Productivity and Wages in the American Economy: A Tale of Two Centuries

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An argument can be made that perhaps the most important single economic relationship is that between wage rates and productivity per unit of labor input in the productive process. A strong statement? Yes. But, there are wage-productivity dimensions to a very wide range of economic phenomena, both of an equity and efficiency nature. On the equity side, the relationship between the productivity of labor and the wage rate it receives is at the core of the marginal productivity theory of functional income distribution, with all its implications for the legitimacy of competitively determined factor rewards. From the standpoint of efficiency, productivity change is the key to economic growth and a rising standard of living, particularly as measured by real wage levels. Additionally, we will argue that the relationship between wage rates and productivity levels is a critical factor in producing cyclical fluctuations in levels of output and employment. These issues will be discussed in the order in which they have been introduced.

WAGES, PRODUCTIVITY, AND ECONOMIC EQUITY

Neoclassical theory suggests that in a sufficiently competitive world the wage rate paid to labor will be equated with its marginal contribution to the output of the economic activity in question. In such a world, it can be argued that labor is being paid according to its productive contribution.[1] However, if noncompetitve conditions are the rule, the possibility exists that workers may be paid less than their marginal product, with the difference reflecting an element of monopsonistic and/or monopolistic exploitation.[2] Such exploitation is of obvious importance when assessing the equity dimensions of the operation of an economic system.

To explore the possibility that exploitation of labor has been an historically important phenomenon, we have examined various data sources, commencing with the year 1820 and continuing through 1920, in an attempt to determine whether the wage rate being paid to labor differs significantly from its marginal product. Our general approach has been to estimate linear-homogeneous production functions of the Cobb-Douglas variety and compare the parametric estimates of the elasticity of output with respect to the labor input with a predicted value for that estimate based on the observed distribution of income to labor and an assumption that the neoclassical equalities are satisified.[3] The neoclassical prediction is used to construct the following null hypothesis:

$$(1) \qquad H_0: \ (\alpha_a - \alpha_n)/\delta\alpha_a = 0$$

where α_a denotes the estimated elasticity of output with respect to labor, α_n is the neoclassical prediction, and $\delta\alpha_a$ is the standard error of α_a. In Table 1, the results of such a test, as applied to a series of data samples, are reported. Positive values for $(\alpha_a - \alpha_n)$ are suggestive of exploitation while negative values are not. There are six different tests, four for all manufacturing (1820, 1860, 1880, and 1920) and two for the cotton textile industry in the ante bellum period (1832 and 1860). In all six cases, the null hypothesis is accepted at the 5-percent level, suggesting no difference between the neoclassical prediction for α and its estimated value. This would seem to indicate that, generally, labor was paid its marginal product during the nineteenth and early twentieth centuries.

After 1920, a variety of other studies suggest that this state of affairs has continued. In particular, we note Hildebrand and Liu's [7] work and Scully's [11] accounting for the phenomenon of regional wage differentials in the United States.

WAGES AND PRODUCTIVITY IN THE LONG RUN

The general findings that workers in American industry historically have been paid their marginal product suggests that the key to the long-run behavior of wage rates in the United States would be increases in the productivity of labor. There are two major sources of such productivity changes; (1) an increase in the stock of factors of production other than labor, especially capital, that are employed with each unit of labor

input and (2) technological progress. Gallman's [6] data indicate a remarkable expansion of the capital stock since 1840. Between 1840 and 1880, the capital stock per head increased by about 2 1/2 percent a year, accounting for about one-third of per capita growth in the period. From 1880 to 1920, the capital stock per unit of labor rose even faster, about another .25 percent a year more, again accounting for about a third of total per capita growth [6]. After 1920, the rate of growth in the capital stock slowed somewhat, to about one-half its pre-1920 level per capita; but, nevertheless, the capital/labor ratio continued to rise [2].

The phenomenon of a rapidly rising capital/labor ratio suggests that throughout the period for which data are available labor has become an increasingly scarce factor of production and capital an increasingly abundant one. Orthodox theory implies that in such a case the price of labor vis-a-vis the price of (or return to) capital should have been rising. Employing a variety of sources of wage data, we have constructed real wage measures for various portions of the period 1840 through 1970[4] and, from Gallman's data [6], we have estimated the real return per unit of capital, beginning with 1840.[5] Setting the wage rate (in this case for unskilled labor) and the return to a unit of capital equal to 100 in 1840, we calculate that the ratio of the real wage rate to the real return to capital has risen from 1.0 in 1840 to 17.6 in 1970, brought about by a rise in the real wage rate to 880 and a fall in the real return to capital index to a value of 50. Similarly, if we use an average wage rate statistic, such as real average annual earnings, we obtain the same result. Between 1870 and 1970, the ratio of real average annual earnings to the return to capital (both in index number form) rose from unity to 8.4. Or, we might correct the annual earnings[6] series for hours worked, which we can do from 1890 onwards.[7] With such a data series, we find that the wage rate/return to capital ratio rises from 1.0 in 1890 to 6.9 in 1970. Decade-by-decade values for the various ratios are presented in Table 2.

Reinforcing the impact of a rising capital/labor ratio have been increases in total factor productivity, an important source of per capita economic growth in the United States.[8] Collectively, these twin fonts of productivity growth have created an economic surplus, a surplus which appears to have been translated systematically, through competitive factor market pressures, into higher real wage rates per unit of labor input and lower returns per unit of capital input.

WAGES, PRODUCTIVITY, AND THE BUSINESS CYCLE

We turn now to the link between the wage-productivity nexus and the business cycle. There is a somewhat hoary argument that runs to the effect that cyclical variations in the level of unemployment in a market-oriented economy are related in a predictable fashion to the behavior of money wage rates, prices, and productivity levels. Specifically, it can be argued from neoclassical economic theory that, ceteris paribus, (1) changes in money wage rates will be negatively related to employment levels, (2) variations in the general price level will be positively associated with the volume of employment, and (3) productivity per unit of labor input will vary positively with employment.[9] As a body, these propositions suggest that unemployment will be positively related to the level of money wage rates adjusted for price- and productivity-level changes. In simple terms, it may be postulated that

$$(2) \qquad U = f(w_r^*),\ dU/dw_r^* > 0\ ,$$

where U is the unemployment rate and w_r^* is the appropriately adjusted wage rate measure. This is a hypothesis that would be familiar to an economist of the pre-Keynesian era.[10] It has lost its currency, though, over the past half century. Perhaps surprisingly, therefore, it provides a remarkably satisfactory explanation for the behavior of unemployment levels in the United States during the twentieth century. For example, a more extended version of Equation (2) explains over 90 percent of the variation in the rate of unemployment in the period 1909-1941 and approximately 70 percent of the variation in that magnitude in the post-World War II era. To illustrate, Table 3 shows the actual and predicated unemployment rates for the years of the Great Depression, using this model. Actually, the Great Depression was the product of a systematic displacement of the adjusted money wage rate from its equilibrium position. At the height of the Great Depression (1933), w_r^* was some 18 percent above its 1929 level, largely because of declines in prices and productivity that placed too great an adjustment burden on the mechanisms that determine money wage rates.

Remarkably, not only does this model explain the behavior of the unemployment rate during that greatest of American economic declines, but it also offers an explanation for the unemployment experience of the 1970s. The driving force behind this model is a short-run money wage adjustment mechanism of an adaptive-expectations type that converges over time towards a long-run money wage adjustment function of the following type:[11]

(3) $$(\dot{w}_m)_t = \dot{P}_t + \dot{\pi}_t$$

where $\dot{w}_m$ is the rate of change in money wage rates, $\dot{P}_t$ is the rate of change in the price level, and $\dot{\pi}_t$ denotes the rate of change in productivity per uit of labor input. The partial short-run adjustment of money wages creates money-illusion effects that give rise to systematic variations in unemployment rates. When prices and productivity rise, money wage rates do not respond immediately, and w_r* falls, producing a lowering of the unemployment rate. In the longer run, money wage rates adjust and unemployment responds accordingly, that is, it moves towards its equilibrium, or natural, rate.[12]

CONCLUDING REMARKS

We have explored a number of implications of the interrelationship between wage rates and productivity levels. If there is one compelling theme to our findings, it is that the empirical evidence describing the operation of the American economy in the nineteenth and twentieth centuries is strikingly consisent with the straightforward propositions of neoclassical economic theory. Workers appear to have been paid their marginal product, wage rates seem to have risen over time in a fashion that implies that competitive market pressures translate increases in productivity into higher real wage rates for workers, and cyclical variations in the economy can be explained by the real wage rate/productivity relationship being a disequilibrium one. To paraphrase a famous editorial of years past, we might say, "Yes, Virginia. There is a neoclassical world."

NOTES

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1. For the purpose of this discussion, we choose to ignore the Marxian notion of exploitation.

2. Our basic concept of exploitation is Robinsonian in character. See [10, pp. 381-91].

3. It is critical that we be able to estimate a production function without assuming that the marginal side conditions are satisfied. For that reason, the CES form is rejected. For a discussion of the methodological issues involves, see [14].

4. For the unskilled wage rate, we use the wage series reported in [1]. For average annual earning, we use the Stanley Lebergott series (D-724) from [13].

5. We updated the Gallman date through 1970.

6. For this purpose, we use data series D-803, D-846, and D-847 from [13].

7. Increased productivity of factor inputs explains about one-half of per capita economic growth in the United States after 1840.

8. We find it particularly noteworthy that this phenomenon is unambiguous, i.e., it is the result of a fall in the absolute real return per unit of capital and a rise in the absolute real wage rate.

9. A point of clarification: The productivity-employment relationship stated here is that occurring in a world in which productivity change occurs over time through technological advance. It should not be confused with the productivity-employment relationship implicit in the short-run concept of diminishing returns.

10. For example, see [8] and [9]. Also of interest is [3].

11. This adjustment mechanism might also be described by the term "asymptotic rational expectations," as defined in [12].

12. A detailed explication of this model is contained in [4] and [5].

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Table 1

Analysis of Exploitation of Labor, United States, 1820-1920

Year	Industry Classification	Character of Data Sample	Test Statistics		Evaluation of Null Hypothesis of No Exploitation
			$(\alpha_a - \alpha_n)$	σ_{α_a}	
1820	All Manufacturing	415 firms	.01	.04	Accept
1832	Textiles	126 firms	- .01	.06	Accept
1860	All Manufacturing	1987 firms	- .05	.03	Accept
1860	Textiles	120 firms	.02	.04	Accept
1880	All Manufacturing	46 States (representative firm)	- .02	.06	Accept
1920	All Manufacturing	160 cities (representative firm)	.09	.05	Accept

Data Sources: 1820: United States Census, *Digest of Accounts of Manufacturing Establishments of the United States and Their Manufactures* (Washington, D.C.: Gales and Seaton, 1823)
1832: House of Representatives, Document No. 308, *Documents Relative to the Manufacturers in the United States* (McLane Report) (Washington, D.C.: Duff Green, 1832)
1860: United States Census, Eighth Census, *Manufactures of the United States in 1860* (Washington, D. C.: Government Printing Office, 1865) and Census manuscript schedules
1880: United States Census, *Report on the Manufactures of the United States and the Tenth Census* (Washington, D.C.: Government Printing Office, 1883)
1920: United States Census, *The 1920 Census of Manufactures: Reports for the States* (Washington, D. C.: Government Printing Office, 1922)

Table 2

Ratios of Indices of Wage Rates to Index of Return per Unit of Capital, United States, 1840-1970

Year	Unskilled Wage/Return to Capital	Average Annual Earnings/Return to Capital	Average Hourly Earnings/Return to Capital
1840	1.0	...	...
1850	1.3	...	...
1860	1.9	...	...
1870	1.9	1.0	...
1880	1.9	1.0	...
1890	3.3	1.7	1.0
1900	4.1	2.1	1.3
1910	4.5	2.7	1.7
1920	6.1	3.1	2.1
1930	6.7	3.8	3.0
1940	11.0	4.6	4.0
1950	12.3	5.8	4.7
1960	16.0	7.3	6.1
1970	17.6	8.4	6.9

Table 3

Actual and Estimated Unemployment Rates, United States, 1929-1941

Year	Unemployment Rate	
	Actual	Estimated
1929	3.2 %	3.0 %
1930	8.7	8.2
1931	15.9	16.4
1932	23.6	22.4
1933	24.9	26.5
1934	21.7	19.1
1935	20.1	18.8
1936	16.9	13.6
1937	14.3	11.7
1938	19.0	17.3
1939	17.2	16.8
1940	14.6	15.1
1941	9.9	11.2