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How Fast Wages Adjust to Prices: A Multi Country Analysis

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Abstract

The adjustment of nominal wages to inflation has implications on the labor market as well as on other areas in economics. In this paper, we employ the Blanchard and Katz (1997, 1999) model of nominal wage determination and try to estimate the adjustment speed. By using the bounds testing approach for cointegration and error-correction modeling we distinguish the short run from the long run. The model is estimated for 29 countries using annual data over the period 1975-2006. We find that inflation, unemployment rate, and labor productivity all have short-run and long-run effects for the majority of the countries. However, nominal wages adjust to inflation fully in 11 of the 29 counties.

Valuable comments of an anonymous referee are greatly appreciated. Any error, however, is ours.
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1. Introduction

In a standard macro textbook the trade-off between the inflation rate and the unemployment rate is labeled after a British economist, Phillips who originally in 1958 introduced the trade-off between the unemployment rate and the rate of change of nominal wages. However, since nominal wages move in tandem with inflation rate, the literature replaced the rate of change of nominal wages with inflation rate and concentrated on the trade-off between inflation rate and the rate of unemployment.

Stagflation in most industrial countries in the early 1970s raised concern about the validity of the Phillips curve, which in turn, enticed researchers to look for explanations. Blanchflower and Oswald (1994, 1995) looked at the empirical foundations of the curve. By relying on micro wage regressions, which illustrate a minor autoregression process in real wages, and by making inflation as a function of the unemployment rate, they questioned the credibility of the Phillips-curve model. Others like Blanchard and Katz (1997, 1999), challenged Blanchflower and Oswald's argument on the downward bias of real wage autoregression. Furthermore, Blanchard and Katz (1997, 1999) theoretically and empirically investigate the role of an error-correction wage share influence. Meanwhile, Plasmans *et al.* (1999) used a different approach and considered the effects of the employment benefit system's generosity on the adjustment speed of money wages by incorporating the demand pressure in the labor market. Moreover, Gali et al. (2001), and Laxton, et al. (1999) investigated inflationary expectations in their augmented wage-price Phillips-curve model and showed that including expected inflation rate as a shift parameter, increases the explanatory power of the relationship.

New framework for monetary policy analysis, using the so-called New Keynesian model, has led to a new literature known as the New Keynesian Phillips-curve. Starting with a basic New Keynesian model, i.e. a model with monopolistically competitive firms, where only a fraction of the firms are allowed to reset prices each period, the New Keynesian Philips Curve (NKPC) embodies the assumption of monopolistic competition, which allows firms to be price-setters rather than price-takers as they would be under pure competition. Price rigidities arising from the behavior of individual firms allow monetary policy to impact the real economy in the short-run faster, hence disturbing the trade off between inflation and unemployment (Taylor 1980, Calvo 1983, Clarida *et al.* 1999). Mankiw (2001) has criticized the NKPC model by arguing that despite the sticky prices in this model, the inflation rate changes rapidly.

A disequilibrium AS-AD model seems to provide another explanation to the break down of the standard Phillips curve. In a recent study, Gali (2010) formulates a baseline disequilibrium AS-AD model and empirically estimates it with time series data for the U.S. economy. His version of the model employs a Phillips-curve, a dynamic IS curve and a Taylor interest rate rule and is based on sticky wages and prices, perfect foresight of current inflation rate, and adaptive expectations concerning the inflationary climate in which the economy operates. A version of Okun's law is used to link capacity utilization to employment. Under the assumption of a constant natural rate of unemployment, Gali derives a structural wage equation and shows the comovement of wage inflation with the unemployment rate in the U.S. economy.

Clearly, the trade off between inflation and unemployment depends on the speed with which wages adjust to inflation to clear the labor market. Greater importance is attached to wage-price dynamics even in other parts of economics literature. For example, in trying to explain the absorption approach to the balance of payments, Alexander (1952) argued how currency depreciation could lead to a decline in domestic absorption. By a reference to the inflationary effects of currency depreciation, he argued that since there are long lags behind the wage-price adjustment mechanism, inflationary effects of depreciation shifts income from workers with high marginal propensity to consume to producers with low marginal propensity to consume, eventually leading to a decline in aggregate consumption and domestic absorption.

Given recent advances in econometrics and time series analysis, the main goal of this paper is to examine the wage-price dynamics one more time. To that end, in Section II we introduce the model and the methodology that differentiates the short run from the long run. Section III reports the estimation results with a summary appearing in Section IV. Data sources and the definitions of variables are discussed in an Appendix.

2. The Model and Methodology[1]

A model that identifies the main determinant of nominal wages has already been introduced by Blanchard and Katz (1997, 1999) and is known as the wage-price Phillips-curve model. We, therefore, borrow their specification as outlined by equation (1):

$$LnW_t = \alpha + \beta LnP_t + \gamma LnU_t + \varphi LnA_t + \varepsilon_t \qquad (1)$$

where W_t is the nominal wage, P_t is the average price level, U_t is the unemployment rate, and A_t is labor productivity per hour. Equation (1) is the long-run equilibrium relationship among the mentioned variables. Thus, if nominal wages are to adjust fully to changes in prices, an estimate of β is expected to be one in the long run, but positive and less than one in the short run. Increased unemployment is expected to depress nominal wages. Hence, an estimate of γ is expected to be negative. Finally, since an increase in labor productivity is expected to lead to an increase in nominal wages, an estimate of φ should be positive.

The estimate of (1) by any method yields only the long-run coefficient estimates. In order to distinguish the long-run effects of right-hand side variables on the dependent variable from their short-run effects, we need to incorporate the short-run dynamic adjustment into (1). Given existing advances in econometrics, a common practice is to specify equation (1) in an error-correction modeling format. For a few reasons, detailed below, we follow Pesaran *et al*.'s (2001) bounds testing approach and adopt the following error-correction specification:

[1] The methodology and explanation in this paper closely follows Bahmani-Oskooee and Hajilee (2010) in this journal. For other applications of this approach see Halicioglu, F., (2007), Tang (2007), Mohammadi et al. (2008), Wong and Tang (2008) and De Vita and Kyaw (2008).

$$\Delta LnW_t = a + \sum_{i=1}^{n1} b_i \Delta LnW_{t-i} + \sum_{i=0}^{n2} c_i \Delta LnP_{t-i} + \sum_{i=0}^{n3} d_i \Delta LnU_{t-i} + \sum_{i=0}^{n4} e_i \Delta LnA_{t-i}$$
$$+ \delta_0 LnW_{t-1} + \delta_1 LnP_{t-1} + \delta_2 LnU_{t-1} + \delta_3 LnA_{t-1} + \nu_t \qquad (2)$$

The error-correction model outlined by equation (2) differs from that of Engle-Granger specification in that a linear combination of lagged level variables has replaced lagged error term from equation (1). One of the main advantages of the above specification is that variables could be stationary or non-stationary. For example, clearly in many countries, while price level is a non-stationary variable, unemployment rate is most likely a stationary variable. Because of this unique property, to justify the inclusion of lagged level variables in equation (2) as a sign of cointegration among variables, Pesaran *et al*. (2001) propose applying the F test with new critical values that depend on the integrating properties of the variables. By assuming all variables to be integrated of order one, an upper bound critical value is provided. And by assuming all variables to be integrated of order zero, a lower bound critical value is provided. For cointegration, the calculated F statistic should be greater than the upper bound critical value.

Another advantage of specification (2) is that the short-run effects and the long-run effects are estimated simultaneously. Short-run effects are inferred by the estimates of coefficients attached to first-differenced variables. For example, the short-run effects of changes in the average price level on nominal wages are obtained by the estimates of c_i's. The long-run effects are judged by the estimate of δ_1-δ_3 normalized on δ_0.

3. The Empirical Results

In this section we estimate (2) for as many countries as data permits. Annual data over the period 1975-2006 for 29 countries were available from the sources identified in the Appendix. The main restriction for extending the list of countries beyond the current sample was the unavailability of the wage index and the unemployment rate. Since the data are annual, a maximum of four lags are imposed on each first-differenced variable in each model and following Bahmani-Oskooee and Tanku (2008) Akaike's Information Criterion (AIC) is used to select the optimum number of lags in each case. The results from each optimum model are reported in Tables 1 and 2.

Table1.Short-Run and Long -Run Coefficient Estimates of Wage Philips Curve Model

Country	Short -Run coefficient Estimates				Long-Run coefficient Estimates			
	$\Delta Ln P_t$	ΔLnP_{t-1}	$\Delta Ln P_{t-2}$	$\Delta Ln P_{t-3}$	*Constant*	*LnP*	*LnU*	*A*
Argentina	1.12(4.58)	-1.13(4.56)			11.43(3.51)	0.68(6.15)	-3.78(2.78)	-0.16(0.89)
Australia	-0.05(0.91)				13.26(1.14)	-0.98(0.54)	1.32(1.36)	0.13(2.01)
Belgium	0.85(9.34)	-1.07(3.42)	0.23(0.47)	-0.02(69.13)	0.31(6.30)	0.89(93.53)	-0.07(3.54)	0.17(1.98)
Canada	0.92(7.66)	0.64(3.93)	-0.29(2.15)		-1.65(0.51)	1.58(2.49)	-0.34(0.53)	0.11(3.49)
Chile	0.11(2.92)				-0.64(0.38)	0.46(2.97)	1.38(1.44)	0.14(2,15)
Colombia	4.07(2.30)	1.59(0,76)	2.62(1.98)		-40.62(0.27)	-1.75(0.28)	9.05(0.29)	-0.97(0,29)
Denmark	-0.01(0.02)	0.54(0.57)	-1.30(2.35)		0.60(1.98)	0.94(15.97)	-0.15(6.44)	0.01(1.14)
Egypt	-0.83(2.84)				3.17(3.52)	0.42(2.38)	0.16(0.36)	-0.17(2.66)
Finland	-0.25(0.97)	0.32(1.68)	0.34(1.72)		-19.87(0.95)	3.84(3.29)	1.89(0.97)	0.17(2.76)
France	0.62(3.68)	0.33(1.56)	0.35(1.65)	-0.42(2.71)	-2.16(5.88)	1.61(26.35)	-0.31(1.43)	0.01(11.18)
Germany	0.03(0.63				1.53(0.55)	0.78(3.44)	-0.19(0.34)	0.38(1.01)
Greece	-1.87(1.53)	-2.01(1.51)	-1.93(1.18)	3.08(6.51)	2.26(1.68)	0.94(12.32)	-0.78(1.83)	0.01(0.24)
Ireland	0.55(6.52)				0.82(4.45)	0.95(28.96)	-0.22(20.07)	0.01(3.53)
Italy	0.78(3.88)	0.26(1.71)			-0.58(1.55)	1.08(20.64)	0.06(0.66)	0.04(2.49)
Jamaica	2.15(1.89)	0.85(1.48)	0.55(1.04)	0.51(0.74)	1.32(0.78)	0.76(5.68)	-0.36(0.73)	0.26(4.38)
Japan	-0.13(0.87)	0.66(2.73)			-6.64(10.29)	2.34(17.56)	0.31(1.57)	0.01(1.91)
Korea	0.47(3.30)	-0.33(2.36)	-0.04(0.23)	-0.45(2.62)	1.86(3.23)	0.85(15.99)	-0.62(2.67)	0.02(20.79)
Malaysia	-1.51(3.24)	1.11(2.71)	-0.89(1.71)	0.87(1.91)	-0.37(0.25)	1.22(4.85)	-0.44(2.69)	0.01(8.32)
Mexico	0.49(6.26)				14.01(2.34)	-0.18(0.39)	-10.33(2.10)	-0.15(0.95)
New Zealand	-0.28(0.38)	-0.81(0.87)	-1.65(2.41)		7.62(1.47)	3.01(7.03)	-1.31(1.19)	0.13(3.75)
Norway	0.62(0.67)	-2.38(2.15)	-6.23(5.88)	-6.22(5.88)	8.89(8.22)	0.63(3.04)	-0.39(2.69)	0.01(2.19)
Pakistan	0.48(0.48)	-0.44(0.31)	2.45(1.86)	-3.59(3.46)	-0.31(2.58)	1.17(43.27)	-0.15(3.96)	-0.01(0.39)
Singapore	-6.75(1.62)				6.13(2.23)	1.66(1.92)	0.71(0.21)	0.05(3.67)
Spain	0.44(1.66)	-0.39(1.36)	0.54(1.83)	0.52(3.34)	-0.65(0.83)	1.18(7.96)	-0.06(2.26)	0.01(7,54)
Sri Lanka	2.22(6.21)	-0.81(2.22)			-14.11(20.56)	3.61(29.31)	0.76(0.81)	-0.01(0.45)
Sri Lanka	2.22(6.21)	-0.81(2.22)			-14.11(20.56)	3.61(29.31)	0.76(0.81)	-0.01(0.45)
Sweden	2.11(1.06)	3.47(1.45)			-12.25(0.76)	1.79(5.43)	1.51(0.53)	0.53(3.25)
Uk	0.65(4.62)	0.23(1.39)	0.25(1.34)	0.73(4.21)	-0.28(0.63)	1.12(13.55)	-0.22(3.19)	0.18(2.24)
US	0.30(3.27)	0.19(1.31)			5.69(0.18)	0.73(0.47)	-2.89(2.01)	0.17(3.21)

Note: Numbers inside parentheses are absolute value of t-ratios.

Table2. Diagnostic Statistics for Wage – Philips Curve Models.

Country	Diagnostics Statistics							
	F at optimal lags	***ECM_{t-1}***	***LM***	***RESET***	***Normality***	***CUSUM***	***CUSUMSQ***	***Adj. R^2***
Argentina	9.13	-0.55(6.63)	0.52	3.26	2.66	S	S	0.73
Australia	4.13	-0.05(4.38)	8.01	3.54	0.15	S	S	0.83
Belgium	3.46	-0.40(3.72)	5.51	11.36	1.31	S	S	0.99
Canada	3.05	-0.18(1.56)	16,59	0.01	0.46	S	S	0.92
Chile	2.74	-0.19(3.39)	0.78	0.27	0.60	S	U	0.76
Colombia	2.58	-0.10(3.66)	1.68	0.65	0.18	S	S	0.67
Denmark	6.52	-0.97(5.62)	0.83	14.78	0.92	S	S	0.78
Egypt	10.46	-0.29(7.02)	2.19	5.34	0.74	S	S	0.65
Finland	14.15	0.03(8.58)	1.17	1.06	1.06	S	S	0.96
France	12.30	0.14(7.34)	0.01	4.88	12.54	S	S	0.95
Germany	5.68	-0.03(4.91)	1.51	5.56	0.51	U	S	0.85
Greece	4.65	-0.85(4.89)	0.38	16.47	1.14	S	S	0.85
Ireland	6.72	-0.61(5.68)	0.15	5.33	0.46	S	U	0.96
Italy	14.51	-.28(8.15)	0.02	0.88	0.78	S	S	0.98
Jamaica	5.94	-1.15(5.98)	7.72	3.68	0.94	S	S	0.82
Japan	5.42	0.30(5.37)	0.86	2.81	0.66	S	S	0.97
Korea	1.95	-0.21(3.15)	5.63	0.32	0.44	S	S	0.79
Malaysia	9.50	-0.42(7.55)	5.08	1.53	0.02	S	S	0.93
Mexico	15.52	-0.06(8.81)	2.77	1.38	7.78	S	U	0.97
New Zealand	4.74	-0.27(4.96)	2.02	1.25	3.44	S	S	0.64
Norway	25.61	-0.49(11.68)	6.73	13.02	0.23	S	S	0.93
Pakistan	8.47	-2.44(6.72)	5.34	0.34	1.44	S	S	0.80
Philippines	12.34	-0.57(8.01)	0.96	0.05	0.83	S	S	0.90
Singapore	25.26	-1.93(11.61)	4.84	1.22	0.54	S	S	0.89
Spain	1.47	-0.39(2.66)	4.86	2.42	0.07	U	S	0.96
Sri Lanka	2.91	-0.42(3.58)	11.52	30.60	0.27	S	S	0.23
Sweden	4.25	-0.16(4.54)	1.42	3.89	2.12	S	S	0.69
Uk	11.42	-0.15(7.44)	2.17	12.71	0.88	S	S	0.97
US	6.25	-0.01(5.26)	0.73	0.71	0.62	S	S	0.93

Notes: (a). Number inside the parenthesis next to a coefficient is absolute value of the t-ratio. (b). At the 10% level of significance the upper bound Critical value of the F test with no trend in the test is 4.11. This comes from Pesaran *et al*. (2001, Table CI (iii), p. 300)). (c). Lagrange multiplier test of residual serial correlation. It is distributed as $\chi^2_{(1)}$. (d). Ramsey's RESET test for functional form. It is distributed as $\chi^2_{(1)}$. (e). Normality test based on a test of skewness and kurtosis of residuals. It is distributed as $\chi^2_{(2)}$. At the 5% level, the critical value of $\chi^2_{(1)} = 3.84$ and the critical value of $\chi^2_{(2)} = 5.99$.

Consider Table 1 first. Due to volume of the results, short-run effects are reported only for the inflation. However, the long-run effects are reported for all variables. From the short-run coefficient estimates, we gather that, except in the results for Australia, Germany, Singapore, and Sweden, there is at least one coefficient that is significant at least at the 10% level of significance. Thus, there is clear evidence of nominal wages adjusting to inflation in the short run. Do these short-run effects last into the long run?

The long-run results show that the price level carries a highly significant coefficient in all countries except in Australia, Colombia, Mexico, and the U.S. Furthermore, the estimated coefficient is positive and close to unity in eleven countries. The eleven countries are: Belgium, Denmark, Germany, Greece, Ireland, Italy, Korea, Malaysia, Pakistan, Spain, and the U.K. As for the long-run impact of unemployment on nominal wages, we gather that in 13 countries in the sample the unemployment rate (*Ln U*) carries a significantly negative coefficient supporting our theoretical expectation. Finally, labor productivity per hour (*Ln A*) carries its expected positive and significant coefficient in 20 countries in the sample, implying that indeed increased productivity leads to higher wages in most countries. The list includes Australia, Belgium, Canada, Chile, Finland, France, Ireland, Italy, Jamaica, Japan, Korea, Malaysia, New Zealand, Norway, Singapore, Spain, Sweden, the United Kingdom and the United States.

However, the above long-run analysis would be meaningful only after establishing cointegration among the variables. To this end, we shift to Table 2 and the results of the F test. This result reveals that the F-statistic for joint significance of lagged variables, or for their cointegration, is greater than its critical value of 4.14 in 15 of the 21 countries. For the remaining countries, following Pesaran *et al*. (2001), we use the long-run coefficient estimates and form an error-correction term, *ECM*. We then replace the lagged level variables by ECM_{t-1} and estimate each model after imposing the optimum number of lags. A significantly negative coefficient obtained for the lagged error-correction term is an alternative way of supporting cointegration (Bahmani-Oskooee and Tanku 2008). As can be seen from Table 2, ECM_{t-1} carries a significantly negative coefficient in all countries, except Canada. Note that in two countries the coefficient is positive, implying that adjustment is toward disequilibrium rather than long run equilibrium. The estimate of this coefficient itself measures the speed with which wages adjust to its long-run determinants. As can be seen, while in some countries (e.g. Australia) the adjustment is very slow, in some others (e.g., Singapore) it is very fast.[2]

Several other diagnostics are also reported in Table 2. To test for autocorrelation, we report the Lagrange multiplier (LM) statistic and to check misspecification we report Ramsey's RESET test statistic. They are both distributed as χ^2 with one degree of freedom. Obviously, in the majority of the models, both statistics are less than the critical value of 3.84, indicating auto-correlation free residuals and correctly specified optimum models. Based on the skewness and kurtosis of residuals, another χ^2 statistic (with two degrees of freedom with critical value of 5.99 at the 5% level) is also reported. This is used to test for normality of the residuals. It appears that the normality assumption is violated only in two cases. Finally, following Bahmani-Oskooee *et*

[2] Note that in some cases the coefficient is greater than one like -1.93 in case of Singapore. Since data is annual, 1.93 implies that almost 97% of adjustment takes place in six months.

al. (2005) we test for stability of all short-run and long-run coefficient estimates of each of the optimum error-correction models by means of CUSUM and CUSUMSQ tests. In the table, we identify stable coefficients by "S" and unstable coefficients by "US". Clearly, in most models estimated coefficients are stable. Finally, it appears that almost all models enjoy a good fit reflected by the size of adjusted R^2, also reported in Table 2.

4. Conclusion and Summary

In his seminal paper, Alexander (1952) argued that if wages do not adjust fully to inflation, income could be shifted from workers with high MPC to owners of capital with low MPC, leading to a decline in aggregate consumption of a country. Theoretically, due to institutional rigidities, full adjustment of nominal wages to inflation could be realized in the long run but not in the short run. The speed with which nominal wages adjust to inflation also has implications for labor market clearance and unemployment.

The main purpose of this paper was to estimate and differentiate the short-run effects of inflation on wages from its long-run effects. For this purpose, the popular Wage-price Philips curve model of Blanchard and Katz (1997, 1999) is employed and estimated using Pesaran *et al.'s* (2001) bounds testing approach for cointegration and error-correction modeling. The main advantage of this approach is that there is no need for pre-unit root testing and variables could be stationary or non-stationary. Furthermore, short-run and long-run effects are estimated in one step. The model estimated using annual data over the period 1975-2006 for each of the 29 countries in our sample.

The results reveal that there is a significant relationship between inflation and wages in the majority of countries in the sample in the short run and in the long run, implying that the link between these two variables is inevitable. In 13 countries in the sample, unemployment rate also had an adverse effect on nominal wages. As expected, in most countries, labor productivity had a significantly positive effect on wages in the long run.

Appendix: Data Definition and Sources

All data are annual over the 1975-2006 period and they come from the following sources:

On line international Financial Statistics of International Monetary Fund, International Labor Statistics, World Economic Outlook and Penn World table.

a. Wage index: Nominal Wage index (2000=100) comes from International Labor Statistics (laborstat) and International Financial Statistics (IFS).

b. Productivity: Labor productivity per hour comes from Penn World Table (Center for International Comparisons at the University of Pennsylvania).

c. Consumer Price Index: CPI (2000=100) comes from International Financial Statistics (IFS) of the International Monetary Fund.

d. Unemployment rate comes from International Financial Statistics (IFS) of the International Monetary Fund.

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