The Slope of the U.S. Nominal Treasury Yield Curve Unemployment and Stability of Wage Determination: United States versus New York State

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ABSTRACT

We find the Phillips-type model performs well in explaining wage adjustment for US non-farm business, US manufacturing, and NY manufacturing sector, showing a typical adjustment to price inflation expectation and labor market tightness. While the basic wage model shows evidence of a structural shift for the post-1991 period, this is not evident in the adjusted models for both US non-farm business and NY manufacturing, implying that the observed structural shift for the post-1991 period is likely to be the result of model mis-, or under-specification. The effect of the fraction of unemployment due to permanent job loss on wage inflation appears to be manufacturing-specific, while a smaller adjustment to price inflation expectation appears to be state-specific. On the other hand, the significant effect of the percent of adults unemployed appears to be a national phenomenon.

Introduction

Historically, both price and wage inflation followed a fairly predictable pattern over the business cycle, increasing during an economic expansion, peaking slightly after the beginning of a recession, and then continuing to decrease through the early stage (first or second year) of a recovery. However, during the 1990s recovery, the United States (US) exhibited unusually low and declining price and wage inflation despite strong growth and a decreasing unemployment rate. Several studies showed that the traditional Phillips curve model consistently overpredicted actual inflation (Duca, 1996; Low and Rich, 1997; Hyclak and Ohn, 2001). Duca (1996) found that overprediction by the Phillips curve was due to unusually high duration of unemployment, while Lown and Rich (1997) linked it to unusually low wage growth. Hyclak and Ohn (2001) confirmed the findings by Duca and Low and Rich that the traditional Phillips curve model overpredicted the inflation rate in the 1990s and showed that the high duration of unemployment was due to an increase in the fraction of older permanent job losers.

While most of the studies on wage adjustment have examined national data, usually from the Current Population Survey, relatively little attention has been paid to regional or local labor markets in the US even though many labor markets are distinctly local in character. Topel (1994) and Karoly and

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Klerman (1994) examine changes in distribution of earnings at the regional and state levels. Borjas and Ramey (1995) examine the impact of trade sensitivity on changes in college earnings premium in a sample of metropolitan areas. Ohn and Kramer (2007) examined wage adjustment for the state of Pennsylvania using a type of wage Phillips model. In this paper, we perform a comparative analysis on the structure of wage adjustment in the US and New York (NY) State. Particularly, this study examines the relationship between wage inflation and the unemployment rate for US nonfarm business, NY manufacturing, and the US manufacturing sector for the period 1975-2006, and the stability of the Phillips model during the post 1991 recovery and the first half of 2000s. We investigate whether the observed low wage inflation can be explained by three characteristics of unemployment spells: the duration of unemployment, the fraction of adults who are unemployed and the fraction of unemployment due to permanent job loss. We find that the Phillips-type model performs well in explaining wage adjustment for the U.S. non-farm business, U.S. manufacturing, and NY manufacturing sector, showing a typical adjustment to price inflation expectation and labor market tightness. Inclusion of demographic variables of unemployment in the adjusted model alters the prediction of wage inflation by the basic Phillips model implying that the evidence of a structural shift for the post-1991 period is likely the result of model mis- or under-specification.

The remainder of the paper is organized as follows. Section II describes the empirical model and the data. Section III discusses: 1) the results of estimating three Phillips-type models; 2) the issue of model stability for those models; and 3) whether the difference between the US and NY State is industry-specific or state-specific. Section IV concludes.

II. Empirical Model and Data

Following Alogoskoufis and Smith (1991) and Hyclak and Ohn (1997, 2001), we examine the quarterly wage adjustment process over the period 1975-2006 using the Phillips-type model:

$$\Delta w_t = \beta_0 + \beta_1 \Delta w_{t-1} + \beta_2 E(inf_t) + \beta_3 U_{t-1} + e_t$$

where Δw_t is quarter-to-quarter wage inflation, $E(inf_t)$ is the expected price inflation, and U_{t-1} is the lagged unemployment rate. We capture the expected price inflation by the lagged actual price inflation, Δp_{t-1} and by the expected rate of consumer price inflation projected at the end of the preceding period, $E(inf_t)$. A number of wage studies based on Phillips-type model(s) include several lags of actual inflation rates to control for inflation expectation. While inclusion of a series of lags is designed to describe the continuous adjustment process toward an unbiased expected inflation (backward-looking), the expected inflation used in this paper is computed based on the forecasted one-year GDP price index (forward-looking). The computed expected inflation is measured at the end (beginning) of the previous (current) quarter for the next one-year period and is supposed to already reflect any influencing factors such as previous inflation expectation, a series of past actual inflations, and other influential factors. In order to allow for the assumption that the aggregate unemployment rate may not fully reflect the recent labor market change as suggested by Duca (1996) and Hyclak and

Ohn (2001), in the adjusted model, we include three demographic factors of unemployment: the duration of unemployment (*DUR*), the percent of unemployed adult population ages 25 and older (*R*25), and the fraction of unemployed due to permanent job loss, (*RJL*). The adjusted model is given by

$$\Delta W_t = \beta_0 + \beta_1 \Delta w_{t-1} + \beta_2 \mathrm{E}(inf_t) + \beta_3 U_{t-1} + \beta_4 DUR_{t-1} + \beta_5 R25_{t-1} + \beta_6 RJL_{t-1} + e_t.$$

Following Valetta (1997, 1998) and Dijk and Folmer (1999), we hypothesize that longer duration of unemployment will put downward pressure on the reservation wage a worker is willing to accept. While skill-biased technological change and corporate downsizing may not have a serious impact on younger workers, they are likely to have a more significant impact on adult (older) workers. We expect to find that the higher the percentage of unemployed adults, the lower will be the reservation wage. Similarly, since permanent job losers, on average, experience longer unemployment spells compared to those who are unemployed for other reasons, we anticipate that the higher the fraction of permanent job-losers, the lower will be the reservation wage. Thus, we expect a significant negative relationship between wage inflation and the duration of unemployment, the percentage of unemployed adults and the percentage of permanent job losers.

The wage data and the unemployment rate for the US and NY state are from the Bureau of Labor Statistics (BLS) website. The wage data are the total hourly wages and salaries for national non-farm business, national manufacturing, and the NY state manufacturing-sector. The three demographic unemployment variables are the average number of weeks unemployed, the percentage of unemployed adults who are 25 years and older, and the percentage unemployed due to permanent job loss. The demographic variables are from the Current Population Survey, while the expected rate of price inflation is from the Survey of Professional Forecasters conducted and reported by the Federal Reserve Bank of Philadelphia. The expected rate of price inflation is computed based on the forecasted one-year GDP price index at the end (beginning) of previous (current) period and the computed expected inflation is for the next one-year period including current period (quarter).

III. Estimation Results

Regression Results of Three Phillips-Type Wage Models

The upper panel of Table 1 shows the results for three different versions of the Phillips-type wage model. Models 1 and 2 show the results of the basic model. In Model 1 we capture the price inflation expectation by lagged actual price inflation, and in Model 2 by expected price inflation. Model 3 adds the three demographic labor market variables.

All three models show that the adjustment to price inflation expectation is a major factor in wage inflation. In all three models, the coefficient of the price inflation expectation is positive and statistically significant for both the US nonfarm business and NY manufacturing. However, the expected price inflation based on the Survey of Professional Forecasters (Models 2 and 3) seems to be a better measure of the price inflation expectation than the lagged actual price inflation (Model 1). When we

Table 1. Test Results on the Wage Phillips Curve Model for the US Nonfarm Business and NY Manufacturing Sector, 1975-2006.

Regression Results

	US			NY		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Constant	4.720**	5.212**	19.193**	-0.344	-0.015	2.504*
	(1.058)	(1.079)	(3.481)	(0.326)	(0.292)	(1.803)
ΔW_{t-1}		0.101	0.055		0.064	0.045
		(0.088)	(0.091)		(0.091)	(0.091)
E(*inf*)[a]	0.407**	1.051**	0.643**	0.060**	0.225**	0.156*
	(0.062)	(0.161)	(0.188)	(0.018)	(0.042)	(0.067)
U_{t-1}	-0.160	-0.744**	-0.556*	0.155**	-0.007	-0.077
	(0.164)	(0.192)	(0.248)	(0.049)	(0.050)	(0.065)
DUR_{t-1}			0.022			-0.028
			(0.115)			(0.037)
$R25_{t-1}$			-0.201**			-0.018
			(0.064)			(0.029)
RJL_{t-1}			-0.021			-0.023*
			(0.048)			(0.011)
Adj-R^2	0.232	0.389	0.502	0.168	0.334	0.382
DW	1.607	2.005	2.006	1.534	1.946	2.008

Results of the Chow Test on the Model Stability for the Post-1991 Period

	US			NY		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
F-statistic	9.817**	1.925+	1.582	6.324**	2.176+	1.329
	[0.000]	[0.089]	[0.146]	[0.000]	[0.076]	[0.244]

[a] E(*inf*) is the inflation expectation of general price level. E(*inf*) = P_{t-1} = lagged actual price inflation (BLS) in Model 1, and E(*inf*) = E(P_t) = expected price inflation from the Survey of Professional Forecasters at the Federal Reserve Bank of Philadelphia.

Standard errors of the coefficients in (parentheses). p-values are in [parentheses].
** significant at the 1% level, * significant at the 5% level, and + significant at the 10% level.

replace the lagged price inflation with the expected price inflation (Model 1 versus Model 2), the coefficient increases from 0.407 to 1.051 for the US, and from 0.060 to 0.225 for the NY State. At the same time the adjusted R^2 increases from 0.335 to 0.436 for the US model and from 0.209 to 0.381 for the NY model. Interestingly, the magnitude of wage adjustment to price inflation expectation is much smaller for the NY manufacturing wage.

The coefficient on expected price inflation variable is larger in magnitude for the US non-farm business than for the NY manufacturing sector (1.051 versus 0.225 in Model 2, and 0.643 versus 0.156 in Model 3). The persistence of wage inflation as measured by the lagged dependent variable (Models 2 and 3) does not have a statistically significant impact on the wage adjustment process. We tested the sensitivity of our results by including lags of expected inflation. However, once we include the longer lags, the coefficients on both current and lagged expected inflation become statistically insignificant.

The coefficient on the lagged unemployment rate in Model 1 is negative, albeit statistically insignificant for the US non-farm business and positive and statistically significant for the NY manufacturing sector. This indicates that the labor market forces do not have an effect on the US non-farm business, and contrary to our expectation, have a positive effect on the NY manufacturing wage. However, once we replace the lagged price inflation by the expected price inflation (Model 1 versus Model 2), the coefficient on the unemployment rate for the US non- farm sector becomes statistically significant and is much larger in magnitude (-0.160 in Model 1 versus -0.744 on Model 2) indicating a typical strong negative effect of the labor market force. This is consistent with the findings by Duca (1996) and Hyclak and Ohn (2001). On the other hand, for the NY manufacturing sector, the coefficient on the unemployment rate switches from positive and statistically significant in Model 1 to negative and not statistically significant in Model 2 indicating that labor market forces have no effect on wage adjustment. When we include three demographic unemployment variables in Model 3, we find that the coefficients on unemployment rate and the percent of unemployed adults who are 25 and older are statistically significant and negatively affect the national wage. The coefficient on the aggregate unemployment rate is smaller in magnitude in Model 3 than in Model 2. It seems that the higher fraction of unemployed adults captures a part of the effect of labor market force which is not represented by the aggregate unemployment rate. For the NY manufacturing wage, only the percent of unemployment due to permanent job loss shows a statistically significant and negative effect on wage adjustment.

Our results indicate that while both the national non-farm business and NY manufacturing wage show a significant adjustment to expected price inflation, the national wage adjustment to long-run labor market force can be explained by the aggregate unemployment rate and the percent of adult unemployment, while the NY manufacturing wage adjustment is driven by the fraction of

unemployment due to permanent job loss. Although the effect of expected price inflation is statistically significant for NY manufacturing, it is quite lower in magnitude compared to the national model.

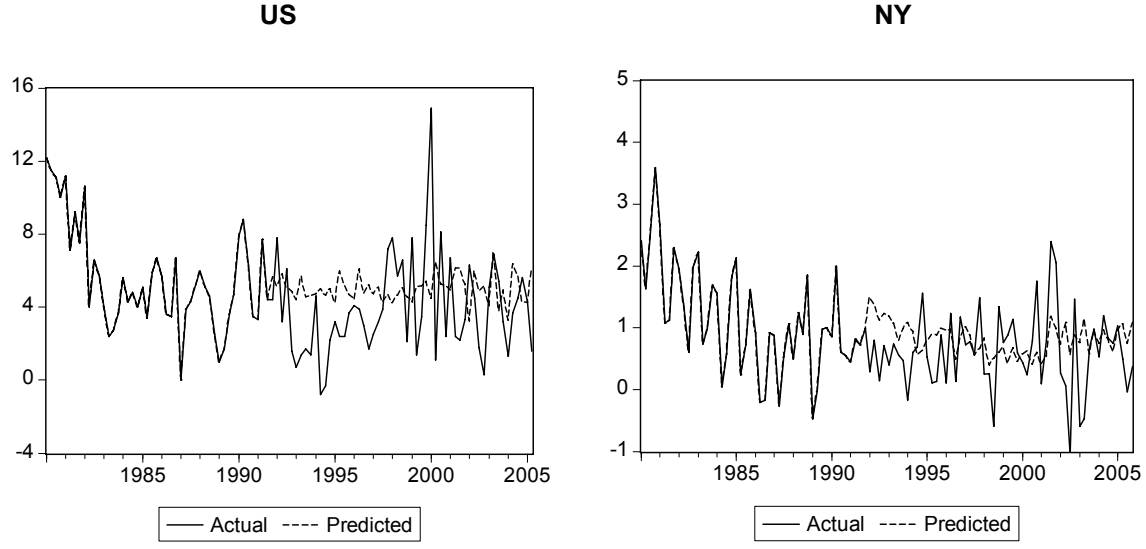
Model Stability

The lower panel of Table 1 shows the result of the Chow test for the model stability over the post-1991 period. The basic model (Model 1) shows significant evidence of a structural shift for the post-1991 period for both the US and NY. When we replace the lagged actual price inflation with the expected price inflation (Model 2), the evidence of a structural shift for the post-1991 period becomes much smaller (the F statistic is significant at the 10 percent for both US and NY State). On the other hand, once we include the three demographic unemployment variables (Model 3), the evidence of a structural change disappears in both the US and NY State. This suggests that the previous finding of over-prediction or a structural shift by the wage Phillips-type model in the 1990s' is a result of model mis-specification or under-specification rather than a result of an actual structural shift.

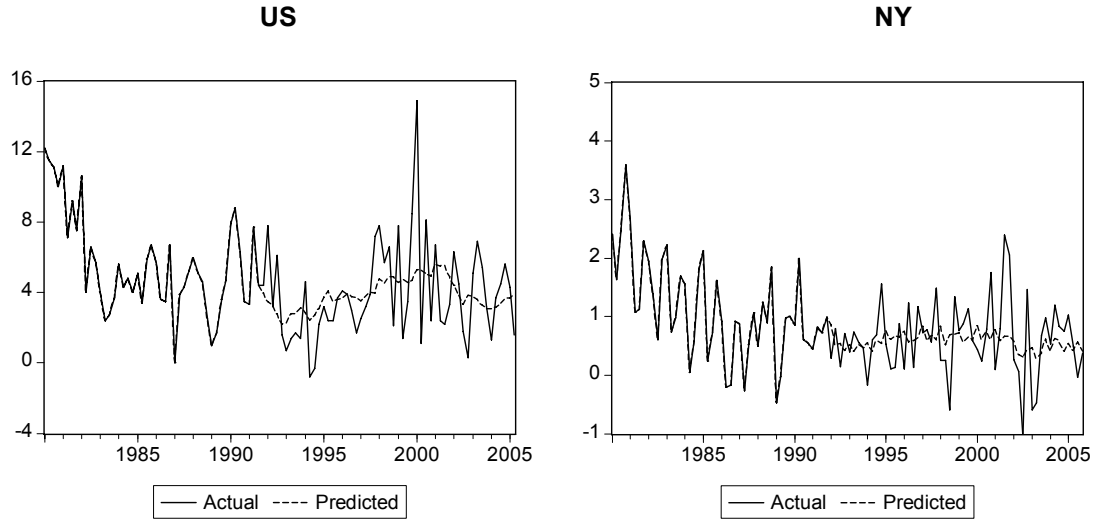
Figure 1 compares the actual and forecasted wage inflation for the post-1991 period. The graphs in Panel A show the actual and forecasted wage inflation for the US non-farm business and NY manufacturing based on Model 1. In the case of both the US and NY, the model consistently overpredicts wage inflation for the post-1991 period but only slightly for the mid-2000s. However, the graphs in Panel B, which compare actual and forecasted wage inflation based on Model 3, do not show any significant over-prediction pattern for the US and NY. The regression and forecast results confirm our finding that the observed structural shift for the 1990s is a result of model mis- or under-specification and not a result of an actual shift.

Figure 1. Actual vs. Forecasted Wage Inflation based on Models 1 and 3: US Non-farm Business vs. NY Manufacturing Sector

A. Actual vs. Forecasted Wage Inflation Based on Model 1, 1992-2006.



B. Actual vs. Forecasted Wage Inflation Based on Model 3, 1992-2006



Difference between the US and NY Results – Industry-specific or State-specific?

The above results raise an interesting question: Are the differences between the national and the NY results sector-specific or state-specific? To answer the question, we examine the wage adjustment process for the US manufacturing sector over the same period. The results are shown in Table 2. The basic model (Model 1) shows a significant adjustment to lagged price inflation but not to employment. The coefficient on the lagged unemployment rate is only marginally significant and has a positive sign. The adjusted models (Models 2 and 3) show a typical positive and significant adjustment to expected price inflation, a negative and significant adjustment to unemployment rate, and a significant positive adjustment to wage inflation persistence. This is different from the results for the US non-farm business and NY manufacturing sector. Recall that the coefficient on the lagged wage inflation variable was not significant for the US non-farm business and NY manufacturing sector (Table 1, Model 2). In Model 3, the significant effect of the unemployment rate found in Model 2 is captured by the fraction of adult population that is unemployed (found in the US non-farm business model) and by the percent of unemployed due to permanent job loss (found in the NY manufacturing sector). The magnitude of the adjustment to expected inflation (0.426) is in between the values for US non-farm business (0.643) and NY manufacturing (0.156).

These findings suggest that for the manufacturing sector, the wage adjustment to unemployment is partially due to permanent job loss at both the NY state and national level. On the other hand, the wage adjustment to unemployment due to a larger fraction of adult unemployment appears to be nation-specific.

Table 2. Test Results on the Wage Phillips Curve Model for the US Manufacturing Sector, 1975-2006

Regression Results

Variable	**Model 1**	**Model 2**	**Model 3**
Constant	0.087 (0.921)	1.984* (0.811)	13.903** (4.496)
ΔW_{t-1}		0.395** (0.081)	0.219* (0.090)
E(*inf*)[a]	0.397** (0.056)	0.764** (0.146)	0.426* (0.204)
U_{t-1}	0.363^{+} (0.244)	-0.354* (0.149)	-0.018 (0.203)
DUR_t			-0.059 (0.092)
$R25_{t-1}$			-0.176* (0.068)
RJL_{t-1}			-0.045^{+} (0.025)
Adj-R^2	0.344	0.546	0.638
DW	1.496	2.019	1.913

Results of the Chow Test on the Model Stability for the Post-1991 Period

F-statisitc	5.104** [0.000]	2.379* [0.042]	2.182^{+} [0..071]

[a] E(*inf*) is the inflation expectation of consumer price. E(*inf*) = P_{t-1} = lagged actual price inflation in Model 1, and E(*inf*) = $E(P_t)$ = expected price inflation from Survey of Professional Forecasters at the Federal Reserve Bank of Philadelphia.

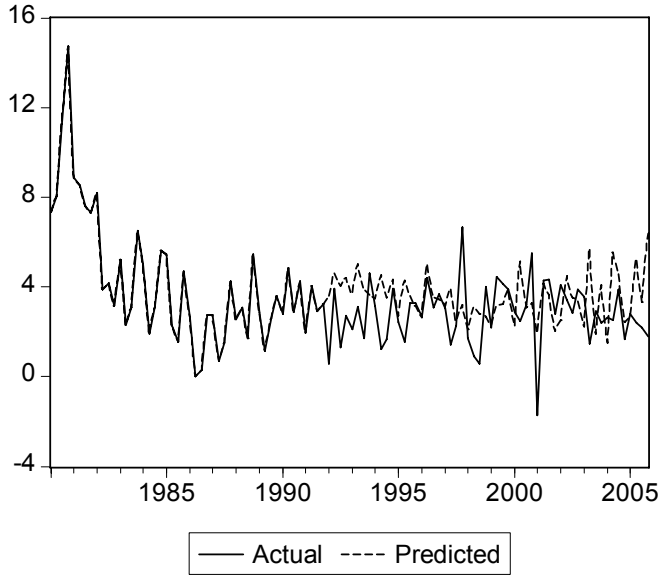
Standard errors of the coefficients in (parentheses). p-values are in [parentheses].
** significant at the 1%, * significant at the 5%, $^{+}$ significant at the 10%.

The test for model stability indicates that the evidence of a structural shift for the post-1991 period based on the basic wage model (Model 1) for the US manufacturing sector does not disappear in two adjusted models (Models 2 and 3). Even though the magnitude of the test statistic decreases in the two adjusted models, it is still statistically significant at the 5 percent level in Model 2 and at the 10 percent level in Model 3.

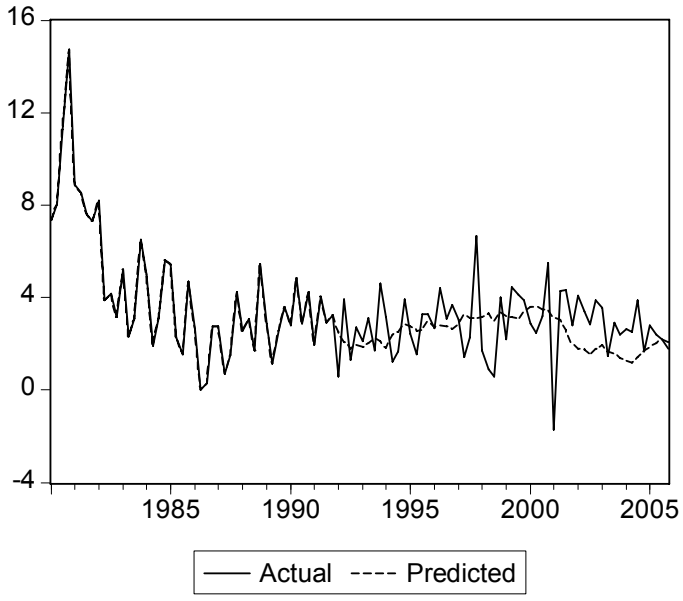
Figure 2 compares the actual and the forecasted values of wage inflation for the US manufacturing sector. The basic model (Model 1) generally overpredicts the wage inflation during the

Figure 2. Actual vs. Forecasted Wage Inflation Based on Models 1 and Model 3: US Manufacturing Sector

A. Actual vs. Forecasted Wage Inflation Based on Model 1, 1992-2006



B. Actual vs. Forecasted Wage Inflation Based on Model 3, 1992-2005



early- to mid-1990s and the mid-2000s, while the adjusted model (Model 3) shows a slight under-prediction for the mid-2000s, which resulted in the marginally significant Chow test statistics for Model 3.

IV. Conclusion

Recently, researchers have questioned the stability of the Phillips model in predicting inflation. The post 1991 recovery period resulted in low rates of price and wage inflation despite strong growth and a declining unemployment rate. In this paper, we examined wage adjustment to price inflation expectation and labor market forces as represented by the unemployment rate and three demographic factors of unemployment for the US non-farm business, NY manufacturing, and the US manufacturing sector. Our results suggest that Phillips-type models do a good job in explaining wage adjustment for both the US non-farm sector and the US and NY manufacturing sectors.

We find that the rise in fraction of the adult population which is unemployed and the rise in the fraction of unemployment due to permanent job loss can explain the behavior of wage inflation during the post 1991 better than the unemployment rate alone. The previously observed structural shift for the post-1991 period seems to be a result of model mis- or under-specification for the US non-farm business and the NY manufacturing but not for the US manufacturing sector. These results suggest that any analysis of US economy during the post 1990 recession must consider structural changes in unemployment.

REFERENCES

Alogokoufis, G. and Smith, R. (1991). On error correction models: specification, Interpretation, Estimation, *Journal of Economic Surveys*, 5(1): 98-128.

Borjas, G. J. and Ramney, V. H. (1995). Foreign competition, market power and wage inequalities, *Quarterly Hournal of Economics*, 110(4): 1075-110.

Duca, J. V. (1996), Inflation, unemployment, and duration, *Economic Letters*, 52: 293-298.

Dijk, J. van and Folmer, H. (1999). Wage effects of unemployment duration and frequency. *Journal of Regional Science*, 39(2): 319-337.

Hyclak, T. and Ohn, J. (2001). Wage inflation and the post-1991 duration puzzle. *Economics Letters* 73(1): 97-104.

_____ and _____ (1997). Occupational wage structure in US local labour markets, *International Journal of Manpower,* 18(5): 373-390.

Karoly, L. A. and Klerman, J. A. (1994). Using regional data to re-examine the contribution of demographic and sectoral changes to increasing US wage inequality, in Bergstrand, J. H., Cosimano, T. and Sheehan, R. G. (Eds), *The Changing Distribution of Income in an Open US Economy*, North Holand, Amsterdam.

Lown, C.S. and Rich, R.W. (1997). Is there an inflation puzzle? *FRBNY Economic Policy Review*, 51-69.

Ohn, J. and Kramer, J. (2007). On the Structure of Wage Adjustment in the United States and Pennsylvania: A Philips-Type Wage Model Analysis, *Northeastern Journal of Business, Economics, and Technology* 14(1): 15-22.

Topel, R.H. (1994). Regional Labour markets and the determinants of wage inequality, *American Economic Review*, 84(2): 17-22.

Valetta, R.G. (1998). Changes in the structure and duration of U.S. unemployment, 1967-1998, *FRBSF Economic Review* 3: 29-40.

_____ (1997). Job loss during the 1990s, *FRBSF Economic Letter* 196-07, Feb 16.