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The Effect of Wages and Industry-Specific Variables on Productivity of Manufacturing Industry in Malaysia: A Dynamic Heterogeneous Panel Evidence

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ABSTRACT

This paper examines the effect of real wages and industry-specific variables (training, IT, R&D) on labour productivity of 44 sub-manufacturing industries in Malaysia over the period of 2000–2015. Using a dynamic heterogeneous panel model namely Pooled Mean Group (PMG) and Mean Group (MG) estimators, the main result reveals that real wages has positive significant impact on labour productivity in the short and long-run. The latter is consistent with the efficiency wage theory which acclaims the idea that the increase in real wages may induce labour productivity in parallel. The industry-specific variables (training, IT, R&D) are also statistically significant in influencing labour productivity in the long-run but not in the short-run. These findings may provide some insights for policy makers in setting the appropriate level of wages for the manufacturing industry and in the implementation or evaluation of labour policies in Malaysia. Financial inducement and other relevant support from the government in training, IT and R&D may boost labour productivity in the manufacturing industry.

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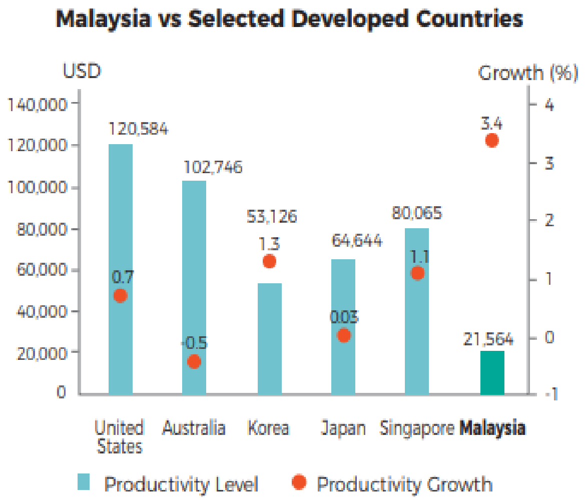
INTRODUCTION

According to Klein (2012), wages and labour productivity should move in a similar direction as postulated in the economic theory. If wages and labour productivity grow at the same pace, relative share of labour in national income is expected to remain unchanged (Feldstein, 2008). Increase in productivity indicates that the economies produce more output for a given level of input, thus generating gains that increase incomes and improve living standards, enhancing competitiveness and generally fostering a better quality of life. Productivity performance of an industry can be measured by labour productivity in which value added per total employees is commonly used. Labour productivity is the amount of wealth created by the company relative to the number of employees it has. A low ratio indicates the unfavourable working procedures such as inadequate salary or wage rates, time and/or material wastage, and high prices of materials and services.

Past studies have mainly focused on the relationship between real wages and labour productivity, but far less is known on the impact of real wages on labour productivity. This information is important in understanding the standard of living of the work force, and also the distribution of income between labour and capital. This study therefore aims to empirically elucidate the effect of real wages and other crucial industry-specific variables, namely training, information technology (IT), and research and development (R&D) on labour productivity.

Akerlof (1982) and Akerlof and Yellen (1986) were first to propose that wages could be an engine of productivity and that employees will put forth greater efforts out of a sense of loyalty to their employers when companies increase their remuneration. The study by Shapiro and Stiglitz (1984) introduced the shirking model which provides a technical description of why wages are unlikely to fall and how involuntary unemployment appears. Akerlof (1982, 1984) mentioned that employees see higher wages as a gift from their employer. Thus, they will return the gift by being more productive. In addition, the fair wage-effort model of Akerlof and Yellen (1990) documented that employees would not put as much effort as they would if they get a fair wage should they be paid a wage below what they perceived to be reasonable.

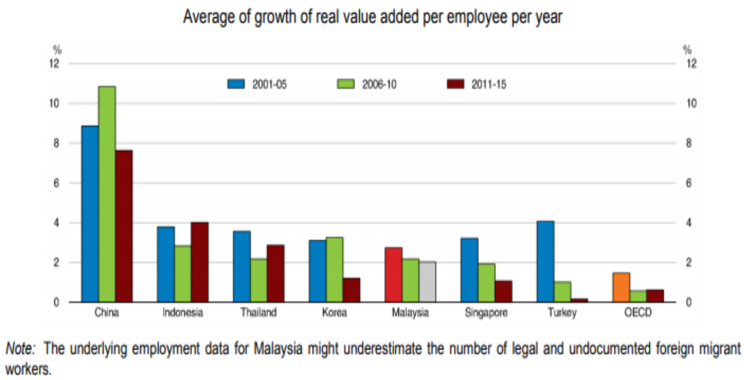
In Malaysia, productivity plays a vital role as the main driver of growth as stated in the Eleventh Malaysia Plan (11MP: 2016-2020). In its trajectory, the target for a high-income economy will be achieved by 2020 against a 3.7% growth in productivity level amounting to RM92,300 per capita. Figure 1 illustrates that Malaysia's productivity level is still trailing some advanced economies such as the United States, Australia, South Korea, Japan and Singapore although it is stabilizing in the last few years.



Source: IMD World Competitiveness Yearbook, 2016

Figure 1 Labour Productivity Level and Growth of Selected Countries, 2015

From the first half of the 2000s productivity growth in Malaysia marked an average of 2.3% per year, fostering per capita income into the higher middle-income country level (see Figure 2). The restructuring of resources to higher value-added sectors such as petrochemical and electronics and electrical (E&E) and increase in industry inflows of foreign direct investment (FDI), have driven economic growth (Asian Productivity Organization, 2015). However, Malaysia is underperforming relative to some of the major regional peers as labour productivity gradually declines since 2001.



Source: OECD calculations based on data provided by national statistical office and OECD (2016), Productivity Statistics (database), http://dx.doi.org/10.1787/data-00685-en.

Figure 2 Labour productivity growth has declined

This study that relates on the issue of the linkage of real wages to labour productivity in Malaysian manufacturing industry was motivated by the following four reasons. *First*, towards attaining high-income country status, it will necessitate productivity improvements that can be achieved through coordinated structural reforms. Such areas where reform can greatly improve productivity include elevating the skills training and quality of education, accelerate innovation, widening the use of information technology, nurturing a smooth-running competitive policy framework, improving the workings of the labour market and the regulatory framework for small and medium-sized enterprises, enhancing public sector productivity and promoting regional integration (Asada et al, 2017). *Second*, the manufacturing industry remains a core sector for sustainable growth under the 11MP (MPC, 2017) designed for Malaysia to achieve high-income nation status by 2020. Productivity should drive the growth needs, as opposed to the accumulation of capital and labour inputs (Asada et al., 2017). *Third*, raising productivity however remains an important challenge for the manufacturing sector in Malaysia. The Government aspires to increase productivity in manufacturing under the 11MP through encouraging industries to elevate their value chain in order to generate high value-added products. The prerequisites for this are more knowledge and skills-intensive activities in compliance with international standards, quality improvement and high-technology. *Finally*, since Malaysia has relatively lower average monthly earnings per employee in comparison to other Asian countries, revisiting the impact of real wages on labour productivity is crucial and should be emphasized so as to ensure that the wage increase would be commensurate with the increase in productivity. This is in line with the efficiency wage theory where some researchers postulated that causality runs from real wages to productivity (Wakeford, 2004).

This paper shall contribute to the continuing debate on the wage-productivity nexus from an empirical perspective on two aspects. *First*, this study supports the existing theory of Cobb-Douglas production function by adding the industry-specific variables and real wages. Although there is a large body of literature that investigates the wage-productivity nexus, very little is known on the impact of real wages and on industry-specific variables on labour productivity in the Malaysian context, specifically the manufacturing industry. Omitting any one of these potentially important variables from analysis could seriously affect the identification of the true drivers involved. *Second*, the study employs advanced econometric technique, the panel autoregressive distributed lag (ARDL) model namely PMG and MG which is the recently developed dynamic panel heterogeneity analysis introduced by Pesaran et al. (1999) and applied to the Cobb-Douglas production function. The use of this model enables this study; (1) to examine both the long-term and short-term effects of selected independent variables on labour productivity; and (2) to consider industry-specific heterogeneity by allowing the long-run coefficients to be equal over the cross-section, but the short-run coefficients and error variances to differ. In this study, panel data models were exclusively used in lieu of their advantages in empirical research such as the ability in; (1) controlling individual heterogeneity, (2) providing more information on data, (3) battering the capture of the dynamics of adjustment, and (4) identifying parameters that would not otherwise be identified with pure cross-sections or pure time-series.

The paper is structured as follows: Section 2 provides the theory and literature review of the effect of wages and the industry-specific variables on labour productivity. Section 3 discusses the theoretical framework, data, model specification and the methodology. Section 4 provides the results and discussions. And the last section delivers the conclusions.

REVIEW OF LITERATURE

The theoretical relationship between wages and productivity can be traced back to the Efficiency Wage Theory which supports the idea that wages affects labour productivity positively, where the increase in wages may stimulate labour productivity to similarly increase. The efficiency wage is the wage above equilibrium that firms voluntarily pay to increase productivity and profits. By paying an efficiency wage, firms can keep the most productive workers and increase their profits. The theory suggests that raising wage levels encourage them to increase productivity in response to high incentives offered by their firms. When companies raise workers' wages the employees will double their efforts as a show of their loyalty to the employers and will further strengthen long-term relationships between firms and employees (Akerlof, 1982; Akerlof and Yellen, 1986). Highly productive workers are not likely to quit or migrate to another company. Employers will eventually prefer to retain more skilled, experienced and productive workers than non-productive new employees.

There are three models that explain the productivity of workers as elucidated from their wages. *First*, the shirking model by Shapiro and Stiglitz (1984) which suggests that when workers are paid a higher wage, they have more to lose from being dismissed. Therefore, if they have a job with significantly higher wage than other alternative jobs, they will have greater motivation to impress their boss and thus retain their employment. Shapiro and Stiglitz posited that workers with higher wages will work at an effort level which involves no shirking. This wage is above market clearing levels. *Second*, in the Gift-Exchange Model, Akerlof (1982, 1984) highlights that higher wages are seen by employees as rewards from employers and the former will return the prize by becoming more productive. In the *third* and last model, the fair Wage-Effort Model by Akerlof and Yellen (1990) denotes that if workers are paid lower wages than what they consider to be reasonable or fair, they will not show the same effort that they perceived as reasonable for fair wages. The above studies concluded that wages affect productivity positively, and not vice versa.

Based on previous research, a positive and significant wage-productivity relationship was found in some developed and developing countries (Hall, 1986; Alexander, 1993; Erenburg 1998; Mora, et al., 2005; Narayan and Smyth, 2009; Kumar et al., 2012; and Dritsaki, 2016). In the case of Malaysia, Ho and Yap (2001), Yusof (2008), and Goh (2009) found that the two variables were positively related. Conversely, Tang (2012, 2014) found that labour productivity and real wages showed a quadratic relationship instead of a linear one.

Although in the past three decades economists have examined the wage-labour nexus, comparatively little is known about the effect of real wages on labour productivity. The clear understanding of this latter is vital in order to sustain long-term economic growth and competitiveness, and to facilitate decision-makers in formulating accurate policy to boost labour productivity.

Several empirical works have been conducted in developed and developing economies to examine the wage-productivity nexus. Millea (2002) estimated the relationship between wages and productivity for several industrialized countries to distinguish between conventional and efficiency wage behaviours using Geweke's linear feedback technique. The review showed that while efficiency wages were paid in Canada, Italy and the United Kingdom there was no such wage setting in Sweden, the United States and France. In the United States, Strauss and Wohar (2004) discovered that real wages Granger motivates productivity. In Australia, between 1965 and 2007, Granger causality test results suggest that real wages Granger trigger productivity in the long run (Kumar et al., 2012). Baffoe-Bonnie and Gyapong (2012) established that a wage increase did not encourage workers in the agricultural sector to work more whereas such increase did induce manufacturing workers to increase their productivity in the short-run. Dritsaki (2016) found a unidirectional causal relationship starting from real wages to labour productivity in Romania. In the most recent study by Karaalp-Orhan (2017), the results suggest the importance of real wages in labour productivity in the long-run. A 1% increase in real wages increases labour productivity by 0.97%. The findings support the wage theory on long-term efficiency in the Turkish manufacturing industry.

Real wages on the other hand, have negative impact on employee productivity in the short-run but not vice versa (Hall, 1986; Alexander, 1993; and Wakeford, 2004). Paradoxically, Hondroyiannis and Papapetrou (1997) found vague impact of wages on productivity in Greece for the period 1975-1992. Tsoku et al. (2014), in his study in South Africa at the macroeconomic level, using annual time series data from 1970 to 2011, concluded that real wages does not Granger cause labour productivity and vice versa. Additionally, Gneezy and Rustichini (2000) found that the effect of wages (monetary compensation) and labour productivity (performance) was non-monotonic. Brown et al., 1976) also showed that offering higher wages did not always motivate labour productivity.

In the Malaysian context, empirical analysis of the wage-productivity linkage is hardly reported in the literature. Goh and Wong (2010) found that real wages have no effect on productivity. And in the most recent study on the same relationship by Tang (2012, 2014) in the Malaysian manufacturing sector, using annual data and the Granger causality test, revealed that real wages Granger effect labour productivity, but there was no evidence of a reverse causation. Hence, the Malaysian evidence support the efficiency wage theory.

The review also identified several information gaps. *First*, the past studies reviewed did not investigate the effects of real wages and important industry-specific factors on labour productivity. Productivity is also a reflection of other explanatory variables such as training, IT and R&D. Previous researchers suggest that investment in R&D have long assumed a key role in enhancing productivity performance at the level of the country, industry and firm (Griliches, 1979, 1988; Patel and Soete, 1988; Guellec et al., 2004; and O'Mahony and Vecchi, 2009). Klette (1996) established that Norwegian manufacturing plants that invested early in R&D produced higher productivity growth relative to that by later investors. A large number of theoretical and empirical studies showed that the major source of long-term growth in input were human capital, accrued through education and training and burgeoning knowledge on new products and processes, spawned through R&D activities (Aghion and Howitt, 1998). Literature on R&D investment has highlighted the importance of the spill over effects.

The pioneering studies on the effect of training-productivity relationship by Barron et al. (1989), Holzer (1990), and Bishop (1991) have estimated that workers gained half of the accrued training benefits resulting from the impact of increased training on productivity growth. More studies also found positive effect of training on productivity (Bartel, 1995; Barron et al., 1997; Groot, 1999, Black and Lynch, 2001; Zwick 2005, 2006; Dearden et al., 2006; Ballot et al., 2006; and Almeida and Carneiro, 2006). Increasing the share of employees participating in training activities produced a positive and significant effect on labour productivity at firm-level (Colombo and Stanca, 2014). Workers' training is closely related to R&D and IT. For instance, Ballot et al. (2006) found that the investment in training and R&D has significant impact on productivity. The basis for capacity building in technology depends on R&D investment by the firms concerned. The same is true in the development of human capital and expertise, especially through on-job training (Cohen and Levinthal, 1989; Lucas, 1993; Mody, 1993; and Audretsch, 1995). R&D not only generates new knowledge but also elevate the firm's capacity to assimilate and exploit extant information. Research since the mid-1990s has centred on Information and Communication Technologies (ICT) which had variously contributed into boosting productivity growth (O'Mahony and Vecchi 2009). However, analysis on function of R&D and ICT has often been conducted separately without consideration of their possible correlations in the production process (Polder et al. 2017).

Second, the issue on the limitations of past methodologies employed that utilized non-panel data. For example; Ho and Yap (2001), Yusof (2008), Kumar et al. (2009), Tang (2012, 2014), and Dritsaki (2016) analyzed the same relationship with Granger causality, Vector Error Correction Method (VECM) Granger causality, and Toda and Yamamoto (1995) who used causality test techniques; all these studies utilized time series data. The adoption of PMG in this study is expected to improve on the results as it has several advantages which cannot be captured in the earlier statistical techniques such as the ability; (1) to examine both the long-term and short-term effects of selected independent variables on labour productivity; and (2) to consider industry-specific heterogeneity by allowing the long-run coefficients to be equal over the cross-section, but permitting the short-run coefficients and error variances to differ. Furthermore, PMG also serves the benefits of dynamic panel econometric technique which will be discussed in the methodology section.

With this background, it is clear that this study should potentially fill the gaps identified in past literature as we believe that this approach is an inaugural one on the application of the PMG or MG estimator in investigating the heterogenous effects of real wages and other industry-specific variables (training, IT, R&D), on labour productivity of the manufacturing industry in Malaysia. Although there is a large body of literature that investigates the wage-productivity nexus, far less is known about the impact exerted by the selected independent variables on labour productivity given their potential importance and their likely pathways. Omitting any from the analysis could seriously affect the identification of the true drivers involved. Our findings suggest that the effect of real wages on labour productivity should be positively significant, both in the short and long-run.

RESEARCH METHODOLOGY

Theoretical Framework

This study employs Cobb–Douglas production function to represent production in sub-manufacturing industries with technology, capital and differentiated labour as factors of production. Capital (K_{it}) and total labour input (L^*_{it}) of firm i and time t are combined with technology level A to produce output Y_{it}. For this article, an augmented Cobb–Douglas production function incorporating Z^*_{it}, comprises; (1) real wages per total employees, and the industry-specific variables including (2) real training expenses, (3) real IT expenses and (4) real R&D expenses in addition to the basic model. The augmented model is:

$$Y_{it} = AK_{it}{}^{\alpha} L^*{}_{it}{}^{\beta} Z^*{}_{it}{}^{\gamma} \tag{1}$$

Similar to Crépon et al. (2002) and Mahlberg et al. (2013), this study decomposes total labour input L^*_{it} of sub-manufacturing industries into the weighted sum of various types, k, of employees, which are perfectly substitutable. λ_{ikt} denotes the sub-industries productivity parameters. The following is the total labour input in sub-industry i:

$$L^*{}_{\text{it}} = \sum_{k=0}^{m} \lambda_{\text{ikt}} L_{\text{ikt}} = \lambda_{\text{i0t}} L_{\text{i0t}} + \sum_{k=1}^{m} \lambda_{\text{ikt}} L_{\text{ikt}} = (1+x)^n$$

$$= \lambda_{\text{i0t}} L_{\text{it}} \left(1 + \textstyle\sum_{k=1}^{m} \left(\frac{\lambda_{\text{ikt}}}{\lambda_{\text{i0t}}} - 1\right) \frac{L_{\text{ikt}}}{L_{\text{it}}}\right)$$

and thus,

$$\ln(L^*{}_{it}) = \ln(\lambda_{i0t}) \ln(L_{it}) + \ln\left(1 + \sum_{k=1}^{m} \gamma_{ikt} \frac{L_{ikt}}{L_{it}}\right) \tag{2}$$

λ_{i0} denotes the productivity of the reference sub-industries and $\gamma_{ikt} = \frac{\lambda_{ikt}}{\lambda_{i0t}} - 1$ signifies the relative productivity difference between an employee of type k and the reference sub-industries. This study assumes constant returns to scale, $\alpha+\beta+\gamma = 1$.

$$\ln(Y_{it}) = \text{In}(A) + \alpha \ln(K_{it}) + (1-\alpha)\ln(L^*{}_{it}) + (1-\alpha-\beta)\ln(Z^*{}_{it})$$

Substituting Equation (2) into Equation (1),

$$\ln(Y_{it}) = \text{In}(A) + \alpha \ln(K_{it}) + (1-\alpha)\ln(\lambda_{i0t}) + (1-\alpha)\ln(L_{it})$$

$$+ (1-\alpha)\ln\left(1 + \textstyle\sum_{k=1}^{m} \gamma_{\text{ikt}} \frac{L_{\text{ikt}}}{L_{\text{it}}}\right) + (1-\alpha-\beta)\ln(Z^*{}_{\text{it}}) \tag{3}$$

With ln (λ_{i0}) denoting the constant term c, subtracting ln (L_i) from both sides and applying the approximation ln (1+x) ≈ x, which holds for x ≪ 1, leads to the following equation of value added per total employees in the manufacturing industry,

$$\ln\left(\frac{Yit}{Lit}\right) = c + \alpha \ln\left(\frac{Kit}{L_{\text{it}}}\right) + (1-\alpha)\textstyle\sum_{k=1}^{m} \gamma_{\text{ikt}} \frac{L_{\text{ikt}}}{L_{\text{it}}} + (1-\alpha-\beta)\ln(Z^*{}_{it})$$

$$+ \delta_j X_{ijt} + u_{it} \tag{4}$$

u_{it} represents the industry-specific error term, assumed to contain both the industry-specific and a time-fixed effect. The error term also captures the part of technology A that cannot be directly explained with the help of further industry-specific explanatory variables X_j.

Equation (4) denotes the labour productivity function of real wages which is in line with the efficiency wage theory. This serves the employees' perspective on wage formation.

Data

The data for this study is the annual manufacturing industry in Malaysia during the period 2000 to 2015 covering the total 44 sub-manufacturing industries, derived from the Annual Survey of Manufacturing Industries published by the Malaysian Department of Statistics. The dependent variable is defined as real labour productivity which refers to the real value added per total employees (in RM'000). The independent variables were real wages per total employees (in RM'000), real value of capital per total employees (in RM'000), real training expenses (in RM'000), real IT expenses (in RM'000), real R&D expenses (in RM'000), and percentage of skilled workers (comprising professionals, executives, technicians and supervisors) per total employees.

Methodology

Panel data model is exclusively used in this study since they have many advantages in empirical research, such as the ability in (1) controlling individual heterogeneity, (2) providing more information on data sets with larger sample size due to pooling of individuals and time dimension, (3) capturing dynamics of adjustment in a superior way, not possible in cross-sectional data, on dynamics and time series data which need to be quite lengthy to provide good estimates of the dynamics of behavior, and (4) to identify parameters that could not be identified with pure cross-sections or pure time-series. The cross-sectional characteristics between sub-industries, for example, can simultaneously be studied in order to capture the dynamic interaction between variables. Further, a large number of observations would allow for increased degree of freedom, thus enabling for a more efficient estimation.

The PMG estimation as proposed by Pesaran et al. (1999) was employed in this study. A lower degree of heterogeneity can thus be considered as it imposes homogeneity in the long-run coefficients while still allowing for heterogeneity in the short-run coefficients and error variances. The basic assumptions in adopting the PMG estimator are as follows: *first*, the error terms are serially uncorrelated and are distributed independently of the regressors which thus suggest that the explanatory variables can be treated as exogenous; *second*, a long-run relationship exists between the dependent and explanatory variables; and *third*, the long-run parameters are the same between sub-industries. The estimator can also allow for long-run coefficient homogeneity over a single subset of regressors and/or sub-industries.

Pooled Mean Group and Mean Group Estimation

Static panel estimators do not take advantage of the data panel dimension by distinguishing between the short-run and long-run nexus (Loayza and Ranciere, 2006). Furthermore, in static panel, the error at any period is uncorrelated with the past, present and future, known as strict exogeneity (Arellano, 2003). Conventional panel data models also assume homogeneity of the coefficients of the lagged dependent variable (Holly and Raissi, 2009) which can lead to a serious bias when in fact the dynamics are heterogeneous across the cross-section units. This confirms that the static panel approaches are unable to capture the dynamic nature of the industry data, which is an essential issue in the empirical economic literature. In addition, these estimators can only deal with the structural heterogeneity in the form of random or fixed effects but impose homogeneous slope coefficients across countries even when there may be substantial variations between them.

This study thus apply the method of PMG estimation of dynamic heterogeneous panels by Pesaran et al. (1999) using ARDL (p, q, q,…, q) model for time periods t = 1, 2, …*T* and groups i = 1, 2, …, *N* as the empirical structure:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} x_{i,t-j} y_{i,t-j} - \sum_{j=0}^{q} \delta_{ij}\, x_{i,t-j} + u_i + \mathcal{E}_{it} \quad (6)$$

Where y_{it} denotes the dependent variable, x_{it} (k × 1) is the vector of independent variables for group $i,$ u_i is the fixed effects, λ_{ij}'s represents the scalar coefficients of the lagged dependent variables, δ_{ij}'s are k × 1 coefficient vectors.

The parametric form of Equation (6) is as the following:

$$\Delta y_{it} = (\emptyset_i y_{i,t-1} + \beta'_i x_{i,t-1}) + \sum_{j=1}^{p-1} \lambda_{ij} y_{i,t-j} - \sum_{j=0}^{q-1} \delta_{ij}\, \Delta x_{i,t-j} + u_i + \mathcal{E}_{it} \quad (7)$$

The disturbance terms ε_{it}'s is assumed to be independently distributed across i and t, with zero means and $\sigma^2{}_i > 0$ variances, and $\emptyset_i < 0$ for all i's. Therefore, the existence of the long-run relationship between y_{it} and x_{it} can be defined as follows:

$$\Delta y_{it} = \theta'^{x_{it}} + \eta_{it} \quad i = 1, 2, \ldots\ldots N;\ t = 1, 2, \ldots\ldots T;$$

where θ_{it}= $-\beta'_i/\theta_i$, represents the k × 1 vector of the long-run coefficients and it η_{it}'s are stationary with possibly non-zero means (including the fixed effects). Thus, Equation (7) can be written as:

$$\Delta y_{it} = \emptyset_i \eta_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} - \sum_{j=0}^{q-1} \delta_{ij}\, \Delta x_{i,t-j} + u_i + \varepsilon_{it} \tag{8}$$

where $\eta_{i,t-1}$ is the error correction term given by Equation (8) and $\emptyset_i$ denotes the error correction term coefficient measuring the speed of adjustment towards the long-run equilibrium. This parameter is expected to be significantly negative in sign, inferring that variables are moving back towards the equilibrium.

The PMG estimation allows short-run coefficients, intercepts and error variances to vary across countries but constrains the long-run coefficients to be equal. This indicates that θ_i = 0 for all i's. Pesaran et al. (1999) adopted the pooled maximum likelihood estimation (MLE) approach to estimate short-run coefficients, the common long-run coefficients by assuming that the disturbances ε_{it} are normally distributed. The estimators are represented by:

$$\widehat{\emptyset}_{PMG} = \frac{\sum_{i=1}^{N} \widetilde{\emptyset}_i}{N}, \quad \hat{\beta}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\beta}_i}{N}, \quad \tilde{\lambda}_{jPMG} = \frac{\sum_{i=1}^{N} \tilde{\lambda}_{ij}}{N}, \quad \mathrm{j} = 1, \ldots., p-1,$$

$$\hat{\delta}_{jPMG} = \frac{\sum_{i=1}^{N} \tilde{\delta}_{ij}}{N}, \quad \mathrm{j} = 0, \ldots., q-1 \text{ and}, \quad \hat{\theta}_{PMG} = \tilde{\theta}$$

Nevertheless, Pesaran and Smith (1995) suggested the MG estimator permits the heterogeneity of all parameters and the below estimates of short run and long run parameters:

$$\widehat{\emptyset}_{PMG} = \frac{\sum_{i=1}^{N} \widehat{\emptyset}_i}{N}, \quad \hat{\beta}_{PMG} = \frac{\sum_{i=1}^{N} \hat{\beta}_i}{N}, \quad \tilde{\lambda}_{jPMG} = \frac{\sum_{i=1}^{N} \hat{\lambda}_{ij}}{N}, \mathrm{j} = 1, \ldots., p-1,$$

$$\hat{\delta}_{jPMG} = \frac{\sum_{i=1}^{N} \hat{\delta}_{ij}}{N}, \quad \mathrm{j} = 0, \ldots., q-1 \text{ and}, \quad \hat{\theta}_{PMG} = \tilde{\theta}$$

The PMG and MG estimator differs between them. Whereas the PMG estimator is always consistent with the assumption of slope homogeneity in the long-run, the latter is also consistent but under the assumption that slope and intercepts may vary between countries. In this paper, we compare the two techniques and test for the suitability of the PMG relative to the MG based on the consistency and efficiency properties of the two estimators using Hausman test.

Hausman Test

The effect of heterogeneity on the means of the coefficients can be determined by a Hausman-type test (Hausman, 1978). This study applies the Hausman test to assess the suitability of either the PMG model or the MG model as the two possess different assumptions. The effect of heterogeneity on the means of the coefficients can be determined by this test. If the parameters are truly homogenous, the PMG estimates should be more efficient than that of MG. In other words, the more efficient estimator under the null hypothesis, i.e. that the PMG would be preferred. Conversely if the null hypothesis is rejected, then the more efficient estimator MG, is preferred. According to Pesaran et al. (1999), PMG estimator is a model positioned in between the very general and extreme model. In the very general model the slopes are unrelated to each other while the extreme model refers to extreme fixed or random effects model that requires all slopes to be identical across groups. This is crucial as groups (refer to sub-industries in this study) may have similarities and differences in certain respects, in which PMG allows intercepts, short-run coefficients and error variances to differ across groups, but the long-run coefficients are constrained to be the same. On the other hand, MG is the least restrictive technique where heterogeneity is allowed for all parameters.

RESULTS AND DISCUSSIONS

Pooled Mean Group and Mean Group Estimation

Table 1 summaries the regression results from the estimation using MG and PMG. Both the basic and augmented models from the Cobb-Douglas production function are presented here. It tabulates the findings in the short-run and long-run and the Hausman statistic for the purpose of selection between PMG and MG estimation. The Hausman test show a result which favour the PMG estimator instead of MG as the p-value is more than 0.05, which indicate that there is no significant difference between MG and PMG, thus accepting the null hypothesis. The PMG approach used to estimate equation (4), allows for heterogeneous short-run effects across 44 sub-manufacturing industries in Malaysia, but constrains the long-run coefficients to be equal. That is, it assumes that the long-run relationship between labour productivity and the independent variables is the same across the manufacturing industry.

Table 1 The Short-Run and Long-Run Effects of Real Wages on Labour Productivity

Long-run	**BASIC model** (1,0,0,0)		**AUGMENTED model** (1,1,1,1,1,1)	
	PMG	*MG*	*PMG*	*MG*
lkl	0.268***	0.257	0.395***	-0.184
	(0.274)	(0.301)	(0.034)	(0.799)
lwl	1.052***	0.860*	0.463***	-1.153
	(0.087)	(0.527)	(0.073)	(2.565)
lrd			0.042***	0.243
			(0.007)	(0.166)
ltrn			0.109***	-1.358
			(0.010)	(0.958)
lit			0.019*	1.720
			(0.013)	(1.579)
npt	0.013***	-0.064*	0.025***	0.009
	(0.004)	(0.043)	(0.002)	(0.097)
Short-run	**BASIC model** (0,0,0,0)		**AUGMENTED model** (0,0,0,0,0,0)	
	PMG	*MG*	*PMG*	*MG*
ect	-0.492	-0.698	-0.466	-1.086
	(0.053)	(0.060)	(0.063)	(0.127)
Δlkl	0.227***	0.048	0.353***	0.379**
	(0.053)	(0.061)	(0.066)	(0.158)
Δlwl	0.367***	0.334*	0.769***	0.631*
	(0.124)	(0.196)	(0.189)	(0.351)
Δlrd			0.009	0.019
			(0.008)	(0.022)
Δltrn			0.049	0.009
			(0.052)	(0.676)
Δlit			-0.021	-0.017
			(0.022)	(0.038)
Δnpt	-0.009	-0.004	0.003	0.020
	(0.007)	(0.006)	(0.007)	(0.019)
Hausman statistic	[0.482]		**[1.000]**	

Notes: The dependent variable is the labour productivity (value added per total employees). All variables except npt (percentage of skilled worker per total employees) are expressed in natural logarithms. Significant level at; *** 1%, ** 5%, and * 10% (refer to the standard errors in brackets). P-values for the Hausman test is in square brackets.

The basic model comprises only three independent variables, which are the real value of capital per total employees, real wages per total employees and percentage of skilled workers per total employees. The augmented model includes the industry-specific variables. The tabulated models are the best fit model with the optimum lag chosen for this study as it has the minimum Akaike Information Criteria (AIC) among all the other models. AIC (Akaike, 1974) is a fined technique based on in-sample fit to estimate the likelihood of a model to estimate the future values.

The results show that real wages per employee has a significant positive impact on labour productivity in the short-run and long-run at the 1% significance level. This is true for real capital per labour too for both basic and augmented models. For an example, the increase of 1% in real wages will increase the dependent variable by 0.77%

in the short-run and 0.46% in the long-run, which support the finding by Alexander (1993) that the strong positive relationships between real wages and employee productivity were gradually diminishing over the long term. The effect is greater as compared to the increase by only 0.37% in the short-run without the industry-specific variables. Results on the effects of the wage-productivity nexus are consistent with those of past empirical studies which showed positive effects of the nexus in the short-run (Baffoe-Bonnie and Gyapong (2012) but are however opposed to findings by Hall (1986) Alexander (1993) and Wakeford (2004). Positive effect of real wages also exists in the long-run as reinforced by findings in Kumar et al. (2012) and Karaalp-Orhan, (2017).

All the industry-specific variables are positively and significantly associated with labour productivity in the long-run at 1% significant level except for IT with only 10% significance, but not in the short-run. This may be due to the reason that the employees may take some time to apply to their work after being trained which is similarly true for the skilled workers to be assessed on productivity. The latter presumption also apply to IT as the worker may have to learn and adapt to the new technology employed by their employer. And for the R&D, it is by nature a medium to long term investment for an industry in which the results from the spill over knowledge on labour productivity cannot be seen in the short-run. This is true in the long run that the relationships between variables to be similar across groups due to the common technologies influencing all groups in a similar way or due to the effect of budget constraints.

The negative and significant error correction term indicates the existence of a long-run relationship between all variables. The coefficient of 0.47 suggests that the estimated speed of adjustment to the long-term relationship is about 47% annually. This denotes that it will take approximately seven years for the system to reach the equilibrium.

For robustness checking, we compare the result in the basic and augmented model as in Table 1, and different optimum lags were employed for several best models. Similar results were obtained by all models, where the positive and negative signs for each variable and the significant level are consistent for all the chosen models.

CONCLUSIONS

This paper examines the effect of real wages and industry-specific variables (training, IT, R&D) on labour productivity in 44 sub-manufacturing industries in Malaysia over the 2000–2015 period using a dynamic heterogeneous panel model namely Pooled Mean Group (PMG) and Mean Group (MG) estimators. The study is justified by the mixed and unresolved findings on the wage-productivity nexus as reported in past studies, and by the pressing issue of declining labour productivity in Malaysia since 2001, causing her to trail some of her major regional peers. The increase in wages may stimulate labour productivity and significantly contribute towards Malaysia's ambition to achieve high-income status.

The finding based on PMG estimator as the preferred model reveals that real wages has positive significant impact on labour productivity in the short and long-run at 1% significance level, confirming the efficiency wage theory. An interesting outcome shows that the increase of 1% in real wages will increase the dependent variable by 0.77% in the short-run and only 0.46% in the long-run, which support the findings of Alexander (1993) that the strong positive relationships between real wages and employee productivity gradually diminish over the long term. The industry-specific variables are also statistically significant in the long-run but not in the short-run. To confirm the consistency of our main findings for robustness purpose, different optimum lags were employed for several best models and we compare the result in the basic and augmented model. Similar results were obtained by all models, where the positive and negative signs for each variable and the significant level are consistent for all the chosen models.

The policy recommendation clearly suggests that authorities should increase wages and promote substantial investment in training, IT and R&D in Malaysia towards achieving higher productivity. Policy makers should continue to emphasis on the real wages adoption as commensurate with labour productivity. The way forward is to enhance the skills of the workforce in order to develop a pool of highly trained knowledge workers, which is the key to raising the nation's labour productivity. To support these efforts, it is timely for Malaysian industries to move upstream to produce high value-added skill- and technology-intensive products particularly when their comparative advantage in producing labour-intensive products have been eroded by the entry of low-wage countries into the international market. This is to assure that the current minimum wages policy is able to create a more rewarding working environment that can stimulate productivity from the lower wage labour to enable them in coping with the rising cost of living in the country.

Furthermore, adequate investment by the industry and incentives given by the government on workers training, IT and R&D are crucial to hasten labour productivity growth on top of the increase in real wages. According to the World Bank (2018) higher labour productivity rates can be achieved by firms if they invest in R&D or provide formal training, oriented to innovation, for their workforce. The World Bank (2018) also identified digital technologies as the recent enabler to growth in productivity. This is crucial if Malaysia were to achieve broad-based improvements to elevate her living standards. A survey conducted by the Malaysia Digital Economy Corporation (MDEC) and the Federation of Malaysian Manufacturers (FMM) however showed that more than 50% of manufacturing firms studied lack access to the internet or had slow internet speeds that constrain them from adequately utilising digital technologies.

This issue on productivity, as focused on the manufacturing industry, is addressed in this study. Future research may have to include other industries, including services, for a holistic and comprehensive picture of the wage-productivity nexus in the country. As this study uses IT expenses for estimation purpose, increase in this expenditure will lead to slight increase in labour productivity in the long run due partly to the level of IT utilisation. Recognising its importance, future studies should also consider examining the efficiency and effectiveness of employing IT to boost productivity. Future research may also need to elucidate the quantum of wage increment necessary or determine the optimum wage level for productivity so as to elicit the most positive impact on labour.

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