DETERMINATION OF THE FIRM-LEVEL WAGE RATE: THE ROLE OF EMPLOYER-EMPLOYEE SPECIFIC EFFECTS

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─Abstract ─

This paper examines the role of employees and firm characteristics in determining the Malaysian economy's pay structure. It utilises a uniquely matched firm-worker dataset from one common year (2006), which allows for a more in-depth analysis of worker- and firm-specific effects on the individual worker's pay. Using this matched data, we are able to estimate the statistical firm effect, but since we only have data for one year, we cannot therefore disentangle aspects of this effect that are due to unobservable worker or firm heterogeneity. And so, we adapted the two-stage estimation strategy proposed by Abowd, Kramarz, and Morgalis (2000) in order to keep any potential simultaneity bias under control.

The result indicates that observable worker characteristics and unobserved firm-effects are important elements of pay determination. However, firm-effects seem to explain the variability in pay determination more than observable worker characteristics. In addition, the relationship between pay components (average predicted pay and firm-effect) and firm performance (productivity and profitability) exhibits a positive tendency. This implies that higher paid workers, either because of worker characteristics or firm-effects, are being employed in firms that are more productive and profitable.

Key Words: *Pay determination, heterogeneity, matched employer-employee data.*
JEL Classification: J31, D21

1. INTRODUCTION

Wage rates, productivity and profitability are the labour market outcomes driven by the interactions of two parties, namely employers and employees. It is crucial and timely to understand these interactions in light of the dramatic changes in the international economy over the past several decades (Haltiwanger *et al.*, 2007). For example, if there are changes in technology or job restructuring at a firm level, these changes affect employees in those firms. Consequently, any policies

are driven by a certain understanding of these effects. Theoretically, the determination of wage rates by employers is based on supply-side (i.e., employees' characteristics) and demand-side (i.e., their employers' characteristics) factors in the labour market. Empirically, the strength of each factor can only be assessed if the observed characteristics of employers and employees are simultaneously captured, as well as allowing for the unobserved person and firm effects within the regression equation that explains the determination of wage.

The aim of this paper is to examine the role of worker and firm characteristics in determining the pay structure in the Malaysian economy. To perform this task, we utilise a cross-sectional MEED from the Malaysian manufacturing sector in 2006. This study is the first empirical analysis of pay determination with employer-employee specific effects in the Malaysian economy. Through the MEED, we are able to control for both observed and unobserved heterogeneity in the workers and their employing firms. However, with a single-year MEED we are unable to identify and estimate worker fixed effects (the effects that are due to unobservable worker heterogeneity) and firm fixed effects (the effects that are due to firm heterogeneity) separately. We can only estimate cluster fixed effect (the effects that are due to the sum of employer fixed effects and the mean value of the worker's fixed effects for each firm).

This paper is organised as follows: Section 2 provides the theoretical motivation for this empirical study. Section 3 provides data and variables. Section 4 discusses the methodology and estimation strategy used in this paper. Section 5 discusses the regression results, and finally draws the conclusions.

2. MOTIVATION

2.1. The importance of employee-employer specific effects

Workers with similar capacity would not be paid differently if the law of one price were to hold in the labour market. But why do such workers get different wages and why do similar firms pay different wages? This important question has motivated numerous studies that attempt to isolate the sources of wage heterogeneity as well as identifying significant market factors that are statistically related to wages. There are three groups of studies that tried to explain the sources of wage heterogeneity. One of them suggested that wage heterogeneity is related to permanent unmeasured differences among the individual workers otherwise known as 'a person fixed effect'. Another group had focused on the extent to which wage heterogeneity is related to permanent differences among employers,

or 'a firm fixed effect'. Still, a third or recent group of studies suggested that wage heterogeneity is related to both person and firm fixed effects.

Along with the availability of MEED, the appropriate econometric techniques to estimate firm and worker fixed effects in wage equation, as well as the computing facilities, are needed to provide a proper understanding of pay determinant and its structure. Abowd, Kramarz, and Morgalis (1999, henceforth AKM) combined these three elements to focus on wage determination with unobserved heterogeneity. They proposed distinguishing between *"employer effects"* which stem from firms' characteristics, and *"employee effects"* due to workers' characteristics.

3. DATA AND VARIABLES

3.1. Matched employer-employee dataset for Malaysia

The matched firm-worker data used in this paper comes from the Second Productivity Investment Climate Survey (PICS 2) for Malaysia. This survey was jointly conducted by the Malaysian Government and the World Bank during in the fiscal year 2007-2008. This survey covered 1,200 manufacturing firms and 300 service firms in six regions: Central or Klang Valley, North, South, East, Sabah and Sarawak. This survey is comprised of both firm and worker characteristics, the latter from a different employee module. The firm-level data consisted of information for 1,115 manufacturing firms in three consecutive years, i.e., 2004 to 2006. Firm data covers the following nine areas: governance and ownership structure; investment, technology and innovation; labour market, education, and skills; investment climate constraints and business relations; infrastructure, access to land and government regulations; international trade; products and inputs; corporate finance; and labour and human resources. Meanwhile, the worker-level data consisted of information on individual characteristics, job features, wages within the survey year (2007) and for the previous year (2006) for up to ten randomly sampled full-time employees for each firm.

This paper utilises a unique matched employer-employee dataset (MEED) for one common year (2006), which allows for more in-depth analysis of worker- and firm-specific effects on wages. The dataset contains a random sample of 7,059 full-time permanent workers employed in the 752 Malaysian manufacturing firms in 2006. It provides information on workers' monthly salaries and other characteristics of the workers and firms. Preparing the MEED for analysis of the Malaysian pay structure involves four important steps. First, we review the names and labels of the selected variables at the firm- and worker-level data. Second, we

verify that each variable is correct. This verification involves everything from assessing the internal consistency of information to looking for unreasonable distributions. The next step involves adding new variables and verifying that they have been created correctly. We apply these three steps to the firm- and worker-level datasets individually. After the employer and employee datasets are clean and new variables added, we finally merge these datasets into one dataset that becomes the Malaysian MEED for analysis.

3.2. Employee-level variables

The dependent variable in our wage rate analysis is the natural logarithm of real monthly pay for employees in 2006. The monthly pay is defined as the sum of monthly salary, including all allowances and bonuses, before tax. Nominal values were deflated by the consumer price index 2006 (2005=100) to get real monthly pay for each worker. The effect of education on wages was measured by two different variables. First, by a continuous measure of the years of completed schooling. Nevertheless, individuals' years of education will be biased estimates of the true effects because some individuals do not earn degrees, and others do not complete their degrees within a standard number of years (Jagear and Page, 1996). Therefore, our dataset has information on both years of education and the highest level of formal education attained, allowing us to improve on earlier estimates. We use five dummies for the highest level of the worker's formal educational attained, namely, degree, diploma as a reference group, upper secondary, lower secondary, and primary plus informal education as well as illiterate as direct estimates of the effects of academic credentials on wages.

Due to the absence of data on experience, Mincer (1974) proposed the alternative of "potential experience", i.e. the number of years an individual could have worked after completing schooling. Assuming that he/she starts schooling at 6 years old and begins working immediately after completed years of schooling, potential experience is equal to age – completed years of schooling – 6. In addition to education and experience, we also control for tenure, distance from job in kilometres, gender with male as a reference group, marital status with single as a reference group, types of occupation i.e. management, professional, skilled-worker), unskilled worker as a reference group, received formal training at the current employer, received formal training at the previous employer, computer skills i.e. none (as a reference group), basic, moderate, and complex, study abroad and ethnicity i.e. Bumiputera as a reference group, Chinese, Indian and others.

3.2. Employer-level variables

Firm performance is based on two variables: firm productivity (i.e., log of value-added per worker) and firm profitability (i.e., log of profit per worker). Firm input variables are logs of employment, capital, and capital-labour ratio, as well as share of skilled workers, female workers, foreign workers, and higher level of education workers in the firm. We also controlled for industry fixed-effects at the second stage of analysis with nine industry dummies. These are based on the 4-digit ISIC for manufacturing firms, i.e. textiles, garments, chemical rubber and plastics, machinery and equipment, electrical appliances, electronic auto parts, wood and furniture, and food processing as a reference group.

4. METHODOLOGY

4.1. Estimating a Cross-Section Pay Equation

We start with a simple pay equation in which workers' pay depends on both employee characteristic (level of education) and employer characteristics (performance and firm size)

$$\ln Pay_{ij} = \beta_1 X_{ij} + \beta_2 F_j + \varepsilon_{ij} \qquad (1)$$

Where $ln\,Pay_{ij}$ is the log of the hourly pay of worker i working at firm j, X_{ij} is the observable characteristic of worker i (years of schooling), F_j is a vector of observable characteristics of firm j (performance and size), ε_{ij} is the disturbance term, and $i = 1,\ldots,N; j = 1,\ldots,J$.

Least squares estimates β_1 and β_2 from equation (1) might be biased due to the problem of endogeneity. This problem arises in two ways. Firstly, equation (1) containing only controls for observable effects of workers and firms. It does not take into account worker and firm unobserved heterogeneity. The absence of controls for unobserved time-invariant employee and employer effects would cause omitted variable bias. For example, an omitted ability in pay equation, where an individual's years of schooling are likely to be correlated with unobserved ability. In addition, although the effects of firm performance on pay can be interpreted as rents, they may also be a result of unobserved employee and employer characteristics. For example, high ability workers might be systematically sorted into high performance firms. To control the potential omitted variable bias, we add worker and firm fixed effects in pay equation.

Secondly, simultaneity arises when firm performance and firm size are determined simultaneously along with pay. For example, based on the efficiency

wage models, high wages can induce high productivity or profits and high productivity or profits can provide high wages. There is an accounting relation going from wages to profits; by definition higher wages reduce profits. This bias has a negative effect on the profits' estimate. We consider this problem by examining the effects of firm performance and size and other firm's inputs on wages according to the two-stage procedure described below.

Using matched firm-worker data and methods of Abowd, Kramarz, and Margolis (1999), we are able to quantify worker and firm fixed effects as well as to estimate these effects simultaneously within the same regression. In order to include worker and firm fixed effects in the pay equation to obtain the fully specified regression model, we propose to modify equation (1) as follows

$$\ln Pay_{ij} = \beta_1 X_{ij} + \theta_{ij} + \psi_{J(i)} + \upsilon_{ij}, \qquad (2)$$

where θ_{ij} is a person-effect representing unobservable worker heterogeneity, $\psi_{J(i)}$ is a firm-effect representing unobservable firm heterogeneity, υ_{ij} is the disturbance term, and the rest of the variable and parameter symbols is defined as in equation (1). Specification model for equation (2) contains now both observed and unobserved worker and firm effects. Since only for one year, 2006, can information on workers be matched with information on their employing firms, we cannot directly estimate the effects θ_{ij} and $\psi_{J(i)}$. Instead, we estimate a single unrestricted, firm effect for each firm *j*, which may be interpreted as $\delta_{J(i)} \equiv \theta_j + \psi_{J(i)}$,

where $\delta_{J(i)}$ is the estimated firm effect which is consists of a combination of the average individual worker effect within the firm and the true firm effect. Thus, the individual worker pay using worker-level data is represented by the following equation

$$ln\, Pay_{ij} = \beta_1 X_{ij} + \delta_{J(i)} + \upsilon_{1ij}. \qquad (3)$$

In the first stage, we estimate equation (3) at the employee-level data using least-squares dummy variables estimator (LSDV). We do not have panel data that would allow us to control for person unobserved fixed effects, however, we expect that by including information on formal education level, occupation, and other human capital variables we mitigate this problem. In addition to the

estimated firm-effect $\hat{\delta}_j$, we calculate the average predicted pay in the firm, given the individual characteristics of employees. Denote this average by $\hat{\beta}_1 \overline{X}_j$.

In the second stage, we use the firm-level data to analyse firm characteristics as listed above. Denote each of these firm variables as Q_j. The firm-level analysis can be expressed as:

$$Q_j = \mu_0 + \mu_1(\hat{\beta}_1 \overline{X}_j) + \mu_2 \delta_J + \varphi_j + \upsilon_j \quad (4)$$

where μ_0, μ_1, and μ_2 are parameters to be estimated, φ_j is a fixed industry effect, and υ_j is the disturbance term. The result from equation (3) explains the impact of observable worker characteristics including the firm-effect on the monthly pay for the Malaysian manufacturing workers in 2006. Meanwhile, equation (4) explains the relation of pay components and firm characteristics. From these results, we can examine the relation between pay structure, firm performance and inputs to production.

5. RESULTS

5.1. Pay estimation including firm-effects at employer-level data

Table-1 shows the result for pay estimation on equation (3) including firm-effects at the employee-level data. Most of the worker characteristics have a significant impact on pay except for tenure squared, training at the previous employer, study abroad, and other ethnicity dummies. The result on education indicates that the one additional year of education and tenure raises pay by 1.5 and 0.9 percent respectively, holding other factors fixed. The results also implied that experience has diminishing effect on pay. The results also suggested that workers with a higher education-level earn more, females earn less than males, married people earn more than singles, workers who received training from current employer get better pay than those who do not receive such training, workers who have computer skills get more pay than those who did not have any computer skills, and Chinese and Indians seem to have better pay than Malays. The R-square value of this model is 0.577, meaning that about 58 percent of the variability in the pay determination of workers is explained by regression on the worker characteristics and firm-effects.

Table-1 : Least Squares Estimates of the Determinants of Real Monthly Pay, Including Firm-Effects

Explanatory Variables	Coeff.	Robust S.E	Explanatory Variables	Coeff.	Robust S.E
Education	.0150***	.0045	Management	.287***	.0371
Experience	.0110***	.0012	Professional	.276***	.0389
Experience^2	-.00036***	.0012	Skilled production	.130***	.0255
Tenure	.00983***	.0022	Non-production	.0759**	.0281
Tenure^2	.00010	.0001	Current training	.0532*	.0237
Log of distance	.0245**	.0086	Previous training	.0173	.0219
University degree	.118***	.0338	Basic comp. skill	.0439	.0224
Upper secondary	-.138***	.0262	Moderate comp. skill	.147***	.0244
Lower secondary	-.147***	.0352	Complex comp. skill	.128**	.0398
Primary school	-.178***	.0499	Study abroad	.0942	.0597
Female	-.151***	.0170	Chinese	.185***	.0227
Married	.0493**	.0175	Indian	.0655*	.0268
			Others	.137	.0942
No. Of observations			7059		
R-square			0.577		
Adjusted R-square			0.525		
rmse			0.470		

Note : The dependent variable is the log of real monthly pay, in Ringgit Malaysia (RM). All included variables are shown in the table. A constant is included in regression. Significance at the 1 percent, 5 percent and 10 percent level is indicated by ***,** and * respectively.

Table-2: Correlation among the Components of worker pay

	Log Monthly Pay	Firm-effects	Worker characteristics	Residual
Log Monthly Pay	1.0000			
firm-effects	0.6272	1.0000		
Worker characteristics	0.5473	0.2042	1.0000	
Residual	0.6505	-0.0000	-0.0000	1.0000

Source: Author's calculations based upon the regression in Table-1.

Table-2 shows the correlations for the components of workers' pay. The components of pay are divided into observable worker characteristics, unobservable firm-effects, and a residual. From the table, one can see that the correlation between unobserved firm-effects and log of real monthly pay is greater than the correlation between observable worker characteristics and log of monthly pay. This implies that unobserved firm-effects are important in explaining the variation in log pay in Malaysia.

5.2. The relation of pay components to the firm's performance and inputs

Table-3 shows the results of relating the pay components (i.e., the average firm-effect and the average predicted pay) of each firm to firm performance with equation (4) using OLS. In this context, firm-effects are a measure of firm-specific pay policies, so these firm-effects represent the base level of pay in each firm. This table also shows the relation between the estimated components of pay and a firm's input such as the logs of employment, capital, and capital labour ratio, as well as share of skilled workers, female workers, foreign workers, and workers with a university level of education.

Table-3 : Estimated relations between pay structure and firm's performance and inputs

Independent variables / Dependent variables	Average firm-effect in pay equation		Average predicted pay in firm	
	Coeff.	Std. Err.	Coeff.	Std. Err
Log value-added per worker				
Log profit per worker				
Log of employment	0.6726***	0.1646	0.4134***	0.0863
Log of capital	1.4667***	0.2934	0.8421***	0.1544
Log of capital labour-ratio	0.7940***	0.2053	0.4287***	0.1316
Most skilled workers	5.0036	3.1567	6.7657***	2.0805
Most female workers	-8.3616***	2.2935	-6.0079***	1.7262
Most foreign workers	-4.1453*	2.4127	3.0202	1.9143
Most higher education workers	6.97357***	1.5534	6.3085***	1.1455

Source : Author's calculations based upon the results in Tables 1 and 2. Significance at 1 percent and 10 percent level is indicated by *** and * respectively.

From Table-3, we observed that firms with a high average base level of pay also employ more productive workers and gain higher profits. In terms of the average predicted pay, firms employing workers with a high average predicted pay employ more productive workers and also have higher profitability. On the one hand, we found that firms which are higher in both components of pay (average predicted pay and average base-level of pay) tend to be large, capital-intensive, having an abundance of skilled-workers, and also having an abundance of worker with a higher level of education. On the other hand, a firm which is lower in both components of pay tends to be a firm with an abundance of female workers.

CONCLUSION

To date, most of the empirical studies on pay determination for Malaysia have had to rely on individual-level data alone. This paper attempts to respond to the shortcomings of the available empirical studies by utilising the rich and unique MEED for the Malaysian manufacturing sector in 2006. In the first stage of analysis, we found that observable worker characteristics and unobserved firm-effect both play an important role in the Malaysian pay determination. The correlation between unobserved firm-effect and log pay is greater than that between observable worker characteristics and log of real monthly pay. In the second stage, we found that higher paid workers, either because of worker characteristics or firm-effects, are employed in firms that are more productive and profitable. The relation between firm-effect and profitability can be either positive or negative depending on either the efficiency wage effect or the rent-sharing effect that dominates. This result implies that the Malaysian pay policies are dominated by the efficiency wage effect. To have more direct interpretations of our results, the production function has yet to be specified, which would be a task for future research.

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