship between the variables of interest. Here, 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):

$$\Delta Z_t = \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_{k-1} \Delta Z_{t-k+1} + e_t \tag{2}$$

where, Δ is the first difference operator, $\left(Z_t - Z_{t-1}\right)$. Z_t is a vector of four endogenous variables of interest $\left[\ln PROD_t,\ \ln W_t,\ \ln W_t^2\right]$. The errors term e_t are assumed to be normally distributed and white noise and *k* is the lag structure in the VECM. The $\left(3\times 3\right)$ Π matrix contains information of the long-run equilibrium relationships between the variables. In addition, we can decompose $\Pi = \alpha\beta'$, where α denotes the speed of adjustment to disequilibrium, while β is the cointegrating vector.

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

$$\Delta \ln PROD_t = a_1 + \delta_{11} ECT_{t-1} + \sum_{j=1}^{p-1} \lambda_{1j} \Delta \ln PROD_{t-j} + \sum_{j=1}^{p-1} \phi_{1j} \Delta \ln W_{t-j} + \sum_{j=1}^{p-1} \varphi_{1j} \Delta \ln W_{t-j}^2 + \varepsilon_t \tag{3}$$

[1] The output to labour force ratio is the common measures for productivity. However, this study used IPI owing to unavailability of high frequency data (i.e., monthly) for labour force. We performed a simple correlation test on annual IPI and output to labour force ratio to verify the appropriateness of using IPI as a proxy for productivity. Interestingly, the result suggests that the variables are highly correlated (97.7 percent). Therefore, IPI is a suitable proxy for productivity.

$$\Delta \ln W_t = a_2 + \delta_{21} ECT_{t-1} + \sum_{j=1}^{p-1} \lambda_{2j} \Delta \ln PROD_{t-j} + \sum_{j=1}^{p-1} \phi_{2j} \Delta \ln W_{t-j} + \sum_{j=1}^{p-1} \varphi_{2j} \Delta \ln W_{t-j}^2 + \varepsilon_{2t} \quad (4)$$

$$\Delta \ln W_t^2 = a_3 + \delta_{31} ECT_{t-1} + \sum_{j=1}^{p-1} \lambda_{3j} \Delta \ln PROD_{t-j} + \sum_{j=1}^{p-1} \phi_{3j} \Delta \ln W_{t-j} + \sum_{j=1}^{p-1} \varphi_{3j} \Delta \ln W_{t-j}^2 + \varepsilon_{3t} \quad (5)$$

where ECT_{t-1} is the one period lagged error-correction term derived from normalised cointegrating vector. These equations allowed 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 $\Delta \ln W_t$ and $\Delta \ln W_t^2$ do not Granger-cause $\Delta \ln PROD_t$ 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 implied that wages induce productivity to change. While, to test productivity does not Granger cause wages, we estimate equations (4) and (5), and apply the Wald test (i.e., weak exogeneity test) on the hypothesis of $H_0 : \lambda_{2j} = \lambda_{3j} = 0$. Similarly, productivity Granger-causes wages if the null hypothesis is rejected. Turning to the long run causality, wages Granger-cause productivity if $\delta_{11} \neq 0$, while productivity Granger-cause wages if $\delta_{21} \neq \delta_{31} \neq 0$.

3. EMPIRICAL RESULTS

Before we start to examine the long-run equilibrium and the causal relationships, it is best for us to identify the order of integration for each variable. Interestingly, at the 1 percent significance level, ADF and also LM unit root tests consistently indicate that the estimated variables are integration of order one, *I*(1) process.[2] This finding is consistent with the notion that most of the macroeconomic series are non-stationary at level, but it is stationary after first differencing (Nelson and Plosser, 1982). Given that the order of integration is uniformly *I*(1), we can proceed to implement the Johansen's cointegration test for the long-run relationship and the results are reported in Table 1.

In Panel A of Table 1, the results suggest that both likelihood ratio tests (i.e., trace and maximum eigenvalues tests) reject the null hypothesis of no cointegrating vector at the 1 percent significance level. However, the test statistics cannot reject the null hypothesis of one cointegrating vector at the 10 percent significance level. Therefore, we surmise that there is one cointegrating rank among the estimated variables.[3] Since the variables are cointegrated

[2] To conserve space, the unit root test results are not reported but it is available upon request.

[3] 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 reported Johansen's cointegration results are robust. However, the cointegration test results for structural breaks are not reported here, but it can be obtained upon request.

and the interest of this study is to investigate the effect of wages on productivity in Malaysia, the cointegrating vector is normalised by its productivity.

Table 1: The result of Johansen cointegration test

Panel A: Multivariate Johansen cointegration test				
Series: $\ln Y_t \;\; \ln W_t \;\; \ln W_t^2$		LR tests statistics	Critical values#	
Hypotheses				
H_0	H_1		1 percent	5 percent
$LR(\lambda_{\text{trace}})$				
$r = 0$	$r \geq 1$	57.305***	35.458	29.797
$r \leq 1$	$r \geq 2$	9.536	19.937	15.495
$r \leq 2$	$r \geq 3$	2.583	6.635	3.841
$LR(\lambda_{\max})$				
$r = 0$	$r = 1$	47.769***	25.861	21.132
$r \leq 1$	$r = 2$	6.952	18.520	14.264
$r \leq 2$	$r = 3$	2.583	6.635	3.841
Panel B: Normalised cointegrating vector				
$\ln Y_t$	$\ln W_t$	$\ln W_t^2$	*Constant*	
1.000	23.254***	–2.879***	–41.467	

Note: *** denotes the significant level at the 1 percent levels, respectively. # represent that the critical values were obtained from MacKinnon et al. (1996). The Akaike's Information Criterion (AIC) was used to select the optimal lag order.

Panel B of Table 1 presents the normalised cointegrating vector. Consistent with economic theories and also our prior expectation, $\ln PROD_t$ is positively related to $\ln W_t$, but negatively related to $\ln W_t^2$. The long-run coefficients of productivity with respect to real wages is found to be $23.25 - 5.76 \ln W_t$. Moreover, the coefficients are statistically significant at the 1 percent level. This result provides some support for the inverse-U shape relationship between wages and productivity in Malaysia that is productivity first increases with wages and declines thereafter. Therefore, our empirical results affirm that the effect of wages on productivity in Malaysia is not monotonic.

Next, we conduct the Granger causality test within the error-correction framework to verify the short- and long-run causal relationship. Table 2 report the Granger causality results. Contrary with the earlier studies, our empirical evidence suggest that real wages and productivity are Granger-cause each other (i.e., bilateral causality) in the short- and long-run. Therefore, both the marginal productivity and also the wages efficiency theories are valid in Malaysia. These results are in harmony with the findings of Alexander (1993), Millea and

Fuess (2002), and Millea (2005) that real wages and productivity is bilateral causality in nature.

Table 2: The results of Granger causality test based on VECM

Null hypotheses	χ^2 - statistics	
	Short-run Granger non-causality test	Long-run weak exogeneity test
$\Delta \ln W_t, \Delta \ln W_t^2 \not\rightarrow \Delta \ln Y_t$	126.602***	4.868**
$\Delta \ln Y_t \not\rightarrow \Delta \ln W_t, \Delta \ln W_t^2$	21.109***	50.565***

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

4. CONCLUDING REMARKS

This study attempts to examine the effect of real wages on productivity in Malaysia. Our empirical results show that wages and productivity shared a common trend and thus they are co-move in the long-run. As a value added to the earlier studies, our empirical results indicate productivity and wages have a quadratic relationship in the long run and hence the effect of real wages on productivity is not monotonic. On the policy side, we also performed the Granger causality test within the VECM framework to examine the short- and long-run causality between real wages and productivity in Malaysia. The Granger causality test revealed bilateral causality between real wages and productivity in the short- and long-run. Hence, wages and productivity is complement in Malaysia.

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