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John Pencavel

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John Pencavel
Stanford University
and IZA

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

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It has become orthodox in economics research to interpret the association between hourly earnings and working hours as the expression of the preferences of workers. This convention originated in H. Gregg Lewis' explanation for the decline in hours of work since the nineteenth century. His explanation rested on an explicit resolution of the identification problem inherent in any quantity (hours) - price (wage) relation. For over forty years, researchers have neglected this identification problem with the result that the findings in the purported "labor supply" literature are of questionable value.

JEL Classification: J22, J23, C13

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Corresponding author:

John Pencavel
Department of Economics
Stanford University
Stanford, CA 94305-6072
USA
E-mail: pencavel@stanford.edu

WHOSE PREFERENCES ARE REVEALED IN HOURS OF WORK ?

John Pencavel [*]

I. The Setting

When observations on the hours worked by individuals in labor markets are related to observations on their hourly earnings, what is the appropriate interpretation of the fitted relationship? This paper asks this question of the research that measures this relationship. This research is best understood in the context of a conceptual framework and, for what follows, I outline this framework briefly. I shall not take issue with this framework but I do have concerns with the manner in which it has been applied. The theory I sketch is conventional and it is the simplest of many variants, some of which may be important in certain circumstances.

First, consider hours of work from the perspective of the consumer-worker who has well-behaved preferences over his consumption of commodities, Q , and his hours of market work, H : $U = U(Q, H)$. He sells his hours to an employer and thereby becomes an employee. His choices are assumed to be constrained by a linear budget constraint: $p.Q = w.H + y$ where p stands for the prices of commodities he consumes, w is take-home hourly earnings, and y is nonlabor income. In this simple model, p , w, and y are given to the consumer-worker. Selecting Q and H so that he does the best he can given his constraints results in commodity demand and labor supply equations, the latter being

$$H = f(p, w, y) \qquad (1)$$

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This equation describes the employee's budget-constrained working hours choices. The effect of higher wages on the employee's choice of hours decomposes into opposite-signed substitution and income effects and empirical research aims to determine which of these two effects dominates. Higher nonlabor income is expected to reduce his preferred working hours.

Second, consider hours of work per worker, *H*, from the perspective of an owner-manager. Her demand for hours per worker (and her choice of the number of workers, *N*, and of other inputs, *Z*) results from her maximization of net revenues: $\Pi = q.X(H , N , Z) - w H N - v N - r Z$ where *q* is the price of each unit of output *X* produced, *r* is the price per unit of *Z,* and *v* are the costs associated with employing each worker (such as the costs of hiring and training new workers) and are independent of *H*.[1] Assume the production function $X(H , N , Z)$ is strictly concave and that *q*, *w*, *v*, and *r* are given to the owner-manager. The demand equation for hours per worker is

$$H = g (q , w , v, r) \qquad (2)$$

Under the conditions given, the demand for hours falls when *w* rises.[2]

When economists use observations on the working hours and hourly wages (and perhaps other variables) of individuals or groups, are they estimating equation (1) or equation (2) or some mixture of the two? The exclusion restrictions should help to discriminate between the two equations: the demand for hours equation implies that increases in a worker's nonwage income do not depress hours of work; the supply of hours equation implies that increases in the price of the

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[1] Because observations on *v* are often lacking, occupational variables are used as surrogates *faute de mieux*. See Rosen (1969) for an example. If the firm is not a price-taker in the product market, variables such as consumers' incomes or the prices of substitutable or complementary products replace *q* .

[2] For a fuller discussion of the demand for hours, see Hamermesh (1993).

output that workers help to make do not increase work hours. The decision-makers in equation (1) are workers while the decision-makers in equation (2) are manager-owners.

This paper takes up this question of identification.[3] In so doing, I survey (very selectively) the research in economics over the previous 60 years on the hours that individuals devote to market work. Also, at some places below, I illustrate my points with the use of observations close at hand on hours and wages. Given the relevance of income tax revenue to finance government activities, the issue of hours of work is salient to many questions in public finance and, given the importance of working hours to workers and employers alike, the topic of hours of work is pertinent to economists concerned with production and distribution in a market economy. Research on this topic proceeds at such a pace that surveys (more thorough than this) are published every few years.[4]

II. The Orthodoxy is Launched

Figure 1 traces annual observations from 1890 to 1930 in average weekly hours of work and average real compensation of production workers in U.S. manufacturing industry.[5] For much of the period, real wages rose and hours worked fell. A scatter diagram of the combinations of annual

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[3] Lest I am characterised as a Johnny-come-lately (pun intended) on this matter, I wrote thirty years ago, "In an econometric exercise associating quantities (hours of work) and prices (wage rates), prior to estimation it is appropriate to enquire whether what is being estimated is a supply function, a demand function, or some hybrid." (Pencavel(1986), p. 59) In fact, it is rare for a researcher to so enquire.

[4] In the last fifteen years, surveys include Blundell and MaCurdy (1999), Meghir and Phillips (2010), Keane (2011), McClelland and Mok (2012), Saez, Slemrod, and Giertz (2012), and Bargain, Orsini, and Peichl (2014). Keane's (2011) authoritative survey lists 117 references.

[5] This series on working hours (based on material put together by Paul A. Douglas (1930)) conceals important differences among classes of workers and industrial groups both in levels and the timing of changes. For example, hours in iron and steel were consistently higher than these figures and changes in iron and steel came later than other manufacturing industries. See Shiells (1985).

values of wage rates and weekly hours between 1890 and 1930 is drawn in Figure 2.

Lewis in 1957

In 1957, H. Gregg Lewis offered an explanation for this decline in the length of the working week until the 1930s.[6] He reasoned as follows: "To a first approximation", the typical employer cares about the aggregate hours worked by the firm's entire work force but, at the given wage, the employer allows each worker to set his or her own work hours according to the worker's income-leisure preferences. Expressed differently, in a figure with the real hourly wage measured on the vertical axis and the average weekly hours worked on the horizontal axis, the typical employer's demand for an individual worker's work hours is a horizontal line. This horizontal demand curve for a worker's hours shifted up over time as the economy grew and as the derived demand for labor rose.

Assume that the labor supply curve remained unchanged; as Lewis expressed it, "tastes for leisure are very stable in the long run". Because hours of work fell as wages rose, this must mean the worker's labor supply curve is negatively-sloped implying the income effect of wage increases exceeded the substitution effect.[7] The typical worker chose to respond to wage increases by working fewer hours. According to Lewis in 1957, "employers' preferences have played only a minor role

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[6] Lewis' teacher, Paul Douglas (1934), had devoted a chapter of his The Theory of Wages to the association between weekly hours of work and hourly earnings using both cross-section (across industries in given years) and time-series (across years within given industries) observations. His consistent finding was that the two variables were negatively correlated. Even though identification issues had been addressed for some years by scholars such as H. Working (1925), E.J.Working (1927), and Wright (1929), unlike Lewis, Douglas does not address the identification problem and simply assumes his estimates describe the preferences of the typical worker.

[7] If the annual observations in Figure 2 are used in a least-squares regression of the logarithm of weekly hours on the logarithm of real hourly compensation for the years 1890 to 1930, the estimated coefficient on hourly earnings is -0.269 with an estimated standard error of 0.016.

in the long-run trend of hours of work in this country" (1957, p.72).[8] Figure 3 illustrates Lewis' rationalization of the hours-wages pattern in U.S. manufacturing industry. The parsimony of Lewis' explanation is appealing: variations in real wages and in hours worked trace out the typical worker's preferences, a labor supply curve.

It is not surprising that, within a few years, a Ph.D. thesis at the University of Chicago (Lewis' academic home at the time) was written using Lewis' framework to describe variations among individual workers in their hours of work. I write "not surprising" because, by many accounts, Lewis was a demanding but very engaged and generous advisor of graduate students.[9] This dissertation was written by Marvin Kosters (1966) who used observations on individual workers from the 1960 Census of Population to relate the working hours (per week and per year) of married men aged 50-64 years to their nonlabor income and to their hourly earnings. In this way, Lewis' proposed explanation for changes in average working hours over time was converted to an explanation of differences in working hours among individuals at a given moment.

Representative of Kosters' estimated equations is the following where H is hours worked of 8,467 husbands in the week preceding the Census, w is average hourly earnings, and y is nonlabor income:

$$\log(H) = \text{.....} - 0.043 \log(w) - 0.010 \log(y)$$
$$(0.009) \qquad (0.011)$$

[8] Lewis recognized that "periods of substantial unemployment or effective legislation affecting hours of work per head" (1957, p.73) would interfere with the identification of the average worker's supply of work hours curve from observations on wages and hours of work. This is why observations from the 1930s and the Second World War are omitted from Figures 1 and 2.

[9] Read the depictions of Lewis by Rees (1976) and Rosen (1994) in the essays written by his colleagues and students. Also see Biddle (1996).

where the dots stand for nine other regressors in the equation (such as regional dummy variables, demographic indicators, and some occupational and industry dummy variables). Estimated standard errors are in parentheses beneath their estimated coefficients.

In the many fitted equations that Kosters reported, the estimate of the uncompensated wage effect is routinely negative suggesting the income effect exceeded the substitution effect just as Lewis had conjectured in his explanation for the decline in average hours between 1890 and 1930 in manufacturing industry. As for the estimated coefficient on nonlabor income, y , Kosters wrote, the estimates ".....were very often positive and small when negative" (p. 35). In fact "only those regressions for which the sign of the estimated income coefficient was non-positive were reported..." (p. 27) .

In many respects, the approach and findings of Kosters' dissertation typify much of the subsequent cross-section research on the hours of work of men: the estimated coefficient on hourly earnings tended to be negative and the estimated coefficient on nonlabor income was often imprecisely estimated and, on a number of occasions, it was positive rather than negative. These findings - that $\partial H/\partial w < 0$ and $\partial H/\partial y \geq 0$ - imply a non-positive substitution effect which some would find a cause for concern for the interpretation of the hours-wage observations as a conventional labor supply function.[10] Nevertheless, Lewis' 1957 model for understanding movements in and differences in hours of work became the norm, usually unquestioned, even though Lewis himself amended his earlier model to allow for a role for employers to play in the

[10] Even with a positive value of the uncompensated wage effect, a positive substitution effect may not be implied if the effect of nonlabor income on hours if sufficiently positive.

determination of hours.[11]

Lewis in 1969

Lewis' amendment appears in an article published in a Spanish-language journal in 1969. An English-language version titled "Employer Interests in Employee Hours of Work" has circulated for over forty years. In this later paper, Lewis distinguished between two types of labor costs: "fixed" costs that varied with the number of workers such as the costs of searching for, hiring, and training a worker[12] ; and costs that varied with hours of work such as the earnings that increased with hours worked. To economize on the fixed costs of employment, an employer is inclined to extend the hours of her work force inducing workers to accept these longer hours with higher hourly wages.

In this 1969 paper, Lewis posited a market wage curve (the "market equalizing wage curve") whose slope depended on the underlying preferences of workers and employers.[13] An optimizing employer selects a wage-hours combination on this market curve. Similarly, a worker chooses a wage-hours bundle from this "market equalizing wage curve". According to Lewis' revised model, normally, observations on hours and wages in a labor market trace out neither the typical employer's demand function for hours nor the typical employee's supply function for hours, but the wage-hour packages that each worker and each employer optimize against.[14]

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[11] Ehrenberg (1971) also demurred. He assumed that a typical firm faced an infinitely elastic supply of hours per worker at the going wage.

[12] Lewis cited Walter Oi's (1962) "quasi-fixed" labor costs and Gary Becker's (1964) "specific on-the-job human investment" costs as examples of these costs.

[13] Lewis wrote, "...the sign of the slope of the [market equalizing] curve, to say nothing of the sign of the second derivative, cannot be derived from the economic theory of hours of work choices by employees and employers I have presented".

[14]The claim that the "average" consumer-worker's preferences for work hours and hourly earnings can be inferred from situations where "persons choose their hours of work by selecting across

Lewis' second model was influential, but not in accounting for differences in hours of work. The model was used by Sherwin Rosen (1974) in an important paper providing a framework for understanding "hedonics". This literature addresses the fact that consumer goods and jobs have attributes and characteristics that are tied to their prices: one car may have more desirable features than another and one job may have different nonpecuniary components from another. Rosen's market hedonic price function in which the price of a product varies with the quantity of its attribute was formally identical (as Rosen fully acknowledged) to Lewis' market equalizing wage curve where employers and workers take as given the market relation between wages and hours of work. It also figures prominently in Rosen's (1986) masterful survey on the research on equalizing wage differentials.

Though Lewis' second model became the paradigm in the hedonics literature, it had negligible impact on labor supply research which followed (usually unacknowledged and uncontested) Lewis' earlier framework and Kosters' application: the dominant line of research consisted of using cross-section observations (or a time-series of cross-section observations) to regress the working hours of individuals on their hourly earnings and other variables with the estimated parameters interpreted as structural parameters of the typical worker's preferences.[15]

There were certainly important contributions in this line of research such as the extension

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employers offering different wage packages"(Blundell and MaCurdy (1999, p.1588)) is not consistent with this model. The different hours-wage bundles that define each worker's opportunity set depend, in part, on what employers find to be optimal so the observed hours-wage relationship maps out a mix of employers' preferences and consumer-workers' preferences. The wage rate is not a sufficient statistic to determine an employee's hours of work.

[15] The only empirical research on working hours that draws on Lewis' 1969 model I am aware of is that by Rosen (1969). Kinoshita (1987) provides a clear exposition of the model.

of the model to account for age-related hours of work choices (Heckman and MaCurdy (1980) and MaCurdy (1981)), the coupling of skill acquisition to intertemporal labor supply decisions (Heckman (1976) and Imai and Keane (2004)), the explicit conjunction of consumer demand analysis and labor supply decisions (Abbott and Ashenfelter (1976)), the appropriate treatment of corner solutions to the worker's optimizing work decision (Heckman (1974)), the incorporation of risk and uncertainty in consumer-workers' decisions (Pistaferri (2003)), and the development of so-called collective models of household decision-making (Browning, Chiappori, and Weiss (2014)). In recent years, much research effort has been devoted to the treatment of nonlinear and, indeed, nonconvex budget sets, an evident complication if hours of work reflect the preferences of workers and if workers respond to post-tax and post-transfer wages and income.

Should economists be confident that the measured relationship between wages and hours maps the preferences of workers, that is, a labor supply function? Examine, first, the role of hours in the production function and, second, the specification of the hours-wage relationship.

III. Hours of Work in the Production Function

Lewis' 1957 solution to the problem of identification was to posit that the wage-taking employer's demand function for an employee's hours of work was infinitely elastic with respect to hours. A horizontal demand function implies a marginal product of hours, $\partial X / \partial H$, that is independent of hours. Writing this as $\partial X / \partial H = F(Z)$ where Z stands for inputs other than hours, then, upon integration, Lewis is assuming $X = F(Z)\, H^{\beta}$ where β is unity.[16] Such a production function might pose problems for a well-defined interior solution for the canonical price-taking profit-maximizing production unit which requires the law of diminishing returns to operate in the

[16] This is also derived in Manning (2001).

neighbourhood of the optimum. Nevertheless, is there empirical support for an exponent on *H* of unity?

In some research on the estimation of production functions, the input of labor is measured by the number of workers only; hours of work are neglected. More frequently, the input of labor is defined as worker-hours, the product of the number of workers and average hours of work implying that employment and hours per worker are completely substitutable. In a small number of cases, average hours of work enters the production function as a separate input from the number of workers. One early example of this distinction is Feldstein's (1967) study of a cross-section of British industries. He used a Cobb-Douglas expression and estimated remarkably (implausibly?) high elasticities of output with respect to weekly hours worked.[17]

Leslie and Wise (1980) revisited the issue with a time-series of a cross-section of industries. With fixed industry effects, they estimated more believable output-hours elasticities and, indeed, their preferred estimate of the output-hours elasticity was significantly less than unity. Also, they could not reject the hypothesis that the output-hours elasticity was no different from the output-employment elasticity, a finding that justified the use of worker-hours as measuring the input of labor services.

Cobb-Douglas production functions with an explicit role for hours are estimated by DeBeaumont and Singell (1999). Using annual observations within 20 four-digit manufacturing industries over time (from 1958 to 1994), they report an estimated coefficient on hours that is significantly less than unity in 16 of the 20 industries, a result implying that the marginal product

[17] Feldstein's point estimates of the elasticity of output with respect to hours were often not merely greater than unity but, in some instances, greater than two. They were imprecisely estimated, however, with values not significantly different (by conventional criteria) from zero nor from unity.

of hours falls as hours increase. A falling marginal product of hours is consistent with research suggesting that long hours of work damage workers' health and work performance.[18] Work fatigue and stress may be more relevant today than it was a few decades ago in view of the fact that, between 1980 and 2005, the fraction of men working more than 48 hours per week rose from 16.6% to 24.3 %.[19] This increase has been greater for college graduates and professional workers. Moreover, for some groups of workers - nurses, medical interns, police officers, truck drivers, merchant seamen, flight attendants, aircraft pilots - there are specific studies into the link between long working hours and fatigue (sometimes measured by accidents).[20]

IV. Identification through Prices and Wages

Consider the following linear-in-the-logarithms annual hours of work equation fitted to 27 conventionally-owned plywood mills in the state of Washington between 1968 and 1986. There are 134 mill-year observations. Annual work hours across mills and over time, H_{it} are regressed on hourly wages w_{it}, the price of plywood output q_{it} , and the price of raw material logs r_{it}, and fixed mill effects (expressed by μ_i) :

$$\underset{}{log\,(H_{it})} = \underset{}{\mu_i} \underset{(0.237)}{-\,0.340\,log\,(w_{it})} + \underset{(0.164)}{0.514\,log\,(q_{it})} \underset{(0.099)}{-\,0.209\,log\,(r_{it})}$$

Heteroskedastic-robust estimated standard errors are in parentheses beneath their estimated coefficients. The point estimates of this equation are consistent with a conventional input demand equation for a price-taking profit-maximizing firm. Indeed, without imposing the restriction, these

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[18] On hours and health, among many articles, see Hulst (2003) and on hours and work performance see the references in Golden (2012).

[19] These numbers come from Kuhn and Lozano (2008).

[20] Many studies may be found in the Journal of Occupational and Environmental Medicine .

estimates exhibit the zero homogeneity property of such input demand functions. The negative sign on the logarithm of hourly earnings is also consistent with a negatively sloped labor supply curve in which the income effect of higher wages outweighs the substitution effect, but it requires an ingenious mind to reconcile with a labor supply function the positive effect of increases in plywood prices on hours and the negative effect of increases in the price of logs on hours worked notwithstanding the imprecision of the estimates.[21]

Unfortunately information on the nonlabor income of the workers is not available. If it were, it would be informative to add it to the right-hand side of the hours equation above to test the hypothesis that the sign of its estimated coefficient is not negative. Each worker in a given mill in a given year worked the same number of hours as all other workers. They started and ended work at the same time of day, patterns that might signal the influence of an employer.[22]

If the regression equation of working hours yielded the result that, other things equal, workers with greater nonlabor income worked fewer hours, this might permit the interpretation of this equation as a labor supply equation. However, if the nonlabor income of these plywood mill workers were available and the variable were added to the hours equation above, I suspect (from the evidence of many investigations into working hours) the estimated coefficient on nonlabor income

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[21] It is entirely plausible for these mills to be characterised as price-takers in input and output markets. The wage was set at multi-employer collective bargaining agreements that permitted pay differentials across mills and that allowed owner-managers to adjust inputs in response to these given wages. Logs were purchased in markets where selling prices were determined by auction and the price of plywood was set in international markets. More information about these data and this industry may be found in Pencavel and Craig (1994).

[22] Weiss (1996) considers how synchronised work schedules deriving from the importance of communication in production may even override differences in work preferences.

would be positive or trivially different from zero as Kosters discovered.[23] This "perverse" finding is usually attributed to error in measuring income independent of labor market activity or to its joint determination with hours in a life cycle context. The frequency with which it has been necessary to resort to such explanations might have caused some to question the orthodoxy, but it is understandable for a researcher to pull back from such a judgment out of concern that others would not question the orthodoxy but question the researcher's skills.

One might think that a situation in which an individual received unexpectedly an inheritance would provide a neat opportunity to measure the effect of nonlabor income on hours of market work. In fact, the effect of surprise inheritances on hours of work appears to be mixed.[24] See Joulfaian and Wilhelm (1994). Somewhat similar to the research on the effects of unexpected gifts on the work hours of beneficiaries is the impact of legislated amendments to Social Security benefits that had the consequence of changing the wealth of particular cohorts. In such an analysis, Krueger and Pischke (1992) report an undetectable effect of such changes on the weeks worked of these cohorts.

V. The Changing Textbooks

Section II above opened with Lewis' 1957 explanation for the decline in hours of work in manufacturing industry from the end of the nineteenth century to 1930. It may be difficult today to

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[23] Kosters' admission that he did not report results where the coefficient on nonlabor income was non-positive is laudable. How many researchers have been less forthcoming and have not mentioned such findings?

[24] To be clear, such surprise bequest are sometimes correlated with labor force withdrawals, but rarely with movements in work hours among those at market work. As Brown *et al.* (2010, p. 425) write, ".....the few studies that have attempted to isolate the effect of a wealth shock on labor supply [*sic*] have found collectively ambiguous results". Using information from the Health and Retirement Study, they provide evidence of the inheritance of assets affecting retirement behavior. Effects on working hours among those remaining at work are not reported.

appreciate the radical change in economists' thinking about working hours that Lewis' paper brought about. One grasps an inkling of this by comparing the dominant textbooks before Lewis with the popular textbooks of today. Textbooks provide a window on prevailing ideas and attitudes and the labor economics textbooks before 1957 offer explanations for the decline in work hours that make no mention of competing income and substitution effects.[25] The contrast with labor economics texts of today is extraordinary. Contemporary textbooks use the words "working hours" and "supply of labor" as synonyms. The notion that working hours is a quantity and the wage rate is a price so that the interpretation of observations on quantities and prices requires attention to an identification problem – something that Lewis explicitly addressed in his work – is not even entertained!

These early texts attributed the decline in hours to trade union activity and "union-sponsored legislation", explanations that barely appear in present-day textbooks.[26] If these explanations are irrelevant, shouldn't those who explicitly or implicitly assume that an employer's marginal product of working hours is independent of hours address the historical record of employers resisting workers' demands for shorter hours? There have been major confrontations between workers and their employers over the length of the work day and of the work week. If "employers are completely indifferent with respect to the hours of work schedules of their employees" (Lewis, 1957, pp.198-9), why did employers oppose so resolutely workers' calls for shorter hours? [27]

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[25] See, for instance, Lester (1946) and Reynolds (1954).

[26] Lewis (1957) mentioned these explanations but argued they were relevant in only some special cases (such as in the railroad industry).

[27] Of course, in Lewis' 1969 model, employer resistance to workers' demands for shorter hours is understandable because there are costs to employing more workers that could be used to offset the decline in hours. In his 1957 model, there is no such hindrance to replacing shorter hours per worker

In their discussion of working hours, the earlier generation of labor economists did consider how hours enter production with one writing "...reductions in the length of the working day generally increase the hourly output of workers and may, depending on the circumstances, cause no decline in total daily output" (Lester (1946, p. 356)). Some years later, this argument was adopted by Edward Denison (1962) in his well-known study of the contribution of different factors to U.S. economic growth. In his research on the effects of the reduction in hours of work, Denison alleged that, in 1929 when average weekly hours were 49, a reduction in hours would leave output unchanged whereas in 1957 when hours per week averaged 40, a ten percent reduction in hours would reduce output by only six percent. The results in Pencavel (2016) may be interpreted as support for Denison's estimates.

Another older text mentioned fatigue as a factor in the setting of working hours and drew the nonlinear production function that is reproduced in Figure 4 (Reynolds (1954), p. 254). In today's textbooks, in their treatment of hours of work, it is unusual[28] for fatigue and stress to receive even footnote attention notwithstanding contemporary evidence that it remains highly relevant for some workers where the incidence of injuries and illness is associated with long working hours (Dembe *et al.* (2005), Ricci *et al*. (2007)).

The older texts provided a historical perspective on reductions in working hours and suggested patterns that seem to be overlooked in modern texts. For instance, although the quality of earlier data on working hours permit only tentative inferences, it does appear as if, from the first half of the nineteenth century, reductions in the length of the working day and week came about

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with more workers.

[28] "Unusual" but not "never". See Cahuc, Carcillo, and Zylberberg (2014, p. 105).

discontinuously, being unchanged for a number of years before a discrete and marked decrease.[29]

Viewed from this perspective, the movements in average real wages and average weekly hours of work in U.S. manufacturing industry from the close of the Second World War to the late 1970s seem not to be at variance with this pattern: while real wages reveal a clear modest upward trend over these years, weekly hours of work are trendless. (See Figure 5.) Hours of work are cyclically sensitive but their value at the end of these thirty years is little different from that at the beginning of this period.[30] Is this combination of rising wages and constant(cycle removed) hours consistent with "very stable" preferences of workers?

VI. Self-Employment

The beginning of this paper presented an equation of the hours of market work from the perspective of an employee, equation (1), and a second hours of work equation from the perspective of the owner-manager, equation (2). This paper has been addressed to the issue (largely neglected to date) of distinguishing between these two equations in empirical research. As most workers in the market are employees, the attention to this class of workers would seem appropriate.

However, there is another class of workers who resemble both the employee and the employer: the self-employed. If a group of self-employed collaborate, the resulting arrangement is called a partnership or a worker co-op or a producer co-op. Either working individually or in collaboration with others, self-employed workers interact directly with the consumer without the

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[29] I infer this from Bienefeld (1972) and Shiells (1985), among others.

[30] Weekly working hours averaged 40.4 over the five years from 1949 to 1953 and averaged 40.1 in the five years from 1975 to 1979. From 1979 to 2006, average real hourly compensation of production workers in manufacturing industry grew little while average weekly work hours changed little.

presence of an intermediary, the employer.

One natural extension of the earlier reasoning might suggest that a self-employed worker selects his work hours (H) and the level of co-operating inputs (Z) to maximize his well-being $U(Q, H)$ given his income-expenditure constraint: $p.Q = q\,X(H, Z) + y - r.Z$ where X denotes the amount of commodity or services produced and sold to the consumer at a price of q per unit. The per unit price of the co-operating input is r. Any income from the ownership of assets is y. The worker's strictly concave production function is $X(H, Z)$ and the unit price of consumption goods is p. Assume, as before, that the lower-case variables are parametric. The consequence of this constrained choice of Z and work hours (and, therefore of consumption goods, Q) can be expressed in equations that, in the case of work hours, may be written:

$$H = \varphi(p, q, r, y) \qquad (3)$$

This equation is a mixture of equations (1) and (2) which is to be expected now that the intermediary, the employer, has been renounced.

For an application to a group of self-employed workers, return to the study of plywood manufacturing in the Pacific Northwest from 1968 to 1986 where between one-third and one-half of the plywood produced came from mills that were owned and managed by the workers who worked in them. For over sixty years, these worker co-ops were the largest and most durable expression of such organizations in U.S. manufacturing industry. Using 55 mill-year observations on eleven of these co-ops in years between 1968 and 1986 in the state of Washington, an abridged least-squares equation fitted to the observations on hours per worker and prices yields the following estimates:

$$\ln H_{jt} = 0.639 \; + \; 0.215 \ln (q/p)_{jt} \; - \; 0.200 \ln (r/p)_{jt}$$

$$(0.513) \quad (0.074) \qquad\qquad (0.106)$$

where j denotes a given mill and t identifies the year and where heteroskedastic-robust standard errors are beneath their relevant coefficients. This is an abridged version of equation (3) because observations on y , the flow of income from the mill's reserves (or the nonlabor income of the individual workers), are lacking. Subject to this important omission, the estimated equation resembles a firm's output supply function: hours of work are positively associated with the price of output and negatively associated with the price of the cooperating input. The equation is also homogeneous of degree zero in p , q, and r .

There is no hourly wage rate in this specification; it is jointly determined with the choice of hours of work. However, a wage rate was paid to each of these workers and it was equal to $(N.H)^{-1}[q\,X(H, Z) - r.Z - C]$ where N stands for the number of member-workers and C measures fixed costs such as the payment of interest on debt or the addition to reserves.[31] It seems to be the case that when the hourly wage is defined in this way, it is negatively associated with hours of work but the association is weak and, over the central tendency of hours, hours vary little with hourly wages.[32] With other self-employed workers, the association between hourly wages and work hours will depend on how hourly wages vary with the prices of output and of cooperating inputs and this association is likely to vary from one activity to another.

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[31] N was ignored in the formulation of the model above because, in year-to-year decisions, the employment of member-workers in these worker co-ops changed little and changes in the labor input were effected principally through variations in hours per worker. All workers worked the same number of hours and each worker received the same hourly pay. See Craig and Pencavel (1992).

[32] See Pencavel (2015).

VII. Two Classes of Research that Recognise the Demand for Hours

Hours and Business Cycles

A role for employers' preferences in the determination of hours of market work that seems to be widely acknowledged concerns business cycle movements in hours. A well-established pattern is that hours are pro-cyclical and, moreover, that movements in hours precede turning points in business activity (production, sales, and new orders).[33] A cut in the working hours of employees tends to be among employers' first reactions to the over-accumulation of inventories and to the weakening of new orders. Because the reductions in hours in a contraction tend to affect lower wage unskilled workers more than the higher wage skilled workers, the observed hours-wage pattern in a cross-section may well differ according to the stage of the cycle to which the cross-section relates and to the skills of the workers.

This may also affect micro-economic research exploiting panel data such as is common in applications of life cycle models. Indeed, in one specification of Frisch's substitution elasticity, MaCurdy (1981) adds calendar year dummy variables (ostensibly to account for variations in the rate of interest but which may be interpreted as absorbing the effects of the business cycle). The consequence of this for his first differenced hours of work equation is to render the point estimate on wage changes to be smaller than its estimated standard error. In this instance, the hypothesis that there is no intertemporal substitution of hours as individuals age cannot be rejected by conventional criteria.[34]

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[33] This finding goes back at least to Bry (1959).

[34] The life cycle results of Browning, Deaton, and Irish (1985) are also sensitive to the presence or absence of calendar year dummy variables.

Minimum Wage Effects on Hours

The literature on the association between hourly earnings and hours of work includes the effect of changes or differences in statutory minimum wages on the hours worked of affected employees. This class of research usually frames the issue without reference to labor demand or to labor supply. There are some instances in which it is assumed the impact of a higher minimum wage must reflect the reaction of an employer, but this assumption is often not used to place a restriction on the set of other variables in the hours of work equation. A variety of different regressors - the logic for which is not always clear - are included when measuring the association between working hours and hourly (minimum) wages. As a consequence of this variety perhaps, there is an assortment of findings on the effects on hours of minimum wages ranging from negative effects to no discernible effects.[35] Would this range be narrowed if a behavioral model were drawn upon to discipline the choice of regressors?

VIII. Employers' Constraints on Employees' Hours Choices

Recognizing a role for the influence of employers' preferences on working hours not only may help to reconcile existing divergent results, but the literature on "rationing" in hours can be provided with a conventional theoretical underpinning. That is, some researchers have expressed discomfort with the assumption that the association between working hours and wage rates reflects the preferences of workers and of workers only. These scholars have speculated that some employees' work preferences are constrained by employers such that employees work more or fewer

[35] Negative effects are reported in Couch and Wittenburg (2001), Neumark, Schweitzer, and Wascher (2004), and Stewart and Swaffield (2008) and no "significant" effects in Connolly and Gregory (2002) and Zavodny (2000).

hours than they prefer at their observed wage rates.[36] Indeed, when asked whether they would choose different hours (at the same hourly wage rate) from those they are currently working, many respond they would choose more or fewer hours (Stewart and Swaffield (1997) and Golden and Gebreselassie (2007)).

Notwithstanding the plausibility of these employer mandates, testing for these constraints has been frustrated by the difficulty of specifying where these hours constraints come from and, consequently, from the fact that differences and variations in the extent of rationing are unobserved. A natural postulate is that variations in employers' mandates come from variations in their product prices (or marginal revenues), in the prices of their non-labor inputs, and in their input-output technology.

Expressed differently, employers' effects on hours of work are not capricious or inexplicable but are systematic and related to their production and price environments. In this way, the literature on employer restrictions on work hours does not need to abandon the conventional labor supply model as a characterisation of the hours preferences of workers. It is the application of the labor supply model that is wanting. The conventional model of labor supply needs to be married to conventional models of employers' preferences to derive a meaningful explanation of the variations in hours of work and wages before it is possible to assess the empirical performance of the neo-classical approach to hours of work

IX. What Is Typically Estimated - The Hybrid Equation?

The argument above has tended to present the issue as one in which the hours-wage

[36] Among many papers on this, see Altonji and Paxson (1988), Bell (1998), Blundell and Walker (1982), Card (1990), Dickens and Lundberg (1993), Kahn and Lang (1991), Moffitt (1982), Rebitzer and Taylor (1995), and Stewart and Swaffield (1997)

observations correspond either to a demand for hours function or to a supply of hours function. In circumstances in which the work setting might provide a strong *a priori* case for one or the other, such an unambiguous determination might be appropriate. Typically, however, researchers report little about the work environment of employees and they put together samples of large numbers of workers in many different workplaces and, subject to certain demographic characteristics such as gender, age, and marital status, a single equation is fitted to a disparate set of observations. In many cases, I suspect, the fitted equation is neither a supply of hours equation that embodies the work-income preferences of workers nor a demand for hours equation that connotes the constrained objectives of employers, but some mixture of the two.

A simple expression of this hybrid equation assumes conveniently log-linear hours-wage relationships. Suppose, as is typical, a large number of workers are observed and the demand for hours equation of these workers takes the form of

$$log\, H_i = \alpha_0 + \alpha_1\, log\, w_i + \alpha_2 X_i^D + \varepsilon_i^D$$

where $\alpha_1 < 0$. X_i^D represents predetermined variables such as the prices of output and inputs and firm or industry specific effects that shift the demand for hours function. The effects of the production technology on hours worked are also embedded in X_i^D. Analogously let the supply of hours equation for these workers be

$$log\, H_i = \beta_0 + \beta_1\, log\, w_i + \beta_2 X_i^S + \varepsilon_i^S$$

where β_1 may be positive or negative. X_i^S are predetermined variables such as nonlabor income that shift the supply of hours function in addition to variables believed to be associated with differences across workers in preferences. Omitted stochastic elements are represented by ε_i^D and ε_i^S.

Suppose λ is the fraction of these workers whose hours conform to the demand function

leaving the remaining fraction 1 - λ of workers who work the hours that satisfy their constrained preferences. Multiplying the demand for hours equation by λ , multiplying the supply of hours equation by 1 - λ , and adding the resulting two equations yields

(4) $$log\, H_i = \gamma_0 + \delta\, log\, w_i + \gamma_1 X_i^D + \gamma_2 X_i^S + u_i$$

where $\delta = \lambda\, \alpha_1 + (1 - \lambda)\, \beta_1$ and u_i incorporates both ε_i^D and ε_i^S. δ may be positive or negative. If it is interpreted as the elasticity of hours with respect to wages in a supply of hours of work function, then δ underestimates the key parameter of employees' preferences, β_1, unless λ is zero. Unfortunately, the value of λ is unknown though it would be audacious to maintain it is zero.

If scholars are fitting equation (4), then differences and variations in δ may be related not to differences in the work-earnings preferences of employees (that is, β_1) as many researchers assume but to differences and variations in λ. To pursue this possibility, perhaps the most consistent result in this literature is that δ is positive for women and that δ is less, perhaps negative, for men. This could mean that β_1 differs between women and men or it could mean that preferences are the same but λ is smaller for women than for men. It is difficult to know if this is the case without some knowledge or guesses about the magnitudes of λ for men and women.

Perhaps workplaces where workers are highly interdependent and complementary for one another and where starting and ending times for work are the same for all employees might signal a situation in which employers unilaterally specify the hours that their employees work. In such workplaces, employees work with high levels of physical capital and the costs of using the machinery are greater when employees are not working together at the same time. An assembly line in a manufacturing plant may come close to the prototype of this workplace.

There remain noticeable differences between men and women in the industries and

occupations in which they work and possibly these are, in turn, related to λ. For instance, about 17 percent of all employed men work in "production, transportation, and material moving occupations"; only 5% of employed women work in these occupations. About 14% of all employed men work in manufacturing industry compared with 6% of all women. A sector in which women employees outnumber men is work in non-profit organizations, workplaces that, I conjecture, are more amenable to accommodating individuals' hours of work preferences. These are guesses of workplaces where the estimate of δ in equation (4) may reflect the value of λ rather than that of β_1. In short, the positive values of δ often estimated for women workers imply that women work in activities in which their work preferences are accommodated by their employers.

Several scholars have reported that, for women, the hours-wage partial correlation has weakened in recent decades.[37] Does this mean that the work-income preferences of women are altering or that the value of λ is changing such that an increasing fraction of women are working in jobs where employers' preferences over hours dominate?

One research study that recognises the relevance of employers' preferences for hours is Blundell, Brewer, and Francesconi (2008) who examine the working hours responses of unmarried women to shocks in the monetary returns to their market work. In this case, over a two year period, about one-fifth of the women altered their working hours by changing their employer whereas "there is little evidence of systematic labor supply-induced movements within jobs" (p.450); that is, following shocks to their budget constraints, 80 percent of these women did not switch employers and their working hours did not change. If their work preferences were satisfied before the changes in their budget constraints, are they now working at an undesirable number of hours? Or are the

[37] See, for instance, Blau and Kahn (2007), Heim (2007) and Bishop, Heim, and Mihaly (2009).

labor supply functions of 80 percent of these women totally inelastic with respect to their net returns to market work?

X. Conclusion

In this selective review of research since the 1970s on what has become known as "labor supply", I opened with Gregg Lewis' explanation for the decline in working hours since the end of the nineteenth century to 1930. I did not do so because I disagree with his explanation. The notion that, in the nineteenth and early twentieth centuries, American workers took some of their real wage increases in the form not of higher consumption but in the form of shorter hours of work is appealing provided the various ways in which the expression of this choice are recognised. That is, I do not view the demands by trade unions for lower working hours and the statutory restrictions on hours as alternative explanations but as highly complementary explanations. Union pressure and legislative mandates were manifestations of workers' preferences.

By contrast, Lewis did express his argument in a form in which union activity and statutory restrictions on hours were alternative explanations. One might see his presentation as preferable on the grounds that trade union activity and government legislation are unnecessary components of an explanation. Or one may view union activity and legislation as providing a richer explanation by providing the mechanism by which workers' preferences were put into action.[38]

The reason that Lewis' argument has occupied an important role in this review is because his simple model has provided the intellectual justification for a vast amount of research on the issue

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[38] Marion Cahill's (1932) account of reductions in working hours since the Civil War identifies three mechanisms by which hours were cut: legislative action, trade union action, and voluntary action by employers. Although she recognizes difficulties in categorizing some hours reductions, she determines that "the reduction in hours by pioneer employers has been less common than that brought about by legislative or trade-union action" (p. 27).

of the relation between hours of work, hourly earnings, and other variables - even though, in later work, Lewis himself put forward a very different characterisation of the labor market. However, the appeal of Lewis' earlier, simple, model has proved irresistible to a whole generation of researchers who have forgotten the need to address the fundamental identification problem that Lewis recognised.

This paper has been concerned with whether the association between hours of work and wages reflects the preferences of workers or the preferences of employers or some mixture of the two. This is not a new issue. For instance, it was raised explicitly by Martin Feldstein (1968) and by Sherwin Rosen (1969) almost fifty years ago. Abbott and Ashenfelter (1976) may have been the last study of hours of work that referred to the issue.

Feldstein reasoned (1968) that, if observations on hours and wages were restricted to a single labor market in which differences among workers' supply curves were small compared with the differences in employers' demand curves, the supply function would be identified. He proceeded to use observations on workers in a single occupation in a single industry in a single region. He admitted that his subsequent estimates allowed for the interpretation that "the identification problem persists" (p. 78).

Using observations on industries, Rosen (1969) specified demand and supply equations for hours per worker using familiar omitted variable restrictions to distinguish the two equations. For example, the fraction of workers covered by collective bargaining agreements is assumed to affect the demand for hours and not the supply whereas workers' nonwage income appears in the supply equation but not the demand. Both the demand for hours and the supply of hours were negatively related to the hourly wage although demand was more wage-responsive than supply. Once again,

variations in nonwage income were uncorrelated with hours per worker. "Demand seems to fit the data better than supply" wrote Rosen (1969, p.269).

If the issue of distinguishing between the supply of work hours and the demand for work hours was worthy of attention in the late 1960s and 1970s, why did it disappear over the next forty years? The character of the research became one of measuring the parameters of a presumed relationship, not of testing hypotheses that the relationship described one structural equation and not the other. Was this a safer line of inquiry than one that questioned the interpretation of the estimated relationship?

I am not suggesting that the vast quantity of research on hours and wages that is presumed to map the preferences of workers is worthless; much of it is both plausible and appealing as a description of the supply of labor. I am proposing that research on hours of work would be enriched if some effort were directed to confirming that the fitted equations describe one set of preferences or the other. If a regression of hours of work on wages and nonwage income yields a positive or zero coefficient on nonwage income, the researcher needs to question the interpretation of the relationship as a labor supply equation. If, moreover, the hours of work of individuals appear to be associated with the prices of inputs and output at their workplaces, the case strengthens for this hours-wage relationship as a demand for labor equation. It would be an advance if a fitted hours-wage relation were not presented as a labor supply function as a matter of faith but if its interpretation as a mapping of employees' working hours preferences were corroborated with some empirical tests.

Once the presumption that the hours-wage relation represents the preferences of workers only is discarded, the question of the relevant control variables in the hours equation can be reconsidered. The usual procedure has been to draw upon large data sets on individual workers such

as the Current Population Survey or the Census of Population and to permit gender, age, and marital status differences in the hours-wage relation, but little more. But for their age, gender, marital status, and wage rates, are the work preferences of agricultural workers in California really the same as those of university teachers in Massachusetts? Rarely are such assumptions tested.

When a role for the demand for hours is accepted, the practice of ignoring types of workplaces and work environments becomes less tenable. Behind the demand for hours lies the production technology and the objectives of the employer so that knowledge of the institutional setting becomes relevant to a description of differences in hours across workers. Some of the most effective and plausible research on working hours has been undertaken on workers where the nature of the work, the character of the workplace, and the types of workers are carefully spelled out and where a persuasive case can be made for the homogeneity of the agents' preferences.[39]

Moreover, refocusing on working hours from the perspective of the employer may offer other insights. For instance, it has become customary to allow for fixed costs of employment (as contained in equation (2) above): these labor costs vary with the number of workers but do not vary with their hours.[40] There are also labor costs that vary with hours but do not vary with employment. These include not only premium hourly earnings for overtime hours but also the ancillary costs of heating, ventilating, and lighting buildings for longer, operating machines for longer, and paying supervisory workers higher earnings for their longer work hours. Further, the cost of accidents, injuries, and errors tends to rise with hours, a link recognised in earlier texts.

There is much more to be done on hours of work. Economists should cease calling hours-

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[39] See, for instance, the research of Ashenfelter, Doran, and Schaller (2010) and Farber (2005) on New York City cab drivers

[40] These costs are often expressed as linear in the number of employees although one may conjecture there are economies of scale in these hiring, training, and separation costs.

wage regressions “labor supply” research. Do not imitate the economist surveying research in 1986 on the hours, work, and wages of men who titled his paper “Labor Supply of Men”. Unless the identification problem is addressed, let the title be “Hours of Work and Wages of Men”or “Market Work Behavior of Men and Their Wages”!

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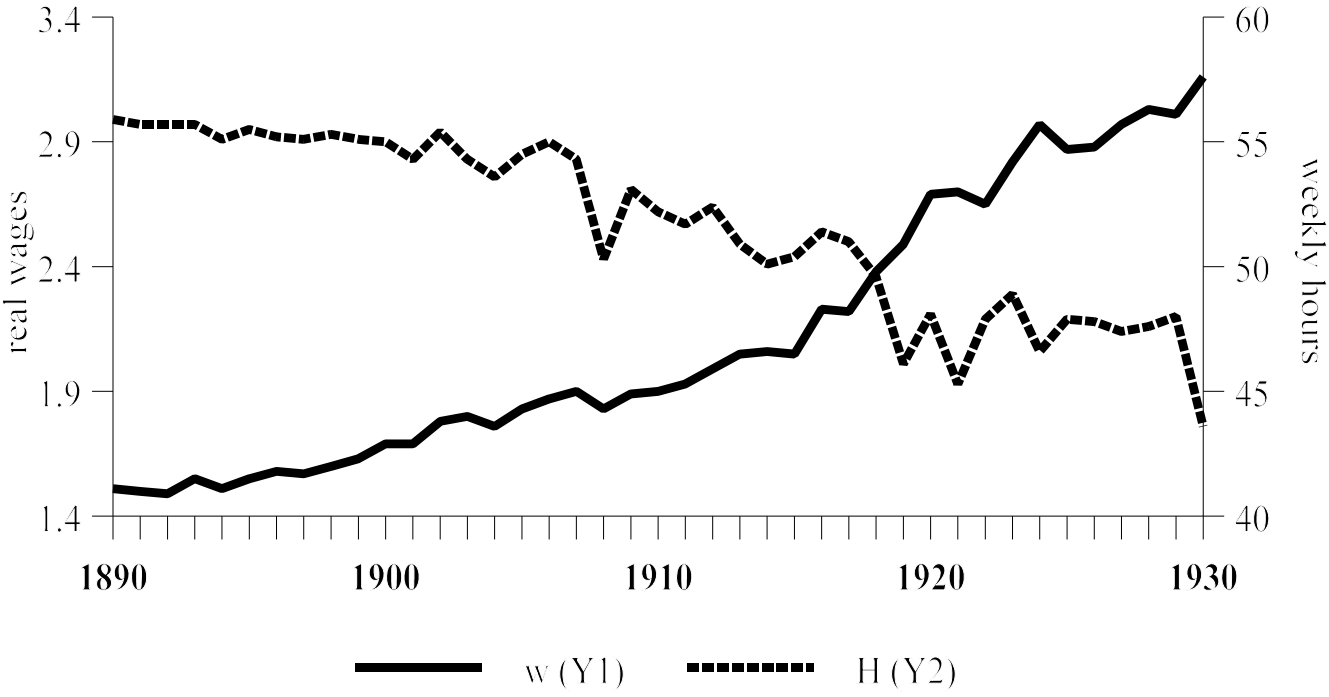
Figure 1

Average Weekly Hours and Average Real Hourly Compensation of Production Workers in U.S. Manufacturing, 1890-1930



In Figure 1, *w*(measured on the left-hand axis) denotes real average hourly compensation in dollars per hour in manufacturing industry (where the price deflator is a consumer price index with base in 1982-84) and *H* is average weekly hours worked (measured on the right-hand axis). The series on *w* is from Officer (2009, Table 7.7, p. 170). For the years 1900 to 1930, the average weekly hours worked in manufacturing are from Jones (1963). Between 1890 and 1899 the hours series is taken from series D-765 in the Historical Statistics of the United States. This series is believed to overstate hours of work. Therefore, using the 1900 figure of 59 hours for series D-765 and Jones' figure for 1900 of 55 hours, the hours figures for each year from 1890 to 1899 were adjusted downwards by 0.932 (which is 55/59).

Figure 2

Annual Values of Real Wages and Weekly Working Hours in

U.S. Manufacturing Industry, 1890- 1930

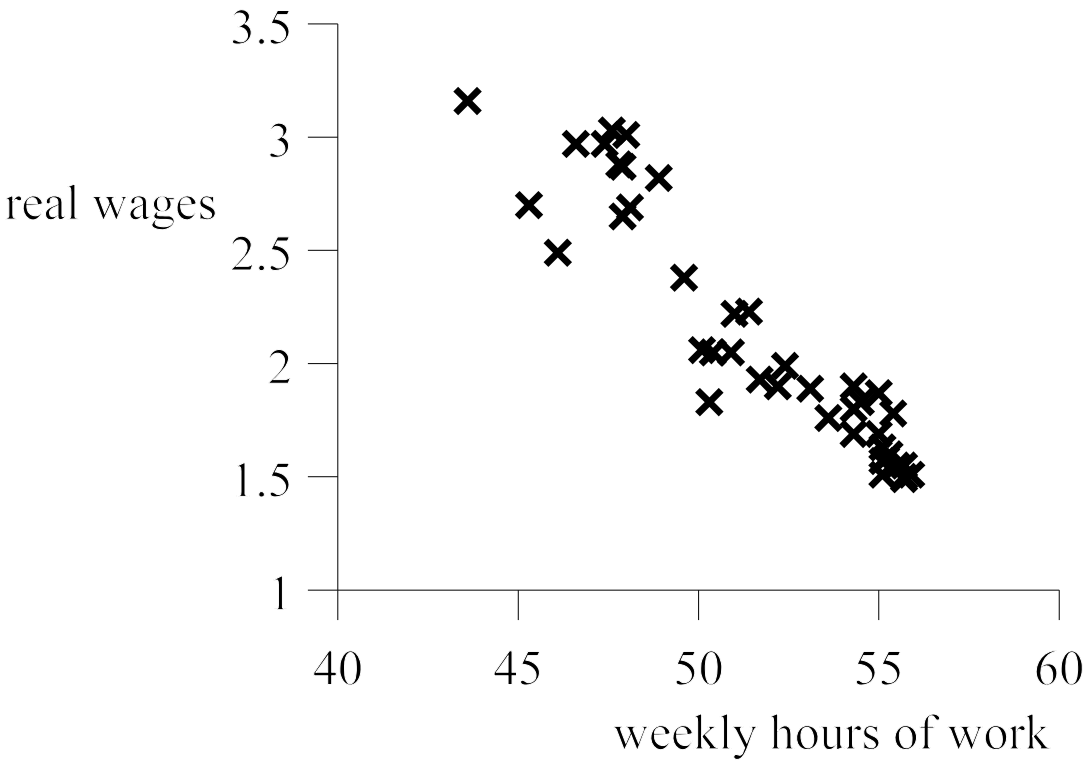
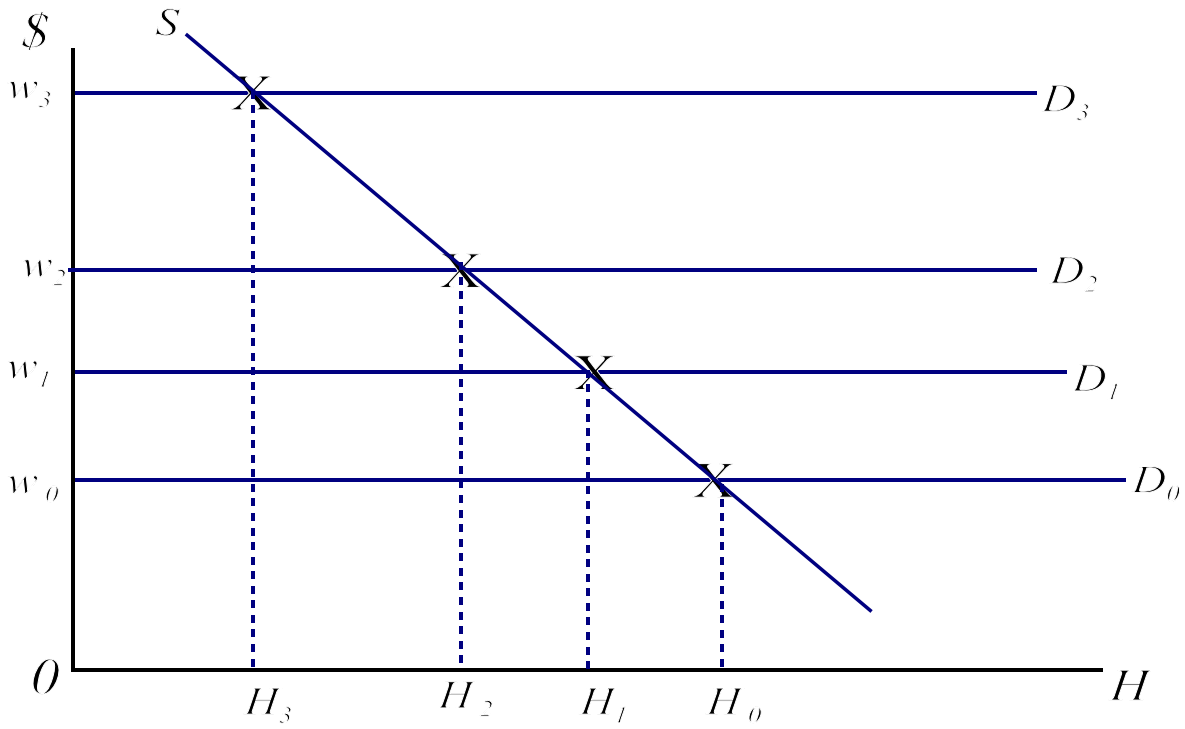


Figure 3. Lewis' Explanation for the Decline in Weekly Hours Worked



In the graph above, the **X** combinations of real wages and work hours trace out the effect of a horizontal labor (hours of work) demand function rising over time (D_0, D_1, D_2, D_3 above) and an unchanged negatively-sloped labor (hours of work) supply function (given by *S* in the figure). Over time, higher real wages (w_0, w_1, w_2, w_3 above) are associated with shorter hours of work (H_0, H_1, H_2, H_3).

Figure 4

The Relation between Output and Weekly Work Hours in Lloyd Reynolds' (1954) Text

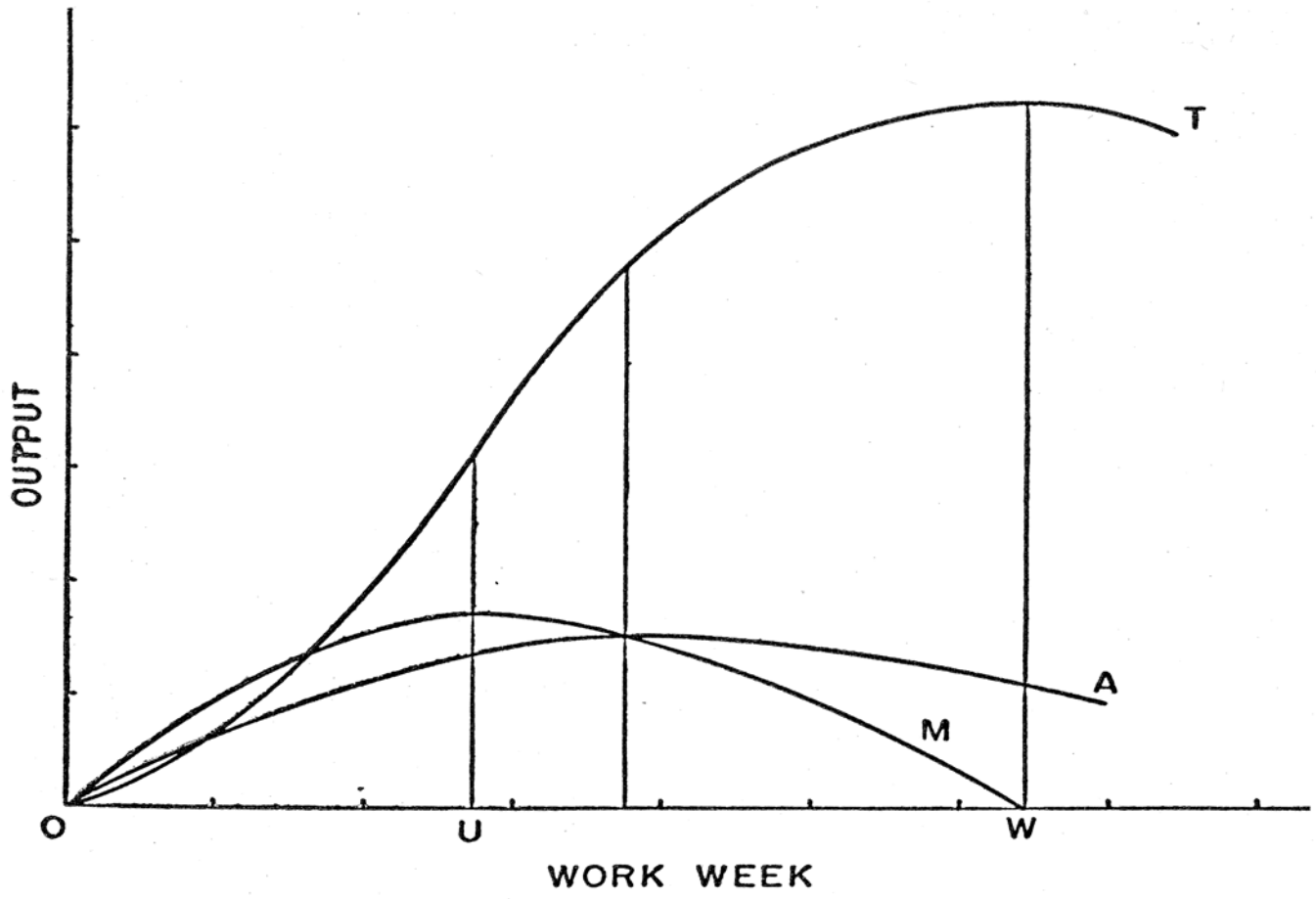
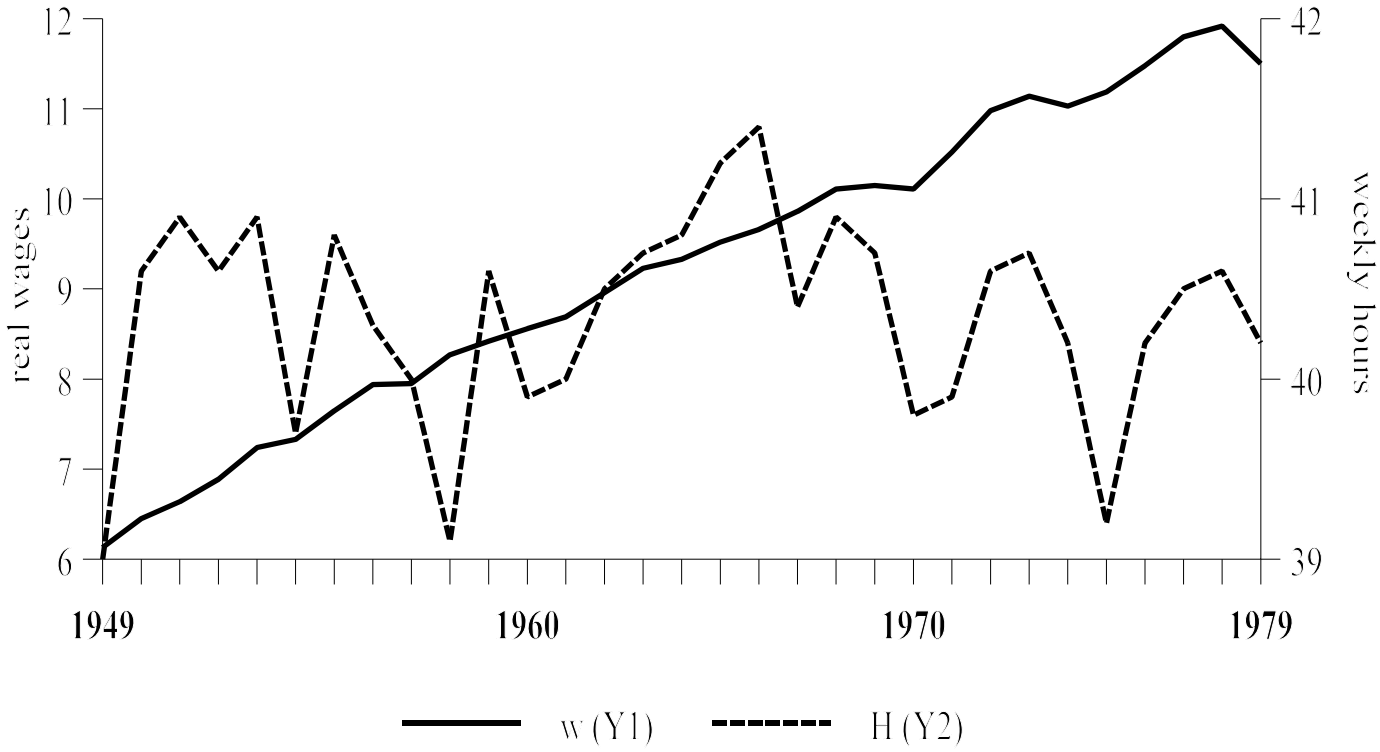


CHART 5. Effect of the Work Week on Output.

OT traces output as a function of working hours. OA is output per hour and OM is the marginal product of hours.

Figure 5

Average Weekly Hours and Average Real Hourly Compensation of Production Workers in U.S. Manufacturing, 1949-1979



In Figure 5, *w* (measured on the left-hand axis) denotes real average hourly compensation in dollars per hour in manufacturing industry (where the price deflator is a consumer price index with base in 1982-84) and *H* is average weekly hours worked (measured on the right-hand axis). The series on *w* is from Officer (2009, Table 7.7, p. 170). Weekly hours are contained in the Bureau of Labor Statistics Current Employment Statistics national survey series of about 490,000 workplaces: http://www.bls.gov/ces/.