INTERTEMPORAL AND INTERREGIONAL WAGE BEHAVIOR IN INDONESIA: A RECONCILIATION OF THE PHILLIPS CURVE AND THE WAGE CURVE?

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Abstract

Combining interregional and intertemporal perspectives of wage behavior in a developing country serve equal importance not only in formulating policy for regional or national economic developments but also towards the development of economic thoughts. Accordingly, we develop a multidimensional augmented wage equation, a panel error-correction model of Phillips curve and wage curve reconciliation, featuring Phillips curve and wage curve contrasting measures, heterogeneity of wage behavior, interregional cross dependency, homogeneous and heterogeneous regimes and structural breaks, and most importantly wage rigidity in the short-run and wage flexibility in the long-run equilibrium. Indonesia labor market development offer stimulating environment and experiences to exercise aforementioned wage equation and complement the growing literature on wage behavior. Using The Indonesian National Labor Force Survey across 26 provinces for the periods of 1986-2015, we exercised multiple dynamic panel data estimators. Our results signify the existence of intertemporal effects of unemployment on wages, heterogeneity of wage rigidity in the short-run, interregional dependence in wage flexibility and differential behavior of wage in the presence of structural breaks and regimes. The findings are in line with the Phillips curve, with temporary effect of unemployment on wage changes. The findings also underlined some adjustments toward a long-run equilibrium with a certain degree of wages flexibility to prices and minimum wages. In regard of wage curve, we found some adjustments towards a long run equilibrium of wages to prices and minimum wages whereas the role of labour market supply might be more intricate than what was expected.

JEL Classification: C23, E24, J31, R23

Keyword: wage rigidity, heterogeneous panel, cross section dependence, structural breaks

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1. INTRODUCTION

Wage rigidity and wage flexibility are important features of wage behavior, particularly in characterizing the dynamics of a labor market. They explain why any change in unemployment, cost of living, or productivity not always follow by the same magnitude or velocity of change in wages as in a competitive labor market setting. Hence, determining the basic relationship of wage and other economic aggregates is crucial in examining wage behavior. A paper by Phillips (1958) described the inverse relationship between a change in wage and the unemployment rate, known as the Phillips curve. The Phillips curve provides a groundwork for studies on the intertemporal relationship between 'changes of wage' and unemployment rates. Alternatively, Blanchflower and Oswald (1994) proposed an inverse relationship between 'level of wage' and the contemporaneous unemployment rate, known as the wage curve. Along with growing studies based on those thoughts, Blanchard and Katz (1997) proposed a reconciliation by augmenting the wage curve into the Phillips curve and structured as an error correction model, featuring short-run adjustments toward a long-run equilibrium of wage.

There are a growing number of studies, either in favor of or in contrast to, the Phillips curve and the wage curve, which indicates the importance of further analysis of wage and unemployment relationship. Blanchard (2016) emphasizes that the Phillips curve is still present, and its current shape will raise serious challenges for monetary policy in the future. However, most of the studies were in case of developed countries, particularly US and European countries, which may have different outcomes in developing country. Furthermore, the Phillips curve studied mostly in regard of macroeconomics, while the wage curve in regard of microeconomics. Thus, studies based on the Phillips curve predominantly exploited aggregate national or multinational level data, while based on the wage curve exploited individual or firm level data. Only a few studies were on developing countries or aimed at sub-national interregional level as in Messina and Sanz-de-Galdeano (2014), Kaur (2014) and Choudhary et al. (2013). More recent studies, with more refined datasets, based on Blanchard and Katz (1999) dynamic approach, have also introduced multi-regimes or structural breaks in the equation featuring different economic environments or different policy stances, e.g. Rusinova, Lipatov and Heinz (2015) and Kumar and Orrenius (2016).

Indonesia economic development offer stimulating environment and experiences to complement those growing literature of wage behavior and fill the aforementioned research gaps, i.e. developing country, sub-national analysis and multiple-regime or structural breaks. For example, post oil boom in late 1980's and industrialization in early 1990's, resulting unemployment rate between 2.55 percent and 4.36 percent and inflation between 4.94 percent and 9.77 percent in 1990-1994. Low unemployment (between 2.55 percent and 4.36 percent) and low inflation (between 4.94 percent and 9.77 percent) in periods of 1990-1994 attributed to oil boom in late 1980's and industrialization in early 1990's. While in following years, Indonesia economy was hit by the currency crisis followed by economic crisis resulting unemployment rate of 11.24 percent and inflation 17.11 percent by 2005. Indonesia has also undergone economic transformation throughout those years. From centralistic government to decentralized government which places a greater roles for the sub national governments in the economic development. Also a transformation from multi-targeting less independent monetary policy to single-targeting more independent monetary policy. All those environment and experiences in economic subject to upturns and downturns of business cycle and eventually affecting the labor market condition.

Accordingly, this study aims to scrutinize nominal and real wage behavior in different states of the business cycle including regimes and structural breaks. Using panel data across 26 provinces and 30 years of labor market development of Indonesia, the objectives of this study including: (i) testing the incidence of the Phillips curve and the wage curve; (ii) testing heterogeneity and dependency of labor markets across provinces; and (iii) examining wage behavior in the presence of homogeneous and heterogeneous regimes and structural breaks. The remainder of this paper is structured as follows: Section 2 provides a discussion of the relevant literature; Section 3 explains the data in use and estimation strategy; Section 4 deals with the presentation and interpretation of the empirical results; and finally, Section 5 conclusions.

2. PHILLIP CURVE AND WAGE CURVE RECONCILIATION

The wage curve have several differences to the Phillips curve. First, the Phillips curve focused on the change of money (nominal) wage rates, while the wage curve addressed the levels of (real) wage rates. Second, this particular difference leads to another argument that the reservation wage is a crucial element in differentiating between the Phillips curve and the wage curve (Reynes, 2010). Third, assuming that changes in nominal wages is a temporary event while the level of the real wage rate is at steady state, the Phillips curve represents a short-run adjustment mechanism while the wage curve represents a long-run steady state (Blanchard and Katz, 1996, 1999). In this regard, Phillips curve serve as a foundation for the wage rigidity while wage curve for the wage flexibility. Fourth, both curves can also be referred to as the difference between macro-econometrics and micro-econometrics, since Phillips (1958) empirical analysis is based on a macroeconomic approach with aggregate data whereas Blanchflower and Oswald (1994) is based on a microeconomic approach with individual data. Another important difference is in term of the objectives of the studies, which The Phillips curve use mainly in intertemporal analyses whereas wage curve in interregional analyses.

Some considerable pros and cons on the model specification of both lines of research worth noted. To begin with, Blanchflower and Oswald (2005) emphasized that the relationship between wage level and unemployment rates in Phillips (1958) was unclear. While Gomes and Parreno (2015) emphasized that Blanchflower and Oswald (1994) might reflect a wage-setting schedule and not the neo-classical aggregation of labor supply curve due to statistically insignificant variables of labor market conditions except for unemployment rates. From an econometric perspective, following Blanchflower and Oswald (1994), some studies argued that Phillips (1958) might have biased due to data aggregation problem, incorrect specification, and measurement errors (Reynes, 2010). L'Horty and Thibault (1997) also claimed that the Phillips curve might be a Granger and Newbold (1974) type of spurious regression.

Some studies also argue that results from Blanchflower and Oswald (1994) are partly an outcome of the use of inappropriate data for the US (Card, 1995; Blanchard and Katz, 1997; Black and FitzRoy, 2000), misspecification errors caused by the forms, and calculation of wage and utilization fixed effect dummies (Albaek et al., 2000; Blanchard and Katz, 1999). Furthermore, Montuenga-Gómez and Ramos-Parreño (2015) also emphasized the possibility of endogeneity bias and common group bias in Blanchflower and Oswald (1994). Although there are growing theoretical developments and empirical studies supporting both line of thoughts, there is no consensus on the exact form of the curve (Villavicencio and Saglio, 2012). Surprisingly, both lines of work acknowledge the possibility of short-run adjustments and long-run equilibrium of wage (Blanchard and Katz, 1997; Blanchflower and Oswald, 2005).

Accordingly, Blanchard and Katz (1997) initiated a reconciliation measure between the Phillips curve and the wage curve. The reconciliation executed by augmenting the wage curve into the Phillips curve was based on an error-correction model featuring short-run adjustment toward long-run equilibrium of wages and unemployment and other economics aggregate. Subsequently, our first motivation in studying the reconciliation of the Phillips curve and the wage curve is the possibility to examine the short-run and long-run behavior of wage. Examining wage behavior in dynamic environments offers the advantage of proving whether temporary wage rigidity causes disequilibrium in the short-run and will need to adjust toward equilibrium of wage flexibility in the long-run. Nevertheless, it is those economies with less flexible labor markets and greater wage rigidities in the long-run, which appear likely to experience greater persistence in both unemployment and inflation (OECD, 1994).

Our other motivation for this study is to exercise several empirical approaches of modelling wage behavior and determine the suitable approach in case of Indonesian labor market. Blanchflower and Oswald (2005) emphasize that while the supply and demand approaches might have been misspecified, many researchers supported one of the approaches. Many US labor economists supported the Harris-Todaro model and some form of the Phillips curve while many European labor economist argued against both of those but supported some form of wage curve. Revisiting the reconciliation of the Phillips curve and the wage curve provides the possibility to distinguish the existence of both wage models particularly in a developing country with a diverse empirical setting. Thus, integrated short-run adjustments and long-run equilibrium analzses is an alternative for contrasting measures between the Phillips curve and the wage curve.

3. WAGE DYNAMICS WITH MULTIPLE REGIMES AND STRUCTURAL BREAKS

Nominal and real wage rigidity also have a long tradition in capturing the effects of the business cycle. The highs and lows of business cycles commonly identified by economic aggregates or economic policies at different points of time are referred to as multiple regimes. Hence, different magnitudes of wage rigidities in different set regimes are commonly associated with the asymmetric behavior of wages. Phillips (1958) initially indicated that changes in nominal wages tends to be high in low unemployment periods and vice versa. Recent literature such as Rusinova, et al. (2015) acknowledge that wages are less responsive to unemployment when there is a positive unemployment gap.

Furthermore, Avsar and Gur (2004) emphasized that the New Keynesian are developed under the assumption that nominal wage rigidity, in the presence of economic shocks, varied according to the level of inflation and inflationary expectations. Avsar and Gur (2004) argument is consistent with Akerlof et al. (1996) where they argue that for periods of low inflation, workers might get used to nominal wage reduction and be less resistant to nominal wage cuts. In contrast, Card and Hyslop (2007) utilized the Phillips curve approach and concluded that real wage is less rigid during high inflation than low inflation regimes. Similarly, Rusinova et al. (2015) found thresholds of inflation regimes where real wage rigidity significantly varied between unemployment and productivity shocks. Despite the different magnitudes of wage rigidities, Goette et al. (2007) confirmed the possibility of different directions of wage rigidities between different inflation regimes. The empirical exercise concluded that low inflation leads to downward nominal wage rigidity while high inflation leads to downward real wage rigidity, implying the importance of the effect of monetary policies on the flexibility of labor market.

Abbritti and Fahr (2013) emphasized that nominal wages grow with some friction, following positive productivity shocks during business-cycle fluctuations. Employment creation becomes more difficult as nominal and real wage continually increase. The lows and highs of business cycles are also referred to as downturns and upswings of the economy. Recent empirical work by Anderton and Bonthuis (2015) and Fallick et al. (2016) show nominal and real wage rigidity during normal times and recessions by including GDP interaction with unemployment rate. They concluded that wage rigidities were higher during economic downturns and declined as the crisis prolonged. While Rusinova et al. (2015) argued that real wage rigidity tend to be lower in downturn than upswings of the unemployment rate change. The results confirm similar works including Woitek (2005), Du Caju et al. (2008), Arpaia and Pichelmann (2007), and Messina et al. (2010). Two features of wage rigidity acknowledged by these results, the possibility of asymmetric adjustment of wages and the downward rigidity of wages. Alternatively, Gali (2011) concluded that excluding crisis periods improves robustness of the equation and heightens the negative effect of unemployment on wages. While Daly and Hobijn (2014) concluded that during recessions, adjustments take place by increasing unemployment rather than decreasing wages.

4. DATA

The main data source for this work is the Indonesian National Labor Force Survey, also known as SAKERNAS. The survey was first established in 1976 and has been conducted regularly since 1986. As a household-based survey, SAKERNAS provides demographic information of selected individual regarding the labor force, wages, and other information required to analzse labor market characteristic. Some development on the definitions, classifications, and measurements have been taking place since 1986 until recently. For example, there were changes in the definition of unemployment. In 1992, the International Labor Organization's (ILO) standard definition for unemployment was introduced, which is defined as someone who does not have a job and is simultaneously looking for a job. Afterward, additional categories were added to unemployment definition in 2012, including: discouraged unemployed, future workers, and starting a new business. For consistency reason, we used the basic definition of unemployment rates based on ILO's standard definition.

Due to differences in survey frequency of SAKERNAS each year, August round were selected for several reason (except for 2005, because the survey was carried out in November). First, it provides the largest sample size each year, relative to other rounds of the survey. Second, any cyclical or seasonal intertemporal biases can be minimized for selecting consistently survey of the same point of month each year. Therefore, a reasonable number of observations can be maintained for aggregation not only at the national level but also at the regional level. Given data availability and the reasons above, we used SAKERNAS survey data from 1986 until 2015 and aggregated the data at the provincial level.

5. ESTIMATION STRATEGY

Our estimation strategy consists of four interrelated steps. **The first step** is to run several pre-estimation tests including cross-dependence test, unit root test and cointegration test. These tests allow us to determine the profile of each variable in used, which latter will be considered to set up a baseline specification, suitable to our data setup. Two measurements exercised to test for cross-dependence (CD test), the Pesaran (2004) CD test for strict cross-sectional independence and the Pesaran (2015) CD test for weak cross-sectional dependence. For stationarity test, we employed two types of panel unit root tests (PURT), the Maddala and Wu (1999) test, and the Pesaran (2007) test. Whereas for the panel cointegration test, we employ a set of panel cointegration tests proposed by Westerlund (2007). The test accommodates panel cointegration test with several difference structure, including the one with completely heterogeneous long-run and short-run specifications, according to our data setup. It also accommodates the possibility of cross-sectional dependence in the panel unit by allowing bootstrapping to obtain robust critical values.

The second step is to run contrasting measures to differentiate the incidence of the Phillips curve and the wage curve. The need of contrasting the Phillips curve and the wage curve is beyond the growing pros and cons on both curves themselves. It will affect the precision of wage behavior analysis and the selection of corresponding policies. Two general approaches are established as the contrasting measures between the Phillips curve and the wage curve, i.e. the level approach and the first-differenced approach. Overall, five contrasting measures were exercised in this study. The first measures, following Blanchflower and Oswald (1994) who proposed the level approach in this following formulation:

$$w_{r,t} = a_0 u_{r,t} + b_0 X_{r,t} + c_0 w_{r,t-1} + g_{0r} + f_{0t} + e_{r,t} \tag{4.1}$$

where (W), (U) and (X) represent wage rate, unemployment rate, and observed characteristics for all individuals in the market, observed in the regional labor market (r) and in time period (t). Lowercase letters denote the logarithm form of the corresponding variable. A regional dummy (g_r) and time dummy (f_t) are considered unrestricted intercepts for different labor markets and different periods, or time and regional fixed effects. The contrasting measure of this approach is the response of wage rates to lagged wage rates (c_0). The wage curve implies that the coefficient of the lagged wage is close to zero ($c_0 \approx 0$) while the Phillips curve implies that the coefficient is close to one ($c_0 \approx 1$).

The second measures following Card (1995) who proposed a first-differenced approach for contrasting the Phillips curve and the wage curve, formulate as follow:

$$\Delta w_{r,t} = a_1 u_{r,t} + a_2 u_{r,t-1} + b_1 X_{r,t} + b_2 X_{r,t-1} + f_{1t} + \Delta e_{r,t} \tag{4.2}$$

where the contrasting measures of this approach are the coefficient of unemployment rates (a_1) and lagged unemployment rate(a_2). Card (1995) argued that opposing values between the coefficients ($a_1 = -a_2$) indicates a wage curve, while a zero coefficient of lagged unemployment rates ($a_2 = 0$) indicates a Phillips curve.

As an alternative of first-differenced approach proposed by Card (1995) above, Blanchard and Katz (1997) proposed the third contrasting measure we employed in this study based on an error correction framework as follows:

$$\Delta w_{r,t} = a_{3w,r} + \Delta p_{t-1} - \theta\left(w_{r,t-1} - p_{t-1} - l_{t-1}\right) - b_3 U_{r,t} + \varepsilon_{w,r,t} \tag{4.3}$$

where (w), (p) and (l) represent nominal wage, price index, and labor productivity levels in logarithm forms so that (Δw), (Δp) and (Δl) represent productivity growth for wage, price, and labor. The idea is augmenting the wage curve into the Phillips curve and use the coefficient of the error correction terms (θ) as a contrasting measure, where the value of zero indicate the Phillips curve versus the value of one for the wage curve. The regional unemployment rate (U) is in percentage form so that equation (4.3) is as semi-log specification.

Madsen (2002) criticized the idea of using an error correction coefficient (θ) as a contrasting measure based. Alternatively, based on a similar error correction approach, Madsen (2002) proposed the inclusion of level and first-difference of unemployment as follow:

$$\Delta w_{r,t} = a_{7r} + d_1 \Delta p_{t-1} + d_7 \Delta z_{t-1} - \theta_r ect - \beta_7 \Delta U_{r,t} - \beta_8 U_t + \varepsilon_{r,t} \qquad (4.4)$$

$$ect = w_{r,t} - \delta_1 p_{t-1} + \delta_2 z_{t-1} - \gamma_2 U_t + \mu_{w,t}$$

where ($\underline{z}_t$) is a vector of wage push variables and (ect) is error correction term. Madsen (2002) argued that the error correction coefficient (θ) cannot be used as contrasting measure due to the potential correlation between lagged dependent variables and the error term. Alternatively, he proposed coefficients of level and first-difference of unemployment rates as the contrasting measure between the Phillips curve and the wage curve. In this setting, the level of unemployment rate is estimated in a pooled specification while first-difference of unemployment rate is estimated in a regional specification. The Phillips curve will be represented by a negative unemployment rate coefficient ($\beta 7<0$), while the wage curve will be represented by a negative change of unemployment rate ($\beta 8<0$). Thus, the Phillips curve is represented by a negative relationship between the change of wage rate and level of unemployment rates, while the wage curve is represented by a negative relationship between the change of wage and unemployment rates.

To this point, particularly under the error correction model, there are at least three aspects are considered in determining the basic structure of the wage behavior, i.e. inclusion, measurement, and form of the variables. We utilize both level and first-difference contrasting measures primarily to determine whether to focus on the intertemporal specification as in the Phillips curve or interregional specification as in the wage curve. This exercise is also set to preclude any biases in estimation results due to specification error, measurement error, and omitted variable biases.
The third step is to set up a baseline model of wage behavior, taken into account all results from previous steps. In this step, we also determined appropriate forms of each variables and introduced additional variables in the model. The error correction model was selected as a starting point of our baseline wage behavior model. In line with Blanchard and Katz (1997), reconciliation model designate the Phillips curve to capture the short-run dynamic behavior of wage (including speed of adjustment), while the wage curve is designated to capture the long-run

equilibrium of wage. Thus, the former established to analzse the incidence of wage rigidity while the latter to analzse incidence of wage flexibility. This combination of the conceptual setup and data profile is in line with the macro-econometric error correction framework of Johansen (1995). With the addition of independent variables, the basic wage and unemployment relationship described in equation (4.4) can be reformulated as follows[1]:

$$\Delta w_{r,t} = \alpha'_0 + \beta'_0 \Delta w_{r,t-1} + \beta'_1 \Delta p_{r,t} + \beta'_2 \Delta u_{r,t} - \theta' ect_{t-1} + \gamma_p \Delta z^p_{r,t} + \mu_{r,t}. \quad (4.5)$$

All variables are computed as aggregate provincial averages. The error correction term (ect) is equal to lagged residuals of the long-run equilibrium ($\varepsilon_{r,t-1}$) of:

$$w_{r,t} = \beta^*_3 p_{r,t} - \beta^*_4 u_{r,t} + \gamma^*_1 z_{r,t} + \varepsilon_{r,t}, \quad (4.6)$$

where the labor output ratio and minimum wage are included in the vector of wage push (z). The error correction coefficient (θ') indicates the speed of short-run adjustment of wage to convergent to its equilibrium. The coefficient must be negative and significant for it to indicate a return to equilibrium (Pesaran et al., 2001; Olawale and Hassan, 2016).

We opt for equation (4.5) and (4.6) as baselines to estimate two main variables of interest, nominal wage and real wage. To estimate the real wage, the equation and other variables are normalized by the consumer price index. Wages are measured as regional averages of individual hourly rates instead of annual average rates to preclude the effects of cyclical fluctuation of working hours among provinces. These effects on annual average wages are negatively correlated with unemployment rates, leading to systematic measurement error[2]. Unemployment rates are measured in accordance with the ILO definition[3]. In the level form, the effect of unemployment rates on wages indicate a shock in the labor supply. We expect a negative effect of the unemployment rate on wages given that, e.g. increasing unemployment due to excess supply should generate downward pressure on wage. Additionally, the effect of lagged unemployment rates on wages indicate a hysteresis effect and is expected to have a positive value. While a change of unemployment captures the speed limit effect and is expected to have a positive value.

Furthermore, the labor output ratio is measured as the ratio of total output to total employment as a proxy of labor productivity. A positive value for the labor output ratio indicates the degree of contribution of labor productivity on the wage setting. Meanwhile, a positive value in the change of consumer price index (i.e. inflation) is expected to be positive for two reasons. First, it indicates

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[1] As recommended for further research in Phillips (1958), Harris andTodaro (1970) and Blanchflower and Oswald (1994).

[2] For further discussion, see: Blanchard and Katz (1997), Black and FitzRoy (2010).

[3] Unemployed person divine as a person of working age (15 or over) who meets three conditions simultaneously :
(i) being without employment, meaning having not worked for at least one hour during the reference week ;
(ii) being available to take up employment within two weeks; and having actively looked for a job in the previous month or having found one starting within the next three months.

the effort of, fully or partially, maintaining wages in the real term due to increases in prices. Second, a higher value of the coefficient indicates a higher degree of bargaining position of labor or wage indexation in the regions (Anderton and Berthuis, 2015). Instead of a homogenous assumption as in Blanchflower and Oswald (1994) which leads to omitted variables bias as described in Bell (1996), we specify heterogeneous labor productivity and consumer prices across regions. Moreover, equation (4.5) and (4.6) also serve as alternative approaches for contrasting between the Phillips curve and the wage curve. In this setup, the coefficient of the error correction method is used as a contrasting measure. Our setup is similar to that of Madsen (2002) with the exception that we include level of employment in the long-run specification.

In the fourth step, after the baseline specification is established, we exercise three additional features to be part of the wage behavior estimations, i.e. heterogeneity, cross-sectional dependence and structural breaks. In this final step, we expect robust estimations that yield the best outcomes for interpretation. To exercise heterogeneity of wage behavior, three estimators are employed, dynamic fixed effect (DFE), mean group (MG), and pooled mean group (PMG). These estimators accommodate different restrictions in heterogeneity of parameters of interest and estimate under the combination of maximum likelihood and ordinary least squares. The heterogeneity of all or part of the parameters in the equation will be decided based on Hausman tests.

MG and PMG estimators exercised in autoregressive distributed lag (ARDL) model particularly for the error correction specification. An application of this dynamic heterogeneous panel specification, among others, is a cointegration test as elaborated in the previous section. Although Johansen (1995) emphasized that a cointegration relationship required an equal degree of integration, Pesaran, et al. (1999) argued that panel ARDL is applicable for variables with different degrees of integration. MG-ARDL and PMG-ARDL also propose the advantage of producing consistent coefficients even in the presence of endogeneity as it includes lagged dependent and independent variables (Pesaran et al., 1999). In the ARDL specification, we analzse not only coefficient sizes but also the speed and lag structure of wage dynamic behavior. In addition, the ARDL-ECM model makes it possible for the simultaneous estimation of both short-run and long-run effects from a dataset with large cross-section and time dimensions. Due to the limitation of our time series dimension, we impose common lag structures across provinces as suggested in Loayza and Ranciere (2006) and Demetriades and Law (2006), i.e. first lag of dependent, and independent variables. In a more simple form, the baseline specification in equation (4.10) is can be formulated in an ARDL-ECM model as:

$$\Delta w_{r,t} = \alpha_0^r + \sum_{j=1}^{p-1} \gamma_j^r \Delta w_{r,t-j} + \theta_r ect + \sum_{j=0}^{q-1} \delta_j^r \Delta u_{r,t-j} + \sum_{j=0}^{q-1} \delta_j^r \Delta p_{r,t-j} + \sum_{j=0}^{q-1} \delta_j^r \Delta z_{r,t-j} + \mu_{r,t} \quad (4.7)$$

In addition to exercising heterogeneity, recent studies on dynamic panel analzses raise the importance of cross-sectional dependence (CSD) due to unobservable common factors or spatial spill over effects. CSD plays an important part to capture the interdependence between cross-sectional units, which in our case represents interregional dependency[4]. Sarafidis and Wansbeek (2012) emphasized that estimators based on the assumption of cross-sectional independence may prove inefficient or even inconsistent. To overcome the problem, Pesaran (2006) introduced common correlated effects (CCE) as additional covariates in heterogeneous panel analysis to capture the contribution of CSD in error variance. Another development in this strand, Chudik and Pesaran (2013), proposed a dynamic common correlated effect (DCCE) to accommodate dynamic analysis because including lagged dependent variables on the right side of the equation would violate strict exogeneity. Therefore, DCCE is implemented by adding cross-sectional means of lagged dependent variables in the unobserved common correlated effects approximation. DCCE is formulated as follows:

$$y_{i,t} = \lambda_i y_{i,t-1} + \beta_i x_{i,t} + e_{i,t}$$

$$e_{i,t} = \gamma_i' f_t + v_{i,t}, \qquad f_t = (\bar{y}_t, \bar{y}_{t-1}, \bar{x}_t)$$

where (f_t) is an unobservable common factor or spatial spill over, approximated by cross-sectional averages of dependent and independent variables with the option of including their lagged terms. Overall, we exercise DFE, MG, and PMG with the inclusion of CCE and DCCE specifications in our estimations[5]. In terms of cross-sectional dependence, equation (4.7) can be specified as:

$$\Delta w_{r,t} = \alpha_0^r + \sum_{j=1}^{p-1} \gamma_j^r \Delta w_{r,t-j} + \theta_r ect' + \sum_{j=0}^{q-1} \delta_j^r \Delta x_{r,t-j} + \sum_{j=0}^{m-1} \pi_r \Delta \bar{z}_{t-j} + + \mu_{r,t} \qquad (4.8)$$

where (z_t) represents cross-sectional average variables, including their lagged values in the case of DCCE. Two conditionalities need to be satisfied to have consistent and efficient DCCE yields. First, the times-series dimension needs to be large enough for dynamic panel analzses i.e. to capture any intertemporal behavior of the wage, and N and T dimensions should grow at the same rate[6]. Implementing this estimation strategy has the advantage of including both heterogeneous time effects and cross-sectional dependencies. DCCE estimators are also robust to endogeneity and simultaneity issues (Karadam, 2015).

Although the size of our dataset is reasonably adequate for a PMG estimation, having satisfied the asymptotic and large assumptions of N and T, we employed a mean adjustment procedure for

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[4] Regions or regional in this paper refer to sub-national administrative area, i.e. provinces.

[5] For empirical analysis using DCCEPMG, see: Bhattacharya, Mann and Nkusu (2018), Cavalcanti, Mohaddes and Raissi (2015), Chudik, et al. (2015).

[6] A data set with N x T dimension of 30 x 34 units would be more appropriate compare to 10.000 x 360 units for the reason that the latter are certainly larger but not grow with the same rates (Ditzen, 2016).

correcting potential small-sample time series bias in dynamic heterogeneous panels. Therefore, the half-panel jack knife and the recursive mean adjustment procedures are exercised following Ditzen (2018) and Chudik and Pesaran (2015b). Between these two adjustment procedures, we choose the recursive mean adjustment procedure because it produced more robust estimation results. Additionally, partial mean within the recursive mean adjustment is lagged by one period to prevent the influence of endogenous observations. Furthermore, the inclusion of lagged average wage is essential to represent the incidence of wage inertia in the market. In the absence of lagged average wage in an interregional wage setting, the time dummies will capture the effect, leading to downward bias caused by wage inertia. Recent studies such as Arpaia and Pichelmann (2007) and Deak, Holden, and Levine (2017) emphasized the existence of wage inertia.

For the last part, homogenous and heterogeneous regimes and structural breaks also exercised in the estimations. Okui and Wang (2018) discuss the importance of considering structural breaks in a panel data model, such as a financial crises, technological progress, or economic transition. A structural break might also mark the beginning of a new regime in the economy. These breaks may affect the relationship of economic variables and cause breaks in the parameters of the selected model. Failure to account for breaks in the data generating process commonly leads to an overestimation of relevant regressors and a failure to include regressors that are only informative in short-lived regimes (Smith et al., 2018). Additionally, independent variables that are subjected to systematic shocks or risks are most likely the source of endogeneity (Okui and Wang, 2018). A panel model with common breaks proposed in Baltagi, Feng and, Kao (2016) is modelled as:

$$y_{i,t} = \alpha_i + \beta_i(k_0)x_{i,t} + e_{i,t}, \qquad i = 1, \dots, N; t = 1, \dots, T$$

$$\beta_i(k_0) = \begin{cases} \beta_{1i}, & t = 1, \dots, k_0, \\ \beta_{2i} = \beta_{1i} + \delta_i, & t = k_0 + 1, \dots, T \end{cases}$$

where (k_0) is a common breakpoint, so that (δ_i) represents the slope jump before and after breakpoint (β_2-β_1). However, a common breakpoint (k_0) is assumed to be unknown in this setup and (k_0) = 0.5T uses a general theoretical rule to determine the breakpoint[7].

We examine the potential deviation of dynamic wage behavior stemming from shocks in the market by including structural breaks in our panel data. Two types of structural breaks are employed, homogenous and heterogeneous break points. The homogenous break is applied equally to all cross-sectional units, while the heterogeneous break is applied uniquely to each cross-sectional unit. In addition to the breakpoints and the size of the breaks, another important component of structural change is the heterogeneity of breaks. Okui and Wang (2018) emphasize

[7] Baltagi, Feng and Kao (2016) exercise multiple set up of N cases trough Monte Carlo simulation and suggest 0.5T as general rule to predict common breakpoint as it is the one that minimized the sum of N individual sum of squared residuals.

the importance of jointly considering heterogeneity and structural breaks. Ignoring the heterogeneity of breaks may lead to an incorrect detection of break points and inconsistent slope coefficient estimates.

We use a stationarity test introduced by Zivot and Andrew (1992) to identify the potential breakpoints of each variables series specifically for each provinces. The test has a null hypothesis of a unit root with drift and exogenous structural breaks. Therefore, potential breakpoints are initially identified in this stationarity test. The potential breakpoint is determined based on minimum ADF t-test statistics of each series. We utilize those breakpoints to generate two additional variables. A dummy variable is applied to differentiate the 'before' and 'after' of hypothetical structural shocks or differentiate between regimes. Interaction variables are also included to represent any deviation of wage behavior on corresponding variables between breakpoint periods. In terms of structural breaks, we name the model a multidimensional augmented wage equation, specified as follows:

$$\Delta w_{r,t} = \alpha_0^r + \sum_{j=1}^{p-1} \gamma_j^r \Delta w_{r,t-j} + \theta_i ect'' + \sum_{j=0}^{q-1} \delta_j^r \Delta x_{r,t-j} + \sum_{j=0}^{s-1} \pi_r \Delta \bar{z}_{t-j} + \vartheta_r \Delta R_i + \mu_{i,t} \quad (4.9)$$

$$ect'' = \varepsilon_{r,t-1} = w_{i,t-1} - \beta_r^1 x_{i,t-1} - \beta_r^2 \bar{z}_{t-1} + \beta_r^3 R_i$$

$$\bar{z}_t = f(\overline{w}_t, \overline{w}_{t-1}, \bar{x}_t)$$

$$R_i = f(D_{r,t}, D_{r,t} X_{r,t})$$

where (R_r) are pairs of structural break variables including dummy breaks and interaction with the independent variables. The pairs represent hypothetical breaks such as currency fluctuations, changes in the business cycle, economic crises, and inflation. Currency attacks are determined by breaks in the exchange rate (Indonesia Rupiah to US Dollar), business cycles is determined by breaks in the provincial unemployment rate, economic crises is determined by provincial economic growth, and inflation regimes is determined by differentiating periods of high and low inflation using the mean of provincial inflation as a benchmark. Robust estimates including the cross-sectional average of (z_t) needs to be established before conducting a least-squares estimation of (K_0).

6. EMPIRICAL RESULTS

6.1. Pre Estimation Tests

All tests and estimations are performed using the STATA 15 platform. For the cross-dependence test, we utilize the *xtcdf* command by Wursten (2017). The command makes it possible to employ the Pesaran (2004) CD test for strict cross-sectional independence[8]. Besides an individual variable

[8] We also exercise Pesaran (2015) CD test for weak cross-sectional dependence and found that Pesaran (2004) CD test for strict cross-sectional independence is more robust in case of our data set.

test, we also test cross-sectional dependence of the baseline specification residuals. Table 4.1 presents the results of the test, show that there are cross-sectional correlations between units of our data panel and wage specification set up. The result suggest that we need to consider cross-sectional dependence in the following tests and estimations.

Table 4. 1 Cross-Sectional Dependence Tests

Variable	Levels		First Differences	
	CD-test	p-value	CD-test	p-value
Nominal Wage	98.299	0.000	37.091	0.000
Real Wage	85.839	0.000	53.386	0.000
Unemployment Rate	70.501	0.000	50.457	0.000
Nominal Minimum Wage	97.582	0.000	40.750	0.000
Real Minimum Wage	92.872	0.000	59.183	0.000
Consumer Price Index	98.619	0.000	93.626	0.000
Nominal Labor Productivity	97.447	0.000	59.325	0.000
Real Labor Productivity	75.218	0.000	57.990	0.000
Nominal Residual Est.	48.259	0.000	36.123	0.000
Real Residual Est.	50.217	0.000	39.755	0.000

Notes: Under the null hypothesis of cross-section independence, CD ~ N(0,1)
P-values close to zero indicate data correlated across panel groups.

The next pre-estimation test is panel stationarity tests where we utilize the *multipurt* command that combines Fisher's types test (Maddala and Wu, 1999) and CIPS test (Pesaran, 2007)[9]. The result of both stationarity tests for all the variables of interest in level and difference forms presented in Table 4.2. Interestingly as CIPS includes cross-sectional dependences in the test specification, the result indicate that at least one series of a provincial unit is stationary in the level for almost all variables of interest. However, both tests indicate that our variables of interest are integrated at the first difference. These results suggest that only the short-run wage behavior estimation will produce non-spurious regressions. Further examination required to determine whether the log-run wage behavior could also be estimate, and produce non-spurious regression. The cointegration test is performed for this examination, and identify if a dependent variable is cointegrated with at least one of the independent variables. For testing cointegration in a panel data setting, we utilize the xtwest command by Persyn and Westerlund (2008).

Table 4.3 presents the results of cointegration tests, where panel (A) is based on nominal wage and panel (B) is based on real wage. We use the same specification of nominal wage and real wage behaviors with the one in the cross dependence test, which included unemployment rate, minimum wage, labor productivity and exchange rates. Results of cointegration test of both nominal wage and real wage specifications are converged, suggesting that there are cointegration

[9] The *multipurt* command by Eberhardt (2011) integrates the *xtfisher* command by Merryman (2004) and the *pescadf* command by Lewandowski (2006).

between wages with at least one of the explanatory variable. The cointegration is sturdier for real wage as we extend the lags of autoregressive variables in the test specification.

Table 4. 2 Panel Unit Root Tests: Fisher's Test and CIPS Test

Variable	lags	(A) Fisher's Test (Maddala and Wu, 1999)				(B) CIPS Test (Pesaran, 2007)			
		Levels		First Differences		Levels		First Differences	
		chi_sq	p-value	chi_sq	p-value	Zt-bar	p-value	Zt-bar	p-value
Nominal Wage	0	16.089	1.000	751.366	0.000	-12.564	0.000	-22.716	0.000
	1	19.507	1.000	238.721	0.000	-5.809	0.000	-17.836	0.000
Real Wage	0	50.400	0.537	1087.941	0.000	-11.028	0.000	-22.685	0.000
	1	36.848	0.945	443.341	0.000	-5.216	0.000	-17.279	0.000
Unemployment	0	166.767	0.000	837.885	0.000	-11.461	0.000	-22.807	0.000
Rate	1	126.928	0.000	591.737	0.000	-6.101	0.000	-16.424	0.000
Nominal	0	333.868	0.000	375.666	0.000	-6.125	0.000	-20.579	0.000
Minimum Wage	1	108.253	0.000	251.264	0.000	-5.677	0.000	-12.227	0.000
Real	0	319.716	0.000	424.867	0.000	-5.529	0.000	-19.897	0.000
Minimum Wage	1	162.650	0.000	253.847	0.000	-4.723	0.000	-12.696	0.000
Consumer	0	10.482	1.000	666.379	0.000	-3.457	0.000	-15.706	0.000
Price Index	1	10.970	1.000	316.383	0.000	-2.620	0.004	-9.483	0.000
Nominal Labor	0	15.871	1.000	1271.297	0.000	-4.287	0.000	-19.319	0.000
Productivity	1	20.569	1.000	552.392	0.000	-1.791	0.037	-10.213	0.000
Real Labor	0	79.103	0.009	1351.475	0.000	-3.353	0.000	-21.069	0.000
Productivity	1	34.171	0.973	598.652	0.000	-0.603	0.273	-12.278	0.000

Notes: Fisher's test assumes cross-sectional independence, while the CIPS test assumes cross-sectional dependence in the form of a single unobserved common factor. All variables are in natural logarithm form.

Table 4. 3 Panel Cointegration Tests

A. Westerlund ECM Panel Cointegration Test : Nominal Wage Model								
	AR (1) with Constant				AR(2) with Constant			
Statistics	Value	Z-value	P-value	Robust P-value	Value	Z-value	P-value	Robust P-value
Gt	-2.869	1.194	0.116	0.025	-2.785	0.742	0.229	0.060
Ga	-14.583	0.243	0.596	0.000	-2.402	7.777	1.000	0.270
Pt	-11.497	0.558	0.712	0.100	-6.011	5.634	1.000	0.445
Pa	-12.030	0.437	0.331	0.000	-1.762	5.846	1.000	0.425
B. Westerlund ECM Panel Cointegration Test: Real Wage Model								
	AR (1) with Constant				AR(2) with Constant			
Statistics	Value	Z-value	P-value	Robust P-value	Value	Z-value	P-value	Robust P-value
Gt	-3.086	3.420	0.000	0.010	-2.822	2.012	0.022	0.000
Ga	-8.517	2.954	0.998	0.400	-4.789	5.435	1.000	0.340
Pt	-14.095	2.899	0.002	0.000	-10.035	0.849	0.802	0.020
Pa	-7.770	1.033	0.849	0.200	-4.402	3.298	1.000	0.135

Notes:

Gt, Ga -> H0: No cointegration of at least one of cross section unit (based on group mean).

Pt, Pa -> H0: No cointegration for all cross section units (based on pooled panel).

Gt, Pt: Normalized by size of T and Ga, Pa: Normalized by conventional standard error.

6.2. Contrasting Phillips and Wage Curve

Before introducing any other components to the wage behavior model, it is important to predetermine the nature of the wage and unemployment relationship. We employ four different approaches in contrasting the Phillips curve and the wage curve. Table 4.4 present the summary results of all four approaches. A level-based approach based on Blanchflower and Oswald (1994) uses coefficients of lagged wages as a contrasting measure between the Phillips curve and the wage curve. The estimation results of both nominal and real wage specifications yield positive and statistically significant coefficients. Despite some drawbacks to this approach, as elaborated in Madsen (2002), discretely pinpointing the Phillips curve or wage curve based on this approach is intricate since the contrasting coefficients are 'in between' and not 'close' to the values of one and zero.

The difference-based approach, however, show that the coefficient of both unemployment rates and its lagged values are indifferent but have opposing signs for the nominal and real wage specifications. The results would indicate a wage curve if the coefficient was statistically insignificant, which is not our case. As in the Blanchard and Katz (1997) ECM-based 1 approach, all the coefficients of speed of adjustment are negative and statistically significant and range from 0.392 to 0.470. The result suggests the existence of a wage curve particularly in the reconciliation setting with the Phillips curve as in Blanchard and Katz (1997). For the Madsen (2002) ECM-based 2 approach, we arrive at different results. The effect of change of unemployment on both nominal and real wages are negative and significant, indicating that a wage curve is present. The effect of unemployment rates in contrast are positive and significant, as opposed to the Phillips curve.

Table 4. 4 Contrasting the Phillips Curve and the Wage Curve

Contrasting Approach	Corresponding Parameters	Nominal Wage - Unemployment		Real Wage - Unemployment	
		Semi-Log	Log - Log	Semi-Log	Log-Log
1. Level-Based (Blanchflower and Oswald, 1994)	Lagged Wages	0.389*** (0.032)	0.388*** (0.032)	0.524*** (0.029)	0.527*** (0.029)
2. Difference-Based (Card, 1995)	Unemployment Rates	-0.005 (0.003)	-0.016 (0.014)	-0.005*** (0.003)	-0.019 (0.014)
	Lagged Unemployment Rates	0.004 (0.003)	0.015 (0.014)	0.005 (0.003)	0.019 (0.014)
3. ECM-Based 1 (Blanchard and Katz, 1997)	Error Correction Term	-0.460*** (0.028)	-0.470*** (0.026)	-0.392* (0.034)	-0.397*** (0.033)
4. ECM-Based 2 (Madsen, 2002)	Level of Unemployment Rates	0.007** (0.002)	0.036*** (0.013)	0.006** (0.002)	0.036** (0.013)
	Change of Unemployment Rates	-0.009** (0.002)	-0.055*** (0.009)	-0.017*** (0.002)	-0.101*** (0.012)

Notes:
All labor productivity and prices in nominal wage estimation as in 'original' specification.
* p<0.05, ** p<0.01, *** p<0.001, standard errors are in parentheses.

Out of four contrasting measures, only the Blanchard and Katz (1997) ECM-based approach provides the most conclusive findings. It also has the advantage of including results from other measures, i.e. taking into account the market's long-run wage behavior. Therefore, we decide to use the ECM-based approach as our baseline specification and elaborate it by introducing other variables and components. We exercise multiple forms of unemployment rates in the specifications as suggested in Phillips (1958) and Blanchflower and Oswald (1994). We decide to employ a natural logarithm of unemployment rates, i.e. a log-log specification, for being the best empirical fit as in Whelan (1997). The results motivate us to use an alternative approach, i.e. ECM-based 3, which specifies the change of unemployment rates in the short-run and level of unemployment rates in the long-run. For the next part of the paper onward, we will focus on ECM-based 1, 2, and 3 specifications to evaluate the heterogeneity of dynamic wage behavior.

6.3. Heterogeneity of Dynamic Wage Behavior

We further exercised the estimations to account for heterogeneity not only in the intercept but also in the slope coefficients of the short-run adjustment and the long-run equilibrium of dynamic wage behavior. To do so, we utilize three estimators to estimate those three ECM-based specifications, i.e. DFE, MG and PMG. Table 4.5 and Table 4.6 presents the results of nominal wage and real wage cases. Hausman tests for both cases conclude that PMG estimators provide consistent and efficient coefficients. This result imply that PMG estimators are more robust than DFE and MG estimators are, suggesting heterogeneous short-run adjustments and homogeneous long-run equilibrium relationships. Accordingly, we focus on utilizing PMG estimators in the following estimations in the nominal wage and real wage models.

Table 4. 5 Nominal Wage Behavior and Heterogeneity

Variables	ECM-Based 1			ECM-Based 2			ECM-Based 3		
	DFE	MG	PMG	DFE	MG	PMG	DFE	MG	PMG
Short-run									
Unemployment Rate (L)	0.002 (0.009)	-0.013 (0.014)	-0.010 (0.011)	0.023* (0.010)	0.009 (0.017)	0.008 (0.012)	-	-	-
Unemployment Rate (D)	-	-	-	-0.050*** (0.010)	-0.043*** (0.013)	-0.038*** (0.010)	-0.026** (0.010)	-0.034* (0.014)	-0.030** (0.010)
Nominal Wages (D.-1)	0.014 (0.035)	0.057 (0.033)	0.062 (0.039)	0.016 (0.034)	0.038 (0.034)	0.058 (0.040)	0.016 (0.034)	0.038 (0.034)	0.068 (0.039)
Labor Productivity (D)	0.028 (0.032)	0.053* (0.025)	0.044* (0.021)	0.032 (0.032)	0.056 (0.031)	0.047 (0.025)	0.032 (0.032)	0.056 (0.031)	0.052* (0.024)
Minimum Wage (D)	0.071 (0.038)	0.154** (0.051)	0.154*** (0.037)	0.080* (0.039)	0.148** (0.053)	0.155*** (0.039)	0.080* (0.039)	0.148** (0.053)	0.153*** (0.040)
Prices (D)	0.299*** (0.043)	0.288*** (0.036)	0.285*** (0.026)	0.309*** (0.042)	0.296*** (0.035)	0.292*** (0.026)	0.309*** (0.042)	0.296*** (0.035)	0.295*** (0.026)
ECT	-0.462*** (0.036)	-0.665*** (0.046)	-0.584*** (0.038)	-0.454*** (0.034)	-0.642*** (0.047)	-0.567*** (0.035)	-0.454*** (0.034)	-0.642*** (0.047)	-0.541*** (0.038)
Cons	0.528*** (0.091)	0.596*** (0.134)	0.473*** (0.038)	0.538*** (0.095)	0.640*** (0.145)	0.509*** (0.040)	0.538*** (0.095)	0.640*** (0.145)	0.454*** (0.028)
Long-run									
Unemployment Rate (L,-1)	-	-	-	-	-	-	0.052* (0.024)	0.046 (0.037)	0.024 (0.017)
Labor Productivity (L,-1)	0.084 (0.070)	0.077 (0.053)	0.099*** (0.027)	0.077 (0.070)	0.065 (0.055)	0.090*** (0.027)	0.077 (0.070)	0.065 (0.055)	0.086** (0.028)
Minimum Wage (L,-1)	0.216*** (0.040)	0.186* (0.076)	0.259*** (0.025)	0.209*** (0.042)	0.156 (0.084)	0.247*** (0.025)	0.209*** (0.042)	0.156 (0.084)	0.253*** (0.025)
Prices (L,-1)	0.777*** (0.081)	0.842*** (0.084)	0.698*** (0.039)	0.786*** (0.082)	0.893*** (0.093)	0.719*** (0.040)	0.786*** (0.082)	0.893*** (0.093)	0.721*** (0.040)
Observations	728	728	728	728	728	728	728	728	728
bic	-	-1,842.19	-1,698.29	-	-1,882.47	-1,728.23	-	-1,882.47	-1,690.89
aic	-	-1,888.09	-1,744.19	-	-1,932.96	-1,778.72	-	-1,932.96	-1,741.38
Hausman MG-DFE		1.000			0.999			1.000	
Hausman MG-PMG		0.430			0.350			0.126	

Note:
* p<0.05, ** p<0.01, *** p<0.001, standard errors are in parentheses.
Hausman tests are based on the probability of Chi-square statistics.

In terms of contrasting the Phillips curve and the wage curve, all specifications show statistically significant error correction coefficients with values ranging from 0.436 to 0.648 for nominal wage and 0.516 to 0.814 for real wage. Based on these speed of adjustment coefficients, the reconciliation of both curves is more profound. Within PMG estimation results, based on AIC and BIC selection criteria, the nominal wage and real wage specifications are in favor ECM-based 3 and ECM-based 1. Similar to the results in the previous section, results of the ECM-based 2 specification are inconclusive.

Table 4. 6 Real Wage Behavior and Heterogeneity

Variables	ECM-Based 1			ECM-Based 2			ECM-Based 3		
	DFE	MG	PMG	DFE	MG	PMG	DFE	MG	PMG
Short-run									
Unemployment Rate (L)	-0.006 (0.011)	-0.015 (0.014)	-0.010 (0.012)	0.025* (0.011)	0.011 (0.016)	0.014 (0.014)	-	-	-
Unemployment Rate (D)	-	-	-	-0.071*** (0.011)	-0.064*** (0.013)	-0.073*** (0.012)	-0.046*** (0.013)	-0.053*** (0.013)	-0.068*** (0.011)
Real Wages (D.L1)	-0.087** (0.032)	0.029 (0.031)	-0.028 (0.033)	-0.073* (0.030)	0.020 (0.032)	-0.024 (0.033)	-0.073* (0.030)	0.020 (0.032)	-0.028 (0.031)
Labor Productivity (D)	0.023 (0.032)	0.092* (0.038)	0.065* (0.030)	0.034 (0.032)	0.092* (0.040)	0.071* (0.034)	0.034 (0.032)	0.092* (0.040)	0.080* (0.036)
Minimum Wage (D)	0.403*** (0.024)	0.479*** (0.024)	0.447*** (0.028)	0.395*** (0.025)	0.467*** (0.024)	0.449*** (0.028)	0.395*** (0.025)	0.467*** (0.024)	0.425*** (0.032)
ECT	-0.458*** (0.039)	-0.707*** (0.060)	-0.582*** (0.057)	-0.454*** (0.036)	-0.689*** (0.061)	-0.574*** (0.057)	-0.454*** (0.036)	-0.689*** (0.061)	-0.543*** (0.057)
Cons	0.634** (0.225)	1.188*** (0.354)	1.122*** (0.115)	0.787*** (0.208)	1.315*** (0.332)	1.159*** (0.123)	0.787*** (0.208)	1.315*** (0.332)	1.074*** (0.109)
Long-run									
Unemployment Rate (L.-1)	-	-	-	-	-	-	0.055* (0.026)	0.054 (0.038)	0.004 (0.017)
Labor Productivity (L,-1)	0.119* (0.058)	0.195** (0.075)	0.107*** (0.033)	0.113* (0.053)	0.185* (0.077)	0.097** (0.032)	0.113* (0.053)	0.185* (0.077)	0.111*** (0.033)
Minimum Wage (L,-1)	0.437*** (0.036)	0.375*** (0.039)	0.405*** (0.020)	0.406*** (0.037)	0.351*** (0.045)	0.401*** (0.020)	0.406*** (0.037)	0.351*** (0.045)	0.394*** (0.020)
Observations	728	728	728	728	728	728	728	728	728
bic	-	-1,583.00	-1,478.35	-	-1,622.77	-1,530.36	-	-1,622.77	-1,488.11
aic	-	-1,619.72	-1,515.08	-	-1,664.08	-1,571.68	-	-1,664.08	-1,529.42
Hausman MG-DFE		0.996			0.998			0.999	
Hausman MG-PMG		0.541			0.531			0.699	

Note:
* p<0.05, ** p<0.01, *** p<0.001, standard errors are in parentheses.
Hausman tests are based on the probability of Chi-square statistics.

6.4. Common Correlated Effects and Interregional Wage Dependencies

In this section, we investigate common correlated effects in the specifications to ease the estimation bias toward cross-section dependences. Our further discussion on common correlated effects and interregional dependencies are based on ECM-based 3 specifications[10]. Table 4.7 and Table 4.8 present estimation results of wage behavior on different setups of cross-section average variables. For comparison reference purposes, the first and second columns present estimation results of the baseline specification, not including the cross-sectional average variables. We include contemporaneous cross-sectional averages for the independent variables (3rd and 4th columns), the addition of their lags (5th and 6th columns), and the lagged dependent variables (7th and 8th columns) to analyze the presence of common correlated effects. Based on a cross-sectional dependence test from the previous section, we included a cross-sectional average of all variables.

[10] We also exercise ECM-based 1 and ECM-based 2 specifications as in previous section. However, we focus in ECM-based 3 specification for providing more robust estimation results.

For each common correlated effects estimator, we exercise two different settings of error correction mechanisms. Model A assumes a homogenous error correction mechanism and model B assumes a heterogeneous error correction mechanism. Out of eight specifications of nominal and real wage cases, the third specification provides the most robust estimation results including effectively accounting for common correlated effects.

In both the nominal and real wage cases, a change in unemployment consistently show significant negative effects to wage in the short-run, except for in the dynamic common correlated effects model. The effects range from 3 percent for nominal wage to 5 percent for real wage. Similar to other studies, e.g. Rusinova, et al. (2015) and Anderton and Bonthuis (2015), the effects are less pronounced than other variables including labor productivity and minimum wage. These findings are not only important for the development of the labor market but also have important implications for monetary policy, e.g. inflation targeting in Indonesia. Despite a statistically insignificant level of unemployment, we keep the parameter in the long-run equation for particular reasons. Our exercises show that excluding unemployment level from the equation would change the robustness of the overall results. The inclusion of unemployment level rates in the long-run are also essential for differentiating the Phillips curve and the wage curve.

The findings suggest two important lessons for the wage and unemployment relationship. First, considered as a supply shock, unemployment has a speed limit effect on the short-run dynamic of wages. Second, the possibility of an intertemporal permanent effect of supply shock in the long-run is most likely hindered by a more pronounced effect, possibly spillover effects from the labor market of neighboring provinces. It highlights the importance of addressing intertemporal and interregional development of labor markets within and between provinces in the short-run adjustment and long-run equilibrium of wages. Concerning our main objective of differentiating the Phillips curve from the wage curve, the results suggest that there are intertemporal short-run effects of unemployment with the possibility of an interregional equilibrium effect in the long-run.

Changes in labor productivity also consistently shows positive effects on changes of nominal wage in the short-run. Concerning employer and worker interaction, these findings indicate wage changes response on the changes of labor productivity. Thus, increasing wage of insider worker might be more preferred than replacing them with a potentially more productive outsider worker in the market, including the added cost of finding and hiring, and the risk of adverse selection. The significant effect of labor productivity on real wages indicates that the employer pays more than the reservation wage in order to avoid the consequence of shirking or even losing their productivity, leading to a loss of profit. The effects of a change in labor productivity are higher than unemployment, suggesting greater issues in terms of industrial relations between workers and employers in the wage dynamic instead of the labor market. We also examine the inclusion of nominal and real labor productivity in the long-run specifications. The results show a less significant effect of labor productivity in the long-run, as suggested in Blanchard and Katz (1999).

Table 4. 7 Nominal Wage Behavior and Interregional Dependencies

Variables	PMG-A	PMG-B	Common Correlated Effect				Dynamic CCE	
			PMG-A	PMG-B	PMG1-A	PMG1-B	PMG1-A	PMG1-B
Short-run								
Unemployment Rate (D)	-0.031**	-0.031**	-0.033**	-0.023*	-0.018	-0.007	-0.025	-0.026
	(0.010)	(0.010)	(0.011)	(0.011)	(0.021)	(0.020)	(0.025)	(0.032)
Unemployment Rate (D,-1)	-	-	-	-	-	-	-0.019	-0.019
							(0.017)	(0.020)
Labor Productivity (D)	0.057*	0.063**	0.135***	0.161***	0.081	0.105*	0.157*	0.080
	(0.025)	(0.024)	(0.025)	(0.025)	(0.049)	(0.050)	(0.068)	(0.086)
Labor Productivity (D,-1)	-	-	-	-	-	-	0.009	-0.026
							(0.044)	(0.055)
Minimum Wage (D)	0.108**	0.104**	0.193***	0.199***	0.131**	0.157***	0.181**	0.274***
	(0.034)	(0.032)	(0.034)	(0.031)	(0.044)	(0.043)	(0.059)	(0.073)
Minimum Wage (D,-1)	-	-	-	-	-	-	0.019	-0.007
							(0.051)	(0.054)
Prices (D)	0.303***	0.322***	0.740***	0.650***	0.512*	0.200	0.297	0.433
	(0.024)	(0.022)	(0.033)	(0.033)	(0.219)	(0.251)	(0.218)	(0.246)
	-	-	-	-	-	-	0.031	0.114
							(0.075)	(0.076)
	-	-	-	-	-	-	-0.079	-0.052
Nominal Wages (D.-1)							(0.049)	(0.064)
ect	-0.455	-0.530***	-0.920***	-0.954***	-0.889***	-0.946***	-0.915*	-1.037***
	(1.269)	(0.005)	(0.108)	(0.013)	(0.252)	(0.020)	(0.358)	(0.114)
Const.	1.494***	1.471***	0.044	0.005	0.052	0.002	0.166	7.468
	(0.028)	(0.075)	(0.045)	(0.052)	(0.056)	(0.071)	(0.203)	(10.440)
Long-run								
Unemployment Rate (L,-1)	0.048	0.039	-0.026	-0.015	0.005	0.020	0.084	0.044
	(0.353)	(0.468)	(0.036)	(0.036)	(0.090)	(0.075)	(0.152)	(0.140)
Labor Productivity (L, -1)	0.099	0.115	0.160*	0.187**	0.137	0.188	0.237	0.199
	(0.499)	(0.620)	(0.074)	(0.062)	(0.201)	(0.123)	(0.287)	(0.268)
Minimum Wage (L, -1)	0.140	0.124	0.277***	0.305***	0.282	0.327**	0.102	0.231
	(0.397)	(0.376)	(0.075)	(0.060)	(0.151)	(0.104)	(0.262)	(0.253)
Prices (L, -1)	0.858	0.866*	0.794***	0.659***	0.806	0.557	0.160	0.185
	(0.812)	(0.361)	(0.201)	(0.172)	(0.505)	(0.463)	(0.800)	(0.701)
Observations	754	754	728	728	728	728	702	702
Adjusted R^2	0.673	0.684	0.626	0.644	0.219	0.268	0.540	0.559
F-Stat	10.930	9.832	5.594	5.540	1.520	1.640	2.581	2.631
CD-Stat	24.620	27.590	-2.160	-2.041	-2.049	-1.956	-1.185	-1.352
Prob CD-Stat	0.000	0.000	0.031	0.041	0.041	0.050	0.236	0.177

Note: * p<0.05, ** p<0.01, *** p<0.001, standard errors are in parentheses.

Following role of the changes in labor productivity above, changes in minimum wages have higher and consistent effects on the change of both nominal and real wages. The changes in minimum wage has contributed approximately 19 percent to the changes in the nominal wage and 32 percent to changes in the real wage. In nominal wage case, the effects indicate the role of minimum wage in wage determination, i.e. the wage indexation to minimum wages to some extent. In the real wage case where it is more pronounced than nominal wage, the effect indicates a more rigorous role of minimum wage beyond inflationary issues. Workers represented by labor unions try to increase minimum wage as much as possible not only in nominal terms but also in real terms. In the long-run, our results also show a permanent effect of minimum wage on the nominal and real wage equilibria.

Table 4. 8 Real Wage Behavior and Interregional Dependencies

Variables	PMG-A	PMG-B	Common Correlated Effect				Dynamic CCE	
			PMG-A	PMG-B	PMG1-A	PMG1-B	PMG1-A	PMG1-B
Short-run								
Unemployment Rate (D)	-0.0576*** (0.010)	-0.0586*** (0.010)	-0.0259* (0.011)	-0.014 (0.011)	-0.029 (0.021)	-0.022 (0.021)	-0.034 (0.022)	-0.039 (0.025)
Unemployment Rate (D,-1)	-	-	-	-	-	-	-0.026 (0.018)	-0.020 (0.017)
Labor Productivity (D)	0.0951** (0.030)	0.0995*** (0.027)	0.296*** (0.036)	0.331*** (0.031)	0.074 (0.079)	0.054 (0.076)	0.048 (0.055)	0.057 (0.053)
Labor Productivity (D,-1)	-	-	-	-	-	-	0.025 (0.039)	0.006 (0.036)
Minimum Wage (D)	0.424*** (0.026)	0.436*** (0.020)	0.324*** (0.025)	0.296*** (0.021)	0.175*** (0.041)	0.179*** (0.037)	0.143** (0.046)	0.173*** (0.044)
Minimum Wage (D,-1)	-	-	-	-	-	-	0.028 (0.041)	0.037 (0.042)
Real Wages (D.-1)	-	-	-	-	-	-	-0.0830* (0.038)	-0.083 (0.055)
ect	-0.458 (1.263)	-0.521*** (0.022)	-0.796*** (0.084)	-0.842*** (0.013)	-0.594*** (0.128)	-0.670*** (0.013)	-0.860 (0.657)	-0.885*** (0.083)
Const.	1.844*** (0.030)	1.420*** (0.298)	-0.009 (0.032)	-0.010 (0.030)	0.005 (0.037)	-0.006 (0.037)	-0.029 (0.038)	-0.135* (0.067)
Long-run								
Unemployment Rate (L,-1)	0.062 (0.908)	0.038 (0.663)	0.012 (0.035)	0.021 (0.032)	0.045 (0.053)	0.038 (0.034)	-0.003 (0.331)	-0.018 (0.328)
Labor Productivity (L, -1)	0.177 (0.610)	0.216 (0.423)	0.381*** (0.094)	0.428*** (0.073)	0.306 (0.213)	0.365*** (0.079)	0.146 (1.174)	0.190 (1.034)
Minimum Wage (L, -1)	0.341 (0.686)	0.321 (0.360)	0.363*** (0.088)	0.316*** (0.074)	0.427* (0.177)	0.370*** (0.077)	0.084 (0.421)	0.135 (0.564)
Observations	754	754	728	728	728	728	702	702
Adjusted R^2	0.408	0.421	0.576	0.612	0.116	0.202	0.606	0.622
F-Stat	5.812	5.128	5.672	5.853	1.304	1.544	3.582	3.603
CD-Stat	27.350	29.730	1.458	0.591	-2.935	-2.913	-1.412	-2.162
Prob CD-Stat	0.000	0.000	0.145	0.555	0.003	0.004	0.158	0.031

Note: * p<0.05, ** p<0.01, *** p<0.001, standard errors are in parentheses.

In the Indonesian labor market, minimum wage has developed from a complementary policy instrument into a prevailing wage reference. These developments resulted from many factors including international pressure in the late 1980's, decentralization of minimum wage legislation in the late 1990's and the strengthening of labor unions in the tripartite system (Sugiyarto and Endriga, 2008). The minimum effect represents the contribution of institutional factors on wage changes, i.e. institutional wage rigidity. As regional minimum wages are mostly applied for unskilled labor, which accounts for nearly half of the labor force (Statistics Indonesia, 2015), the institutional rigidity effect will most likely persist. A consistent increase of regional minimum wages might eventually discourage efforts to alleviate the unemployment problem (Sugiyarto and Endriga, 2008).

Prices have the highest effect and contributes approximately 70 percent to changes in nominal wages. Unemployment and labor productivity are considered to play a role, where price change contributes to the nominal part of wage rigidity. Interestingly, aside from being responsive to changes in the minimum wage, nominal wages are also responsive to changes in prices, i.e. inflation. In this case, inflation might raise other input costs, and in aggregate terms, force employers to raise wages and changing the menu cost. At least employer and worker will have to agree on raising nominal wages in order to preserve part or overall wages in real terms. This finding could also signify the backward-looking effect on wages where workers try to maintain their budget constraint at least to levelling off the raise of prices. Although a moderate level of inflation might be required to 'grease the wheels of labor market', keeping the change of wage responding into inflation might trading off the capacity to absorb labor supply shock.

Error correction coefficients for both nominal and real wages are dynamically stable and convergence, evidenced by the significant and negative value of the coefficients. The results suggest nominal and real wage rigidities and certain adjustment processes toward the long-run equilibrium of wage behaviors. The coefficients range from 0.53 to 1.04 for nominal wage and from 0.52 to 0.89 for real wage. The higher the error correction coefficient, the faster the adjustment and convergence of wages to their long-run equilibrium. Taking model CCEPMG-A (3rd columns) as an example, nominal wage converges towards its long-run equilibrium as much as 90 percent within a year. While the real wage converges to 80 percent of the long-run equilibrium within a year. These findings indicate that real wage rigidity is more severe than nominal wage rigidity.

6.5. Homogenous and Heterogeneous Regimes and Structural Breaks

We exercise four pairs of dummy and interaction variables in the following estimations. The pairs represent regimes and structural breaks in the labor market or in the economy, driven by currency attack, business cycle, economic crisis, and inflation regimes. The currency attack is homogenous (i.e. common across provinces) while the others are heterogeneous (i.e. specific to each province). We also exercise a dummy regime, which examine potential behavior deviation of wage in downward and upward changes. Interaction variables also includes in the estimations to examine wage behavior specifically after the structural breaks. Table 4.9 presents the estimation results in nominal and real wage cases with additional pairs of structural break variables. Overall, nominal wages are more stable during structural breaks, except in the break of economic crises. This finding indicates a more rigid nominal wage to adjust to its long-run equilibrium after a break of economic crisis. Wage change is higher in the short-run after an economic crisis, and will eventually require longer periods to adjust to its equilibrium. Thus, the higher wage rigidity in the short-run, the lower wage flexibility in the long-run. Overall, economic shocks in the provinces might have caused a change or shift in the economic structure and thus, affected the labor market.

Real wage behavior is also subject to multiple structural breaks. The first are structural breaks driven by an external factor such as exchange rates. A currency attack, determined by the largest fluctuation in exchange rates during the periods of our study, signify the effect of currency attacks in Indonesia in late 1997. Our results show that the response of real wages to the exchange rate are greater after a currency attack. Thus, real wage is more rigid after a currency attack. A change of real wages also shows statistically significant differences during the shift of a business cycle. The peaks in unemployment rates determines business cycles during the overall period. Accordingly, a contraction period include years leading up to the peak, and the peak itself, whereas an expansion period include years of post-peak. Our findings suggest a different rate of real wage rigidity during expansion and contraction episodes in the provincial economies. This finding is similar with Rusinova, et al. (2011), suggesting that real wages are less responsive to unemployment during higher unemployment periods as indicated in Phillips (1958).

Table 4. 9 Nominal and Real Wages Behavior and Structural Breaks

Variables	Nominal Wage with Structural Break of				Real Wage with Structural Break of			
	Currency Attack	Business Cycle	Economic Crisis	Inflation Regime	Currency attack	Business Cycle	Economic Crisis	Inflation Regime
Short-run								
Unemployment Rate (D)	0.120*** (0.028)	-0.016 (0.016)	-0.031** (0.010)	-0.0321** (0.010)	-0.038*** (0.010)	-0.018 (0.015)	-0.028** (0.009)	-0.015 (0.009)
Labor Productivity (D)	-0.030** (0.009)	0.121*** (0.025)	0.116*** (0.029)	0.132*** (0.021)	0.249*** (0.034)	0.268*** (0.034)	0.268*** (0.035)	0.199*** (0.036)
Minimum Wage (D)	0.117*** (0.033)	0.121*** (0.031)	0.143*** (0.035)	0.115*** (0.031)	0.234*** (0.022)	0.211*** (0.019)	0.227*** (0.025)	0.110** (0.034)
Prices (D)	0.682*** (0.038)	0.604*** (0.039)	0.703*** (0.051)	0.724*** (0.211)	-	-	-	-
Break Dummies	0.030 (0.062)	0.005 (0.033)	0.076* (0.033)	0.023 (0.021)	-0.047 (0.027)	-0.053** (0.017)	-0.003 (0.024)	0.055*** (0.013)
Interaction Breaks	0.017 (0.027)	-0.005 (0.018)	-0.174 (0.100)	-0.002 (0.003)	-0.076** (0.029)	-0.011 (0.018)	-0.031 (0.369)	-0.006*** (0.001)
Downward - Upward Wage Dummy	0.091*** (0.011)	0.100*** (0.012)	0.091*** (0.012)	0.097*** (0.011)	0.093*** (0.006)	0.103*** (0.007)	0.092*** (0.006)	0.106*** (0.007)
ECT	-0.787*** (0.142)	-0.735*** (0.139)	-0.756*** (0.161)	-0.723*** (0.138)	-0.588*** (0.104)	-0.550*** (0.087)	-0.637*** (0.115)	-0.450 (0.232)
_cons	0.004 (0.057)	0.029 (0.047)	0.054 (0.052)	0.059 (0.052)	0.142* (0.070)	0.086 (0.046)	-0.017 (0.044)	0.128** (0.040)
Long-run								
Unemployment Rate (L,-1)	-0.033 (0.039)	-0.009 (0.045)	-0.024 (0.079)	-0.043 (0.037)	-0.053 (0.039)	0.005 (0.048)	-0.029 (0.037)	-0.007 (0.246)
Labor Productivity (L, -1)	0.154 (0.100)	0.173 (0.093)	0.168 (0.120)	0.173 (0.096)	0.417** (0.134)	0.490*** (0.088)	0.420*** (0.093)	0.453 (0.979)
Minimum Wage (L, -1)	0.281*** (0.082)	0.295** (0.098)	0.287** (0.105)	0.293*** (0.087)	0.325*** (0.098)	0.259*** (0.065)	0.335*** (0.071)	0.320 (0.835)
Prices (L, -1)	0.856* (0.332)	0.764** (0.283)	0.764* (0.326)	0.780** (0.293)	-	-	-	-
Observations	728	728	728	728	728	728	728	728
Adjusted R2	0.717	0.709	0.710	0.718	0.751	0.719	0.755	0.751
F-Stat	6.380	6.183	6.216	6.405	8.596	7.427	8.766	8.599
cd	-0.470	-0.046	-0.465	0.241	3.137	3.327	1.657	3.481
Prob CD-Stat	0.639	0.963	0.642	0.809	0.002	0.001	0.098	0.000

Note: * p<0.05, ** p<0.01, *** p<0.001, standard errors are in parentheses.

We also study the response of wages during high and low inflation regimes, differentiated heterogeneously by intertemporal means of inflation for overall periods. Interestingly, our results show statistically significant effects of the dummy regime and the interaction variable on the real wage change. The findings suggest that changes in real wages are greater in high inflation regimes, while the response to change in prices are less pronounced. These findings indicate that under certain economic conditions, e.g. cost of living in general are high, employers and workers might focus on nominal rather than real wages although respond to nominal wage eventually leads to higher real wage change. Moreover, both nominal and real wages show statistically significant differences between the downward and upward regimes. These findings suggest that downward wage rigidities are more pronounced than upward wage rigidities. The rest of the estimation results are consistent with results in the previous section. Nevertheless, the error correction coefficient is lesser than previous results as we take into account the structural breaks. These differences suggest that nominal and real wages are actually stickier in the event of various breaks in the market.

4.1. CONCLUSION

This study analyzed the extent of nominal and real wage rigidity in three interrelated parts, which are the nature of wage and unemployment relations (i.e. the incidence of the Phillips curve or the wage curve), the incidences of provincial heterogeneity and dependencies across labor markets, and wage behavior in the presence of homogenous and heterogeneous structural breaks. The results signify the existence of temporary effects of unemployment on wages, heterogeneity of wage behavior in the short-run, interregional dependence in wage flexibility and differentiated behavior of wages in the presence of regimes and structural breaks. Thus, in the short-run, wages require a certain periods to adjust with the temporary structural breaks and regime effects, correcting the disequilibrium, and eventually convergence toward its long-run equilibrium.

In the long-run, flexibility of nominal wage is determined largely by the minimum wage whereas for real wage also includes labor productivity. The findings are in line with the Phillips curve, with a temporary effect of unemployment to a change in wages. For the wage curve, some adjustments towards a long-run equilibrium of wages does take place while the role of labor market supply shocks might be more complicated than what is expected. In our cases, labor market supply shocks between provinces might have an equal role, if not more, as within provinces themselves. Those findings imply that spillover effects spread directly through wage or indirectly through labor mobility across provinces. It underlines the importance of considering intertemporal and interregional development of labor markets within and between provinces in the short-run adjustment and long-run equilibrium of wages. In regards to structural breaks and regimes, our results show that nominal wage is more sensitive to economic changes, whereas real wage is more sensitive to business cycle and inflation regimes. Both signify the asymmetric behavior of wage rigidity in the presence of structural breaks of regime shifts. The results also imply that both nominal and real wage rigidity are more pronounced during downward-leaning wage regimes. Nominal and real wage rigidity do coexist. The essential part of dealing with nominal and real wage rigidities are to determine the behavior in a certain economic setting and formulate appropriate policy to deal with.

A more intensive structure of panel data, i.e. utilizing sub-provincial levels and longer periods of the dataset, will provide more advantages for further studies. Not only can it provide significant additional observations for the analyses of wage behavior, but it may also make it possible to scrutinize specific issues in wage dynamic behaviors including the structure of intertemporal wage dynamics and interregional wage spatial. Finally, our findings on wage behavior in the Indonesian labor market has several policy implications. First, development towards a more competitive labor market is necessary in order to amplify the wage response to the labor market equilibrium. The less wage rigidity there is, the more jobs will be created. Second, labor productivity improvement is necessary to ease labor productivity uncertainty and occupational mismatch. Only then, the incentives to keep the wages above market-clearing rate are diminished. Third, development of a wage-setting stance is needed to account for labor market and aggregate economic development of neighboring provinces. Fourth, maintaining a stable level of inflation will be more appropriate for easing the stickiness of real wages. Finally, institutional developments including setting a minimum wage are crucial for developing a more competitive labor

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