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WAGES AND UNEMPLOYMENT IN THE UNITED STATES: REVIVING A WAGE GAP EXPLANATION[*]

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[*] I have benefited from comments and suggestions from Bernardo Blum, Janet Currie, Sebastian Edwards, Arnold Harberger, Luisa Lambertini, Edward Leamer and Carlos Vegh, as well as seminar participants at several places. Financial support from Russell Sage Foundation is gratefully acknowledged. All remaining errors are mine.

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Wages and Unemployment in the United States: Reviving a Wage Gap Explanation*

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January 2003

Abstract

The unemployment path in the United States in the last forty years can be significantly explained by the evolution of excessive real wages. An estimation of the evolution of market-clearing wages is presented and its difference with observed average wages - the wage gap - is shown to track significantly the path of the unemployment rate. Aside from emphasizing unemployment as an involuntary phenomenon, the neoclassical nature of the labor demand function used casts doubts with respect to effectiveness of aggregate demand policies, contrasting with some natural rate theories whose labor demand side provides room for extensive demand shocks. In this context, a fall in real wages appears as the key mechanism to generate a rise in aggregate employment.

JEL: E24, E32, J23.

Key Words: Unemployment, Wage Gap, Labor Demand.

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1 Introduction

The evolution of wages and unemployment during the last 30 years in OECD countries (depicted in Figures 1 and 2) has dominated research efforts in the trade, macro and labor literatures and generated increasing concern among policy makers. According to Gordon (1995): "The persistence of high unemployment rates dominates European policy discussions, whereas American economists are increasingly concerned with the slow growth rate of real wages and the large increase in the dispersion of incomes." In fact, in the United States the main focus has been on the stagnation of average wages since the mid 1970s and specially the rise in wage inequality since the late 1970s. In the familiar trade and wages debate, the emphasis is on whether globalization or technological change have been the driving forces behind the evolution of real wages and wage dispersion. The literature on unemployment has focused on the determinants of high and persistent unemployment rates, with special emphasis on explaining the different unemployment experiences of OECD countries.

[*Insert Figure* 1]

[*Insert Figure* 2]

In this context, theories of natural or equilibrium rate of unemployment that emphasize unemployment as an involuntary phenomenon have been developed out of two main building blocks. The first is a downward sloping labor demand or price-setting curve where employment and price decisions are taken by firms. The second building block is an upward sloping wage-setting curve aimed to explain why wages in equilibrium may not be at their full-employment level. The interaction of both curves determine the employment (or unemployment) level and the real wage supporting it.[1] In general, the literature has focused either a) on the determinants of cross-country differences in unemployment

[1]See Layard, Nickel and Jackman (1991), Phelps (1994) and Blanchard and Katz (1997) for some representative natural rate models.

rates where the determinants of the wage-setting curve play a significant role or b) in the time series evolution of the unemployment rate where variations in the labor demand curve seem to play a mayor role. As Bean (1994) shows, studies of unemployment have highlighted, among other things, the role of contractionary demand policies; increases in union power and unemployment benefits; increases in the price markup due to higher interest rates; and differences between productivity growth and workers expectations. The identification of the nature of unemployment becomes crucial in determining the policies that can affect it.

This paper provides evidence that the evolution of unemployment in the U.S. in the last 40 years has been significantly determined by the evolution of the wage gap, defined as the difference between observed and full-employment wages. Like natural rate theories, it emphasizes unemployment as an involuntary phenomenon. However, the crucial difference with the existing literature rests on the neoclassical nature of the labor demand curve, derived from the maximization process of firms operating in perfectly competitive markets. In a context where the real wage/employment locus belongs to the labor demand function of firms participating in perfectly competitive markets, aggregate demand shocks cannot affect the determinants of the demand for labor (productivity, capital stock and relative prices), at least in the short run. Consequently, the role of aggregate demand shocks in explaining the evolution of unemployment is dubious and the space for effective demand policies weakens. A fall in real wages becomes the fundamental mechanism to generate a rise in aggregate employment. This amounts to a supply-side explanation for unemployment.

This explanation contrasts with those of many natural rate theories that have rejected the neoclassical labor demand curve as the locus where employment decisions by firms are taken. As Phelps (1994) observes "The other problem to be met [in developing a natural rate theory] was to release the demand side of the labor market from the marginal productivity straightjacket of the neoclassical aggregative school." Layard et al., (1991) are less radical but more explicit: "we prefer to think of the 'price equation' as representing a

locus of price-employment combinations consistent with profit-maximization behavior by monopolistically competitive firms." Alternative models of labor demand determination include some where firms take employment decisions based on inter-temporal considerations; where the markup over marginal costs varies with the product demand; or where product prices are set before employment decisions are taken. In all cases, demand policies can affect the labor demand curve through variations in interest rates or by directly affecting aggregate demand.[2] Indeed, as Phelps (1994) acknowledges, some policy implications of natural rate theories are similar to those of traditional Keynesian theories. However, this is merely coincidence, for the nature of unemployment in the two cases is radically different.

[*Insert Figure* 3]

In terms of Figure 3, the paper estimates the extent to which we can explain the evolution of unemployment $(L_1 - L_0)/L_1$ with an estimate of the evolution of the wage gap w_0/w_e, where the labor demand curve is neoclassical. A multi-sector general equilibrium model is developed with firms operating in perfectly competitive product and factor markets. An expression for the evolution of constant-unemployment wages for any given set of shocks to exogenous variables is derived and estimated using measures of observed sectorial productivity growth, relative price changes, capital accumulation and labor force growth. It is shown that deviations of the wage rate from its market-clearing path can explain a substantial portion of the variation in U.S. unemployment rates over the last 40 years. This association holds not only for short-run fluctuations but also for medium-run trends. These results imply that a neoclassical labor demand curve cannot be easily rejected, as is proposed by some natural rate theories. However, the role of demand shocks in certain episodes cannot be ruled out. Therefore, the paper does not constitute a test against demand-driven unemployment. Nevertheless, it does suggest that excessive wages

[2]See Nickell (1990).

measured along a neoclassical labor demand curve can explain a substantial portion of the variation in aggregate employment.

A second fundamental issue in an explanation of unemployment based on excessive real wages is related to the nature of excessive wages. Natural rate theories emphasize several mechanisms by which an upward-sloping curve between real wages and employment (not a labor supply curve) exists. Efficiency wages, unions, workers' bargaining power or unemployment benefits can explain why equilibrium real wages – higher than the supply price of labor – fail to clear the labor market. The specific explanation for why wages are above their market-clearing level may affect the concept of excessive real wages. It may be the case that firms have incentives to pay wages higher than their opportunity cost in order to increase productivity. In this case, a fall in real wages is not a viable way to increase aggregate employment. The paper does not focus on explaining the evolution of the wage gap; instead, it focuses on its implications.[3]

The association between unemployment and the wage gap presented is similar to the one popularized by Bruno and Sachs (1985) to explain the stagnation of OECD economies in the 1970s. Several criticisms to their approach, both conceptually and methodologically, are found in Bean (1994). As he points out, the wage gap concept is associated with the use of a labor demand function under perfect competition; hence, it fails to acknowledge that wages and unemployment are jointly determined by the interaction of wage-setters, who determine the nominal wage, and firms, which set the nominal price. The results in this paper show that regardless of the wage-setting structure, the assumption of a labor

[3]In another paper (Claro 2002) I develop a model which emphasizes the role of sectorial shocks in the wage-setting process at the industry level, acknowledging the presence of some degree of rent sharing. In this context, the evolution of the wage gap follows from the asymmetric response of sectorial wages to sector specific shocks. The paper provides empirical evidence regarding the procyclical pattern of interindustry wage differentials. At the aggregate level, there exists a negative association between variations in aggregate employment and the wage gap measured as the difference between average observed wages and market-clearing wages.

demand derived from firms operating under perfect competition is not only consistent with the evolution of employment but it also can explain a significant part of its variation. Furthermore, Bean argues that studies such as Bruno (1986) and Gordon (1988) tend to find that the wage gap had disappeared in most countries by the mid-eighties. This paper offers contrary evidence, at least for the United States.

A second criticism of the wage gap approach is that it usually fails to explain why wages are too high. Although relevant, this criticism does not address what I consider the most significant difference between the wage gap approach and other natural rate models: namely, the nature of the labor demand curve. The nature of unemployment and its policy implications depend not only on the reasons behind excessively high wages but also on the determinants of the labor demand curve.

It is important to point out some limitations of the empirical analysis. First, one cannot estimate the level of wage overvaluation at any given moment; only an index of its evolution can be calculated. For example, it is not possible to claim that the 10% unemployment rate in the United States in 1982 was due to an overvaluation of 30% in wages; however, we can note that the rise in unemployment from 8% to 10% from 1981 to 1982 is associated with a 5% rise in the wage gap. Second, because it is not possible to ascertain the precise wage gap, eventual cross-country comparisons of the wage gap and unemployment are meaningless.

The paper is divided as follows: Section 2 presents a model to determine the factors affecting the evolution of market-clearing wages. Section 3 offers the empirical estimation; and Section 4 concludes.

2 The Model

Consider an economy with $j = 1,...,T+1$ sectors of production. T of them produce tradable goods, which prices are set in international markets. Industry $T+1$ produces an internationally immobile good. There are two factors of production. Labor L is

mobile across sectors but capital K is sector-specific. Technologies are of constant-returns-to-scale type, and markets are perfectly competitive. The equilibrium is therefore characterized by a set of zero profit conditions in each sector, a market clearing condition in the labor market, full capital utilization and market clearing in the market for the non-tradable good. In each period these equations are given by

a. Zero-profit conditions

$$P_j = a_{Lj}W + a_{Kj}r_j \qquad \forall j. \tag{1}$$

b. Labor market clearing condition

$$\overline{L} = \sum_{i=1}^{T} a_{Li}Q_i + a_{LN}Q_N. \tag{2}$$

c. Full capital utilization

$$K_j = a_{Kj}Q_j \qquad \forall j. \tag{3}$$

The nominal price of good j is P_j while W and r_j represent the nominal wage and rental rates of sector-specific capital in sector j respectively. a_{Fj} represents the requirements of factor F to produce one unit of good j, that is, the inverse of average productivity. Given the CRS technology assumption, a_{Fj} depends on exogenous technological parameters as well as relative factor prices. Therefore, equation (1) represents the traditional equality between price and marginal costs.

In (2), $\overline{L}$ represents aggregate employment. For now, and before introducing the possibility of unemployment, it is equal to the labor force and it is considered completely inelastic. This assumption emphasizes the role of changes in labor demand in the employment cycle, leaving aside changes in labor supply. However, its impact on the results is minor because the equilibrium in the labor market is established with the intersection between the labor demand and some wage-setting mechanism. Q_j represents output of good j. Therefore, $a_{Lj}Q_j$ is the demand for labor in each sector, that is a function of

output, wages, product prices and technology. K_j represents the (sector-specific) stock of capital in industry j. At any point in time,output is determined by the stock of capital and the technology available.

To state the non-tradable (NT) market-clearing condition it is necessary to specify a demand function for NT. Consider a simple demand function derived from the maximization problem of the representative individual of her log-linear utility function. In such case, the consumption level is a constant share of income.[4] In this case, the demand for NT shifts only in response to changes in the value of production of tradable goods.[5] The market-clearing condition for the non-tradable good is

$$P_N Q_N = \frac{\alpha_N}{1-\alpha_N} \sum_{i=1}^{T} P_i Q_i \tag{4}$$

where α_N is the preference parameter for the non-tradable good.

Expressions (1) to (4) comprise a set of $2T+4$ equations that can solved for $2T+4$ unknowns: the wage level w, $T+1$ sector-specific rental rates r_j, $T+1$ employment allocations $L_j (= a_{Lj} K_j / a_{Kj})$ and the equilibrium price for the non-tradable good p_N.

Totally differentiating (1) we get[6]

$$\widehat{P}_j + \widehat{TFP}_j = \theta_{Lj} \widehat{W} + \theta_{Kj} \widehat{r_j} \tag{5}$$

where $\widehat{TFP}_j = \theta_{Kj} \delta_{Kj} + \theta_{Lj} \delta_{Lj}$ where δ_{Fj} is the factor-specific technological change of factor F and θ_{Fj} is the share of factor F in total costs. Totally differentiating (3) and

[4]The maximization of $\sum_{j \in T,NT} \alpha_j \ln c_j$ subject to a resource constraint given by $\sum_j P_j c_j = \sum_j P_j Q_j$ yields the following first order condition: $c_N P_N = \frac{\alpha_N}{1-\alpha_N} \sum_{i \in T} P_i Q_i$. In this case, consumption is a constant share of total income.

[5]A second mechanism not considered in this paper is the change in demand for NT due to substitution-possibilities associated with changes in the real exchange rate. This channel has been widely analyzed in the literature (see Edwards 1989). In this paper I mainly focus on supply-side mechanisms.

[6]By the definition of average productivity we know that $\widehat{a_{Lj}} = -\theta_{Kj} \sigma_j (\widehat{w} - \widehat{r_j}) - \delta_{Lj}$ and $\widehat{a_{Kj}} = \theta_{Lj} \sigma_j (\widehat{w} - \widehat{r_j}) - \delta_{Kj}$ where σ_j is the elasticity of substitution between labor and capital in sector j defined as $\sigma_j = \theta_{Kj} (\widehat{a_{Kj}} - \widehat{a_{Lj}}) / (\widehat{w} - \widehat{P_j})$. This is the elasticity of the marginal productivity of the mobile factor, defined as positive.

combining it with (5) we get the following expression for the change in sector's j labor demand

$$\widehat{L_j} = \frac{\sigma_j}{\theta_{Kj}}\left(\widehat{P_j} + \widehat{TFP_j} - \widehat{W}\right) + (\delta_{Kj} - \delta_{Lj}) + \widehat{K_j}. \tag{6}$$

Equation (6) reveals the change in employment in sector j for exogenous change in product prices, productivity, capital stock and the wage rate. The term $(\delta_{Kj} - \delta_{Lj})$ reflects the effect of factor-biased technological change. In the case of the non-tradable good, P_N is endogenously determined. We therefore have to solve for $\widehat{P_N}$ by totally differentiating equation (4). This yields

$$\begin{aligned}\widehat{P_N} &= \frac{\theta_{KN}}{\theta_{KN} + \theta_{Ln}\sigma_N} \cdot \\ &\left[\sum_{i=1}^{T} \phi_i^{'}\left(\widehat{K_i} + \widehat{P_i} + \delta_{Ki} + \frac{\theta_{Li}\sigma_i}{\theta_{Ki}}\left(\widehat{P_i} + \widehat{TFP_i} - \widehat{W}\right)\right) - \widehat{K_N} - \delta_{KN} + \frac{\theta_{LN}\sigma_N}{\theta_{KN}}\left(\widehat{TFP_N} - \widehat{W}\right)\right]\end{aligned} \tag{7}$$

where $\phi_i^{'}$ is the share of tradable sector i in total tradable value-added.

We have now all the elements to solve for the change in wages $\widehat{W_e}$ consistent with the full-employment condition (2). Plugging (6) and (7) into the log-difference equation derived from (2) we get

$$\widehat{W_e} = \widehat{W_E} - \frac{Z_N}{\Gamma}\frac{d\overline{L}}{\overline{L}} \tag{8}$$

where

$$\begin{aligned}\widehat{W_E} &= \frac{1}{\Gamma}\{\sum_{i\in T}\phi_i^{'}\widehat{P_i} + \sum_i \phi_i^{'}\frac{\theta_{Li}\sigma_i}{\theta_{Ki}}\widehat{P_i} + Z_N\sum_i \lambda_{Li}\frac{\sigma_i}{\theta_{Ki}}\widehat{P_i} \\ &+ \sum_i \phi_i^{'}\delta_{Ki} + \sum_i \phi_i^{'}\frac{\theta_{Li}\sigma_i}{\theta_{Ki}}\widehat{TFP_i} + Z_N\sum_i \lambda_{Li}\frac{\sigma_i}{\theta_{Ki}}\widehat{TFP_i} \\ &+ \sum_i \phi_i^{'}\widehat{K_i} + Z_N\sum_i \lambda_{Li}\widehat{K_i} + \frac{\theta_{KN}(1-\sigma_N)}{\sigma_N}\widehat{K_N} \\ &- Z_N\sum_i \lambda_{Li}(\delta_{Li} - \delta_{Ki}) + \widehat{TFP_N} - \delta_{KN} - Z_N(\delta_{LN} - \delta_{KN})\}\end{aligned}$$

with $\Gamma = \sum_i \phi_i^{'} + \sum_i \phi_i^{'}\theta_{Li}\sigma_i/\theta_{Ki} + Z_N \cdot \sum_i \lambda_{Li}\sigma_i/\theta_{Ki}$ and $Z_N = (\theta_{KN} + \theta_{LN}\sigma_N)/\lambda_{LN}\sigma_N$. Substracting an index of average product prices changes in both sides of (8) we get a

similar expression with $\widehat{w_e}$ being the percentage change in real wages and $\widehat{p_i}$ being the percentage change in relative prices. From now on, we refer to low-case variables w and p as real variables.

This expression summarizes the two transmission mechanisms of shocks in tradable industries to real wages. The first mechanism reflects the direct effect of shifts in labor demand in tradable sectors at the initial distribution of employment between tradable and non-tradable sectors. The second mechanism measures the effect of shocks to tradable industries on real wages through its effect on the supply and demand for NT goods. Also, shocks to non-tradable industries affect real wages through their relative impact of NT supply and demand.

The first three terms in $\widehat{w_E}$ indicate the effect of changes in relative prices of tradable products on wages. The first two show the effect associated with shifts in NT demand due an income effect, while the third term reflects relative labor-demand changes in tradable industries. Productivity changes in tradable sectors are transmitted through similar channels. The income effect of price and productivity changes contains a term associated with changes in the value of the initial production structure (factor allocation) and another term reflecting the gains due to reallocation of resources across sectors. In the case of productivity changes, only technological changes associated with capital affects output given the assumption of capital specificity.

Variations in capital stock within tradable sectors also have a direct effect on wages via changes in labor demand. There is also an indirect effect of changes in NT demand. Capital accumulation in tradable sectors has an unambiguously positive effect on real wages by raising the marginal productivity of labor. In contrast, the effect of capital accumulation in non-tradable sectors is ambiguous, because the rise in labor demand is compensated by a fall in non-tradable prices. The final effect depends on the elasticity of substitution between labor and capital in NT sectors. If σ_N is small enough, capital accumulation implies a major rise in labor demand that dominates the negative effect of P_N fall. Expression (8) also indicates the traditional negative effect of a rise in labor

supply and the effect of skilled-bias technological change in tradable sectors.

Finally, productivity changes in non-tradable sectors affect the supply of NT goods. Its impact on wages depend on whether productivity change affects the demand for labor. The last three terms in expression $\widehat{w_E}$ can be written as a function of $(\delta_{KN} - \delta_{LN})$, revealing that only factor-saving technological change in NT industries affects real wages. Unlike productivity growth in tradable sectors, technological change in NT sectors generates a shift in output supply that deflates non-tradable prices, offsetting the effect on labor demand of greater productivity. These two effects cancel each other if technological change is Hicks-neutral, under the assumption that NT consumption is a constant share of income.

Despite its limitations, expression (8) offers evidence that shocks to tradable industries can have significant effects on real wages even if their share in total output and employment is small. This holds true even when the most important changes in productivity are in non-tradable industries. If the latter are mainly Hicks-neutral, their impact on real wages may be completely dominated by shocks to tradable sectors.

2.1 Wages and Unemployment

So far, it has been assumed that the labor market clears. Consider now the possibility that of real wages following a different path from the market-clearing one just described. In other words, consider the presence of a wage-setting mechanism (not modeled) that may eventually result in a wage level different from the one that supports zero unemployment. It is not the objective of this paper to study possible causes of such wage gap, but rather to analyze its potential consequences. As discussed in the introduction, this may limit the scope of conclusions of the study but it does not prevent us for discussing to what extent excessive real wages measured along a neo-classical labor demand function can explain the evolution of unemployment.

It proves useful to decompose the labor force (LF) into three components: $LF =$

$U + L_T + L_N$ where U is the number of people unemployed, and L_T and L_N equal the number of people employed in tradable and non-tradable industries respectively. Totally differentiating we get

$$\widehat{LF} = \mu\widehat{U} + \lambda_T\widehat{L_T} + \lambda_N\widehat{L_N} \tag{9}$$

where μ is the unemployment rate and λ_i is the share of employment in sector i in total labor force ($\mu + \lambda_T + \lambda_N = 1$). Summing over tradable and non-tradable industries we get the following change in L_T and L_N

$$\lambda_T\widehat{L_T} = \sum_{i=1}^{T}\left(\lambda_{Li}\frac{\sigma_i}{\theta_{Ki}}\left(\widehat{P_i} + \widehat{TFP_i} - \widehat{W}\right) + (\delta_{Ki} - \delta_{Li}) + \widehat{K_i}\right) \tag{10}$$

and

$$\lambda_N\widehat{L_N} = \lambda_{LN}\frac{\sigma_N}{\theta_{KN}}\left(\widehat{P_N} + \widehat{TFP_N} - \widehat{W}\right) + (\delta_{KN} - \delta_{LN}) + \widehat{K_N}. \tag{11}$$

Replacing (7), (10) and (11) into (9) for any change in real wages $\widehat{w_0}$ yields

$$\widehat{w_0} = \widehat{w_E} - \frac{Z_N}{\Gamma}\frac{dLF}{LF} + \frac{Z_N}{\Gamma}\mu\widehat{U} = \widehat{w_E} - \frac{Z_N}{\Gamma}(1-\mu)\widehat{LF} + \frac{Z_N}{\Gamma}\mu\widehat{\mu}. \tag{12}$$

This is a fundamental result. It states that the change in real wages consistent with a constant level of unemployment (i.e., $\widehat{U} = 0$; all the change in the labor force is absorbed), $\widehat{w_e}\,|_{\overline{U}}$ is

$$\widehat{w_e}\,|_{\overline{U}} = \widehat{w_E} - \frac{Z_N}{\Gamma}\widehat{LF}. \tag{13}$$

Likewise, the percentage change in real wages associated with no change in the unemployment rate, $\widehat{w_e}\,|_{\overline{\mu}}$, is given by

$$\widehat{w_e}\,|_{\overline{\mu}} = \widehat{w_E} - \frac{Z_N}{\Gamma}(1-\mu)\widehat{LF}. \tag{14}$$

Both (13) and (14) have similar implications. Variations in aggregate employment are a positive function of the difference between changes in observed and *constant-unemployment*

wages - the wage gap.[7] Let us focus on (14). Wage increases greater than $\widehat{w_e}\,|_{\overline{\mu}}$ imply an increase in the rate of unemployment, meaning that given changes in labor demand, firms are willing to absorb only part of the increase in the labor force. Indeed, the percentage increase in employment is smaller than the percentage increase in labor force. Therefore, we should observe increases in the unemployment rate in periods where observed wage changes are greater than $\widehat{w_e}\,|_{\overline{\mu}}$, while periods of falling μ are periods of change increases smaller than $\widehat{w_e}\,|_{\overline{\mu}}$. As expected, the wage increase required to keep U constant is necessarily smaller than the real wage change consistent with a constant μ.

The relationship between changes in μ and the wage gap can be written as follows

$$\widehat{\mu} = \frac{\Gamma}{Z_N \mu} \left(\widehat{w_0} - \widehat{w_e}\,|_{\overline{\mu}}\right). \tag{15}$$

This relationship can be interpreted as the dynamic equivalent of a relationship between the unemployment rate and the ratio between observed and full employment wages, as figure 3 shows. Consider the following function $\mu = h(w_0/\widetilde{w})$ with $h' > 0$ and $h(1) = \mu_N$ where μ_N is the frictional rate of unemployment and $\widetilde{w}$ is the wage level that supports it. Differences across time or countries in the function $h()$ may reflect changes in the frictional component of the unemployment rate, so that a similar wage gap is consistent with different unemployment rates. Alternatively, variations in the wage elasticity of labor demand can imply very different employment responses to changes in the wage gap.

Totally differentiating h implies that $\widehat{\mu} = (h' w_o / h\widetilde{w}) \cdot (\widehat{w_o} - \widehat{\widetilde{w}})$. If the economy is at full employment, then by definition the percentage change in $\widetilde{w}$ is exactly equal to $\widehat{w_e}\,|_{\overline{\mu}}$. Hence, the coefficient accompanying $(\widehat{w_0} - \widehat{w_e}\,|_{\overline{\mu}})$ on (15) can be interpreted as $h' w_o / h\widetilde{w}$. If unemployment is positive, then $\widehat{w_e}\,|_{\overline{\mu}}$ is a good proxy for $\widehat{\widetilde{w}}$ as long as the response of labor demand to exogenous shocks is not significantly affected by the initial level of aggregate employment. The stability of the structural parameters of equation (8) over

[7] The term *constant-unemployment* wages is written in italics to highlight that it refers to constant unemployment level in the case of (13) and constant unemployment rate in the case of (14).

the business cycle makes it reasonable to assume that this is the case.[8]

In order to interpret causality in equation (15), it is important to examine the degree to which the determinants of market-clearing wages are not affected by changes in aggregate employment conditions. We therefore have to focus on the cyclical properties of relative prices, sectorial productivity, capital accumulation and labor force movements. I come back to the endogeneity issue in next section.

A final implication of the model is related to the distribution of employment between tradable and non-tradable sectors. Indeed, we can analyze to what extent the evolution of manufacturing employment vis-a-vis non-manufacturing sectors can be explained by the observed evolution of wages. Rearranging terms in equation (10) we get[9]

$$\widehat{L_T} = -\sum_{i\in T} \lambda'_{Li} \frac{\sigma_i}{\theta_{Ki}} \left(\widehat{W_o} - \widehat{P_i} - \widehat{TFP_i} \right) + \sum_{i\in T} \lambda'_{Li} \widehat{K_i} = (\widehat{w_T} - \widehat{w_o}) \sum_{i\in T} \lambda'_{Li} \frac{\sigma_i}{\theta_{Ki}} \qquad (16)$$

where λ'_{Li} is the share in total manufacturing employment of sector i ($\sum_{i\in T} \lambda'_{Li} = 1$). w_T/w_0 is a measure of the tradable wage gap. The condition to keep manufacturing employment constant is not the same as the one required to keep aggregate employment constant, as labor can move between tradable and non-tradable sectors without affecting the level of unemployment. This will depend on the response of the demand and supply of NT to changes in tradable markets and real wages. In terms of the model, if $\widehat{w_0} = \widehat{w_e} \mid_{\overline{\mu}} > \widehat{w_T}$, falls in manufacturing employment are completely absorbed in NT sectors.

Summarizing, the model has two empirical implications. First, we can estimate the evolution of wages consistent with no change in unemployment according to equation (8)

[8] According to equation (8), the effect of exogenous shocks on equilibrium wages depends on the characteristics of the production structure. As long as the production structure is not dramatically affected by excess real wages, the assumption that $\widehat{w_e} \mid_{\overline{\mu}} = \widehat{\overline{w}}$ is reasonable. The characteristics of the production structure are the distribution of employment and the share of capital in total costs, variables that tend to be quite stable over the course of the business cycle. Indeed, more than 95% of the variation in the variables of the right hand side of (8) is explained by shocks and not by variations in the initial conditions.

[9] where $\widehat{w_T} = \frac{\sum_{i\in T} \lambda_{Li} \frac{\sigma_i}{\theta_{Ki}} (\widehat{P_i} + \widehat{TFP_i}) + \sum_{i\in T} \lambda_{Li} \widehat{K_i}}{\sum_{i\in T} \lambda_{Li} \frac{\sigma_i}{\theta_{Ki}}}$.

to check whether the evolution of aggregate employment is consistent with changes in the wage gap. Second, we can perform a similar exercise to determine whether a similar mechanism is behind the evolution of manufacturing employment. The following section provides empirical validity for such relationships.

3 Empirical Estimation

I examine the NBER Productivity Database for 448 4-digit manufacturing sectors from 1958 until 1996. It contains data on sectorial employment, producer prices, value-added and production, materials, energy, labor and capital costs as well as data on total-factor productivity changes and capital stock. Data for an aggregate non-tradable sector are obtained from several sources; employment shares from the Bureau of Labor Statistics (BLS) and TFP changes are calculated as the difference between the growth of non-manufacturing output (from national accounts) and the rate of change in services employment and capital stock obtained from BLS.

Due to data limitations, I assume that all technological change has been Hicks-neutral. Therefore, the terms $\delta_{Lj} - \delta_{Kj}$ in equation (8) vanish for $j \in T, NT$. This assumption has the limitation of imposing a null effect on real wages of productivity changes in non-tradable industries. The only missing data required to compute each component in (8) is the elasticity of substitution between labor and capital in each sector. For simplicity, it is assumed that $\sigma_j = 1 \quad \forall j \in T, NT$. I support this assumption for two reasons. First, almost all the variation in the components of equation (8) comes from the shocks themselves, and not from changes in the structural parameters imbedded in them. Moreover, the evolution of constant-unemployment wages does not change with the use of alternative measures of σ_i.[10] Second, several studies show that a unitary elasticity

[10] I estimated (not reported) the elasticity of substitution between labor and capital for each industry based on a CES production function, yielding values between 0.5 and 6. The inclusion of this values have a negligible effect on the evolution of the components of constant-unemployment wages.

of substitution between labor and capital is a reasonable value (see Krueger (1981)). A drawback of this assumption is that it implies a null effect of capital accumulation in non-tradable sectors on real wages. However, this series is highly correlated with capital accumulation in manufacturing sectors, so the latter variable captures a major part of the effect of aggregate capital accumulation.

The assumption that labor and capital are the only factors of production implies that production has to be measured in value-added terms and price changes as value-added price changes. Percentage changes in value-added prices are calculated as

$$\widehat{P_i^{va}} = \frac{\widehat{P}_i - \sum_j \theta_{ji}\widehat{P}_j}{1 - \sum_j \theta_{ji}}$$

where θ_{ji} is the share of intermediate input j = materials, energy in total output.[11] I first compute the for each year the values for each element on the right hand side of (8), and then I either calculate or estimate the evolution of constant-unemployment wages. The components on the right-hand-side of (8) are

$$A.\ \mathrm{d}PRICE = \frac{1}{\Gamma}\{\sum_{i\in T}\phi_i'\widehat{p}_i + \sum_{i\in T}\phi_i'\frac{\theta_{Li}\sigma_i}{\theta_{Ki}}\widehat{p}_i + Z_N\sum_{i\in T}\lambda_{Li}\frac{\sigma_i}{\theta_{Ki}}\widehat{p}_i\}$$

$$B.\ \mathrm{d}TFPT = \frac{1}{\Gamma}\{\sum_{i\in T}(\phi_i'\frac{\theta_{Li}\sigma_i}{\theta_{Ki}} + \phi_i')\widehat{TFP_i} + Z_N\sum_{i\in T}\lambda_{Li}\frac{\sigma_i}{\theta_{Ki}}\widehat{TFP_i}\}$$

$$C.\ \mathrm{d}KT = \frac{1}{\Gamma}\{\sum_{i\in T}\phi_i'\widehat{K_i} + Z_N\sum_{i\in T}\lambda_{Li}\widehat{K_i}\}$$

$$D.\ \mathrm{d}LF = \frac{Z_N}{\Gamma}\widehat{LF}$$

[11] The results are not affected is relative changes in product prices rather than value-added prices are used.

where $\widehat{p_i}$ is the change in the relative value-added price of sector i deflated by a weighted average (by value-added) of manufacturing nominal product prices, i stands for each 448 4-digit SIC manufacturing industries and N stands for an aggregate of non-tradable sectors.[12]

[*Insert Figure* 4]

Figure 4 plots an index of d$PRICE$, d$TFPT$ and dKT computed as $I_t = I_{t-1}(1+dI_t)$ with $I_0 = 1$. The well documented stagnation of productivity growth in mid 1970s and 1980s is evident. Indeed, the level of real wages mandated by productivity changes in manufacturing industries in 1996 is 9% higher than its level in 1973, compared to the 17% difference between 1973 and 1958. The evolution of the relative price index shows a dramatic downward pressure on wages in the 1970s, followed by a smooth upward trend thereafter. This results is consistent with Leamer's 1998 result that the 1970s experienced a dramatic fall in prices of labor-intensive manufacturing products. The level of the real wage induced by changes in relative prices was 22% lower in 1970 compared to its 1958-level.

[*Insert Figure* 5]

It is possible to decompose the effect of changes in manufacturing prices, productivity and capital stock into two components: one related to the direct impact in real wages through changes in tradable sectors' labor demand, and a second indirect impact through changes in the demand and supply of non-tradable goods. Figure 5 shows three panels that plots the direct and indirect impact on real wages of these three components of constant-unemployment wages. Panel (a) reveals that the direct impact of variations in relative prices is very similar to the indirect impact, although the during the 1970s and beginning of 1980s the strongest effect was due to changes in NT demand. The demand for

[12]The results do not change if rather than deflating nominal value-added prices with average manufacturing product prices we use CPI inflation.

NT has also reacted significantly to changes in multi-factor productivity in manufacturing industries. Finally, the direct impact of capital accumulation in manufacturing industries has been minor compared to its indirect effect.

[*Insert Figure* 6]

With all the components of equation (8) we can now compute an index for the evolution of real wages consistent with a constant rate of unemployment. Figure 6 plots the unemployment rate between 1959 and 1996 against indices of observed real hourly compensation costs and constant-unemployment wage changes.[13] There exists a clear relationship between unemployment and the wage gap in the 1974 and 1981 recessions, as well as other smaller short-run fluctuations. However, there exists also a very neat medium-run association between these variables, that go beyond the short-run cycles. For example, the 1970s is a decade of a steady increase in real compensation costs. However, downward pressures on wages, specially from product price changes, are significant. The fail of observed real compensation costs to follow the constant-unemployment wage path coincides with the rise in unemployment since the beginning of the 1970s. The evolution of unemployment since its peak in 1981 has a similar explanation. Aside from the evident cyclical fluctuations, the stagnation of real wages in a period of increasing upward pressures on constant-unemployment wages (due to price and productivity pressures) coincide with the steady fall in unemployment, only altered by the 1991 recession. Finally, this medium run relationship is more evident in 1960s. The steady fall in unemployment coincides with a observed wages growing at a smaller rate then constant-unemployment wages, all over a period with minor negligible employment cycles.

[13]Real hourly compensation costs from BLS include all workers instead of production workers only, and they also include all compensations and not only wages. (See Lawrence and Slaughter (1993) and Bosworth and Perry (1994) for discussions on these differences.) I prefer real compensation costs because they better reflect firms' hiring costs (the relevant concept in the model). However, the use of real hourly wages does not affect the results.

This evidence, that requires further analysis, is important because it weakens the problem associated with the of endogeneity of the components of constant-unemployment wages. Short-run fluctuations may have an impact on productivity, capital accumulation or even relative prices. Therefore, any interpretation of causality in equation (8) may be subject to criticism. However, in longer periods, when the endogeneity issue vanishes, the association between unemployment and the wage gap seems to hold. In any case, it is necessary to discuss the possible endogeneity of the components of constant-unemployment wages.

Regarding price changes, I have shown elsewhere using the same database[14] that capital-intensive industries tend to have relative price increases in expansions and relative price falls in recessions. In that paper I argue that an explanation where relative price changes cause labor demand shifts and wage adjustments that in equilibrium generate the observed changes in aggregate employment. In any case, as it becomes clear bellow, no significant relationship between the price components of $\widehat{w_e}$ and the evolution of aggregate employment exists.

Regarding productivity changes and capital accumulation, it has been argued by different authors that the evolution of productivity and the capital stock was affected by the path of the unemployment rate, specially during the 1970s. Bruno and Sachs (1985) argue that excessive real wages discouraged investment, producing the slowdown in capital accumulation and affecting productivity growth in the medium run. Gordon (1995) offers a different view, where high unemployment rates causes high productivity growth.

In the case of investment, the data show that variations in capital stock are very smooth for the period under analysis. Thereby, they are not a significant source of procyclicality of full-employment wages. However, even if aggregate capital accumulation in the short-run can be considered exogenous, the sectorial distribution of that capital is certainly expected to be affected by the evolution of relative prices and productivity growth

[14]See Claro 2002.

across industries. The term dKT suggests however that the cross-industry distribution of capital accumulation has a very minor impact on full-employment wages, unless the cross-industry dispersion if very high. This is not the case. With respect to productivity growth, although arguments like labor hoarding could be behind the cyclical evolution of aggregate productivity, this does not seem to be the most significant part of the explanation. This is because the correlation between employment changes and productivity change at the sectorial level is rather small. As discussed in Claro (2002), although expansions are periods of relative goods price and productivity changes in capital-intensive industries, the increase in wages is also greater in these sectors. Therefore, no clear pattern of employment at the micro level exists between employment and productivity. Nevertheless, even if productivity growth were endogenous to a significant extent, the results below reveal that the *difference* between observed wages and the other determinants of market-clearing wages have a significant impact on the evolution of unemployment. I continue with these caveats in mind.

[*Insert Table* 1]

I present two alternative approaches to provide a more systematic analysis of the association between unemployment and the difference between observed and constant-unemployment wages. The first approach, called calibration method, follows literally the model in the sense of computing the evolution of constant-unemployment wages as the linear sum of the components in expression (8). This is the variable plotted in figure 6. The first column in table 1 shows the results of a regression of equation (15). The left-hand-side variable is the percentage change in unemployment rate $\widehat{\mu}$ and the right-hand-side variables are the percentage change in observed and calibrated constant-unemployment wages. Both variables are highly significant and have the expected signs. The probability that the absolute value of the coefficients are equal (restriction implicit in (15)) is 75%. Therefore, increases in unemployment are associated with increases in the ratio of observed to constant-unemployment wages. This result is not affected by the

inclusion of the initial level of unemployment as independent variable. Regression (3) provides evidence that this relationship holds if trends, rather than one-year changes, are considered. In column 3, all three variables in 4-year moving averages. (Other trends yield similar results.)

[*Insert Figure* 7]

Implicit in the first three regressions of table 1 is a generalization of equation (15), where $\widehat{\mu} = \alpha\widehat{w_0} - \beta\widehat{w_e} + \upsilon$. The literal implication of the model is $\alpha = \beta$. The evolution of the wage gap with this restriction is depicted in figure 7 The upper graph plots the percentage change in μ against the log change in the wage ratio w_0/w_e. The correlation coefficient is 0.62. The bottom graph shows the evolution of an index of the ratio of observed to constant-unemployment wages and the unemployment rate. The lack of an initial condition for the wage ratio implies that specific value of the index (arbitrarily set to 1 in 1958) is meaningless. The positive and significant correlation of 0.81 confirms that excessive real wages can explain a significant part of the unemployment path in the United States in the last 40 years. Therefore, a classical or supply-side explanation of unemployment is supported by the data. Nevertheless, the results also show that something else is behind the recovery in 1979 and the recession in 1991.

An alternative approach - regression method - can be performed. It is based on a more flexible interpretation of equation (8), allowing the coefficients of the determinants of constant-unemployment wages to differ from 1 and from each other. This is equivalent to consider that changes in exogenous variables affect $\widehat{w_e}\,|_{\overline{\mu}}$ in the following manner:

$$\widehat{w_e} = \gamma_0 + \gamma_1 \mathrm{d}PRICE + \gamma_2 \mathrm{d}TFPT + \gamma_3 \mathrm{d}KT + \gamma_4 \mathrm{d}LF + \varepsilon. \tag{17}$$

The general form of equation (15) becomes $\widehat{\mu} = \alpha\widehat{w_o} - \beta(\gamma_0 + \gamma_1 \mathrm{d}PRICE + \gamma_2 \mathrm{d}TFPT + \gamma_3 \mathrm{d}KT + \gamma_4 \mathrm{d}LF + \varepsilon) + \upsilon$. Column 4 in table 1 reports the result of this regression. All variables have expected signs, and only $\mathrm{d}LF$ is not significant. Note also that the coefficient on observed compensation costs is very similar to the same variable in the first

three regressions, showing that its effect on unemployment changes does not depend on the specification form of constant-unemployment wages. This feature is used to identify from the coefficients of regression (4) the component related to the determinants of full-employment wages and the effect of market-clearing wages on unemployment changes, given by β.

[*Insert Table* 2]

[*Insert Figure* 8]

Imposing the restriction that $\beta = -\alpha = -4.028$ (see regression (4) in table 1), the resulting γ coefficients are reported in table 2. With these coefficients it is possible to estimate the evolution of an index of the ratio between observed and constant-unemployment wages. This is depicted in figure 8, confirming the evidence of figure 7.

[*Insert Table* 3]

Finally, the model provides a simple yet insightful examination of the determinants of employment in manufacturing industries. The results of the empirical estimation of equation (16) are reported in table 3. Using the same procedure described above, I compute the series for the determinants of constant-manufacturing-employment wages based on (16). Column 1 uses as observed wages the percentage change in average manufacturing real wages, while column 2 uses average economy-wide wages. The probability that the coefficients on $\widehat{w_0}$ and $\widehat{w_T}$ are equal in regression 1 is 97%. Regression 3 allows for different effects of the determinants of $\widehat{w_T}$. The results strongly support the mechanism stressed in the paper; wage changes in excess of those required to keep manufacturing employment constant do have a significant effect on the evolution of L_T.

4 Conclusion

The paper conveys one fundamental message: real labor compensation costs in the United States have failed to follow their market-clearing path, and the consequent wage gap can

significantly track the evolution of unemployment. This significant relationship is valid not only to explain some important short-run fluctuations of the employment cycle in the last 40 years but also medium-run trends in the unemployment rate. Is this surprising? No, as long as we expect that markets adjust either through prices or quantities. Yes, because the labor demand curve by which the wage gap is measured is a neoclassical one where aggregate demand policies or shocks are sterile. Without ruling out the role of demand shocks in some specific events, this casts doubts on the validity of the rejection of a neoclassical labor demand function by some natural rate theories, suggesting that a significant portion of the evolution of unemployment during the last 40 years in the United States can be interpreted as a supply-side phenomenon. In this context, the role for demand policies is less clear, and a fall in real wages appears to play a critical role in generating rises in aggregate employment.

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Figure 1

Real Hourly Compensation Costs

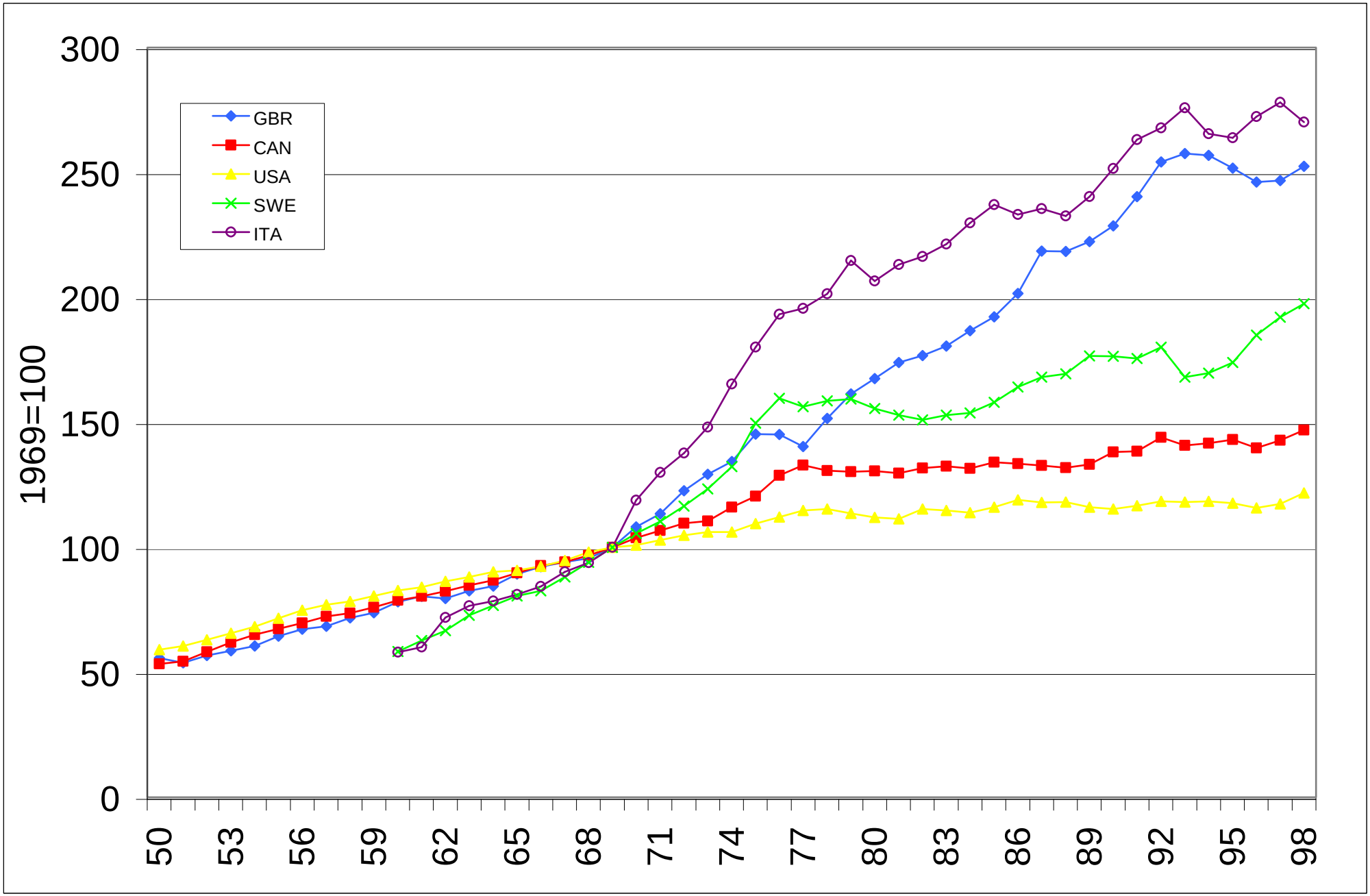


Figure 2

Unemployment Rates of Selected OECD Countries

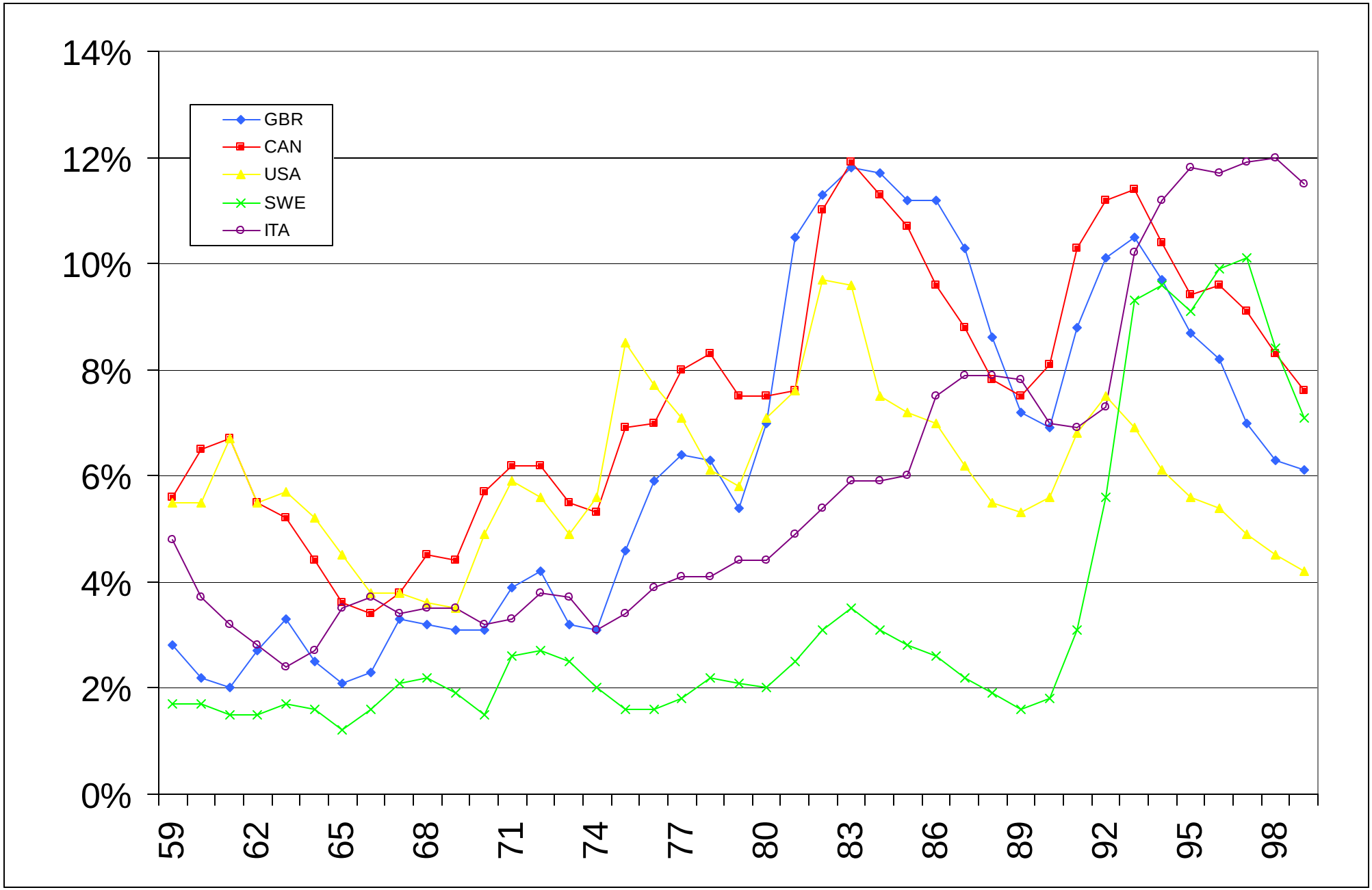


Figure 3

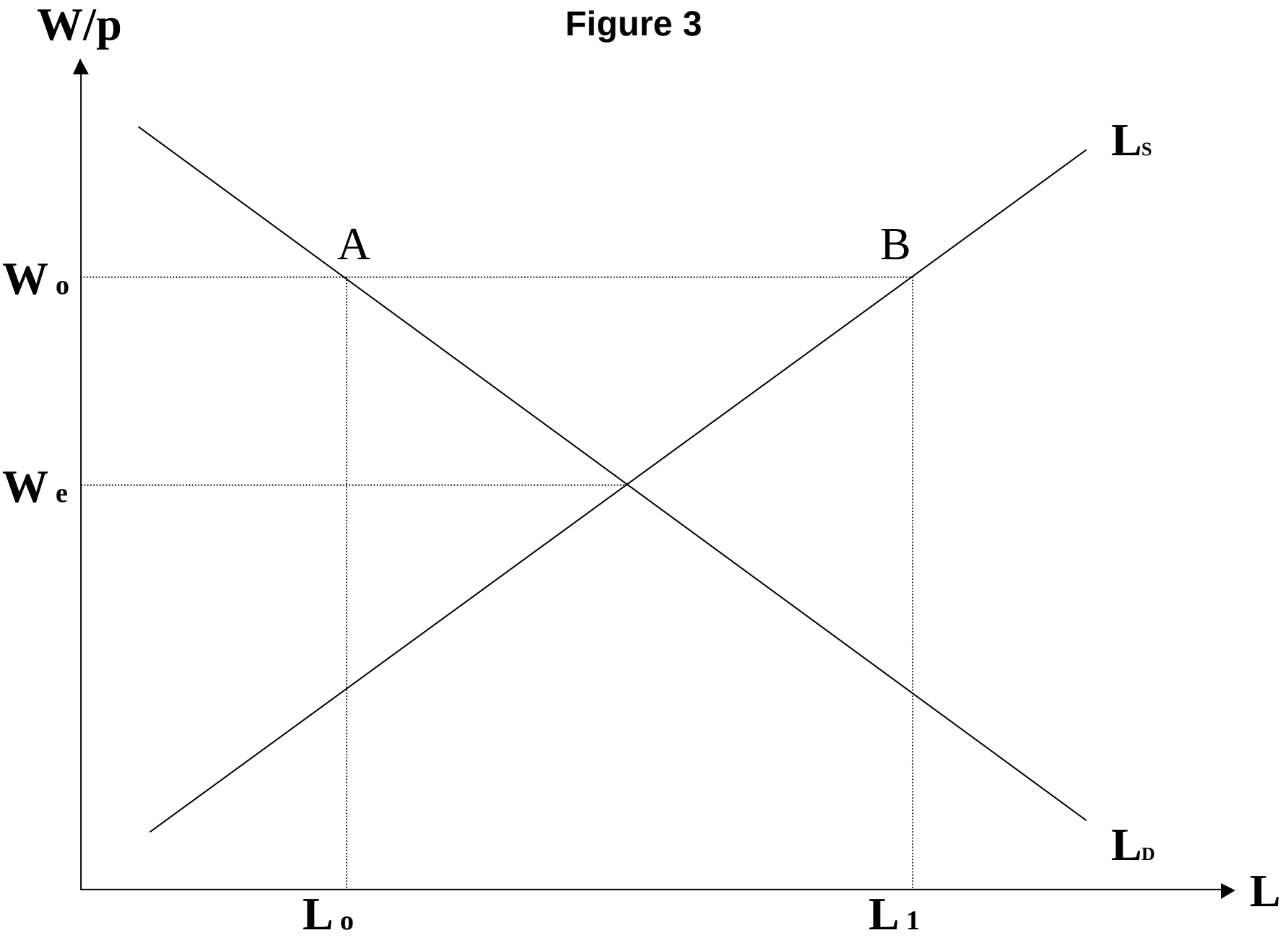


Figure 4

Components of market-clearing wage changes

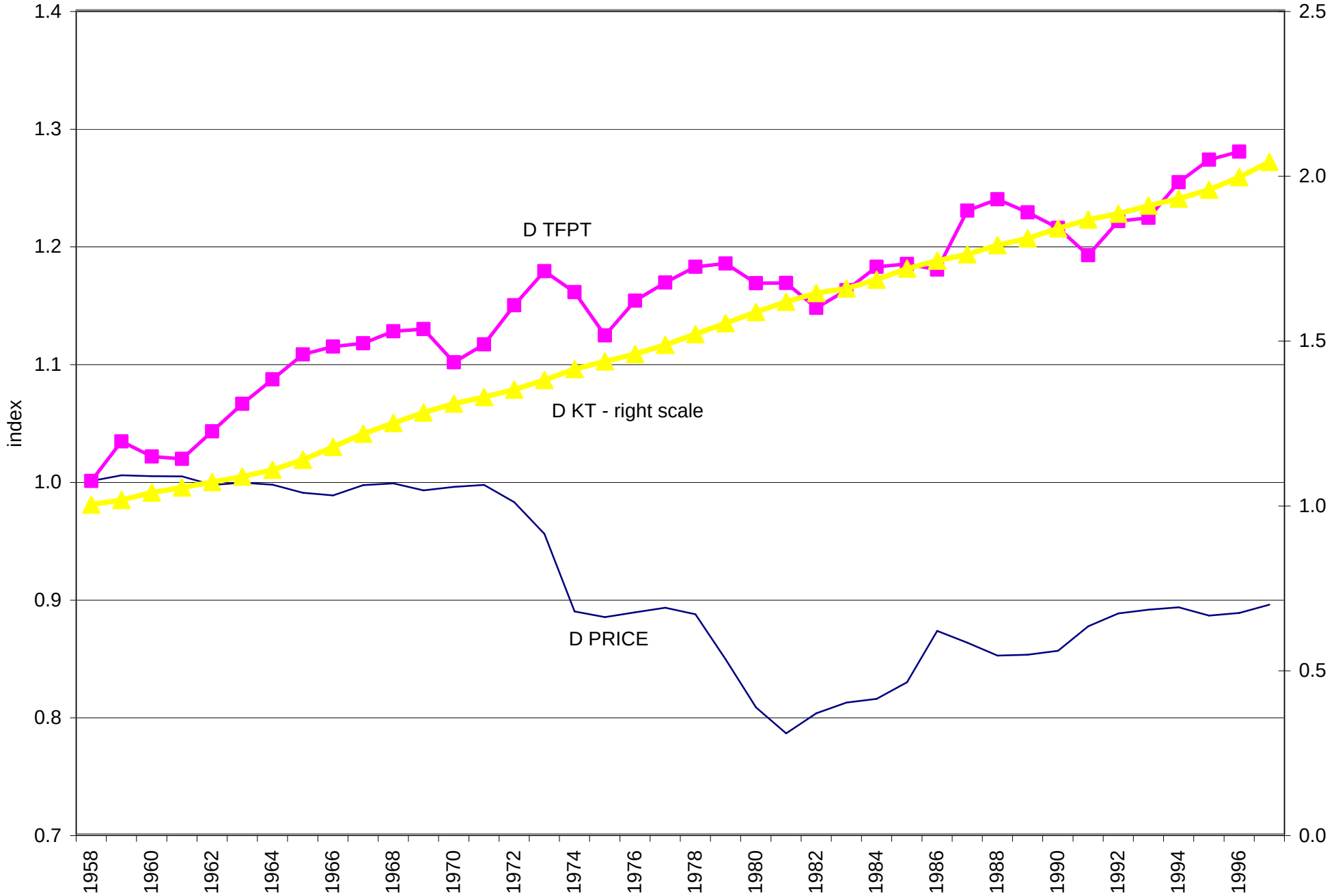
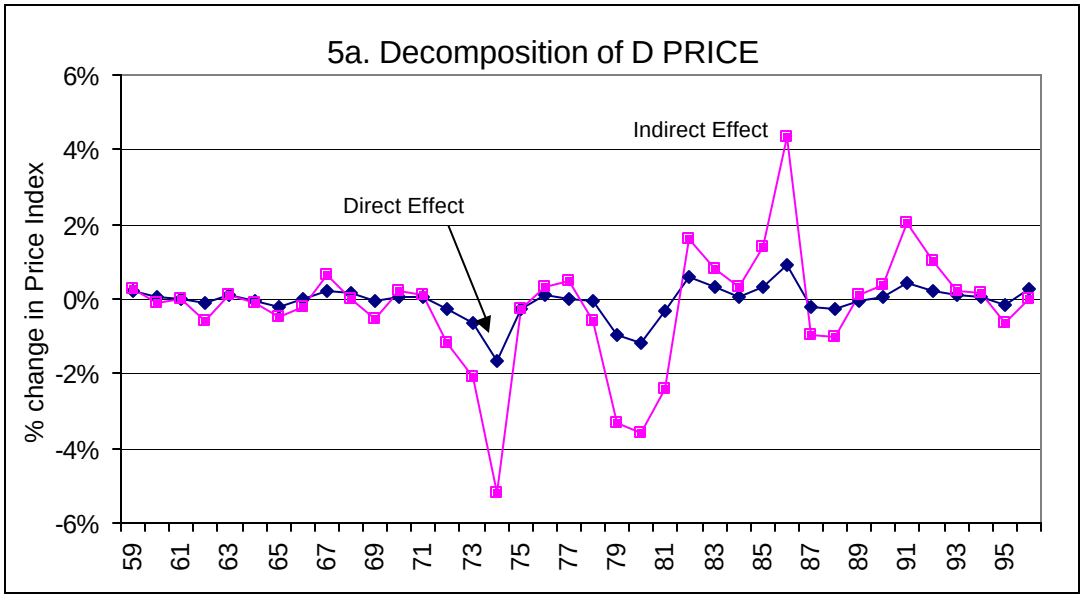
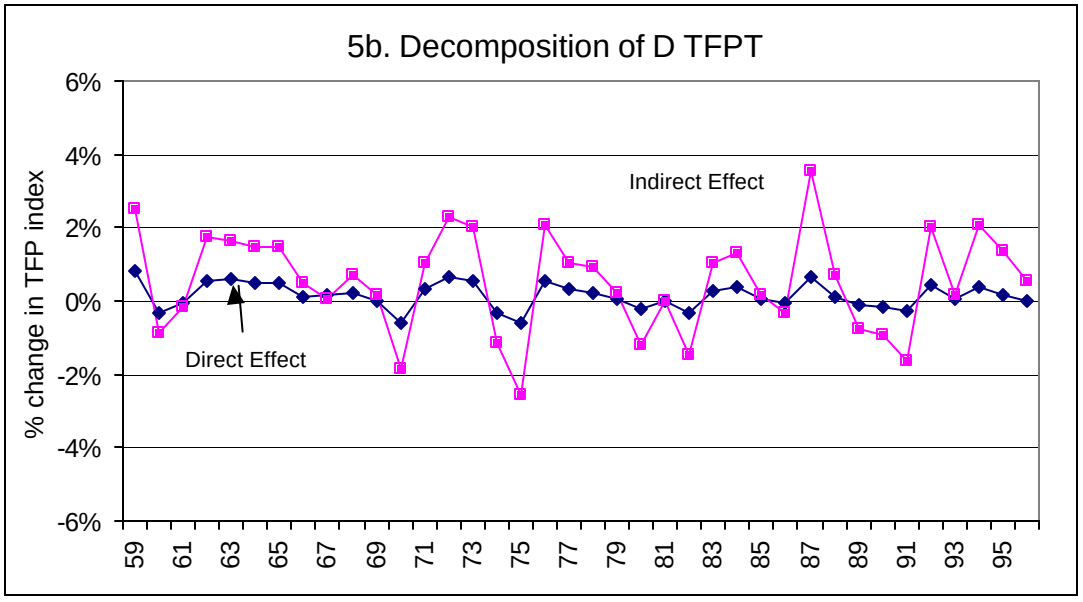


Figure 5

Decomposition of Wage Determinants





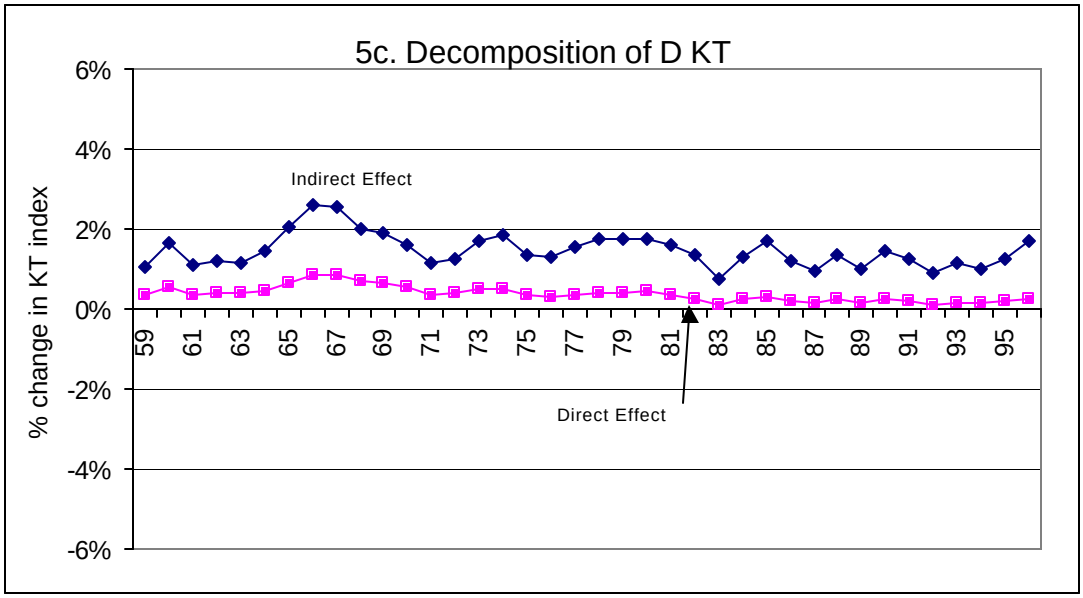


Figure 6

Unemployment and Real Compensation Costs

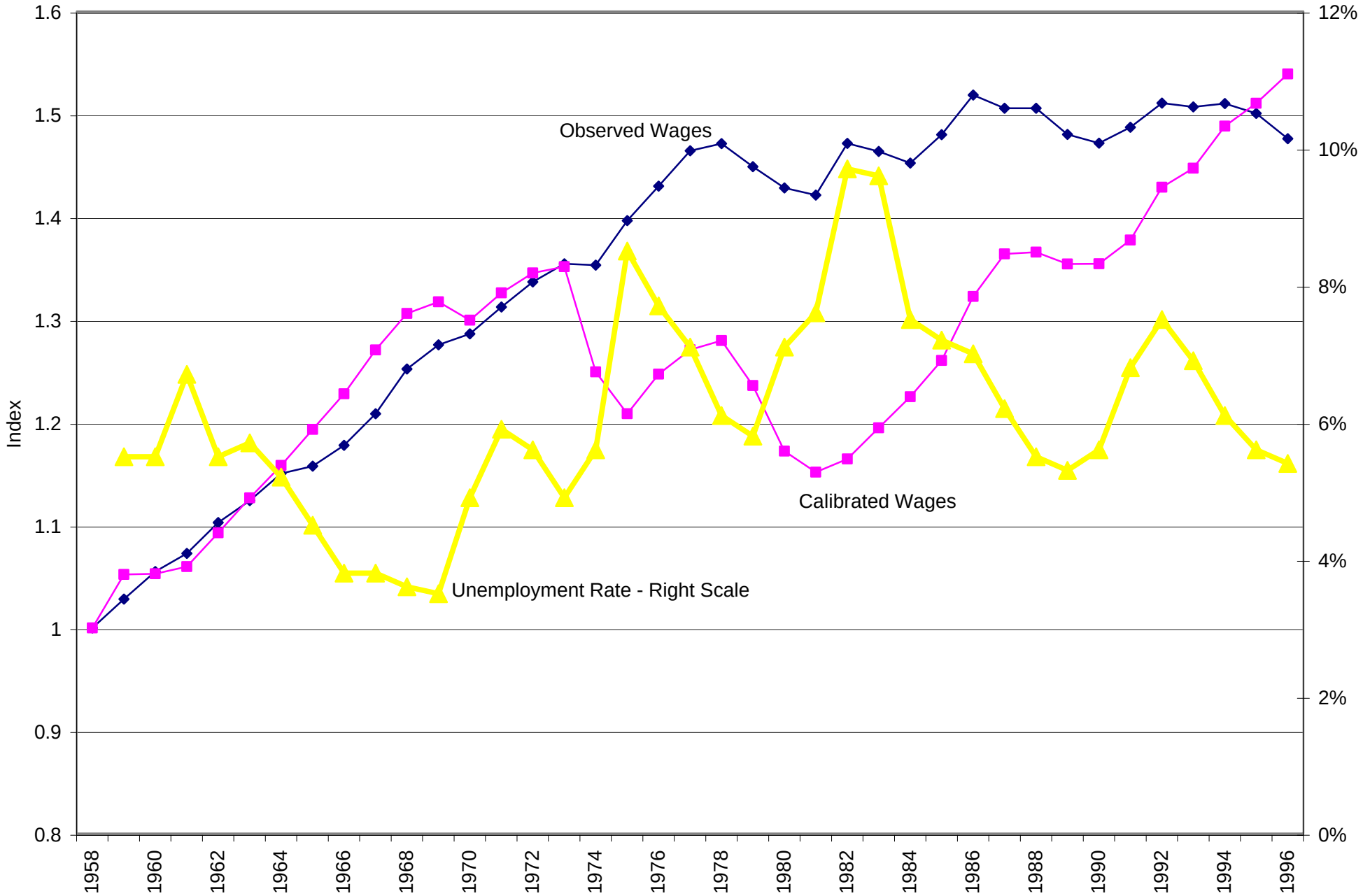
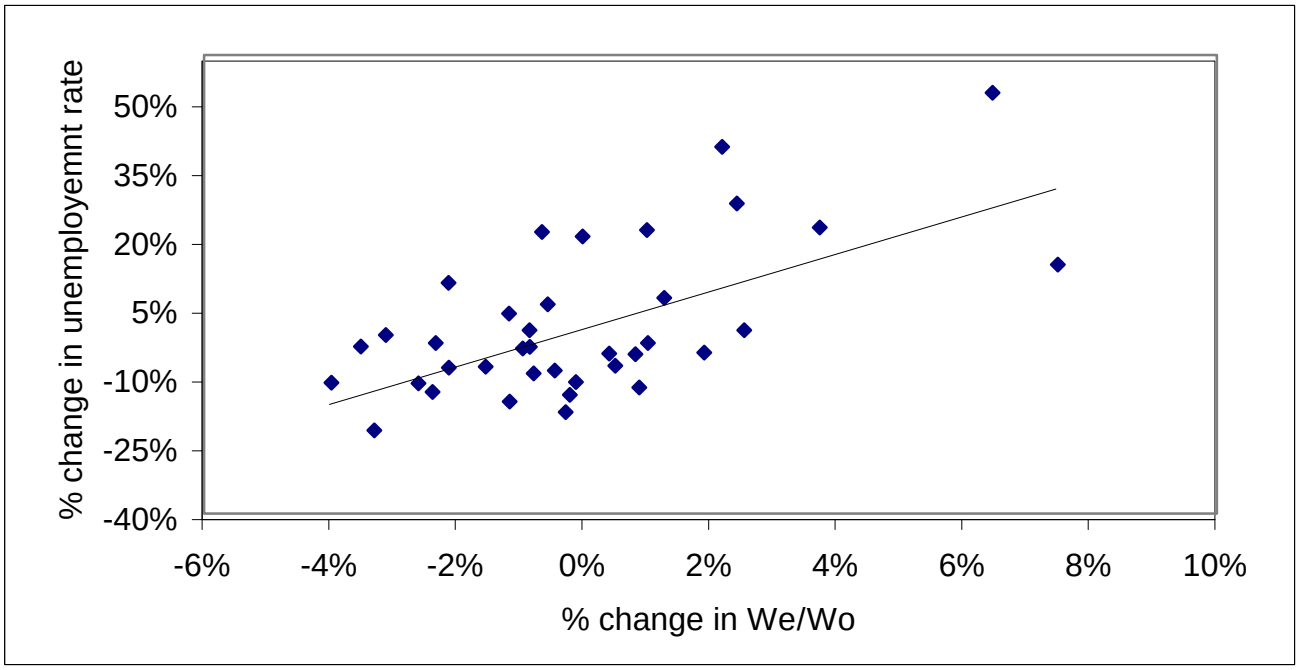


Figure 7

Evolution of Unemployment and Wage Gap: Calibration Method



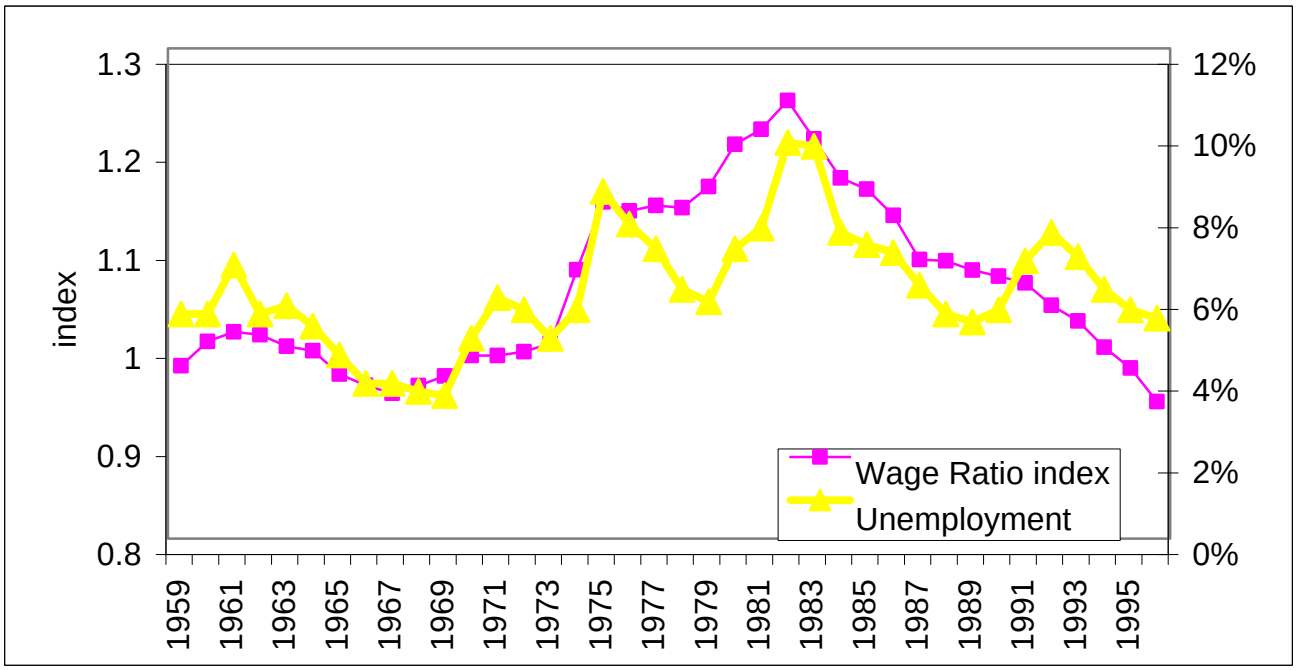
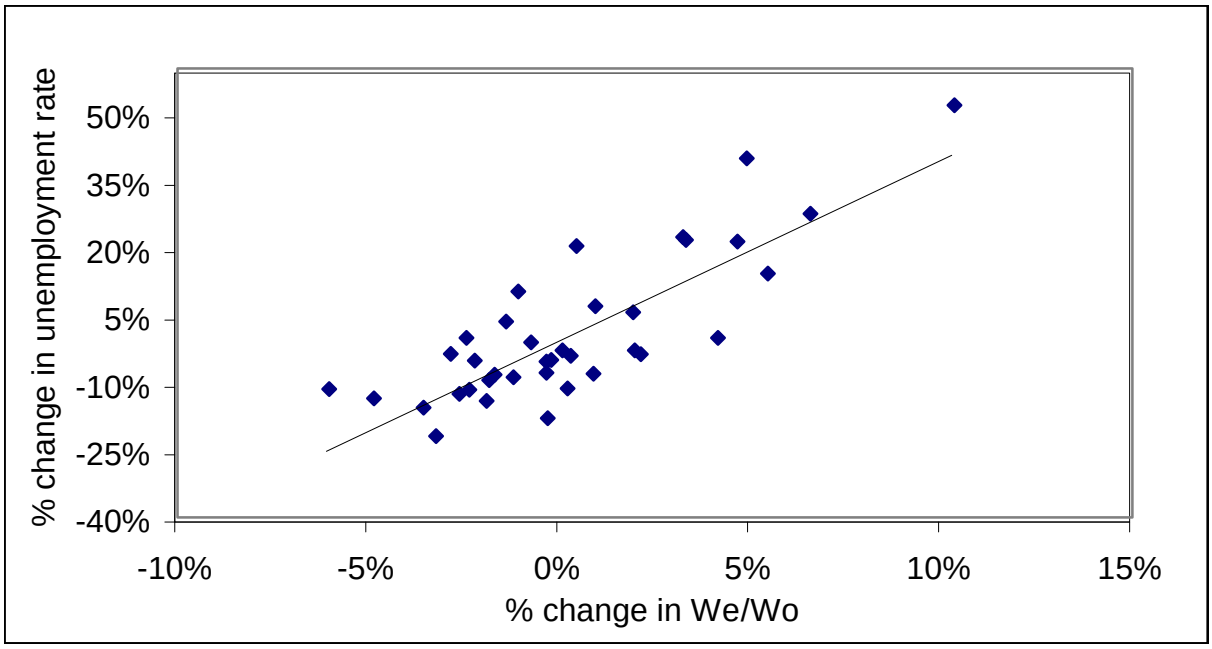


Figure 8

Evolution of Unemployment and Wage Gap: Regression Method



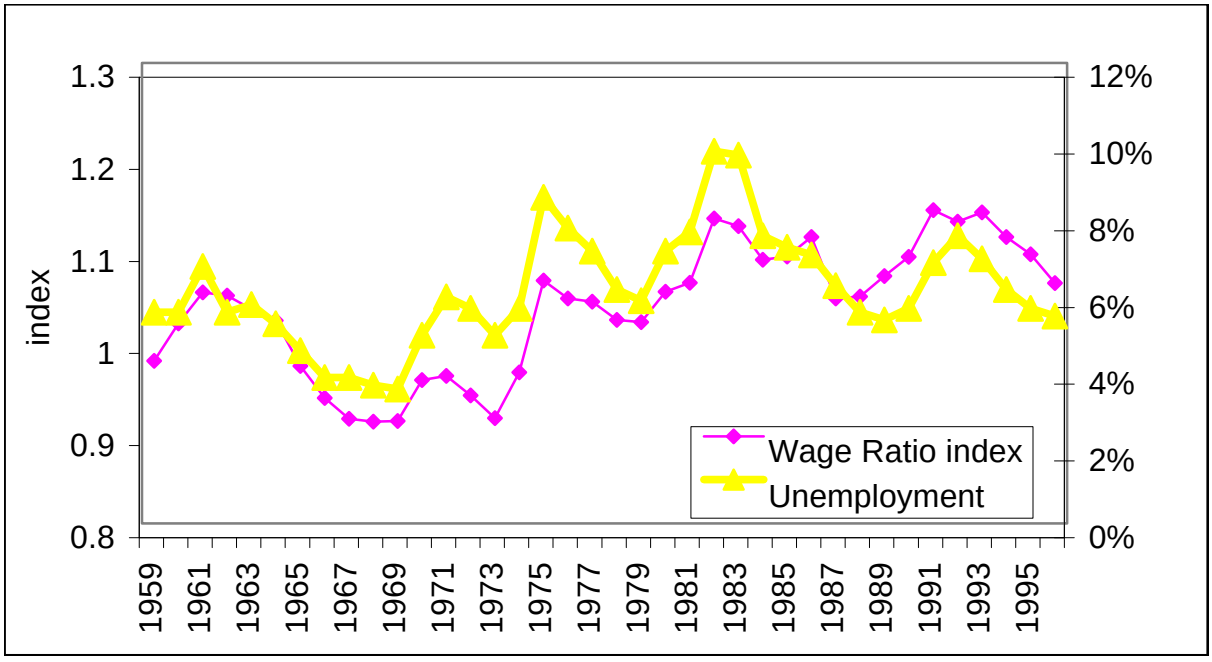


Table 1
Unemployment and the Wage Gap

	(1)	(2)	(3)*	(4)
	Dependent Variable			
Variable	$\Delta \mu$	$\Delta \mu$	$\Delta \mu$	$\Delta \mu$
Constant	0.010	0.066	0.025	0.215
	0.026	*0.105*	*0.015*	*0.070*
Δw_0	4.479	4.207	2.420	4.029
	1.523	*1.615*	*1.086*	*1.296*
Δw_e	-4.032	-3.848	-3.489	
	0.911	*0.979*	*0.595*	
μ (-1)		-0.904		
		1.634		
Δ PRICE				-2.278
				1.020
Δ TFPT				-7.684
				1.021
Δ KT				-11.293
				3.326
Δ LF				0.298
				4.584
R^2	0.387	0.393	0.530	0.677
Adjusted R^2	0.351	0.338	0.500	0.625
Sample	1960-96	1960-96	1963-96	1960-96

Source: NBER Productivity Database
Standard Errors in italics
Variables:
$\Delta \mu$: Percentage change in the unemployment rate
Δw_0: Percentage change in Real Hourly Compensation Costs
Δw_e: dPRICE+dTFPT+dKT-dLF
dPRICE: See text
dTFPT: See text
dKT: See text
dLF: See text
Notes:
* The variables in regression (2) are 4-year moving averages

Table 2
Determinants of constant-unemployment Wage changes

Explanatory Variable	
Constant	-0.053 *0.022*
Δ PRICE	0.565 *0.223*
Δ TFPT	1.907 *0.675*
Δ KT	2.803 *1.322*
Δ LF	-0.074 *1.317*

Standard Errors in italics (delta method)

Table 3
Manufacturing Employment

	(1)*	(2)**	(3)*
	Dependent Variable		
Variables	Δ LT	Δ LT	Δ LT
Constant	-0.003	-0.003	-0.022
	0.006	*0.005*	*0.006*
Δ w_0	-1.481	-0.712	-1.991
	0.820	*0.320*	*0.696*
Δ w_T	1.453	1.499	
	0.493	*0.470*	
Δ PRICE_T			0.047
			0.472
Δ TFPT_T			3.244
			0.503
Δ KT_T			3.852
			1.041
R^2	0.205	0.239	0.635
Adjusted R^2	0.158	0.194	0.590
Sample	1960-96	1960-96	1960-96

Standard Errors in Italics

Note:

* Δ w_0 refers to average manufacturing wage changes

** Δ w_0 refers to average economy-wide wage changes

Variables

Δ LT: % change in manufacturing employment

Δ w_T = Δ PRICE_T + Δ TFPT_T + Δ KT_T

Δ PRICE_T: Price in right-hand-side of (16)

Δ TFPT_T: TFP term in rhs of (16)

Δ KT_T: K term in rhs of (16)