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## **An examination of the wage curve: A research note**

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**Abstract.** We examine the existence and stability of the wage curve, as hypothesized by Blanchflower and Oswald, using cross-sectional data from 3,106 U.S. counties. The data support the existence of an inverse relationship between wage levels and unemployment rates. The unemployment elasticity of pay ranges between -0.08 and -0.17, with an average of -0.13. This range is in line with Blanchflower and Oswald's estimated value of -0.1.

### **1. Introduction**

Local labor markets across the U.S. are becoming increasingly diverse. Aggregate measures of labor market performance, such as national or state-level unemployment rates and wage levels, mask significant heterogeneity at the local level. In Wisconsin, for example, the statewide unemployment rate is 3.4 percent as of October 1998. But Madison, the state capital and home to the University of Wisconsin, is experiencing a severe labor shortage with a reported unemployment rate of 1.6 percent. Menominee County, in rural northeast Wisconsin, has an unemployment rate of 9.2 percent. Perhaps more importantly, the changes in local labor markets have been widely varying across the U.S. Consider, for example, Barron County, a rural county in northwest Wisconsin. In January 1993 the local unemployment rate was 9.3 percent. But only five years later the unemployment rate was 3.1 percent. Menominee County, on the other hand, had only a modest decline over the same period, going from 11.4 percent to 9.2 percent.

Such dramatic differences in local labor markets have prompted questions at the local level about the relationship between levels of unemployment and wages. Specifically, if local labor markets can be described as experiencing shortages in qualified people, will firms bid up wages to attract the needed

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workers? If firms do respond to low levels of unemployment by raising wages, how much should they be expected to rise? This simple direct question has received significant attention in the academic literature of the past decade. Layard and Nickell (1986, 1987), Nickell (1987), Arellano and Bond (1991), and Manning (1994) find little empirical evidence for a negative relationship between unemployment and earnings. But more recently, Blanchflower and Oswald (1996) examine national survey data for 16 countries and find strong evidence that a country's joblessness is negatively related to wage rate. The latter's empirical results are sufficiently strong that they advance the existence of a downward sloping convex curve in wage/unemployment space which they refer to as the *wage curve*.

The purpose of this applied analysis is simple. We are attempting to explore the empirical characteristics of the wage curve for small local labor markets within the U.S. If such a relationship exists, how do regional differentials—such as potentiality of market demands, quality of market supplies, and metro status—influence the degree of negative relationship between wage rate and unemployment. To achieve our research goals, we develop several empirical models to represent the determinants of a regional wage rate and apply the models to U.S. aggregated county-level data. In each model, we calculate the unemployment elasticity of pay. Our interest is to examine the sign and the range of the unemployment elasticity of pay.

## 2. A simple theoretical framework

In developing their theoretical framework Blanchflower and Oswald build from the now classic Roback (1982, 1988) model of amenity capitalization into wages and rents. Blanchflower and Oswald argue that Roback is correct in that it seems obvious at the intuitive level that the spatial structure of wages must depend on the distribution of inherent amenities across regions. In Roback's theoretical and empirical modeling she assumes that workers and firms are freely mobile and they will locate in areas that maximize utility and profit. Regions offer, in equilibrium, wage rates and land rental prices that exactly offset their natural advantages.

Roback assumes that a representative firm is a profit-maximizing price-taker facing constant-returns-to-scale technology. Inputs into the production process are land and labor. While the firm's profit is a decreasing function of wages and land rents, the worker's utility is an increasing function of wages and a decreasing function of rent. Given free mobility, the region must provide firms and workers with the going market level of profit and utility. In other words, in equilibrium, profit and utility levels must be identical across all regions regardless of the distribution of amenities. While this latter assumption appears to be

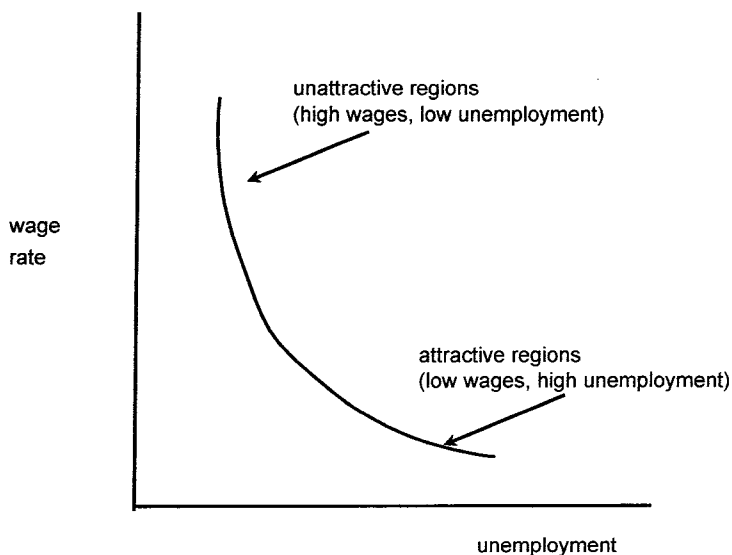
strong, it is increasingly common within the regional economics literature (e.g., Brueckner 1979, 1982; Blomquist, et al. 1988; Deller 1990).

The unique wage and rent combination that satisfies this equilibrium condition is given by the intersection of a downward-sloping firm iso-profit contour with an upward-sloping worker indifference curve in wage-rent space. Because amenities enter directly into the iso-profit and indifference contours, regions with different amenities will yield different equilibrium wage and land rent levels. The empirical work of Roback [and subsequent others such as Gyourko and Tracy (1991) and Giannias (1996)] generally has found that higher levels of amenities result in lower wages and higher land rents.

Blanchflower and Oswald build on the Roback framework by explicitly incorporating Adam Smith's (1985) notion of compensating differentials in the presence of unemployment. The free mobility assumption of firms, and more importantly workers, underpins the wage-rent trade-off identified by Roback. If migration is costly, however, firms and workers are likely to view the decision to migrate as an investment. Agents will be inclined to base the decision to migrate on expected or permanent returns and costs. Blanchflower and Oswald accomplish this expansion of the theoretical construct by allowing workers to maximize utility by either a) working and earning a wage, or b) becoming unemployed and collecting unemployment insurance and participating in other public support programs. By explicitly introducing unemployment as an option for the worker, the notion of a wage-unemployment trade-off is captured.

Blanchflower and Oswald advance two key propositions that are directly relevant to this particular applied research note. First, regions have different equilibrium levels of wages and unemployment levels, and high amenity regions have lower wages. This proposition is intuitively obvious and is consistent with Roback. If a worker places high values on consuming amenities, such as climate or some selected natural resource amenity, the decision to remain in a region with high amenities and become unemployed is perfectly rational. Second, there is a negatively sloped function (i.e., a wage curve) linking wages and unemployment. As depicted in Figure 1, the Roback result is expanded to allow for unemployment as an option for the worker.

The logic is straightforward. From Roback we have the result that high amenity regions will tend to pay lower wages. Conversely, low amenity regions will have to pay higher wages to compensate workers for living in a low amenity region. If migration is costly, workers in high amenity areas are looking at the trade-off between working for low wages, remaining in the area and become unemployed with minimal income levels from public support programs, but continue to consume the amenities. For low amenity regions, the gap between high wages and minimal income from support programs should be sufficiently high to discourage unemployment as an option.

**Figure 1.** The wage curve across regions

To test their theoretically derived relationship between the wage and unemployment rates, Blanchflower and Oswald use national survey data from 16 countries to empirically estimate a number of wage curve specifications. They conclude that the consistency in their empirical results supports the existence of an empirical law between unemployment and wages. This empirical law can be represented as  $\ln w = -0.1 \ln u + \varepsilon$ , where  $\ln w$  and  $\ln u$  are the natural logarithms of wage and unemployment rates, and  $\varepsilon$  is the error term representing the characteristics of the worker.<sup>1</sup> Given this empirical result on the *unemployment elasticity of pay*, Blanchflower and Oswald conclude that a one-unit decrease in the unemployment rate will lead to a 10 percent increase in pay.

### 3. Empirical models

The intent of this research note is to test Blanchflower and Oswald's *wage curve law* using county level data ( $n = 3,106$ ) for the U.S. While county boundaries do not necessarily reflect actual local labor markets, they represent a reasonable proxy and are superior to state and national-level data that tend to dominate this literature. Data are from 1990 and are drawn from the *Census*,

<sup>1</sup> Blanchflower and Oswald analysis is micro-based using individual data and control each for each observation's years of experience of work, education, married status, sex, color, state dummies, and industrial dummies.

*City and County Databook*, and the Bureau of Economic Analysis' Regional Economic Information System.

We report six empirical models to explore the relationship between the wage and unemployment rate. The specifications range from the simplistic base model, where the unemployment rate is regressed on wages, to more comprehensive specifications to account for amenity and other factors. The overriding purpose for altering the right-side specification of the base model is to assure that our analytical results on the unemployment elasticity of pay is not affected by model specification. In other words, by moving from a simplistic base model we can test the sensitive of the unemployment elasticity of pay. Among these models, the first three are used to test whether the wage curve appears in U.S. county data; the last three models are used to test if regional differentials, with specific attention to amenities, have any impact on the shape of the wage curve.

While the theory implies that there is a nonlinear relationship between wages and unemployment, it provides no insight into the specific functional form that the estimated equations should assume. To allow for flexibility in determining the possible range of values for the unemployment elasticity of pay, we assume four functional forms: logarithmic, linear, quadratic and a flexible form known as the Box-Cox. The latter approach allows the data to determine the correct functional form by allowing the data to determine the value of a maximum likelihood system parameter  $\lambda$ . Here  $\lambda$  is a monotonic transformation parameter on both dependent and independent variables. It can be shown that as  $\lambda$  approaches zero, the data support a logarithmic specification, while a  $\lambda$  value of one suggests a linear specification.

Denote  $\omega$  and  $\upsilon$  as the levels of wage rate (proxied by average annual wages/salaries reported by the BEA) and unemployment,  $X$  as a vector representing regional differentials, and  $\varepsilon$  as an error term. These six empirical models are represented as:

$$\ln\omega = \alpha_0 + \alpha_1 \ln\upsilon + \varepsilon_A, \text{ (base log-log)} \quad (1)$$

$$\omega = \beta_0 + \beta_1 \upsilon + \varepsilon_B, \text{ (base linear)} \quad (2)$$

$$\omega = \gamma_0 + \gamma_1 \upsilon + \gamma_2 \upsilon^2 + \varepsilon_C, \text{ (base quadratic)} \quad (3)$$

$$\omega = \tau_0 + \tau_1 \upsilon + \sum_{i=2,\dots,n} \tau_i X + \varepsilon_D, \text{ (expanded linear)} \quad (4)$$

$$\omega = \varphi_0 + \varphi_1 \upsilon + \varphi_2 \upsilon^2 + \sum_{i=2,\dots,n} \varphi_i X + \varepsilon_E, \text{ (expanded quadratic)} \quad (5)$$

$$\omega = \mu_0 + \mu_1 \upsilon + \sum_{i=2,\dots,n} \mu_i X + \varepsilon_F \text{ (expanded Box-Cox)} \quad (6)$$

In the design of regional differentials  $X$ , we follow the logic proposed by Duffy (1994) and Wagner and Deller (1998); we hypothesize that there are two broad classifications of factors influencing regional wage determination: market demands and labor supplies. We suggest that regional wage rate is determined

through the interplay of these two broad classifications of factors along with its metro-nonmetro status and unemployment rate.

**Market**—In this category, we are attempting to capture factors that influence the demand side of regional markets. Generally, these factors are designed to describe the region's market size and consumption ability. We propose four variables to capture market characteristics:

1. Level of population (1990).
2. Percent of population that is nonwhite (1990).<sup>2</sup>
3. Percent of households with income below the poverty level (1989).
4. Entropy index of regional income distribution.

We obtain the entropy index of income distribution by using the simple measure  $\sum_i x_i^2$ , where each  $x_i$  ( $i = 1$  to 6) represents a percentage of households with a certain level of income.<sup>3</sup> Other things being equal, a region with less-equal income distribution is associated with a higher entropy index.

**Labor**—This category is intended to capture the ability of regional markets to supply the goods and services needed to satisfy regional demand. Variables that measure human capital stocks and flows are sufficient to capture the influences of this side of the market on regional growth. Human capital here refers to broad levels of education, health, and attitudes. The variables we propose that would capture labor characteristics include:

1. Percent of persons with a high school diploma (1990).
2. Numbers of active nonfederal physicians per 100,000 population (1990).
3. Numbers of serious crimes per 100,000 population (1991).

Several of our market and labor variables also serve as proxies that capture some of the amenity characteristics of the region. For example, crime and number of physicians are commonly used within the literature as amenity, or quality of life, proxies. While more traditional measures, such as sunny weather, humidity, and snow, are not included in this analysis, the inclusion of all possible measures of amenity attributes makes the modeling effort unwieldy.

## 4. Empirical results

The results of models A through F are listed in Table 1. In each of the models, the unemployment rate and transformations of the rate are significantly related to wage levels across all six specifications of the simple empirical model. When appropriate, the system F statistic is significant at or above the 95 percent

<sup>2</sup> The nonwhite population includes Black, American Indian, Eskimo, Aleut, Asian, Pacific Islander, and Hispanic peoples.

<sup>3</sup> Overall, there are six different levels of household incomes: 1) less than \$15,000; 2) \$15,000 to \$24,999; 3) \$25,000 to \$34,999; 4) \$35,000 to \$49,999; 5) \$50,000 to \$74,999 and 6) \$75,000 or more.

Table 1. Estimated wage curve for U.S. counties, 1990 (Number in parentheses is the absolute value of the t-statistic.)

Variable	Model A	Model B	Model C	Model D	Model E	Model F
Unemployment rate	---	-44.2667 (7.36)	-89.1425 (4.26)	-34.5450 (4.09)	-85.6987 (3.24)	-0.044 (3.72)
Unemployment rate squared	---	---	2.3775 (2.59)	---	2.7032 (2.47)	---
Log unemployment rate	-.5081 (28.39)	---	---	---	---	---
Population 1990	---	---	---	.0001 (1.69)	.0001 (1.72)	.4423e-7 (3.23)
Crimes per 100,000 persons	---	---	---	.0062 (0.36)	.0090 (0.51)	.7930e-5 (4.07)
Physicians per 100,000 persons	---	---	---	1.9161 (4.32)	1.9055 (4.27)	.0003 (4.49)
Percent population with HS degree	---	---	---	7.8522 (1.81)	6.3473 (1.36)	.0033 (4.39)
Percent of persons below poverty	---	---	---	29.4880 (3.01)	29.3058 (3.00)	.0047 (3.70)
Percent of population nonwhite	---	---	---	-.0195 (0.01)	-.0005 (0.01)	.0003 (1.45)
Entropy measure of income distribution	---	---	---	-.4521 (2.95)	-.4859 (3.03)	-.5757e-4 (3.39)
Metropolitan	---	---	---	-181.6843 (2.90)	-186.1665 (2.95)	-.0564 (4.37)
Intercept term	8.5858 (249.81)	2534.9807 (49.45)	2709.4980 (26.66)	2382.8604 (4.40)	2760.2904 (4.32)	4.6836 (11.83)
F <sub>statistic</sub>	---	56.56	33.24	56.49	52.57	---
R <sup>2</sup>	.1544	.0179	.0210	.1420	.1462	---
Box-Cox λ	---	---	---	---	---	---
Estimated elasticity	-.5081	-1.434	-1.781	-1.119	-1.518	-1.283 -0.840



level of confidence. The adjusted  $R^2$  ranges from .0179 to .1544. While it appears to be small, it is not uncommon for cross-sectional studies such as the current analysis. Breusch-Pagan tests suggest that heteroskedasticity is a problem with five of the six specifications, and White's method for correcting the covariance matrix is employed. Finally, the Box-Cox estimator (Model F) suggests that the data appear to support a logarithmic functional form with the fully specified model (Box-Cox  $\lambda = -.1283$ ).

A detailed discussion of the labor and market factors, along with the accompanying amenity attributes, is beyond the focus of this analysis but the results generally suggest that local factors influence the wage/unemployment space relationship. For example, the negative coefficient on the entropy measure of income distribution implies that counties with greater levels of income inequality tend to have lower average annual wages. This latter result is consistent with a recent study by Ngarambe, Goetz, and Debertin (1998). In addition, somewhat surprisingly, the racial makeup of the county, as proxied by the percent of the population nonwhite, does not appear to significantly influence overall wage levels.

Each specification of the model suggests that there exists a negative relationship between wage rate and unemployment rate as reflected in U.S. county data. The range of the estimated unemployment elasticity of pay is between -0.0840 and -0.1781, with one outlier estimate of -0.5081. Removing the outlier (Model A), the average elasticity is about -0.1338, which is consistent with the original findings of Blanchflower and Oswald. This suggests, all else held constant, that a 10 percent increase in the unemployment rate will result in a 1.3 percent reduction in average annual wages. Results for Models C and E suggest that the wage-unemployment-lotus is nonlinear and convex in wage-unemployment space. The marginal drop of wage rate is decreasing with the level of unemployment.

Our results suggest that regional differentials do not have much effect on the wage curve slope. The estimated unemployment elasticity of pay in Models D, E, and F are between -0.08 and -0.17. This range is close to Blanchflower and Oswald's empirical law where the elasticity of pay ranges from -0.08 to -0.11. Still, while regional differentials do not change the slope of the wage curve much, they do play a role in determining the level of wage rate. Regions with higher stronger market demands and better labor quality often have higher wage rates. More precisely, three market factors—higher level of population, equal income distribution, and higher percentage of persons below poverty—contribute positively and significantly to wage rate. Moreover, a region with higher qualified human resources (percentage of persons with high school degree) and better medical systems is also associated with higher wage rates.

## 5. Conclusion

In this brief analysis, we explore the relationship between existing wage rates and unemployment rates. Using U.S. county data, our empirical results suggest that the relationship between wage rate and unemployment rate is negative; the unemployment elasticity of pay ranges from  $-0.08$  to  $-0.17$  with an average value of  $-0.13$ . This implies that the wage curve as hypothesized by Blanchflower and Oswald is supported by the U.S. county data. Moreover, the unemployment elasticities of pay appear to be stable; they do not vary much because of model specifications and regional differentials. The slope of the wage curve is only slightly (3 percent) smaller when incorporating regional characteristics into the models. Our empirical findings support that wage rates have a degree of stickiness in regional labor markets. While wage levels respond to changes in the unemployment rate, those changes are small and nonlinear. While we are not willing to go as far as Blanchflower and Oswald and argue that there is a wage curve law, there is sufficient statistical evidence to suggest that a relationship does exist.

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