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Do Phillips Curve Respond Asymmetrically to Unemployment? Evidence from Korea and the U.S.

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Abstract

Purpose – This study empirically analyses the changes in unemployment rates to understand push factors of generating wage pressure and how it affects the aggregate demand in Korea and the United States. We use a structural macroeconomic model which is centered on the labor market and simultaneously explains the natural rate of unemployment and deviations.

Research design, data and methodology – We attempt to empirically analyse the unemployment rates through two countries to analyse the economic effects of real wages and aggregate demand between 2000 and 2016. We introduce having estimated the whole model that the growth of unemployment into the part caused by each of these factors.

Results – The results of this study show that in the long run, there is not only a natural level of employment but also a natural level of real demand are positively related. in the short run,
demand can vary from bring about changes in employment by means of price or wage surprises.

Conclusions – The pressure of demand in the labor market shows up strongly in both countries. The estimated labor-demand equation are consistent with this framework and generally have well defined real wage and demand effects.

Keywords: Unemployment, Real Wage, Inflation Rates, Aggregate Demand.

JEL Classifications: C32, E39, E64, E66.

1. Introduction

An active debate is now under way in the Korea and United States about the scope for expansionary macroeconomic policies in the near term. The real wage issue seems to invite extreme positions. In some models real wages are no significance for macroeconomic outcomes, while in others they are of decisive importance. High real wage levels of unemployment in OECD countries during much of the past decades.

Real wages do not explain the sharp jump in unemployment since 2000 in most countries; that jump is clearly tied to monetary contraction rather than to supply factors. This is in marked contrast to the United States where unemployment has risen and fallen around a more gentle upward trend. In korea both the fluctuations of unemployment and its trend have been minor. Real wages do help explain the secular rise in unemployment since 2000. Furthermore, while high real wages complicate demand management policies.

The following average unemployment rates give some idea of the marked differences in trend(<Table 1>). Whereas in the United States there was a jump between the later 2009s but no clear trend otherwise. Interestingly, the labor force has been relatively constant and unemployment has risen, while in the United States and Korea the labor force has grown sharply and unemployment has not(Kim, 2016).

To explain the different movements of unemployment, we use a structural macroeconomic model which is centered on the labor market and simultaneously explains the natural rate of unemployment and deviations. The mode1 has two main features, First, with regard to the determinants of employment, it cuts through the fruitless debate now raging as to whether current unemployment is “classical”(meaning due to excessive real wages) or keynesian(meaning due to

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deficient demand). In our formulation we allow both these influences to affect employment.

We argue that the perfect competition framework within which the discussion is usually conducted is unhelpful and that imperfect competition is more realistic. In perfect competition prices are set by impersonal forces, and it is not clear what could possibly stop prices from clearing the market. Instead it is more reasonable to think of prices as being set by imperfectly competitive firms, existing prices being the best they can think of, given the demand they face. In this context firms' demand for labor will depend on both the real product wage and the level of real aggregate demand. This approach conforms both to common sense and to the date. However, it does not imply that employment can be made to grow without limit by pumping up real demand. The mode1 consists of three equations(an employment equation, a price equation, and a wage equation); and in the long run, when price surprises are eliminated, there are three endogenous variables (employment, real wages, and real demand). Thus in the long run there is not only a natural level of employment but also a natural level of real aggregate demand. In the short run, demand can vary from this level, bringing about changes in employment by means of price or wage surprises(Geary & Kennan, 1982).

This brings us to the second feature of the mode1 – the wage equation. If for one reason or another there is pressure for higher real wages, this will reduce the natural level of real aggregate demand and raise the natural level of unemployment. Thus the key to understanding the medium-term changes in unemployment is to understand the "push factors" generating wage pressure. We are able to identify in particular the roles of unions, of search intensity (by unemployed workers or y firms), of taxes, and of import prices. Having estimated the whole mode1, we are then able to decompose the growth of unemployment into the part caused by each of these factors and the part caused by changes in real aggregate demand(Grubb & Layard, 1983).

2. Literature Review & Hypothesis Development

Most of the macro-economic models currently in use explain the rate of change in wages with the level of unemployment and the actual or expected rate of price inflation as the principal determinants(the augmented Phillips curve). The rate of price change is modelled as a mark-up on unit costs, and employment is "driven by" aggregate demand for output, with relative or real factor prices having either no impact or only a marginal one. The wage and price relations may be combined into a first or higher order difference equation(in either prices or wages) which is dynamically stable, although to some extent this is the result of assuming exogenous exchange rates(Elsby, 2009).

The Phillips curve has evolved over time as new variables have been added and the contribution to annual wage growth of the various wage determinants has changed. Nonetheless, it has essentially remained a disequilibrium approach with movements in either nominal or real wages being "driven by" the degree of excess demand in the labor market. The latter, measured by the rate of unemployment, is taken to be exogenous, and this has two implications: firstly, the Phillips curve is neutral with regard to supply and demand-induced changes in the rate of unemployment; and, secondly, those factors – including the rate of wage inflation itself and ensuing wage/price ratio – which may affect the demand for and supply of labor are ignored. Consequently, the inflation process is isolated from other behavioural relationships, and despite its dynamic stability, there is a risk that wage and price changes may not be consistent with equilibrium in labor and product markets(Fehr & Goette, 2015).

At the same time, there has been a parallel development in the theory of wage determination which, at the empirical level, differs from the Phillips curve approach by adding the lagged level of real wages to the explanatory variables. This alternative theory is often referred to as the "real wage hypothesis", but its influence and significance go far beyond the mere addition of another variable. By incorporating lagged real wages, the change in nominal or real wages can be more closely related to long run market clearing conditions(Flaschel & Semmler, 2007).

Using a set of integration and error correction methods that do not assume a linear adjustment, this paper investigates labor market adjustment in the Korea and the U.S. in the between 2000 and 2018 period(OECD.SAT, 2018).

It will be clearest if we discuss our complete model at the outset, and how it works. we shall leave till later the detailed justification of the various functional relationships. The model is(ignoring lags):

EMPLOYMENT

$$\frac{N}{K} = f^1\left(\frac{W}{P}, A, \delta\right) \quad (1)$$

PRICES P/w = f2(K/L, A, alpha, P/Pe, W/We) (2)

WAGES W/P = F3(N/L, Z, K/L, A, alpha, P/Pe) (3)

where L is labor force
N is employment
K is capital stock
W is hourly labor cost(including employment taxes)
P is the GDP deflator
A is technical progress
alpha is real demand for output(a vector of detrended real world trade, adjusted fiscal deficit relative to GDP, real interest rate, and competitiveness).
Z is "push factors"(listed earlier).

Source : Geary & Kennan(1982).

<Table 1> Unemployment Rates(2000-2017)

Subject		Unemployment rate, Aged 15 and over, All persons																	
Measure		Level, rate or quantity series, s.a.																	
Unit		Percentage																	
Frequency																			
Time		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Country	Korea	4.4	4.0	3.3	3.6	3.7	3.7	3.5	3.3	3.2	3.7	3.7	3.4	3.2	3.1	3.5	3.6	3.7	3.7
	United States	4.0	4.7	5.8	6.0	5.5	5.1	4.6	4.6	5.8	9.3	9.6	9.0	8.1	7.4	6.2	5.3	4.9	4.4

Source: OECD.Sat(2018).

<Table 2> Growth in GDP(2000-2016).

Subject	Measure	Unit	Time	Country	
				Korea	United States
GDP per capita, constant prices	Annual growth/change	Percentage	2000	8.0	3.0
			2001	3.7	0.0
			2002	6.8	0.8
			2003	2.4	1.9
			2004	4.5	2.9
			2005	3.7	2.4
			2006	4.6	1.7
			2007	4.9	0.8
			2008	2.1	-1.2
			2009	0.2	-3.6
			2010	6.0	1.7
			2011	2.9	0.8
			2012	1.8	1.5
			2013	2.4	1.0
			2014	2.7	1.8
			2015	2.3	2.1
			2016	2.4	0.8

Source: OECD.Stat(2018).

<Table 3> Consumer Prices(2000-2016).

Subject	Measure	Unit	Time	Country	
				Korea	United States
Consumer prices - all items	Index	Index, 2010=100	2000	73.1	79.0
			2001	76.1	81.2
			2002	78.2	82.6
			2003	80.9	84.4
			2004	83.8	86.6
			2005	86.2	89.6
			2006	88.1	92.4
			2007	90.3	95.1
			2008	94.5	98.7
			2009	97.1	98.4
			2010	100.0	100.0
			2011	104.0	103.2
			2012	106.3	105.3
			2013	107.7	106.8
			2014	109.1	108.6
			2015	109.8	108.7
			2016	110.9	110.1

Source: OECD.Sat(2018).

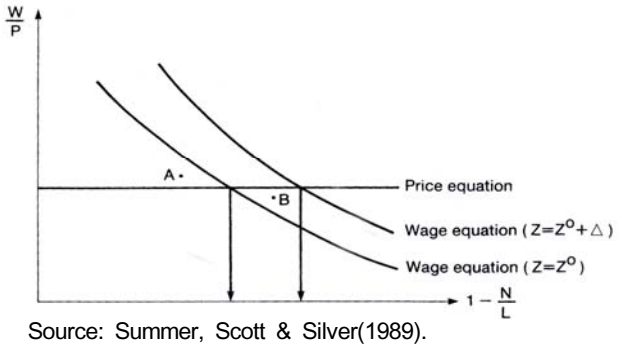
<Table 4> Labor Force Statistics by sex and age(2000-2016).

Frequency	Series	Ages	Unit	Time	Country					
					Korea			United States		
					Sex					
					Men	Women	All persons	Men	Women	All persons
Annual	Employment/population ratio	15 to 64	Percentage	2000	73.1	50.0	61.5	80.6	67.8	74.1
				2001	73.5	50.9	62.1	79.4	67.1	73.1
				2002	74.9	52.0	63.3	78.0	66.1	71.9
				2003	75.0	51.1	63.0	76.9	65.7	71.2
				2004	75.2	52.2	63.6	77.2	65.4	71.2
				2005	75.0	53.1	63.7	77.6	65.6	71.5
				2006	74.6	53.2	63.8	78.1	66.1	72.0
				2007	74.7	52.2	63.9	77.8	65.9	71.8
				2008	74.4	52.6	63.8	76.4	65.5	70.9
				2009	73.6	52.2	62.9	72.0	63.4	67.6
				2010	73.9	52.6	63.3	71.1	62.4	66.7
				2011	74.5	53.1	63.9	71.4	62.0	66.6
				2012	74.9	53.5	64.2	72.3	62.2	67.1
				2013	74.9	53.9	64.4	72.6	62.3	67.4
				2014	75.7	54.9	65.3	73.5	63.0	68.1
				2015	75.7	55.7	65.7	74.2	63.4	68.7
				2016	75.8	56.2	66.1	74.8	64.0	69.4

Source: OECD.Sat(2018).

If there are no price or wage surprises, this model solves for the employment rate(N/L), product demand(σ), and real wage(W/P) as functions of Z, K, L and A, taken as exogenous, we argue later that it is implausible(given the last two hundred years of history) to suppose that in the long run the capital stock or the labor force or technical progress will affect unemployment. This leaves the "push factors"(z) as the only variables able to change the natural rate of unemployment.

To understand further the workings of the model, we can note the empirical finding that the effects of demand(σ) in the wage and price equations are insignificant in most countries. If we ignore these, the long-ren model(without surprises) has a completely recursive structure. First, real wages are determined in the price equation. Next, the natural rate of employment is determined in the wage equation. Finally, the natural level of demand is determined in the employment equation.



Source: Summer, Scott & Silver(1989).

<Figure1> Research Model: Real Wages, Employment, and Phillips Curve

Focussing on the natural rate of employment, we can illustrate it in the following diagram, where for the sake of familiarity we have put unemployment on the horizontal axis (<Figure 1>). unemployment(a "real- wage phillips curve"). the pricing behavior of firms than determines the "feasible" real wage, and the level of unemployment must be such that wage-setters are willing to settle for that same feasible real wage. If there is greater wage push and the "push factors" increase, unemployment will have to rise(Hall, 1979).

We can now consider the dynamics of the system. If demand goes above its natural level, both nominal wages and prices will be forced above their expected levels. This reduces the actual real wage set by wage-setters to below level intended at the now higher level of employment. It also raises the real wage permitted by price-setters. Thus wage-setting and price-setting behavior become consistent at a point such as A. If expectations have elements of nominal inertia in them, then(w/w and p/p) can be proxied by terms such as $\triangle 2$ LogW and $\triangle 2$logP, and higher-than-natural employment will be associated with increasing inflation, with wage-setters and price-setters aiming at inconsistently large markups. The reverse is true in a demand downturn, as at B(Geary & Kennan, 1982).

3. Research Design, Data and Methodology

In focussing on imperfect competition it resembles most estimated macroeconomic forecasting models(and differs of course from most models in undergraduate textbook). Where it differs from many models is in its treatment of wage

behavior. The majority of wage equations relate to changes in wages(real or nominal) and have no long-run solution for the level of the real wage. this is an empirical question and our finding is that there is a clear longrun real wage equation. This is why we have to chink of unemployment as the mechanism bringing about consistency between the "desired" and "feasible" level of real wages rather than growth of real wages. This is the key feature of the model. we also explore a wider range of possible(z) factors affecting wage-setting than is usual in macro models less heavily focussed on the extraordinary change in unemployment which have taken place.

Reverting to the role of demand, the variables we have listed are clearly not exogenous, except for world trade. For consistent estimation, they need to be instrumented, and in a wider setting they could be explained by further equations. Equally the capital stock and the labor force could be explained, though this would be less important since their role in explaining variations in unemployment is not large.

To explain the movement of unemployment in the short run we take the employment function(1) and substitute out for the real wage, using the wage equation(3). This gives a short-run unemployment equation

$$1-\frac{N}{L}=f^{4}(Z,\sigma,\frac{P}{P^{e}},K,L,A) \tag{4}$$

Source: Geary & Kennan(1982).

The prime objective of the paper is to use a medium-term version of(4) to provide a decomposition of the changes in unemployment.

We begin with the employment and pricing behavior of firms. We suppose that the economy consists of a number(n) of identical imperfectly competitive firms. Each Firm's final output is produced by a production in which inputs(i.e., materials) are separable from capital and labor. we impose this restriction because it increases the efficiency of our estimates and does not appear to violate the data. Hence the I th firm's production of value added is determined by its capital(Ki) and its labor(n I). In each period, the firm uses the capital stock with which it begins the period: any investment undertaken during the period influences the capital stock only for next period. production involves some fixed set-up cost, 3 but thereafter the I th fire's output is produced at constant returns to scale. Technical progress(A) is assumed to be labor-augmenting(for which we later find strong empirical support, except for Japan), with the firm's output depending on Ki and ANi. Hence, given constant returns to scale, value-added output, Yi, is given by,

$$Yi=\Psi\frac{ANi}{Ki}Ki \tag{5}$$

Source: Geary & Kennan(1982).

and the firm's labor requirement is

$$Ni=f[\frac{Yi}{Ki}]\frac{Ki}{A}(f=\Psi^{-1},f^{'},f^{''}>0) \tag{6}$$

Source: Geary & Kennan(1982).

The firm incurs a cost per worker(W), including employment taxes. 4 Thus W/P is the real cost per worker in units of value added, which we shale The firm's revenue depends on demand conditions, Its demand depends on the relative price it charges(P_i/P) and on the location of the demand curve, which depends in turn on the aggregate real demand in the economy (σ). Hence the demand for the firm's output is

$$Yi=D\ \ \frac{Pi}{P},\sigma \tag{7}$$

Source: Geary & Kennan(1982)

and the firm's real revenue is $YiPi/P$.

The firm now maximizes real profit(revenue minus cost) with respect to P_i/P. It follows that its employment must depend on those variables in revenue and cost which are parametric to the firm – namely W/P, σ, K, and A. This is the basis of our employment function(1).

However, we need to examine its structure in more detail. The firm's optimal price is chosen to equate the marginal revenue per unit of output to the marginal cost. In other words

$$\frac{\Pi}{P}1-\frac{1}{n(\sigma)}=\frac{W}{PA}f'\frac{Yi}{Ki} \tag{8}$$

Source: Geary & Kennan(1982).

where η is the absolute elasticity of product demand faced by the firm, assumed to depend on real aggregate demand (σ).

To obtain the employment function we use the labor-requirement function(6) to replace $Y_i/K_i by\, f^{-1}(AN_i/K_i)$. Aggregating to the level of the whole economy by dropping the I subscript we find

$$1-\frac{1}{n(\sigma)}=\frac{W}{PA}f'f^{-1}(\frac{AN}{K}) \tag{9}$$

or

$$\frac{N}{K}=\frac{1}{A}g^{1}\frac{W}{PA},\sigma \tag{10}$$

Source: Geary & Kennan(1982).

this is our basic employment equation.

Two comments are in order. First demand(σ) will have the same qualitative effect on employment as it has on the elasticity demand.

Under perfect competition it has no effect, since η is always infinity.

Under imperfect competition it is often asserted that η rises in a boom, which would explain why higher aggregate demand in fact increases employment. Another explanation could be that oligopolistic firms do not practice a constant markup of prices over short-run marginal cost since this would lead to an excessive markup of prices on wages in booms(when marginal labor requirements are high). In booms they reduce the markup of prices over marginal cost, so that higher demand leads to higher employment (Domberger, 1979).

Second, technical progress must have a specific effect on employment. As equation(10) makes clear

$$\frac{a\log N}{a\log A} = |\frac{a\log N}{a\log W/P}| - 1 \tag{11}$$

Source: Geary & Kennan(1982).

Turning to the price equation we need to be more careful in our definition of σ. For our purposes it is convenient to measure not real demand but real demand relative to potential output. The potential output of the economy is $\psi(AL/K)K$, and the representative firm's share of this is one n^{th} or $\Psi(AL/K)K_i$. Hence a fuller specification of the demand for the firm's output is

$$Y_i = D\frac{P_i}{P}, \sigma\psi\frac{AL}{K}K_i \quad (\psi' > 0) \tag{12}$$

Source: Geary & Kennan(1982).

where σ now measures aggregate demand relative to potential output. To obtain the price equation we equation we substitute this into(8) and obtain after aggregation our basic price equation 5

$$\frac{P}{W} = g^2\frac{K}{L}', A, \sigma \tag{13}$$

Source: Geary & Kennan(1982).

If n^I>0, the impact of σ is indeterminate, since a rise in σ reduces the markup of prices over marginal cost but at the same time the real marginal labor requirement rises. The impact of technical progress is also indeterminate.

We should also note(for future use) the following approximate results concerning the price and employment functions: $^{\delta}$

$$\frac{a\log p}{a\log(K/L)} = \frac{a\log N}{a\log(W/P)}^{-1} \tag{14a}$$

$$\frac{a\log P}{a\log(K/L)} = \frac{a\log N}{a\log(W/P)}^{-1} \tag{14b}$$

Source: Geary & Kennan(1982).

Finally we need to introduce dynamics into the equations and to attempt an explicit modelling of expectations. We begin with labor demand. Our basic labor-demand equation based on(10) has the following structure, where ϕ is the lag operator:

$$(1-\alpha_1\phi-\alpha_2{}^{\phi^2})\log N = {}^{\alpha}0+{}^{\alpha}3\log\frac{W}{P} + {}^{\alpha}4^{\alpha+\alpha}5\log A + (1-{}^{\alpha}1^{-\alpha}2)\log K \tag{15}$$

Source: Geary & Kennan(1982).

The lags may arise from adjustment costs and aggregation over different labor types. Adjustment cost models, of course, lead to employment being a function of expected future as well as current variables.(15) is thus the specification with these future expectation variables substituted out, thereby compounding expectational and adjustment lags. This may lead to some difficulties because we are not identifying the underlying structural parameters, and thus we cannot use the equations to investigate the response of employment to price fluctuations which are inconsistent with the time series processes generating the sample data. These problems may not be too serious, however, in view of the fact that variables such as the real wage follow a process close to a random walk and, for example, given the current real wage, other current variables appear to be of little value in forecasting future real wages.

The price equation based on(13) requires adjustment before it can confront the data. Each firm will be setting prices for discrete periods and must, therefore, forecast competitors' prices and wage levels. If competitors' prices or wages are under-predicted, actual prices will be lower(relative to actual wages) than they would otherwise have been. This explains the negative coefficients assigned to P/P^e and W/W^e in the price equation as set out in(2). Though we experimented with a number of proxies for expectation errors, in practice we focussed mainly(here and in the wage equation) on the second differences $\triangle^2\log P$ and $\triangle^2\log$ w and their lags. The rationale for this is that, in a period where inflation is not clearly trended, expectations of inflation may have a considerable inertia. 8 A reasonable price equation would than be

$$(1-\phi\beta_1)(\log P-\log P-\log W) = {}^{\beta}0+{}^{\beta}2^{\triangle 2}\log P+{}^{\beta}3^{\triangle 2}\log W+{}^{\beta}4^{\sigma} \pm {}^{\beta}5(\log K-\log L)+{}^{\beta}6\log A \tag{16}$$

Source: Geary & Kennan(1982).

Finally it is worth setting out the restrictions implied by(11)

and(14a, b) These are

$$^{\alpha}5 = |^{\alpha}3| - (^{1-\alpha}1^{-\alpha}2) \quad (17a)$$

$$\frac{^{\beta}5}{^{1-\beta}1} = \frac{^{\alpha}3}{^{1-\alpha}1^{-\alpha}2}^{-1} \quad (17b)$$

$$\frac{^{1-\beta}1^{+\beta}6}{^{1-\beta}1} = \frac{|^{\alpha}3|}{^{1-\alpha}1^{-\alpha}2}^{-1} \quad (17c)$$

Source: Geary & Kennan(1982).

WAGE DETERMINATION

We turn next to wage formation. Initially, we suppose that prices are correctly foreseen, so there is no discrepancy between the real wage that agents intend to bring about as a result of their activities and the real wage that actually occurs.

We can imagine real wages being determined by four possible mechanisms: (i) supply and demand(i.e., by impersonal forces); (ii) firms; (iii) unions; (iv) bargaining between firms and unions. Any of the last three can give rise to involuntary unemployment(Johnson & Layard, 1984). It does not require unions to produce "real-wage resistance".

It is highly probable that all four mechanisms are used in various sectors of the economy. It is important, therefore, that our estimated model of wage determination is sufficiently general to encompass all types of models. In fact, this is not as difficult as it seems because all the models have broadly similar implications. In order to see how this comes about, let us start with the standard model of competitive wage determination.

The demand for labor is given by(10) and we can write the supply of labor, conditional on the labor force, as

$$N = g^3\frac{W}{P}, Z^S L \quad (18)$$

Source: Summer, Scott, & Silver(1989).

where g^3 is the proportion of the labor force prepared to work at the real wage W/P. Z^S is a set of variables which influence labor supply. These would include taxes as well as relative import prices and any other variables affecting the search intensity and willingness of the unemployed to work, such as the size and availability of unemployment benefit. Equating supply and demand in the labor market generates an equilibrium real-wage function of the form

$$\frac{W}{P} = h^1(Z^S, \frac{K}{L}, A, \sigma) \quad (19a)$$

Source: Summer, Scott, & Silver(1989).

The real wage is influenced by the variables which affect the supply and demand for labor, with K/L being the key variable explaining the secular rise in the real wage over time. This is, of course, a reduced-form equation relative to the labor market.

Now suppose firms set wages. There are numerous models of firms' wage-setting behavior, many of which are summarized in Johnson and Layard(1984) and Stiglitz(1984). A typical group of such models is the efficiency wage type. These have the property that, for one reason or another, an increase in the wage paid generates a benefit to the firm, which partially offsets the direct cost. For example, increasing wages relative to some externally given level 9 reduces quitting(Pencavel, 1972) or reduces vacancies (Jackman, Layard, & Pissarides, 1984), or raises employees' work effort(Shapiro & Stiglitz, 1984). The firm thus sets the wage to equate the marginal benefit with the direct marginal cost. This generates a wage function which may thought of as a pseudo supply-price relationship. The wages set depend on outside opportunities, which would include an alternative wage level as well as the outside employment rate and the Z^S variables, such as the unemployment benefit levels.

One possibility is that the wage-setting equation requires the wage set to be proportional to the expected outside wage. In that case, in the absence of expectational errors, the natural rate of unemployment is determined very simply. When the wage-setting equations are averaged across all firms, the average level of wages would not appear in the resulting relationship. Instead, the equation determines the employment rate as a function of the Z^S variables. this is in the sprit of the traditional augmented phillips curve. However, it is better to allow for the possibility that the wages set are not proportional to the expected outside wage. There will then be, in fully-anticipated equilibrium, a long-run relationship among the prevailing real wage, the employment rate, and the Z^S variables. Eliminating the employment rate via the labor-demand function would lead to a reduced-form real-wage function much the same as that in(19a).

Similar conclusions follow from union or bargaining models of wage determination, which are discussed fully in Layard and Nickell(1985). There are strong grounds for believing that, even in the presence of unions, employers fix employment, taking the wage as given(See Oswald, 1984, Oswald & Turnbull, 1985). Thus, in bargaining, unions and firms compute their welfare and profit function of the i^{th} firm will depend on all the variables entering the firm's profit equation(especially Wi/P, σ, A, K/L, and Ki. The welfare function of the union will depend on Wi/P, on any other determinants of employment(as above), on any wedges between real labor costs and real take-home pay(taxes and import prices), and on the alternative opportunities open to union members who do not get work in the firm. The outside opportunities will be affected by the outside wage(W/P), the general level of employment(N/L), and the level of well-being of those who are unemployed.

Thus the final level of the real wage settled for(W1/P) will

depend on σ, K, A, K/L, N/L, W/P and the whole set of supply-side variables(ZS) it will also, of course, depend on the degree of union strength(Up). Taking the equilibrium relationship(with WI = W) gives us(provided Wi is not proportional to W) a structural real-wage equation

$$\frac{W}{P} = h^2 \frac{N}{L}, Z^S, {}^U P' \frac{K}{L}, A, \sigma \quad (19b)$$

Source: Summer, Scott, & Silver(1989).

This differs from(18) in that it is a structural equation yet includes demand side variables($\sigma, A, \frac{K}{L}$). It differs from the reduced-form equation(19a) in that it includes employment. It is thus the most general wage equation and forms the basis of our approach to estimation. It is the long-run version of (3).

As we said, the key to understanding unemployment lies in understanding the "push" variables($Z^S \text{ and } U_P$). we need, therefore, to discuss them more fully. We begin with the most obvious Factors which might raise the target net consumption wage of workers.

4. Results

Next we consider the price equations. Sample neutrality(9) was imposed without much difficulty, but the equations themselves are not entirely satisfactory. The lagged dependent variable coefficient is very high. We tried many different ways of capturing wage/price surprises, and we able to obtain sensible results using $\triangle^2$ logW terms as proxies for these variables. Demand variables did not show up, and we feel that there are other important variables (aside from productivity effects) influencing the markup of price over costs which have not been captured in our equation. this is clearly an area where further work should be done.

For our purposes, however , the key equations are those explaining wages based on(16). As in the price equations, we impose "sample neutrality" on the capital/labor-force ratio and technical-progress terms to ensure that these have no long-run impact on unemployment. Overall these equations are fairly good, although the United States equation has a lagged dependent variable coefficient which is too close to unity for comfort. The other four equations appear to yield satisfactory long-run solutions for the real wage, this being particularly true for the European equations. Again with the exception of the United States, all the equations have reasonable vacancies coefficients and significant union effects. Given the size and importance of the union sector in all the countries except the United States, this latter fact is not surprising(Symons, 1984). All the counties exhibit some positive import price effect, and interestingly enough this effect appears permanent effect in the former(Kim, 2014). We put considerable effort into investigating the separate impact of the three different tax rates(t_1, t_2, t_3 see p.163) in both the short and the long run. the results were unsatisfactory in the sense that the coefficients were often ludicrous(e.g., very large and/or incorrectly signed) and highly sensitive to the precise equation specification. We eventually concluded that there was simply not enough information in the data to disentangle all the effects, and we simply considered the sum of the tax rates(T).

<Table 6> Regressions of Aggregate Unemployment on the Wage Gap(2000-2018)

Country	Independent variable						Summary statistic	
	Lagged unemployment rate	Time trend	Trend shift	Log of lagged product wage	Lagged wage gap	Log of lagged real money balance	R^2	Durbin-H
Korea	0.19 (1.45)	-0.36 (-3.98)	0.14 (3.86)	3.50 (4.23)			0.93	-1.05
	0.35 (2.72)	-0.01 (-1.03)			3.36 (3.99)		0.94	-1.30
	0.20 (1.31)	0.02 (0.96)			3.34 (4.11)	-0.31 (-1.55)	0.94	-1.17
United States	0.68 (3.68)	-0.68 (-1.41)	0.18 (0.99)	22.10 (1.51)			0.55	1.28
	0.62 (3.43)	0.04 (1.04)			10.67 (1.07)		0.54	1.93
	0.32 (1.50)	0.38 (2.41)			-15.28 (-1.03)	-11.17 (-2.20)	0.54	1.31

<Table 7> Phillips Curve Equations for Consumer Prices(2000-2018)

Country	Independent variable				Summary statistic	
	Lagged rate of change in consumer prices	Lagged rate of change in import prices	Lagged unemployment rate	Lagged wage gap	R^2	Durbin-Watson
Koera	0.07 (0.25)	0.15 (2.65)	-13.51 (-2.10)	50.05 (1.73)	0.58	2.07
United States	0.85 (5.48)	0.17 (5.00)	-1.21 (-3.68)	36.25 (2.88)	0.90	1.34

Another noteworthy feature is the strong negative effect of price-level accelerations in the United States which is reinforced by the 2000 dummy which is used to pick up the impact of the rapid jump in the price level in that year. We were unable to find any sensible replacement ratio effects in any country, nor could we find any impact of the productivity slowdown which we attempted to discover by including terms in $\triangle^2 \log K/L$.

<Table 8> Wage Equations(2000-2017)

Dependent variable	log(W/P)	
Country	Korea	United States
Independent variable		
Constant	0.426(5.7)	-0.187(2.1)
log(W/P)-1	0.745(9.2)	0.852(12.1)
Δlog(W/P)-1		0.651(2.4)
Δ2logP	-0.486(2.7)	-0.647(2.9)
1/V	-0.0805(2.1)	
Up	1.530(3.2)	
MM		
Sm log(Pm/P)		
ΔSm log(Pm/P)	2.07(3.2)	0.762(1.1)
T		
ΔT		0.554(2.2)
σ		0.080(1.1)
logA		
2017 dummy		-0.020(1.2)
log(K/L)	This coefficient is imposed, see note(1).	
SE	0.023	0.0085
DW	2.13	2.59

We also investigated equations with unemployment instead of vacancies, looking at a variety of lag structures, including rates of change. In no country did unemployment dominate vacancies as a pressure-of-demand indicator, although the converse is not true. Neither did we have any success with lagged or rate-of-change terms in unemployment.

The overall impression given by these equations is that, outside the United States, union activities have influenced real wage levels and that in the European countries real wages adjust less easily to outside shocks than they do elsewhere. However, the real implications of these equations can be seen more easily if we combine them with the employment equations to generate the empirical counterpart to equation(16).

In order to do this we must make use of estimated UV curves in order to generate a search-intensity variable. The UV curves are reported in <Table 4>. These may be substituted into the wage equations, eliminating V^{-1}. “Search intensity” is then proxied by the trend and trend^2 terms as in equation(16).

Finally, we can give estimates of the natural rate. Here we compute the long-run solution of the complete model by eliminating demand, using the price equation in addition to the other two. Given our worries about this equation we feel that these estimates are not very reliable. Nevertheless, the exercise is probably worth doing and we base it on the same sub periods as before. We cumulate changes in the natural rate starting from the assumption that the average unemployment over the first period(2000-2017) represents the long-run equilibrium level alongside the actual values. Note that we allow changes in import prices and tax rates to affect the natural rate.

Using these estimates of the changes in the natural rate, we can now return and ask how much of any increase in unemployment due to falls in aggregate demand reflected a “need” for aggregate demand to fall owing to the rise in the natural rate. This is easily discovered by taking the rise in the natural rate and subtracting from it all increases in unemployment.

5. Conclusion

5.1. Discussion

We had developed and estimated wage equation macroeconomic model both Korea and United Sates in order to shed light on unemployment trends in the postwar period. The model are that firms are assumed to be price-setters, and wages are not necessarily determined by labor-market “clearing” in the competitive sense. The first feature implies that output prices are not rigidly related to marginal costs over the cycle, so that labor demand is influenced both by real wages in terms of value added and by aggregate demand. The second implies that wage determination is affected not only by standard labor-supply variables but also by variables such as union pressure and employment protection legislation. Nevertheless, the model has the

standard neutrality property in the sense that deviations from the "natural rate" are possible only if there are wage/price "surprises."

The estimated wage-demand equations are consistent with this framework and generally have well-defined real wage and demand effects. We are also able to estimate the impact of technical change on wage demand and this proves to be compatible with the hypothesis that technical progress is labor-augmenting. The wage equations work reasonable well. The pressure of demand in the wage market shows up strongly in countries. In addition, the following "push factors" generate upward pressure on real wages.

We therefore adopt an indirect approach to the issue. We measure shifts in all these factors by shifts in the U/V curve: this curve has shifted out in all countries to a greater or lesser degree. We then obtain a final form of the wage equation by taking the estimated equation and replacing vacancies by unemployment and the location of the U/V curve(as a measure of "search intensity").

This is consistent with the known facts about the increasing generosity of the benefit system and strictness of the employment protection laws in Korea and the United States.

Bringing these factors together, we can summarize their historical impact on the level of unemployment. The United States unemployment rose substantially between the later 2000s and the later 2010s. Trade-union wage pressure intensified. In Korea, this was merely extension of a change that had already begun in the lats 2000s, and in Korea trade-union pressure accounted for an important part of the rise in unemployment in the 2000s. There was no comparable development in the United States. Another important influence in Korea in the 2000s was the fall in "search intensity" on both sides of the market, as measured by the outward shift of the U/V curve. This was especially so in Korea, where in each case the trend had already set in during the 2000s. It is worth reiterating that the outward shift in the U/V curve captures reductions in search intensity by workers, increases in mismatch, and any factors which make firms more cautious about hiring(employment protection legislations, for example). The shift itself is just a particular function of time and time squared and could, in principle, be capturing other trended effects which we have omitted. So when we observe the dramatic effects of this variable in the United States. We must obviously be somewhat cautious in our interpretation. It is important, however, to stress that this trend is not same as the crude upward trend in unemployment, since it represents changes in unemployment at given vacancies. It is also worth pointing out that Europe in general ha unemployment benefit systems which have become more open-ended than those of the United States and Korea, and it also has employment protection laws which have become more draconian.

Turning to the dramatic further rise in unemployment in the United States in the early 2000s, it seems that relative import prices have played no role, nor have there been further rises in union militancy. There have been further falls in "search intensity" in the United States. But the most powerful factor in the United States has been the fall in "demand," which has also been important in Korea.

We should stress that all our estimates are extremely approximate – perhaps even more so than is usual in economic metric work. Our paper should be viewed as an early attempt to explore a new way of analyzing these problems. We believe our model has much to offer, compared with earlier approaches. It represents an attempt to model the natural rate and the current unemployment rate within a single structural model. It offers new insight into the employment effects of technical progress. Above all, it cuts through the fruitless debate about whether current unemployment is classical or Keynesian.

5.2. Limitations and future research directions

The recent unemployment divergence poses a challenge. As a possible explanation, the social safety nets in the two countries attract the most attention. Korea's unemployment insurance system offers longer duration of benefits than comparable U.S. programs with less restrictive eligibility requirements. The availability of benefits for maternity leaves, sickness, and training in Korea may be contributing factors as well. While one-third of the unemployed collect unemployment benefits in the U.S. more than 90% of those unemployed in Korea collect benefits(Yi & Mah, 2016). There is also a decline in unionization in the U.S. relative to Korea, which has been cited as a contributing factor to wage inequality and labor market flexibility in the U.S.(Coo, 2018). These differences notwithstanding, benefit patterns in the two countries have exited in the last 30 years(Rahmon & Khatun, 2016). And, The paper may not be sufficient to explain the recent divergence in unemployment rates in the two countries. In that regard, evidence presented above regrading asymmetric adjustment in Korea and symmetric adjustment in the U.S. labor market may provide an important clue. This difference between Korea and the U.S. may provide a clue to the recent divergence of unemployment rates between the two countries.

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