The Effect of Average Wages on the Economy: The Case of the United States

Gerardo Angeles-Castro
Jonatan Juárez-Cruz
Miguel Flores-Ortega
School of Economics
Instituto Politécnico Nacional
México

Abstract

The paper applies vector autoregressive and error correction models, in order to explore the effect of average wages growth on economic growth, inflation and unemployment rate in the United States from the first quarter of 1964 to the first quarter of 2013. We find that average wage growth increases economic growth, reduces inflation and does not affect unemployment. Therefore, those policies oriented to boost wages can be convenient to strength the domestic market and the macro economy of countries, following the case of the US.

Keywords:VAR models, wages, employment, inflation, GDP growth

1. Introduction

The effect of real wages on the economy can be diverse. On the one hand, an increase in this variable can improve consumption and economic growth, while prices remain relatively stable. On the other hand, higher real wages might increase inflation, discourage job creation and reduce the economic activity.

Neoclassical theory conventionally predicts a negative relationship between real wages and output.However,past empirical research suggests that when a supply-sideshock exists there is a positive correlation between real wage and output and, when there is a demand-side shock the relationship is not clear (Kim, 2005).

A popular model of the inflation process is the expectations-augmented Phillips curve model, which predicts that wages and prices may be causally related with feedbacks going in both directions (Ghali, 1999). However previous studieshave shown contradictory results. For example, Stiglitz (1997) argues that the labour market explains, to a larger extent, changes in prices, while Gordon (1988) states that variations in wages and inflation rate are not related in the Granger-causal sense. Barth and Bennett (1975) and Mehra (1977, 1991) claim that the causality runs only from inflation to wages, which suggests that labour cost variables do not determine inflation rate.

The standard model of wages predicts that in a competitive equilibrium, there is a negative correlation between wages and employment. In contrast, past empirical studies do not show that this relationship can be downward sloping (Katz and Krueger, 1992; Card, 1992) and that the theoretical wage-employment trade-off is not always readily observed in practice (Bhorat et al., 2013).

In order to investigate the relationship between wages and economic variables previous studies have incorporated diverse methodologies. Williams and Mills (1998) use quarterly data for the first quarter of 1954 to the last quarter of 1993, to investigate the relationship between employment, wages and a set of controls in the US, they apply a dynamic system through a vector autoregressive (VAR) methodology and also explore causality between variables and impulse-response functions. Kim (2005) conducts a three-variable (real wage, real output and nominal money supply) VAR model to examine the relationship between them and their response to shocks, in four Pacific-rim countries (New Zealand, Japan, Korea and Australia). Bhorat et al. (2013) use a polled dataset consisting of 15 waves of the South African Labour Force Survey, the 15 waves are polled and are treated as repeated cross-sections over time; in the study they explore the effect of wages on employment introducing individual and district control variables in the specification.

Due to the slow economic growth that most of the globe has experimented over the currentmillennium and even before, and the instability of capital and goods international markets, a recent discussion has emerged, supporting the idea of boosting the domestic market and the internal demand in order to provide the impulse to the national economies, both developing and developed, that the international markets, exports and foreign investments have been unable to provide (Palley, 2012). Additional literature states that while exports remain an important determinant of growth, the domestic market plays also an important role to achieve sustained economic growth (Tsen, 2007).

One of the transmission channels to boost the domestic market and the internal consumption is through the rise of real wages. In this respect, in the US the real wage has increased over the last decade in the same proportion than inflation or even above it during several quarters. Hence, this country represents and interesting study case in order to explore the effect of wage growth on the economy.

This paper is aimed at analysing the effect of wage growth on representative macroeconomic variables such as growth, unemployment and inflation in the US, through Vector Autoregressive (VAR) models and additional time series econometric techniques, using quarterly data from the first quarter of 1964 to the first quarter of 2013. We find that wage growth increases economic growth, reduces inflation and does not damage employment; hence, the increase of real wages can represent an innovative policy to achieve sustained growth.

The paper is organised as follows: Section 2 comments on the variables and presents a preliminary graphic analysis. Section 3conducts the econometric methodology used in the study including the VAR models, stationarity and cointegration, the impulse response functions (IRF), the vector error correction models (VEC) and causality tests. Finally concluding remarks are presented in Section 4.

2. The Variables

The time span studied in the paper comprises the period between the first quarter of 1964 and the first quarter of 2013, in total there are 197 observations in the sample. All the variables, except the Gross Domestic Product, are obtained on a monthly basis,the quarterly figures are calculated through the average of the corresponding three months.

The inflation rate is computed through the consumer price index (CPI). The variable on wages is average hourly earnings of production and nonsupervisory employees, total private, presented in current U.S. dollars per hour. For this study we use the rate of growth of the wage variable and it is computed by taking the logs and then the first differences of the quarterly data. In order to obtain constant U.S. dollars the inflation adjusted values are encountered with the CPI. The unemploymentvariable is civilian unemployment rate. The GDP is expressed in constant U.S. dollars. For this variable we also use the rate of growth, and as before, it is computed by taking the logs and then the first differences of the quarterly data.

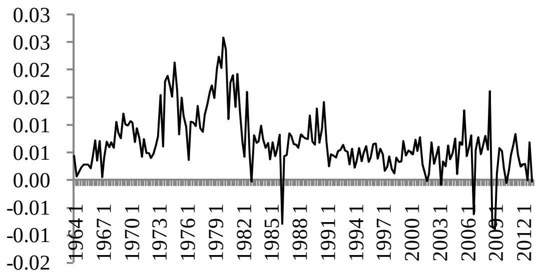
As for the CPI, the average wage and the unemployment rate, the source is the U.S. Department of Labor, Bureau of Labor Statistics, 2013. The real GDP is obtained from the U.S. Department of Commerce, Bureau of Economic Analysis, 2013.

2.1. Preliminary Graphic Analysis

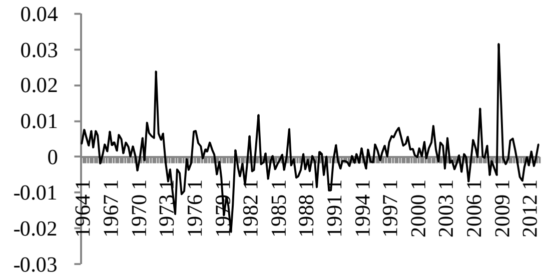
In this section we present the graphs of the variable in order to observe to main points: 1) if the data follow any stationary pattern with constant mean and variance. 2) If the time series have an intercept or a trend or both, this graphic analysis is convenient to select the appropriate specification of the unit root test in the variables.The graphs are shown in Figure 1.

Figure 1: Graphs of the Variables

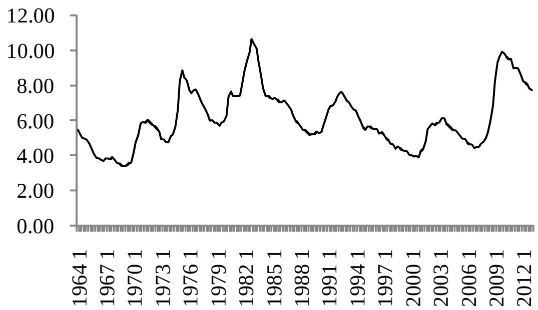
A. Inflation rate



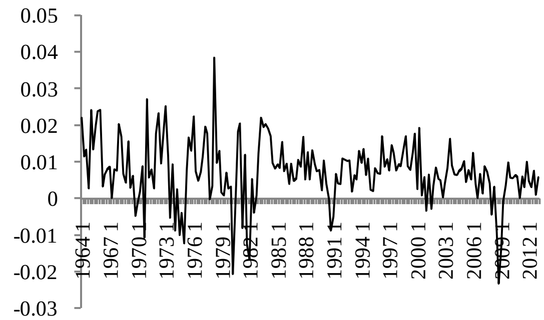
B. Wage growth



C. Unemployment



D. GDP growth



Source: The U.S. Department of Labor, Bureau of Labor Statistics, 2013. The U.S. Department of Commerce, Bureau of Economic Analysis, 2013

The series do not seem to have a trend and they all have an intercept. Although it is not clear whether the mean and variance of the variables remain constant across the whole sample, they do not change drastically over time, especially in the case of inflation rate, wage growth and GDP growth. In this sense, the Augmented Dickey-Fuller test (ADF) for unit root,to be applied in the four variables, is the one presented in Equation 1, with a constant and no trend.

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \, \Delta y_{t-1} + u_t \qquad (1)$$

whereα_0 represents the intercept, γ is the coefficient of the lagged variable in levels and β_i is the coefficient of the lagged dependent variable.

3. Econometric Approach

3.1. Unit Root Tests

The Augmented Dickey-Fuller unit root test that formally tests for non-stationarity (Dickey and Fuller, 1979, 1981) is conducted for every variable. The results, reported in Table 1, show the specification of the test in which the coefficient of the last lagged dependent variable is statistically significant, at conventional levels, and the Breusch-Godfrey Lagrange Multiplier tests fails to reject the null hypothesis of no autocorrelation in the residuals. All the series are stationary and therefore, it is not necessary to apply the unit root test on their first differences

Table 1: Unit Root Test on the Variables

Variable	ADF test statistic		Specification	BGLM test statistic
Inflation rate	-3.193	**	Intercept, two lags	(0.7482)
Wage growth	-4.631	*	Intercept, two lags	(0.1945)
Unemployment	-3.194	**	Intercept, one lag	(0.7476)
GDP growth	-6.745	*	Intercept, one lag	(0.8281)

Notes: ADF test H_0: there is a unit root, $\phi = 1$, $\gamma = 0$. BGLM tests H_0: no autocorrelation in the residuals. * Statistically significant at the 1 per cent level. ** Statistically significant at the 5 per cent level. p values in parenthesis.

3.2. Cointegration and Vector Error Correction Models

Table 2 shows the cointegration tests, which are the result of conducting the Dickey-Fuller unit root test on the residuals, also known as the Engle-Granger test (Engle and Granger, 1987), estimated from the regressions of Inflation rate (1), unemployment rate (2) and GDP growth (3) on the wage growth variable.

Table 2: Cointegration Test, Unit Root Test on the Residuals

Regression	Dependent variable	Coefficient		Constant		EG test statistic	
1	Inflation rate	-0.661	*	0.007	*	-7.285	*
2	Unemployment rate	-33.524	♦	6.120	*	-1.532	
2a	Δ unemployment rate	-4.499		0.013		-6.243	*
3	GDP growth	0.226	**	0.007	*	-10.091	*

Notes: The explanatory variable is wage growth. EG test H_0: there is a unit root, $\phi = 1$, $\gamma = 0$. * Statistically significant at the 1 per cent level. ** Statistically significant at the 5 per cent level. ♦Statistically significant at the 10 per cent level.

The regressions of inflation rate (1) and GDP growth (3) on wage growth are cointegrated. Only regression (2), that associates unemployment rate and wage growth, does not have a long-run relationship. Consequently, we regress the first difference of the unemployment rate on wage growth (2a) and find that are cointegrated. The coefficients on the integrated regressions are the long-run parameters. From the results we can say that over the long-run a rise of 1 per cent on wages is associated to a reduction of 0.661 points in inflation and to an increase of 0.226 per cent in GDP, while the effect of wage growth on variations of unemployment is not statistically significant.

The vector error correction model is performed applying Equation 2 as follows:

$$\Delta X_{1t} = \alpha_0 + \eta_1 \hat{u}_{1t-1} \quad (2)$$

where$\hat{u}_{it}$ is the residual obtained from the cointegrated equation. The error correction term is η_i, it is expected to be negative in order to restore the equilibrium value of X_{it} and its magnitude defines how quickly the equilibrium is achieved in one quarter.

The model uses, as explanatory variable, first lagged values of the residuals of the integrated equationsin Table 2 to measure the one quarter response of the variables to wage growth. We also estimate the equations in which wage growth is the dependent variable and the other three time series are explanatory variables. The results from Equation 2 are reported in Table 3. The statistically significant and negative sign of η_1, the error correction term, indicates that inflation rate (column 2), differences in unemployment (column 3) and GDP growth (column 4) depend on wage growth to adjust to their equilibrium value.Around 70 per cent of the GDP growth equilibrium error is corrected in one quarter, while 47 and 34 per cent of inflation rate and changes in unemployment equilibrium error is corrected in one quarter respectively. On the other hand, wage growth does not depend on any of the explanatory variable to adjust towards its equilibrium, as η_1 is not statistically significant in any of the three panels in column 1.

The results support the idea that inflation rate, unemployment variations and GDP growth depend on wage growth more than wage growth depends on these three variables to restore the equilibrium. From the long-run equations in Table 2, it is possible to observe that GDP growth accelerates and inflation rate falls with wage growth; moreover, employmentis not affected through higher wages and therefore, the effect of wage growth on the economy is not adverse.

Table 3: Error Correction Mechanism

Explanatory Variable	Dependent variable							
	(1) Wage growth		(2) Inflation rate		(3)ΔUnemployment rate		(4) GDP growth	
(1) Inflation rate								
Constant	-0.00000							
$\hat{u}_{1t-1}$	0.058657							
(2) ΔUnemployment								
Constant	-0.0000227							
$\hat{u}_{1t-1}$	0.0020646							
(3) GDP growth								
Constant	-0.000000							
$\hat{u}_{1t-1}$	-0.0638043							
(4) Wage growth								
Constant			-0.0000119		0.001027		-0.0000757	
$\hat{u}_{1t-1}$			-0.4731629	*	-0.3441382	*	-0.6958294	*

Notes: * Statistically significant at the 1 per cent level. ** Statistically significant at the 5 per cent level. ♦Statistically significant at the 10 per cent level.

3.3. Vector Autoregressive Specification and the Impulse Response Functions

In this study we perform regressions to explain the relationship between average hourly wages and three variables GDP growth, inflation and unemployment. In this sense, we conduct three different VAR models.If the variables are cointegrated the VAR model is estimated with the series in levels, as in Equations 3 and 4, if not we use the series that have been transformed to their stationary values, that is the differenced variables. Every model incorporates k lag values of the X_1andX_2 variables, and therefore every variable is represented as a linear function of its own lags and the lags of the other variable in the system, as follows:

$$X_{1t} = \alpha_1 + \sum_{j=1}^{k} \beta_{1j} X_{1t-j} + \sum_{j=1}^{k} \beta_{2j} X_{2t-j} + u_{1t} \quad (3)$$

$$X_{2t} = \alpha_1 + \sum_{j=1}^{k} \beta_{1j} X_{1t-j} + \sum_{j=1}^{k} \beta_{2j} X_{2t-j} + u_{2t} \quad (4)$$

where the u's are the stochastic error terms.

In the VAR model it is assumed that both u_{1t} and $u_{2t}$are uncorrelated error terms. In this sense, the number of lags in the specification is determined through the application of a Lagrange Multiplier test for autocorrelation (LMAR) in the residuals, as suggested by Adkins and Hill (2008). If the residuals appear to be autocorrelated it is convenient to add additional lags to the VAR until the null hypothesis of the test "H_0: no autocorrelation" is not rejected. In order to confirm the right lag length and following Andreica et al. (2010), we report the Akaike information criterion (AIC) and the Schwarz information criterion (SC), obtained as follows:

$$AIC\ (p) = ln|\Sigma(p)| + (k + pk^2)\frac{2}{T} \quad (5)$$

$$SC\ (p) = ln|\Sigma(p)| + (k + pk^2)\frac{\ln(T)}{T} \quad (6)$$

The VAR specification with the lowest criterion is more convenient compared to the alternative specifications.

Once the VAR models are estimated the study presents the analysis of the impulse response function (IRF), which measures the effect of a shock to an endogenous variable on itself or on another endogenous variable Becketti (2013). This analysis is constructed to provide information on the size and speed of the impact of wages on Inflation, unemployment and GDP growth and in the opposite direction, through a graphic approach.

The first specification associates wage growth and inflation rate. As the variables are cointegrated, they are incorporated in levels in the equation. Five lags of the variables are included in the equation in order to eliminate autocorrelation, the magnitude of the AIC and the SC is the smallest for this specification. Although some of the coefficients are not statistically significant, collectively they are significant on the basis of the standard F test. In this case the null hypothesis is "H_0: all the slope coefficients are simultaneously zero".

As the computed *F* statistic exceeds the *F*-critical value, we reject the null hypothesis and conclude that not all the slope coefficients are simultaneously zero. The outcome of the regression and the tests are presented in Table 4.

Table 4: Vector Autoregressive Estimation for Wage Growth and Inflation Rate Based on Five Lags

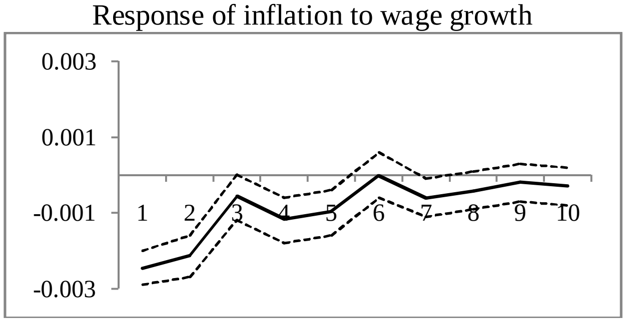
Explanatory variables	Wage growth		Inflation rate	
Wage growth				
L1	0.6585263	*	-0.4860323	*
L2	0.0724167		0.23498	*
L3	0.0926554		0.0174332	
L4	-0.1649523		0.1071408	
L5	-0.1060996		0.2572849	*
Inflation rate				
L1	0.4384198	*	-0.0992255	
L2	0.043936		0.3574918	*
L3	-0.342721	**	0.2839077	*
L4	-0.0823035		0.0959894	
L5	-0.1455181		0.3169061	*
Constant	0.0007154		0.0002448	
R^2	0.329349		0.619475	
Adj. R^2	0.292296		0.598451	
Akaike information criterion	-7.750716		-8.461667	
Schwarz information criterion	-7.564089		-8.275040	
F statistic	8.88870	*	29.46583	*
Lagrange Multiplier Test				
Autoregressive 1	2. 8556 (0.58227)			
Autoregressive 2	2.1226 (0.71321)			
Akaike information criterion	-16.94116			
Schwarz information criterion	-16.56790			

Notes: * Statistically significant at the 1 per cent level. ** Statistically significant at the 5 per cent level. ♦Statistically significant at the 10 per cent level.*p*-value in parenthesis.

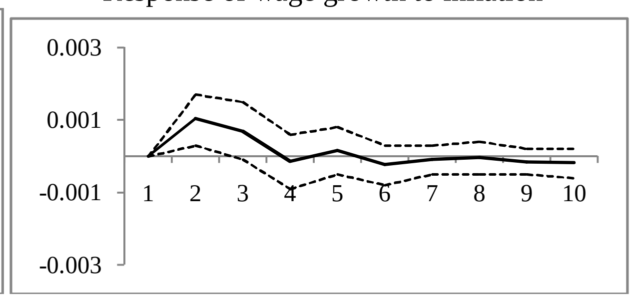
The analysis of the IRF presented in Figure 2 shows that wage growth shocks have a negative impact on inflation over the 10 periods analysed, while the shocks on inflation have a positive and small impact on wage growth over the first three periods and then the effect alternates close to cero.

Figure 2: Response to Cholesky one S.D. Innovations (Wage Growth and Inflation)

Response of inflation to wage growth



Response of wage growth to inflation



Source: Computed with information from the U.S. Department of Labor, Bureau of Labor Statistics, 2013 and the U.S. Department of Commerce, Bureau of Economic Analysis, 2013.

The second VAR model incorporates wage growth and GDP growth in the specification. The variables are taken in levels because they are cointegrated. The Lagrange Multiplier test fails to reject the null hypothesis of no autocorrelation in the residuals when three lags of the variables are included in the model and the magnitude of the AIC and the SC is the smallest for this specification. The coefficients are collectively significant on the basis of the standard *F* tests.The results of the regression and the tests are reported in Table 5.

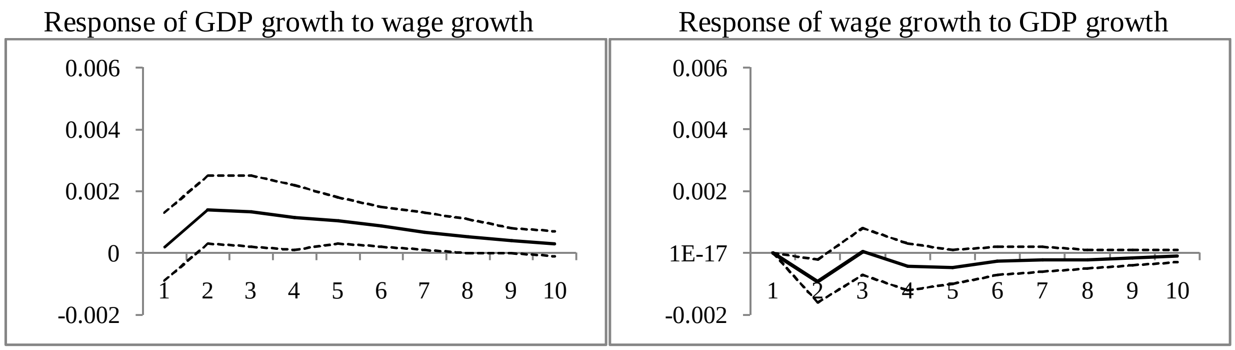
Table 5: Vector Autoregressive Estimation for Wage Growth and GDP Growth Based on Three Lags

Explanatory variables	Wage growth		GDP growth	
Wage growth				
L1	0.4546038	*	0.2797751	*
L2	-0.0493796		0.0745661	
L3	0.2773207	*	0.0539588	
GDP growth				
L1	-0.1192847	*	0.2311075	*
L2	0.0884845	**	0.1832078	**
L3	-0.0606926		-0.0279652	
Constant	0.000721		0.0042593	*
R^2	0.318720		0.190877	
Adj. R^2	0.296861		0.164916	
Akaike information criterion	-7.778777		-6.834389	
Schwarz criterion	-7.660864		-6.716477	
F statistic	14.58056	*	7.352421	*
Lagrange Multiplier Test				
Autoregressive 1	5.379 (0.25057)			
Autoregressive 2	6.2929 (0.17831)			
Akaike information criterion	-14.61374			
Schwarz criterion	-14.37791			

Notes: * Statistically significant at the 1 per cent level. ** Statistically significant at the 5 per cent level. ♦Statistically significant at the 10 per cent level.*p*-value in parenthesis.

The graphs of the IRF shown in Figure 3 illustrate that wage growth shocks have a positive impact on GDP growth over the whole horizon analysed; on the other hand, GDP growth shocks have a negative impact on wage growth with oscillatingmagnitude the first three periods and then converges to cero gradually, but overall the impact is smaller than in the opposite direction.

Figure 3: Response to Cholesky one S.D. Innovations (Wage Growth and GDP Growth)



Source: Computed with information from the U.S. Department of Labor, Bureau of Labor Statistics, 2013 and the U.S. Department of Commerce, Bureau of Economic Analysis, 2013.

Table 6 presents the results and tests of the third VAR model. In this case the variables in levels are not cointegrated and thus, we use the stationary time series. The rate of growth of the wage variable is stationary; hence it is not necessary to use the differences, but we need to take the first differences of the unemployment rate to have a stationary time series. Once this procedure is conducted, we observe that the wage growth and the first differencesof the unemployment rate are cointegrated time series (Table 2). As in the previous models, some of the coefficients are not statistically significant but, on the basis of the standard *F* test, the equations are statistically significant as a whole. The model requires the incorporation of three lagged terms to satisfy LM test for autocorrelation and to obtain the smallest AIC and SC.

Table 6: Vector Autoregressive Estimation for Wage Growth and ΔUnemployment Rate Based on Three Lags

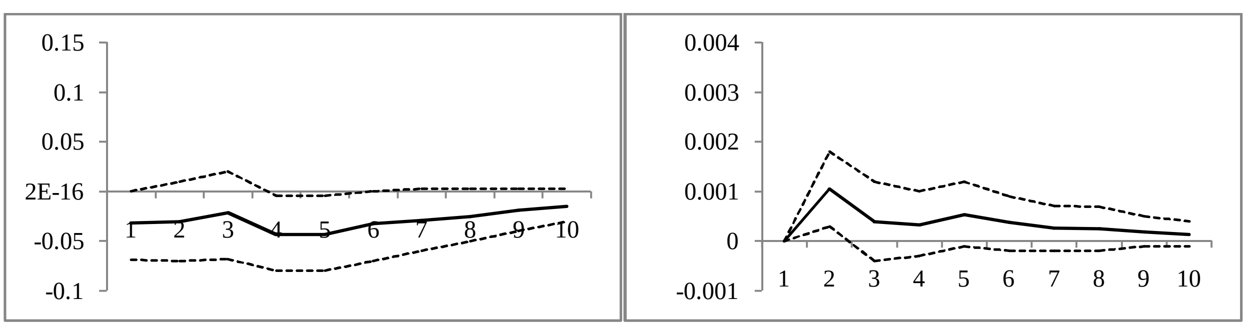
Explanatory variables	Wage growth		ΔUnemployment rate	
Wage growth				
L1	0.4539523	*	-1.890955	
L2	-0.0663635		0.5784567	
L3	0.2783998	*	-6.289713	♦
ΔUnemployment rate				
L1	0.0041308	*	0.662953	
L2	-0.0030541	♦	-0.0020382	
L3	0.0011283		-0.0384461	
Constant	0.0000315		0.0075715	
R^2	0.31248687		0.45102568	
Adj. R^2	0.29030903		0.43331683	
Akaike information criterion	-7.76548638		0.14416698	
Schwarz criterion	-7.64715046		0.26250289	
F statistic	14.0900482	*	25.4689436	*
Lagrange Multiplier Test				
Autoregressive 1	5.2018 (0.26721)			
Autoregressive 2	8.1358 (0.10673)			
Akaike information criterion	-7.63684244			
Schwarz criterion	-7.40017061			

Notes: * Statistically significant at the 1 per cent level. ** Statistically significant at the 5 per cent level. ♦Statistically significant at the 10 per cent level.*p*-value in parenthesis

As for the response of difference in unemployment rate to wage growth shocks we observe from Figure 4that the impact is negative during all 10 periods explored;in the opposite direction the response of wage growth to difference in unemployment rate shocks is permanently positive and the magnitude of the impact is smaller and decreases gradually.

Figure 4: Response to Cholesky one S.D. Innovations (Wage Growth and ΔUnemployment Rate)

Response of Δunemployment to wage growth Response of wage growth to Δunemployment



Source: Computed with information from the U.S. Department of Labor, Bureau of Labor Statistics, 2013 and the U.S. Department of Commerce, Bureau of Economic Analysis, 2013.

3.4. Testing Causality

In this section the Granger Causality test is performed in the three VAR specifications reported before. The results are presented in Table 7. It can be noticed, from row 1 and 2 that there is bilateral causality between inflation rate and wage growth, however the effect is more robust in the direction from wage growth to inflation rate, because the estimated *F* test is significant at the 1 percent level and in the other way, the *F* test is significant at the 5 percent level. A similar result is obtained from rows 3 and 4 where the causality from wage growth to GDP growth is more robust than in the opposite direction.

These results are in keeping with those presented in the VEC analysis in Table 3 and 4, to the extent thatinflation rate and GDP growth depend on wage growth more than wage growth depends on these two variables to restore the equilibrium. It can be seen from rows 5 and 6 that there is causality only from ΔUnemplyoment rate to wage growth but not in the opposite direction.

Table 7: Granger Causality Test in the VAR Specifications

Null hypothesis	F statistic	*p*-value	Lags
1. Inflation rate does not granger cause wage growth	2.563	0.029	5
2. Wage growth does not granger cause inflation rate	13.444	0.000	5
3. GDP growth does not granger cause wage growth	3.603	0.015	3
4. Wage growth does not granger cause GDP growth	4.040	0.008	3
5. ΔUnemplyoment rate does not granger cause wage growth	3.077	0.029	3
6. Wage growth does not granger cause ΔUnemplyoment rate	1.495	0.217	3

4. Conclusions

According to the results obtained from the cointegration analysis this study showed that over the long run wage growth is associated to a reduction of inflation and to the expansion of the economy;regarding the effect on unemployment the coefficient is not statistically significant. The analysis conducted through the impulse response functionsconfirms that the impact of wage growth on GDP growth is positive, while it is negative on inflation. The evidence obtained from the vector error correction equationsindicates that inflation, GDP growth and unemployment depend on wage growth to adjust to their equilibrium value. In this respect, it is interesting to note that the equilibrium error is corrected faster in the case of the GDP growth and the correction is slower for the case of unemployment. The causality tests reveal that wage growth causes GDP growth and inflation but does not cause unemployment. Therefore, there is evidence that inflation and GDP growth depend on wage growth and there is also evidence that this variable benefits the economy of the US to the extent that it is associated to more economic growth and less inflation. The impact of wage growth on unemployment is not robust and hence, there is not enough evidence to argue that higher wages reduce unemployment. In this sense, although the study does not support the idea that wage growth reduces unemployment, it does not find any evidence that more unemployment could be the result of higher wages.

The vector error correction equations reveal that wage growth does not depend on GDP growth, inflation and unemployment to adjust to its equilibrium value. Hence, there is not enough evidence to argue that inflation, unemployment and GDP growth correct the wage growth equilibrium error; in contrast, in the opposite direction, wage growth restores the equilibrium error of the three variables in consideration. The granger causality testis consistent with the previous conclusions to the extent that the causality from wage growth to GDP growth and inflation is more robust than in the opposite direction.

Our results do not find support for neoclassical theory or standard models, which associate higher wages with less economic growth, less employment and more inflation. In contrast we find that, for the case of the US, higher wages benefit the economy in terms of more economic growth and less inflation and do not affect employment. This empirical evidence could be useful for policy makers in the US and other countries as a support to analyse or apply policies to boost wages.

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