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Workweek Flexibility and Hours Variation

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Abstract

I use the term workweek flexibility to describe the ease of changing output by altering the number of hours per worker. Despite the fact that workweek flexibility is potentially important for understanding the cyclical behavior of marginal cost and prices, as well as cyclical movements in hours and output, it has received little attention. Using insights from a simple model of employment and the workweek, I use mean workweek levels to identify the effect of workweek flexibility and then show that it is an important determinant of firms' marginal cost schedules and the variance of industry workweeks and hours. I use the same identification scheme with panel data to see if an increase in workweek flexibility has been behind the rise in hours per worker over the past 30 years and find that it has not.

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1. Introduction

The ease of changing output by altering the number of hours per worker is potentially important for understanding the cyclical behavior of marginal cost and prices, as well as cyclical movements in hours and output. The cost of an additional unit of output produced by increasing the workweek reflects the shapes of the marginal product and the marginal disutility curves for hours per worker. The slopes of these curves are determined by the organization of plants' production processes, and I use the term workweek flexibility to summarize the influence of these production processes on the shape of these curves. Greater workweek flexibility should lead to greater movements in hours per worker and potentially flatter marginal cost curves and greater movements in total hours and output in response to demand shocks.

Despite its potential importance, workweek flexibility has received little attention, perhaps because of the difficulty of identifying its effects. I use a simple model of employment and the workweek to illustrate how workweek flexibility should be correlated with mean workweek levels and the variation in the workweek, employment and total hours. I then use these insights to test for the relevance of workweek flexibility to the variance of industry-level workweeks and total hours, and by implication to firms' short-run and medium-run marginal cost curves.

First, I show that across industry differences in workweek flexibility is significant and that workweek flexibility is an important determinant of the cyclical variation in workweeks, and, by implication, short-run cost curves. The intuition behind the identification of the effect of workweek flexibility is shown in figure 1, where greater flexibility in the form of flatter marginal product and/or marginal disutility curves for hours per worker lead to a flatter workweek supply (marginal cost) curve for the flexible industry (F) than for the inflexible industry (I). As a result, both the mean workweek and the cyclical variation of the workweek (as produced by changes in a demand shifter, ξ, and shown by the difference between H1 and H0) are greater in the flexible industry. To test for differences in flexibility, I use the mean workweek as indicator of flexibility and see whether industries with greater mean workweeks are also industries with greater cyclical variances in workweeks.

The usefulness of the mean workweek as an indicator of workweek flexibility depends on the ability to account or control for other influences on mean workweek levels, such as employment flexibility and linear costs of employment. Rosen, 1968, has shown that a positive correlation between mean workweeks and workweek variation could also reflect the costs of adjusting employment (employment flexibility). But in this case, higher mean workweeks should also be associated with smaller variances in employment. Therefore, the relationship between the mean workweek and the variance of employment can be used to test the validity of the mean workweek as an indicator of workweek flexibility. Other factors, such as fixed or linear costs of employment (see Hammermesh, 1993, chapter 2), are also important determinants of workweek levels but are unrelated to workweek flexibility. To the extent that I am unable to control for these factors, my estimates will be biased. However, given that these factors are unrelated to workweek variation, the direction of the bias is known: coefficients tying mean workweeks to the variation in workweeks will be baised downward due to attenuation, and one can regard them as lower bound estimates of the effect of differences in workweek flexibility.

It is possible for workweek flexibility to affect workweek variation and cost curves in the short-run, but have no influences over the shape of cost curves at medium-term frequencies. For example, because of fixed costs of employment adjustment, employers may use workweeks to adjust to shocks of expected short duration. But if employment and the workweek are perfect substitutes and employment is more flexible once the fixed cost has been paid, then employers will switch to adjusting only on the employment margin once shocks are realized to be longer lasting. As a result, at turning points, the workweek and employment will be negatively correlated as employers move workweeks below trend levels while employment remains above trend levels immediately following peaks and visa versa immediately following troughs. As the workweek becomes more flexible, movements in the workweek may be greater, but so may the negative covariance between the workweek and employment caused by the timing of workweek and employment movements. The two effects may offset, leaving workweek flexibility with no effect on total hours variation. On the other hand, if the workweek and employment are not perfect substitutes or if employment is not always more flexible after the fixed cost has been paid, then greater workweek flexibility may add to total hours variation.

In the former case, it is employment flexibility that determines the shape of employers' marginal cost schedules for shocks that are large enough or of long enough duration. In the latter case, workweek flexibility is also an important determinant of the shape of employers' medium-term marginal cost curves, and greater flexibility should lead to greater total hours variation over the cycle. The data support the latter interpretation and imply that workweek flexibility affects medium-term cost curves as well as short-run.

The relationship between flexibility and mean workweek levels raises the possibility that the rise in the manufacturing workweek since the mid-1970s has been due changes in factory production processes that have increased workweek flexibility. If this were true, then the results from the cross sectional analysis described above should also hold in a panel setting. More specifically, industries with large increases in mean workweeks from 1972-1987 to 1987-1996 should also have experienced increases in the relative variability of their workweeks. In fact, changes in mean workweeks appear to be unrelated to changes in workweek variation. Therefore, I conclude that the rise in the manufacturing workweek has likely owed to other factors, such as increases in workers' skills, see Hetrick, 2000, or increases in employee benefits, see Beaulieu, 1995.

Most papers on the workweek have focused on the relationship between average workweek levels and regulations on overtime compensation (Trejo, 2003, Hammermesh and Trejo, 2000, and Costa, 2000) rather than the importance of the workweek as a margin of hours adjustment. Bils, 1987, estimates the cost of increasing the workweek but only considers costs related to overtime premiums. As Bernanke, 1986, shows, when compensation schedules are non-linear, overtime premiums become irrelevant to the choice of hours per worker, and the marginal cost of the workweek is determined instead by the disutility of labor. I follow this approach, and in the model presented below differences in workweek levels are not tied to compensation regulations.[1] More closely

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1. To the extent that overtime regulations influence marginal cost schedules, one would expect to find a negative relationship between mean workweeks and workweek flexibility, as higher (continued...)

related to the current paper are Bernanke, 1986, who investigates the elasticity of hourly earnings with respect to hours per worker for several industries during the Great Depression, and Rosen, 1968, who uses average workweeks and cyclical variation in workweeks as indirect measures of firm specific human capital. However, neither of these papers, nor any other paper that I am aware of, has attempted to estimate the importance of workweek flexibility to the variability of workweeks and aggregate hours and, by implication, to firms' marginal cost schedules.[2]

The next section describes the data on workweeks and employment. Section 3 constructs a simple model to illustrate how workweek flexibility is correlated with mean workweek levels and variation in workweeks, employment and total hours. Section 4 uses the analysis in section 3 to construct estimation equations, section 5 presents results, and section 6 concludes.

2. The data

Data on the workweek come from the Current Employment Statistics (CES) survey. Each month the survey samples data from establishments representing about 30 percent of private nonfarm employment. For production workers, establishments are asked for data on total hours paid and total employment for the pay period including the 12th of the month. The BLS converts the hours paid figure to a weekly basis and divides by employment to compute average weekly hours.[3]

While aggregate employment data go back to 1939, detailed industry data on workweeks is more limited. In addition, there are breaks in industry classification, the most important occurring in 1972 and 1987. Consequently, I focus on two periods 1972-1987 and 1988-1996. Each of these periods contains at least one recession, and during each period industrial classification systems did not change. The 1972-1987 period

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1. (...continued)
workweeks push firms to a more inelastic portion of the workweek supply curve. In fact, as described in section 5, I find a strong positive correlation.

2. Fleischman (1995) examines the effect of employment adjustment costs to across industry variation in employment flexibility.

3. For more information about the survey, see Employment & Earnings, Bureau of Labor Statistics, Washington, D.C.

contains 151 four-digit industries representing 58 percent of manufacturing production worker employment, while the 1988-1996 period contains 173 four-digit industries representing 63 percent of manufacturing production worker employment. I also construct a two period panel using those industries which were not affected by the break in industry classification in 1987 (the large majority).

The CES also provides data on earnings and the number of women workers but does not collect any output related data. For this I rely instead on annual data from the NBER productivity database. The data on value added from this source extend through 1996 and determines the terminal point of my sample.

To get a sense of the representativeness of my sample, I compute a weighted average of workweeks from sampled industries and compare the result with the published data for the aggregate manufacturing sector.[4] Observations are for the last month of the relevant year. Figure 2 shows these time series. For the most part, the behavior of the two measures is quite similar, though sample workweeks tend to be above the average for the aggregate manufacturing sector. As shown in the figure, the mean workweek increased significantly from the early 1970s to the late 1990s. The dot-dashed line in the figure also shows what the increase in the workweek would have been had all employment shares been held constant at their 1972 levels. It is apparent that industry shifts were not an important contributor to the rise in the workweek over the thirty years of the sample.

The workweek has important high and low frequency components to its total variation. I am interested in the component of variation related to the business cycle and use a band pass filter from Baxter and King, 1999, to remove both very high and very low frequency variation. Specifically, I isolate the components of the workweek with a period of between one and one-half and eight years. The Baxter-King filter uses a symmetric backward and forward weighted moving average to isolate these frequencies. Following their recommendation, I use a centered seven-year window to compute these moving averages. This reduces the years used in my analysis to 1975-1984 and 1991-

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4. To preserve comparability across time I use disaggregated and aggregate data published prior to the conversion of the CES to NAICS and random sampling in June 2003, see Employment and Earnings, June 2003.

1996.[5] I also isolate the cyclical components of production worker employment and production worker hours. To focus on percent deviations from long term trends, I take the natural log of variables before filtering. To illustrate the behavior of the resulting variables, figure 3 plots the cyclical components of the workweek and employment for the automobile assembly industry.

Table 1 shows statistics on the cross industry distribution of the variables I will be using in my analysis: the across-industry means and standard deviations of the natural log of hours per worker, average hourly earnings, and the share of women workers; and the across industry means and standard deviations of the variances of the cyclical components of the natural logs of hours per worker, production worker employment, total production worker hours, and value added. The table shows that the average variance of the percent deviation of production worker employment from its long-term trend is well in excess of the same measure for the workweek, indicating that employment has been a more important margin of hours adjustment. As shown by the second and fourth columns in the table, there appears to be considerable across industry variation in both average workweek levels and cyclical movements in the workweek and employment.

3. Model

I use a simple partial equilibrium model drawn largely from Bernanke, 1986, of a profit maximizing firm choosing employment and hours per worker subject to a participation constraint for workers. Workers derive utility from consumption and leisure and are willing to work if the offered package of hours and compensation provides them with utility at least equal to their best alternative. The model shows that an employer's reliance on the workweek to adjust hours in response to a shock to marginal revenue will depend on the workweek's flexibility. An input is more flexible the smaller are the absolute values of the elasticities of the revenue and cost functions with respect to the input.

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5. Because use of the Baxter-King filter on value added data would limit my second period sample to 1991-1993, I instead remove the trend in this second period by regressing value added on a time trend.

Input flexibilities are not observed, but the model shows that the mean workweek should be positively correlated with workweek flexibility and thus can act as a proxy for it. However, the mean workweek reflects factors other than workweek flexibility, and it is important to control or account for their effects. The model shows that a positive correlation between the mean and variance of workweeks could reflect the influence of employment flexibility, rather than workweek flexibility. This is because industries with less flexible employment should have more variable workweeks and perhaps higher mean workweeks. However, in this case, mean workweeks should be negatively correlated with employment variation. Thus, the relationship between workweek flexibility and employment variation can be used to test whether the relationship between the mean and variance of workweeks is due to workweek flexibility rather than employment flexibility. In addition, there exist factors that influence mean workweek levels without changing either employment or workweek flexibility (e.g. fixed costs of employment or costs that vary linearly with employment).[6] To the extent that such factors cannot be controlled for using observable variables, they render the workweek an imperfect gauge of workweek flexibility and biased downward coefficients estimating the effect of workweek flexibility on workweek variation.

Though workweek flexibility may be relevant for firms' cost curves over the short-run, as time horizons lengthen, or as shocks are recognized as more permanent, employers may substitute employment adjustment for the workweek. To illustrate this, I modify the model to allow for sunk costs of employment adjustment. In such a model, workweek flexibility may flatten firms' cost curves when shocks are small enough or of short enough expected duration to limit hours adjustment to movements in the workweek. Over longer time horizons, however, firms may rely solely on employment to adjust hours. In this case, the relationship between workweek flexibility and total hours variation may be quite weak, with the implication that greater workweek flexibility may not change the shape of cost curves relevant for medium term movements in demand. A

6. The cost of employee training is one example of such a cost. However, to the extent that such training is firm specific, it may (as Rosen, 1968) shows be positively correlated with employment flexibility.

significant relationship between workweek flexibility and total hours variation would, however, lead one to the opposite conclusion.

The object of the analysis below is not to construct structural models of hours demand and hours supply to then take to the data. The assumptions required to be able to use my data to identify relevant parameters would likely render estimated coefficients relatively meaningless. Instead, I assume that fluctuations in hours at cyclical frequencies are due entirely to labor demand shocks. Measures of variability of labor inputs thus provide information about the shape of labor supply curves, or firm's short-run cost curves. Rather than parameterize these curves, I, instead, examine the relationship between labor input variability and a measure of workweek flexibility (mean workweeks) to see if workweek flexibility is an important determinant of across industry differences in short-run and medium-run cost curves.

In the model an employer chooses employment, compensation per worker and weekly hours per worker to maximize profits subject to a participation constraint.

$$\begin{aligned} &\underset{\{e_t,h_t,W_t\}_{t=0}^{\infty}}{Max}\ E\left[\sum_{t=0}\beta^t R(e_t,h_t,\xi_t)-e_tW_t\right] \\ &s.t.\ U(W,h)-U^*\geq 0 \end{aligned} \tag{1}$$

where β is a discount factor, R is revenue, e is employment, h is hours per worker, W is compensation per worker, ξ is a marginal revenue shifter, U^* is the utility value of a worker's next best alternative, and E is the expectations operator. I assume that U is additively separable in its two arguments and that workers' outside opportunities are distributed according to the cumulative density function, $G(U^*)$.

$$\begin{aligned} &U(c,h)=g(c)-f(h) \\ &g'(c)>0, g''(c)<0; f'(h)>0, f''>0 \\ &c=W \\ &U^*=G^{-1}(e/L) \end{aligned} \tag{2}$$

where c is consumption and L is the exogenous total labor supply available to the firm. One can then substitute out W using the participation constraint and the fact that consumption is equal to compensation (there is no saving in the model) to get

$$\underset{\{e_t,h_t\}_{t=0}^{\infty}}{Max} E\left[R(e_t,h_t,\xi_t)-C(e_t,h_t)\right] \tag{1'}$$

where

$$C(e_t,h_t)=g^{-1}\left(G^{-1}(e/L)+f(h)\right)e_t \tag{3}$$

and

$$\begin{aligned}
&R_e>0,R_h>0,R_\xi>0;\\
&R_{ee}\le 0,R_{hh}<0,R_{eh}\ge 0;\\
&R_i(0,h)=R_i(e,0)=0,\ i=e,h\\
&C_e>0,C_h>0;\\
&C_{ee}\ge 0,C_{hh}>0,C_{eh}>0;C_{eh}\ge R_{eh};\\
&C_i(0,h)=C_i(e,0)=0,\ i=e,h
\end{aligned} \tag{4}$$

The restrictions in (4) follow from the assumption that disutility is convex in hours, utility is concave in consumption, each input is necessary to produce output, and the distribution of outside opportunities is not degenerate. Below I discuss how inclusion of sunk costs of employment adjustment can affect the relationship between workweek variation and total hours variation, but for the moment I ignore this issue. The first order conditions equate the marginal revenue of an input with its marginal cost.

$$\begin{aligned}
R_h(h,e,\xi)&=C_h(h,e)\\
R_e(h,e,\xi)&=C_e(h,e)
\end{aligned} \tag{5}$$

Workweek Flexibility and Workweek Variation

In this model, workweek flexibility affects workweek variation through the workweek supply (marginal cost) curve. To show this, I log linearize the first order conditions around the long-term log levels of employment and hours per worker.

$$\begin{aligned}
&\partial\log(\xi)+\tfrac{\partial\log(R_h)}{\partial\log(h)}\partial\log(\tfrac{h}{H})-\tfrac{\partial\log(C_h)}{\partial\log(h)}\partial\log(\tfrac{h}{H})+\tfrac{\partial\log(R_h)}{\partial\log(e)}\partial\log(\tfrac{e}{E})-\tfrac{\partial\log(C_h)}{\partial\log(e)}\partial\log(\tfrac{e}{E})=0\\
&\partial\log(\xi)+\tfrac{\partial\log(R_e)}{\partial\log(e)}\partial\log(\tfrac{e}{E})-\tfrac{\partial\log(C_e)}{\partial\log(e)}\partial\log(\tfrac{e}{E})+\tfrac{\partial\log(R_e)}{\partial\log(h)}\partial\log(\tfrac{h}{H})-\tfrac{\partial\log(C_e)}{\partial\log(h)}\partial\log(\tfrac{h}{H})=0
\end{aligned} \tag{6}$$

where I have assumed the demand shifter to be multiplicatively separable in the marginal revenue function, and H and E represent long-term levels of hours per worker and employment, respectively. To derive the response of hours per worker to a change in demand, I solve the equations assuming constant elasticities around the long-run trend levels.

$$\frac{\partial h}{\partial \xi} = \frac{-F_e(r - F_e)}{F_e F_h - r^2} > 0 \tag{7}$$

where

$$\begin{aligned} F_j &= \tfrac{\partial \log(R_j)}{\partial \log(j)} - \tfrac{\partial \log(C_j)}{\partial \log(j)}; \;\; j = h, e \\ r &= \tfrac{\partial \log(R_h)}{\partial \log(e)} - \tfrac{\partial \log(C_h)}{\partial \log(e)} = \tfrac{\partial \log(R_e)}{\partial \log(h)} - \tfrac{\partial \log(C_e)}{\partial \log(h)} < 0, \;\; |r| < |F_j|; \;\; j = h, e \end{aligned} \tag{8}$$

The expression in (7) also represents the inverted supply curve for hours per worker. The slope of the supply curve depends on workweek flexibility, as determined by F_h, employment flexibility, as determined by F_e, and the ability to substitute between the two inputs, as determined by r. As shown in (8), I assume that inputs are substitutes ($r<0$) and that the absolute value of an input's own elasticity ($|F_j|, j=e,h$) is greater than the absolute value of its cross elasticity, ($|r|$). The greater the concavity of the revenue function with respect to an input and the greater the convexity of the cost function, the more negative are the F_j ($j=h,e$) and the less flexible and, consequently, less variable the input is.

$$\frac{\frac{\partial h}{\partial \xi}}{\partial F_h} = \frac{F_e^2(r - F_e)}{(F_e F_h - r^2)^2} > 0 \tag{9}$$

For example, if the tasks an employer assigns a worker are particularly arduous or unpleasant, then fatigue or disutility are likely to rise quickly as hours per worker increase, and this will increase the concavity of the revenue function and convexity of the cost function with respect to hours per worker, making the workweek a less flexible margin of adjustment. Similarly, if the supply of workers who are proficient at the work required by an employer is limited, the amount of training new workers require would increase rapidly as employment expands. In the model if costs of training are born by the employee, then increased costs would be reflected by increases in workers' reservation utilities; if born by the firm, by reductions in the slope of the revenue function with respect to employment. Additionally, if the capital stock per worker is not easily expanded, then the marginal product of workers may decrease as workers are added. In these circumstances, employment would not be a very flexible factor. Finally, variation in an input depends on the other input's flexibility and the elasticity of substitution between the two inputs. If the other input is relatively more flexible and it is fairly easy to substitute one input for another, then an input's variation will decline.

Workweek Flexibility and the Mean Workweek

Flexibility is not observed, making it difficult to test whether greater flexibility in an input leads to greater variation in the input in response to changes in demand. Ideally, it would be desirable to find an observable variable whose correlation with workweek variation derives solely from its effect on flexibility. While the actual variation of inputs are observed, these can be importantly influenced by other factors, such as variation in demand and the fact that some industries may be more flexible in moving hours, regardless of whether this movement involves the workweek or employment, than others. Of particular importance in this regard is the fact that the data I will use to examine the effect of workweek flexibility are industry-level. The variance of industry-level workweeks equals the sum of the plant level variances plus the sum of the across plant covariances. Since it is the within plant variance that I am interested in, I need a variable that is correlated with the variance terms, but not the covariance terms. It is unlikely that this would be true of measures deriving from industry-level workweek variances. As shown below, mean industry-level workweeks are correlated with workweek flexibility. At the same time, it seems plausible that the mean industry-level workweek should not be correlated with average plant covariances in workweek movements (except if greater plant level workweek flexibility leads to greater covariances).

To derive an expression for the level of the workweek, I first assume that the marginal product and marginal cost functions are multiplicatively separable in h and e and then express (5) as

$$\log\xi + \int_0^h \left(\frac{\partial \log R_h(e,i)}{\partial \log(i)} - \frac{\partial \log C_h(e,i)}{\partial \log(i)}\right)\partial \log(i) + K_h + \int_0^e \left(\frac{\partial \log R_h(j,h)}{\partial \log(j)} - \frac{\partial \log C_h(j,h)}{\partial \log(j)}\right)\partial \log(j) + K_{rh}$$
$$\log\xi + \int_0^e \left(\frac{\partial \log R_e(j,h)}{\partial \log(j)} - \frac{\partial \log C_e(j,h)}{\partial \log(j)}\right)\partial \log(j) + K_e + \int_0^h \left(\frac{\partial \log R_e(e,i)}{\partial \log(i)} - \frac{\partial \log C_e(e,i)}{\partial \log(i)}\right)\partial \log(i) + K_{re} \quad (10)$$

where the *K*s are constants of integration. Next I assume that diminishing marginal product and rising marginal cost of hours per worker are relatively small up until some critical level $\underline{h}$. After this threshhold, the difference between marginal product and marginal cost changes with constant elasticity F_h. This captures the notion that fatigue, etc. do not really set in until some base level of hours per worker, after which they change fairly rapidly. Second, I assume that other elasticities are constant, that $K_{r,h}$ and $K_{r,e}$ equal 0 and that K_h and K_e are greater than 0. Then one can solve the equations for the average level of hours per worker.

$$H = \frac{F_e F_h \underline{h} - F_e(\overline{\xi} + K_h) + r(\overline{\xi} + K_e)}{F_e F_h - r^2} \quad (11)$$

where $\overline{\xi}$ is the long-term average of ξ. One can differentiate (11) with respect to F_h to show that if H is positive then workweek flexibility is positively correlated with mean workweeks.

$$\frac{\partial H}{\partial F_h} = \frac{F_e\left(-r^2\underline{h} + F_e(\overline{\xi} + K_h) - F_e r(\overline{\xi} + K_e)\right)}{\left(F_e F_h - r^2\right)^2} > 0 \quad (12)$$

As the supply curve for hours per worker becomes more elastic, firms will use more of it on average.

This suggests using mean workweek levels to proxy for workweek flexibility. There are two complications, however. First, flexibility in employment (high F_e) also affects both mean workweeks and variation in the workweek. However, while the effect of workweek flexibility on the mean and variation of the workweek is unambiguously positive, the effect of employment flexibility is nonpositive on workweek variation and ambiguous on the level of the workweek. For example, if r is zero, then employment flexibility has no effect on the level or variation of the workweek.

In addition, the employment supply curve depends positively on employment flexibility

$$\frac{\partial \frac{\partial e}{\partial \xi}}{\partial (F_e)} = \frac{-(r - F_h)F_h}{(F_e F_h - r^2)^2} > 0 \tag{13}$$

Thus, one can check the validity of the assumption that any positive correlation between the mean and variance of workweeks reflects workweek flexibility rather than employment flexibility by seeing whether mean workweek levels are negatively correlated with employment variation.

A second complication is that other factors, such as fixed costs of employment (see Hammermesh, 1993, chapter 2), which would be captured in K_e, are also important in determining workweek levels. However, as shown in equation (7), they have no effect on workweek variation. Thus, to the extent that they are not controlled for, the mean workweek will be a noisy measure of workweek flexibility, and estimates of the effect of workweek flexibility on workweek variation will be biased downward due to attenuation.[7]

Total Hours Variation and Workweek Flexibility

In the model described above workweek flexibility adds both to workweek variation and total hours variation. The variance of the log of total hours is

$$var(\log(e*h)) = var(\log(h)) + var(\log(e)) + 2*Cov(\log(h), \log(e)) \tag{14}$$

One can show that

$$\begin{gathered} \frac{\partial Var(\log(h))}{\partial (F_h)} > 0,\ \frac{\partial Var(\log(e))}{\partial (F_h)} < 0, \\ \frac{\partial Var(\log(h))}{\partial F_h} > \left| \frac{\partial Var(\log(e))}{\partial (F_h)} \right|,\ Cov(\log(h), \log(e)) > 0 \end{gathered} \tag{15}$$

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7. In Rosen, 1968, employment flexibility and linear costs of employment (hiring costs) are correlated because of firm-specific capital. In this case, one would expect the mean and variance of the workweek to be positively correlated, but one would also expect a negative correlation between the mean workweek and employment variation. In addition, to the extent that the elasticities of marginal product and marginal cost increase as h increases, one would expect increases in K_e to lead to decreases in workweek variation and offset the positive correlation between the mean and variance of the workweek mentioned above.

However, if there are sunk costs of employment adjustment, and the workweek is primarily used to substitute for employment when shocks are small or of expected short duration, it could still be that increases in workweek flexibility have no effect on total hours variation. To see this, I modify the employer's maximization problem to include a fixed cost *S* that the employer must pay every time it changes the level of employment.

Several researchers have noted that there appear to be fixed costs of adjusting employment. Davis, Haltiwanger, and Schuh, 1996, show that the modal value of employment changes at manufacturing plants is 0, which is consistent with plants not reacting to small shocks because of fixed costs of adjustment. Hamermesh, 1989, finds that a fixed cost model of employment adjustment fits a small plant-level data set better than a model of convex costs of adjustment, and Caballero, Engel and Haltiwanger, 1997, using a model of hours adjustment with employment and workweek margins, find that plants are more likely to adjust employment the farther away plants are from their target levels of employment (the levels of employment to which plants would move in the absence of adjustment costs), consistent with the existence of fixed costs of employment adjustment. Finally, Cooper, Haltiwanger, and Willis, 2004, find that a model with fixed adjustment costs matches moments of plant level data better than a convex adjustment cost model.

Also consistent with fixed costs of employment adjustment is the fact that the workweek leads employment over the cycle. Focusing on the cyclical component of employment and the workweek (that is, excluding very high and very low frequency movements), the peak correlation between employment and the workweek in the aggregate data occurs when the workweek is lagged by 5 months. For my sample of manufacturing industries the peak of the employment-weighted average correlation occurs when the workweek is lagged four months, and the correlations between lagged values of the workweek and contemporaneous employment are on average much greater than the correlations between lagged employment and the contemporaneous workweek.[8]

With the addition of fixed costs, the employer's objective function becomes

8. For more on the dynamic behavior of the workweek, see Golden (1990) and Glosser and Golden (1990).

$$\underset{\{e_t,h_t\}}{Max}\, E\left[\sum_t \beta^t R(e_t,h_t,\xi_t) - C(e_t,h_t) - S*I\right]$$
$$I = \begin{Bmatrix} 1 \text{ if } e_t \neq e_{t-1} \\ 0 \text{ if } e_t = e_{t-1} \end{Bmatrix} \tag{16}$$

and the conditions characterizing maximization are

$$R_e(e_t^*,h_t,\xi_t) - C_e(e_t^*,h_t) + E\beta V_e\left(e_t^*,\xi_{t+1}\right) = 0$$
$$\begin{Bmatrix} e_t = e^* \text{ if } \begin{pmatrix} \left(R(e_t^*,h_t,\xi_t) - C(e_t^*,h_t)\right) - \left(R(e_{t-1},h_t,\xi_t) - C(e_{t-1},h_t)\right) + \\ E\beta\left(V(e_t^*,\xi_{t+1}) - V(e_{t-1},\xi_{t+1})\right) \end{pmatrix} \geq S \\ e_t = e_{t-1} \text{ otherwise} \end{Bmatrix}$$
$$R_h(e_t,h_t,\xi_t) - C_h(e_t,h_t) = 0 \tag{17}$$
$$V_e = \sum_{i=0} \beta^{t+i} \begin{Bmatrix} \phi(\overline{\xi}_{t+i},e_t)\left\{\sum_{j=1}^{i-1}\left(R_e(e_t,h_{t+j},\xi_{t+j}) - C_e(e_t,h_{t+j})\right)\right\} \\ + \dfrac{\partial\phi(\overline{\xi}_{t+i},e_t)}{\partial e_t}\begin{Bmatrix} \sum_{j=1}^{i-1}\left(R(e_t,h_{t+j},\xi_{t+j}) - C(e_t,h_{t+j})\right) + \\ \begin{pmatrix} R(e_{t+i}^*,h_{t+i},\xi_{t+i}) - C(e_{t+i}^*,h_{t+i},\xi_{t+i}) + \\ \beta V(e_{t+i}^*,\xi_{t+i+1}) - S \end{pmatrix} \end{Bmatrix} \end{Bmatrix}$$

where ϕ is a cumulative probability function.

$$\phi(\overline{\xi}_{t+i},e_t) = \begin{Bmatrix} \Pr\left(J(e_{t+i}^*) - J(e_t) \geq S\right) \cap \Pr\left(J(e_{t+i-1}^*) - J(e_t) < S\right) \cap \\ \ldots \cap \Pr\left(J(e_{t+1}^*) - J(e_t) < S\right) \end{Bmatrix}$$
$$J(e_t) = R(e_t,h_t,\xi_t) - C(e_t,h_t) + E\beta V(e_t,\xi_{t+1}) \tag{18}$$
$$\overline{\xi}_{t+i} = \{\xi_{t+1},\xi_{t+2},\ldots,\xi_{t+i}\}$$

The first equation in (17) defines e^* as the employment level that equates the marginal benefit and cost of employment. The two equations in the brackets show that e_t=e^* when the net benefit of adjusting employment exceeds the fixed cost of adjusting employment, S_t. Otherwise, employment equals its previous value. The fourth equation states that the marginal benefit from changing hours per worker should equal the marginal cost, while the fifth equation shows the marginal value of employment level e_t. This comprises two terms. The first summarizes the effect of e_t on future profits holding the probabilities that employment will next change in period $t+i$ fixed. The second summarizes the effect of e_t on the probabilities that employment will next change in period $t+i$.

From these conditions follow several observations about the dynamics of employment and the workweek. First, employment will not adjust to all shifts in demand. Specifically, if the net benefit of adjusting employment is less than the fixed cost, *S*, employment will not adjust. Second, since there are no costs of adjusting the workweek, the workweek will adjust to all changes in ξ when there is no employment adjustment, though, perhaps not to changes in ξ when there is employment adjustment. These observations are consistent with the facts noted above that employment at the plant level appears not to adjust to all shocks and that the manufacturing workweek leads employment over the business cycle. Third, an increase in the expected duration of a shock increases adjustment along the employment margin and decreases adjustment along the workweek margin. This can be seen by substituting the last equation from (17) into the first. The value of adjusting employment depends negatively on the likelihood of having to adjust employment back toward its *t-1* value in period *t+1*. Thus, when faced with shocks of expected short duration, employers will rely more heavily on the workweek margin.

To see how the inclusion of fixed costs affects the relationship between workweek flexibility and total hours variation, suppose there are two types of shocks, a transitory shock and a lasting shock, that there are two states, $\overline{\xi}$ and $\underline{\xi}$, that the revenue and cost function are homogeneous of degree one in employment, and that the distribution of U^* (threshold utility) is degenerate. Suppose also that initially an employer is uncertain about whether the shock is transitory or lasting, but that after one period the persistence of the shock is known. If the initial probability that it is a long-duration shock is small enough, the employer will change the workweek, but not employment. And, if the workweek is more flexible, the employer will change the workweek by more. However, if the size of the shock is large enough, then once the shock is deemed to be permanent, the employer will adjust employment and move hours per worker back to its original value. In this case, a more flexible workweek allows an employer to adjust hours by more sooner, but in the end the change in hours from its peak to its trough is not affected. This is because, given a large enough shock with long enough duration, employment is infinitely flexible (revenue and cost functions are homogeneous of degree 1 in employment) in the long run and, thus, employers will adjust only along this margin. Given both the duration and magnitude of cyclical fluctuations, the influence of workweek flexibility on cyclical total hours variation may be minimal.

4. Estimation Equations

Workweek variation (Short-run Cost Curves)

The above analysis suggests using the average workweek as an observable variable to proxy for the flexibility of the workweek in the following estimation equations.

$$\begin{aligned} \mu_{ww}^{i} &= X_1^i \beta_{1,1} + \varepsilon_1^i \\ \mathrm{var}_e^i &= \beta_{2,1}\varepsilon_1^i + X_2^i \beta_{2,2} + \varepsilon_2^i \\ \mathrm{var}_{ww}^i &= \beta_{3,1}\varepsilon_1^i + X_3^i \beta_{3,2} + \varepsilon_3^i \end{aligned} \tag{19}$$

where *i* indexes industry, μ_{ww} represents the mean of the natural log of the trend workweek, var_e represents the variance of detrended log employment, and var_{ww} represents the variance of the detrended log workweek.[9]

In the first equation, X_1 contains variables correlated with factors, such as high fixed costs of employment (K_e is high), that affect the average level of the workweek but are not related to workweek flexibility. The residual from this regression should then be purged of some of the variation unrelated to flexibility. If the variables in X_1 fail to fully control for these other factors, then the residual will contain their effect as well, and it will be an imperfect proxy for workweek flexibility. Given that the factors affecting only first derivatives of the profit function (K_e, K_h) have no effect on workweek variation, their inclusion in ε_1 will bias toward zero coefficients estimating the effect of workweek flexibility on employment variation and workweek variation in the next two equations.

In the second equation, the coefficient on ε_1 should be less than or equal to zero (higher workweek flexibility should have a nonpositive effect on employment variation). X_2 in this equation contains observable variables correlated with the cyclical variance of employment, such as an industry's demand variability. There also likely exist factors

9. I estimate trends using a low pass filter. Using mean trends controls for circumstances in which the cyclical conditions for an industry do not average to be neutral over the time period in question.

that cause both the workweek and employment to be more flexible and that are distinct from workweek flexibility, which describes the ease of adjusting the workweek independent of the ease of adjusting employment. For example, if a plant has a certain minimum number of hours each week that must be devoted to plant maintenance (where these hours can come from either employment or hours per worker), then its ability to adjust hours downward would be constrained. If not correlated with observables, such factors should be captured in the residual of the second equation.

The third equation then relates variation in the workweek to workweek flexibility (as proxied by ε_1) and observable variables correlated with important determinants of workweek variation, such as demand variability and the flexibility in total hours. Identification of the effect of workweek flexibility rests on the assumption that the correlation between the variance and mean of workweeks reflects workweek flexibility rather than employment flexibility. The second and third equations in (19) provide a simple test of this assumption. If the correlation reflects employment flexibility, then the coefficient on the mean workweek in the second equation flexibility should be negative.

Total Hours Variation (Medium-term Cost Curves)

Equation (14) and the analysis of workweek flexibility and hours variation in section 3 suggest testing for the influence of workweek flexibility on medium term cost curves with the following equation

$$\operatorname{var}(TH^i) = \beta_{4,1}\operatorname{var}(ww^{i,f}) + \beta_{4,2}\operatorname{var}(ww^{i,o}) + \beta_{4,3}\varepsilon_3^i + \beta_4\operatorname{var}(e^i) + \varepsilon_4^i \tag{20}$$

in which total hours variation is regressed on components of workweek variation and employment variation. The first component of workweek variation, $\operatorname{var}^{i,f}(\log(ww))$, represents the contribution of workweek flexibility to workweek variation and is the product of ε_1 and its estimated coefficient from the third equation of (19). The second and third components represent the effects of observed and unobserved variables, respectively, on workweek variation. The second component is computed as the predicted value from the third equation in (19) minus the effect attributable to workweek flexibility, while the third component is the residual from the third equation in (19).

The error term in this equation, ε_4^i , contains the covariance between employment and the workweek. Thus, the estimate of $\beta_{4,1}$ will contain both the direct effect of workweek flexibility on total hours variation and the indirect effect due to any tendency for increased workweek variation caused by greater workweek flexibility to be negatively correlated with the covariance between employment and the workweek, as discussed in section 3. Estimates of $\beta_{4,1}$ significantly different from 0 would indicate that the direct effect outweighs the indirect effect and that workweek flexibility flattens medium term as well as short-term cost curves.

5. Results

Table 2A shows results from the estimation of the third equation in (19). The first four columns display results for the 1972-1987 period, the next four for the 1988-1996 period. Within each sample period, the four columns display results under different assumptions regarding the variables contained in X_1, X_2, and X_3. Because there is no direct correspondence between the observable variables at hand and the theoretically relevant variables and/or parameters and because the indirect correspondence seems stronger for some observed variables than others, it seems reasonable to see how robust results are to different specifications. Because observations for some variables were not always available, the sample size reported in the last row of table 2A varies across specification. All regressions are OLS, and observations are weighted by industries' number of production workers.

In columns headed by (1) in table 2A, I report results from a bare-bones specification including only a constant and the variance of the cyclical component of the log of value added (to capture the effects of differences in demand variation) in X_2 and X_3 and only a constant in X_1. The second specification, results of which are reported in columns headed by (2), is similar to the first, only it excludes the cyclical variation in value added from the workweek variation equation to see whether the endogeneity of this variable is important (greater workweek flexibility should cause greater variation in value added).

In the third specification, results of which are reported in columns headed by (3), I use variables that appear to have a reasonably direct correspondence to variables and/or parameters that likely enter the relevant equation. For X_1 I use the percent of women workers and average hourly earnings. Because of child-rearing responsibilities, women may be drawn to industries with relatively low fixed costs of employment (K_e^i is low) and hence relatively low workweeks. Regarding average hourly earnings, Rosen, 1968, argues that because of firm specific skills, high wages and high workweeks should be positively correlated. The usefulness of average hourly earnings in capturing this effect will depend on the share of across industry variation in average hourly earnings due to firm-specific human capital and the share of across industry variation due to other factors, such as general human capital. In X_2 I include the cyclical variance of the log of value added and a dummy variable for continuous processors.[10] The latter variable may partially control for variation in the flexibility of total hours. Continuous processors have workweeks of capital close to the maximum when operating (e.g. chemical plants, paper mills, petroleum refineries), see Mattey and Strongin, 1994, and thus may have higher minimum required hours than other industries. For X_3, I use the cyclical variance of value added, a dummy variable for continuous processors and ε_2 (which may capture the effect of greater total hours flexibility—to the extent it is not captured by the continuous processor dummy—as well as other determinants of production worker variability not included in X_2).

In the fourth specification, I include the share of women workers, average hourly earnings, a continuous processor dummy, and the cyclical variances of value added and production worker employment in X_3 and all of these variables except the cyclical variance of production worker employment in X_2. If there is a poor correspondence between the observable variables chosen for the third specification and the theoretically

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10. Oi, 1962, and Rosen, 1968, argue that workers with greater specific human capital should have smaller employment variation, which might indicate that average hourly earnings should be negatively correlated with employment variation and, thus, should be included in X_2. However, empirically average hourly earnings are significantly positively correlated with employment variability. It must be that average hourly earnings are correlated with some unobservable variable (unionization, the prevalence of temporary layoffs) that increases employment variation. Not knowing the source of its correlation with employment variation, I leave average hourly earnings out of X_2 in the third specification, including its effect, instead, in the residual of the second equation of (19). In the fourth specification, average hourly earnings are included as a right hand side variable in the second equation of (19).

relevant variables and/or parameters, then estimation results from the third specification may stem from spurious correlations. In this case, it may be better to control for all observable variables. Table 3 shows the variables used in each equation under the four different specifications.

The main results in table 2A are that workweek flexibility varies significantly across industries and that greater flexibility leads to greater workweek variation and, implicitly, flatter short-run marginal cost curves. In the 1972-87 period, most estimates of $\beta_{3,1}$ are near 2, which means that a two hour, or 5 percent, increase in the workweek leads to an increase in the variance of the percent deviation of the workweek from its long-term trend of about 0.1, or about a third of a standard deviation of the variance. The interpretation of these estimates is that the short-run marginal cost curve is flatter in industries with more flexible workweeks, though the estimated effect of workweek flexibility is not large. However, it is important to note that the estimated effect is likely a lower bound. As discussed in sections 3 and 4, my controls for fixed employment costs (contained in K_e) may not be adequate and, as a result, my proxy for workweek flexibility may contain substantial measurement error, producing attenuation bias. Given both the limited number of controls and the fairly rough correspondence between them and the characteristics (e.g. linear costs of employment, firm specific human capital) that theory suggests should matter, this is almost certainly the case.

The estimates of $\beta_{3,2}$ and $\beta_{3,3}$ for the 1972-1987 period are as expected. The variance of value added significantly increases workweek variation and the residual from the second equation in (19) has a significantly positive coefficient, implying that it captures the effect of greater total hours flexibility.

Table 2B shows estimates for the second equation of (19) for the 1972-1987 period. These support the assumption that the positive association between the mean and variance of workweeks found from estimating the third equation of (19) reflects workweek rather than employment flexibility. The coefficient on the mean workweek is estimated to be positive but not significantly different from 0 in all specifications. The other coefficient estimates for the second equation are as expected: the variance of value added adds to employment variance, while the continuous process dummy decreases it.[11]

Estimated coefficients from the 1988-96 period are different from the earlier period, perhaps because labor market conditions were also different. The recession during this period was shallower than the recessions in the earlier period, and the downturn in the labor market was more drawn out. Other changes in manufacturing labor markets, such as the increasing use of temporary help workers, also took place in this period. The mean workweek during this period does not appear to have been as good an indicator of workweek flexibility as in the earlier period, particularly that portion of the workweek orthogonal to other observable variables. Part of the explanation for this appears to be that employment flexibility became a more important determinant of mean workweeks during this period.

In the 1988-1996 period, estimates of $\beta_{3,1}$ from the third and fourth specifications, which use variation in the workweek orthogonal to other observable variables to identify the effect of workweek flexibility, are not statistically different from 0, and estimates of $\beta_{2,1}$ are significantly less than 0. These results are consistent with the variation in mean workweeks across industries being due to employment flexibility rather than workweek flexibility.[12] Estimates of $\beta_{3,1}$ in the first two specifications, which use the variation in the workweek that is both orthogonal and correlated with other observable variables to identify the effect of workweek flexibility, are, on average, below estimates from the earlier period, though they are still significantly positive. Overall, the smaller estimated $\beta_{3,1}$s for this time period do not appear to owe to a smaller influence of workweek flexibility on across industry differences in cost curves. Rather they appear to be due to a weaker correlation between mean workweeks and workweek flexibility.

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11. Estimation results from the first equation of (19) for the third specification (not shown) were as expected: the share of women workers significantly lowers the mean workweek, and the level of average hourly earnings raises it.

12. If employment and the workweek are substitutes, less employment flexibility should lead to greater workweek variation. If, however, the reduction in employment flexibility moves firms up an increasingly inelastic workweek supply curve, then the negative association between employment flexibility and workweek variation could be offset or even reversed.

Turning to the effect of workweek flexibility on total hours variation, table 4 shows estimates from equation (20). As shown in the first row, for the 1972-1987 period the coefficient on workweek variation due to workweek flexibility is significantly different from 0 in all specifications, with an average estimate close to 5. One explanation for these results is that employment and the workweek covary negatively over the cycle in industries with low workweek flexibility, but, as the workweek becomes more flexible, firms cease using employment to substitute for it after sunk costs of employment adjustment are paid, and the workweek and employment covary positively. However, it is likely, given the large estimate, that across plant, as well as within plant covariances are also at work.

As workweek flexibility increases, the covariance between employment and the workweek across plants likely increases as well. Suppose that instead of a representative agent model of the industry, in which flexibility is perfectly correlated across plants, that plants in an industry have different levels of workweek flexibility, and that variation in flexibility across industries reflects the number of plants within an industry that have workweeks flexible enough to covary positively with employment. An industry with a higher mean workweek has a greater number of plants whose workweeks covary positively with employment. This also means that within these industries, the covariance of employment and the workweek across plants will be greater—there will be more plants of type *i* and *j*, for which when plant *i*'s workweek is below average, plant *j*'s employment is below average and visa versa. Thus, the estimates in table 4 likely reflect across plants, as well as within plant effects. Both effects are important. For questions related to plant-level costs curves, one would only want the within plant effect, while for industry-level cost curves, one would want both. Exactly what portion of the coefficient estimate is due to within plant and what portion is due to across plant effects is not possible to determine without plant-level data.[13]

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13. Biased coefficient estimates for the third equation in (19) could also be responsible for the magnitude of estimates of $\beta_{4,1}$. While measurement error in my proxy for workweek flexibility would bias coefficient estimates of $\beta_{4,1}$ downward, downward biased estimates of $\beta_{3,1}$ would bias estimates of $\beta_{4,1}$ upward. The net effect is uncertain, but perhaps the latter effect dominates. In this case, accounting for upward bias would diminish the magnitude of the estimated effect of workweek flexibility on total hours variation; it would not, however, change the sign.

For the 1988-1996 period, estimates from the first two specifications are both positive, but both are less than one and neither is statistically significant. The limited number of years in this period may make estimates less reliable, while the period's relatively mild, but drawn out, labor market downturn may cause estimates to differ from those of the pervious period. The influence of employment flexibility on mean workweeks during this period, described above, may also make it more difficult to estimate the true effect of workweek flexibility.

As shown in figure 2, average workweeks have trended up over the past twenty-five years. Thus, it could be that workweek flexibility increased over this period, which would have potentially important implications for short-run and, perhaps, medium-run cost curves. Although the change in the aggregate workweek seems to have been reflected by increases in most industries, table 1 shows that there is still some variation in the change in workweeks across industries. One should be aware, however, that the source of variation in the change in average workweeks in the panel analysis may be quite different from that in the cross sectional analysis and, thus, may not be closely tied to workweek flexibility.

The last four columns of table 2A and 2B present estimates of the second two equations in (19) after both sides of these equations have been differenced to reflect changes from the 1972-87 period to the 1988-96 period. The main result, shown in table 2A, is that estimates for $\beta_{3,1}$ are negative and not statistically significantly different from zero. In addition, increases in mean workweeks have been associated with decreases in employment variation, the second row of table 2B, though most estimates are not significant. Thus, unless changes in workweek flexibility were constant across industries, it is unlikely that increases in workweek flexibility were behind the increase in the workweek over the past 25 years. Why the workweek has increased is uncertain. Hetrick, 2000, suggests that manufacturing firms' increased reliance on more skilled workers may have lead to an increase in the workweek. Unions placing greater emphasis on job security could also have been a factor. In addition, it could be that other factors, not related to employment flexibility, such as a greater share of benefits in employee compensation, may have caused the workweek to increase, see Beaulieu, 1995.

6. Conclusion

The reaction of producers to economic shocks depends on the how costly it is to change inputs. This cost depends, in part, on the ease of varying workweeks, or on the slopes of the workweek's marginal product and marginal disutility curves—what I term workweek flexibility. The organization of production process, which determines these slopes, may differ across industries and may evolve over time, and this paper investigated these possibilities. First, the paper demonstrated the relevance of workweek flexibility by showing that it is a significant determinant of the cyclical variability of industry workweeks and, by implications short-run marginal cost curves. Next, the paper demonstrated that since employment is apparently not a perfect substitute for the workweek over the business cycle, greater workweek flexibility also leads to greater hours variation and, by implication flatter medium-term marginal cost curves. Thus, industry production processes differ significantly across industries in regard to the use of hours per worker, and industries having production processes that allow more flexible use of the workweek have flatter marginal cost schedules.

Identification of these effects comes from a cross section of industries and relies on across industry variation in workweek flexibility being large enough to significantly affect across industry variation in mean workweeks. In a two period panel of industries, across industry variation in the change in flexibility was not large enough to significantly affect changes in mean workweeks. Therefore, unless changes in flexibility were unusually uniform across industries, it is unlikely that increases in workweek flexibility were the cause of the rise in the manufacturing workweek since the 1970s.

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Table 1A. Cross Sectional Means and Standard Deviations of Regressor Variables

	1972-1987		1988-1996	
	Mean	Std. Dev.	Mean	Std. Dev.
Mean Log Workweek	3.69	0.05	3.72	0.05
Variance Of Cyclical Component of Workweek	0.42	0.34	0.26	0.23
Variance Of Cyclical Component of Log Production Worker Employment	6.07	7.93	1.48	1.89
Variance Of Cyclical Component of Log Production Worker Hours	8.23	9.57	2.01	2.38
Variance Of Cyclical Component of Log Value Added	93.04	50.5	8.10	2.28
Women Worker Share	25.70	22.50	24.62	24.76
Average Hourly Earnings	6.52	1.50	11.68	2.62

Table 1B. Cross Sectional Means and Variance Of Changes: 1972-1987 to 1988-1996

	Mean	Std. Dev.
Mean Log Workweek	0.03	0.02
Variance Of Cyclical Component of Workweek	-0.16	0.32
Variance Of Cyclical Component of Log Production Worker Employment	-4.67	7.13
Variance Of Cyclical Component of Log Production Worker Hours	-6.15	8.21
Variance Of Cyclical Component of Log Value Added	-91.8	54.92
Women Worker Share	-1.28	15.86
Average Hourly Earnings	5.16	1.35

Note. All variances are multiplied by 1000 to ease exposition.

Table 2A. Workweek Flexibility and Variation in the Workweek

	1972-1987				1988-1996				Panel			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-2.88*	7.70***	0.07	-6.26	-3.9***	-4.0***	2.3***	-1.97	0.04	-0.06	-0.04	0.08
	(1.6)	(1.97)	(2.71)	(2.67)	(1.13)	(1.14)	(0.26)	(2.04)	(0.05)	(0.05)	(0.05)	(0.21)
Workweek Equation Residual	0.80*	2.18***	1.90**	1.89**	1.11***	1.11***	0.33	0.43	-1.74	-3.01	-1.52	-1.04
	(0.43)	(0.54)	(0.76)	(0.77)	(0.30)	(0.30)	(0.64)	(0.61)	(1.07)	(1.26)	(1.37)	(1.40)
Production Worker Variation				13.1**				18.97			19.0**	19.0**
				(6.8)				(15.1)			(7.63)	(7.9)
Production Worker Variation Residual			12.4**				42.2***					
			(6.2)				(14.8)					
Women Worker Share				0.01				-0.01				-0.07
				(0.04)				(0.02)				(0.08)
Average Hourly Earnings				-0.38**				0.26				-1.19
				(0.17)				(0.14)				(3.42)
Variance Value Added	3.66**		3.98***	3.6***	1.71		3.34	1.01	1.60***		1.62***	0.93*
	(0.36)		(0.38)	(0.49)	(2.14)		(2.72)	(2.62)	(0.39)		(0.46)	(0.54)
Continuous Processor			-0.10	-0.05			-0.1	-0.21*				
			(0.08)	(0.10)			(0.08)	(0.07)				
R^2	0.47	0.10	0.56	0.56	0.08	0.08	0.09	0.20	0.15	0.05	0.20	0.20
No. Observations	151	151	105	105	173	173	127	127	104	104	104	104

*—10 percent level of significance. **—5 percent level of significance. ***—1 percent level of significance.
Note. All coefficients are multiplied by 1000.

Table 2B. Determinants of Average Workweek Levels and Production Worker Variability

	1972-1987				1988-1996				Panel			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-2.71	-2.72	0.11	-0.01	-0.33	-0.33	0.12***	2.59**	0.04	0.04	-0.07	-0.41
	(3.23)	(3.24)	(0.08)	(3.9)	(0.84)	(0.84)	(0.02)	(1.20)	(0.09)	(0.09)	(0.07)	(0.27)
Mean Workweek residual	0.76	0.76	0.25	-0.10	0.12	0.12	-0.81**	-0.87**	-1.87	-1.87	-2.78	-2.75
	(0.88)	(0.88)	(1.21)	(1.12)	(2.27)	(2.27)	(0.39)	(0.36)	(1.79)	(1.79)	(1.79)	(1.76)
Women Worker Share				-1.15**				-0.03				-0.01
				(0.55)				(0.01)				(0.10)
Average Hourly Earnings				0.53**				0.34				0.80*
				(0.25)				(0.08)				(0.43)
Variance Value Added	5.0***	5.0***	4.25***	3.16***	5.33	5.33	2.01	0.65	4.28***	4.28***	3.36***	3.40***
	(0.73)	(0.73)	(0.60)	(0.65)	(1.60)	(1.60)	(1.66)	(1.5)	(0.65)	(0.65)	(0.59)	(0.59)
Continuous Processor			-0.23*	-0.5***			-0.07	-0.1***				
			(0.13)	(0.13)			(0.05)	(0.05)				
R^2	0.28	0.28	0.34	0.44	0.07	0.07	0.05	0.19	0.27	0.27	0.31	0.36
No. Observations	151	151	105	105	173	173	127	127	104	104	104	104

*—10 percent level of significance. **—5 percent level of significance. ***—1 percent level of significance.

Note. All coefficients are multiplied by 100.

Table 3. Variables Used in Different Specifications

Left Hand Side Variable	Right Hand Side Variables used in Specification			
	(1)	(2)	(3)	(4)
Mean Workweek	constant	constant	constant, average hourly earnings, women worker share	constant
Variance of employment	constant, ε_1, variance of value added	constant, ε_1, variance of value added	constant, variance of value added, ε_1, continuous processor dummy	constant, variance of value added,ε_1, mean of average hourly earnings, mean of women worker share, continuous processor dummy
Variance of Workweek	constant, ε_1, variance of value added	constant, ε_1	constant, variance of value added, ε_1, continuous processor dummy, ε_2	constant, variance of value added, ε_1, variance of employment, mean of average hourly earnings, mean of women worker share, continuous processor dummy

Note. Variances are of the cyclical component of the log of the referenced variable.

Table 4. Variation in Total Hours and Workweek Flexibility

	1972-1987				1988-1996			
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
Intercept	-0.01*	-0.01**	-0.01***	-0.01	0.01	-0.00	-0.00	0.01
	(0.00)	(0.00)	(0.00)	0.00	(0.01)	(0.00)	(0.00)	(0.00)
Variation in Workweek due to Workweek Flexibility	6.42***	4.98***	3.88***	4.57***	0.56	0.65	-3.45	-2.01
	(1.25)	(0.45)	(0.81)	(0.55)	(0.63)	(0.60)	(4.91)	(2.30)
Variation in Workweek due to Other Observables	4.30***		3.98***	3.75***	3.02		2.66	2.27***
	(0.26)		(0.28)	(0.27)	(3.02)		(1.72)	(0.80)
Variation in Workweek due to Unobservables	3.60***	3.84***	3.46***	3.51***	1.56***	1.55***	1.41***	1.43***
	(0.19)	(0.16)	(0.21)	(0.21)	(0.18)	(0.18)	(0.20)	(0.22)
Variation in employment	1.07***	1.08***	1.11***	1.11***	1.14***	1.14***	1.03***	1.06***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.08)	(0.04)
R^2	0.99	0.99	0.99	0.99	0.94	0.94	0.91	0.92

*—15 percent level of significance. **—5 percent level of significance. ***—1 percent level of significance.

Figure 1. Workweek Flexibility and Workweek Variation

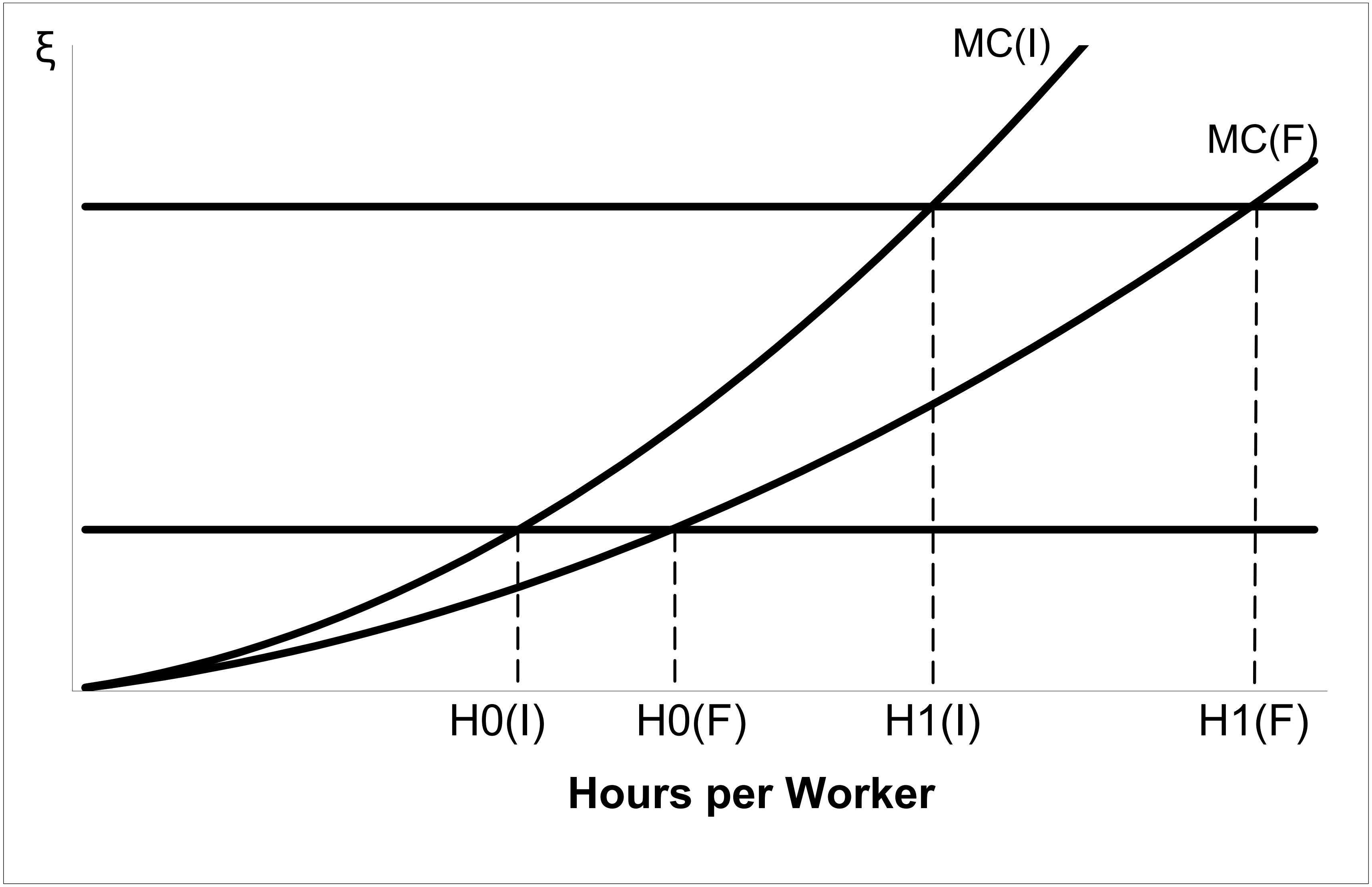


Figure 2
Manufacturing Workweek

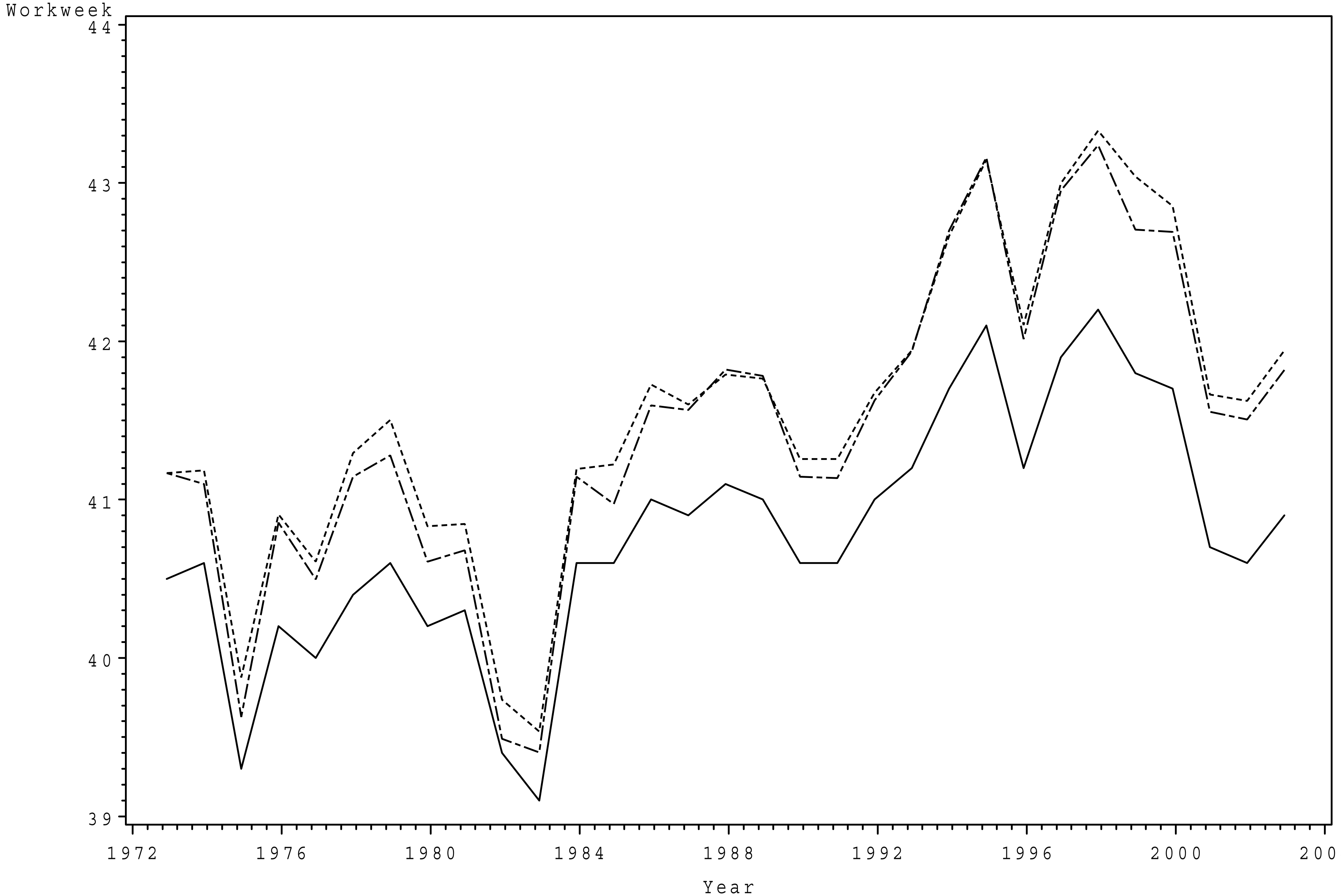
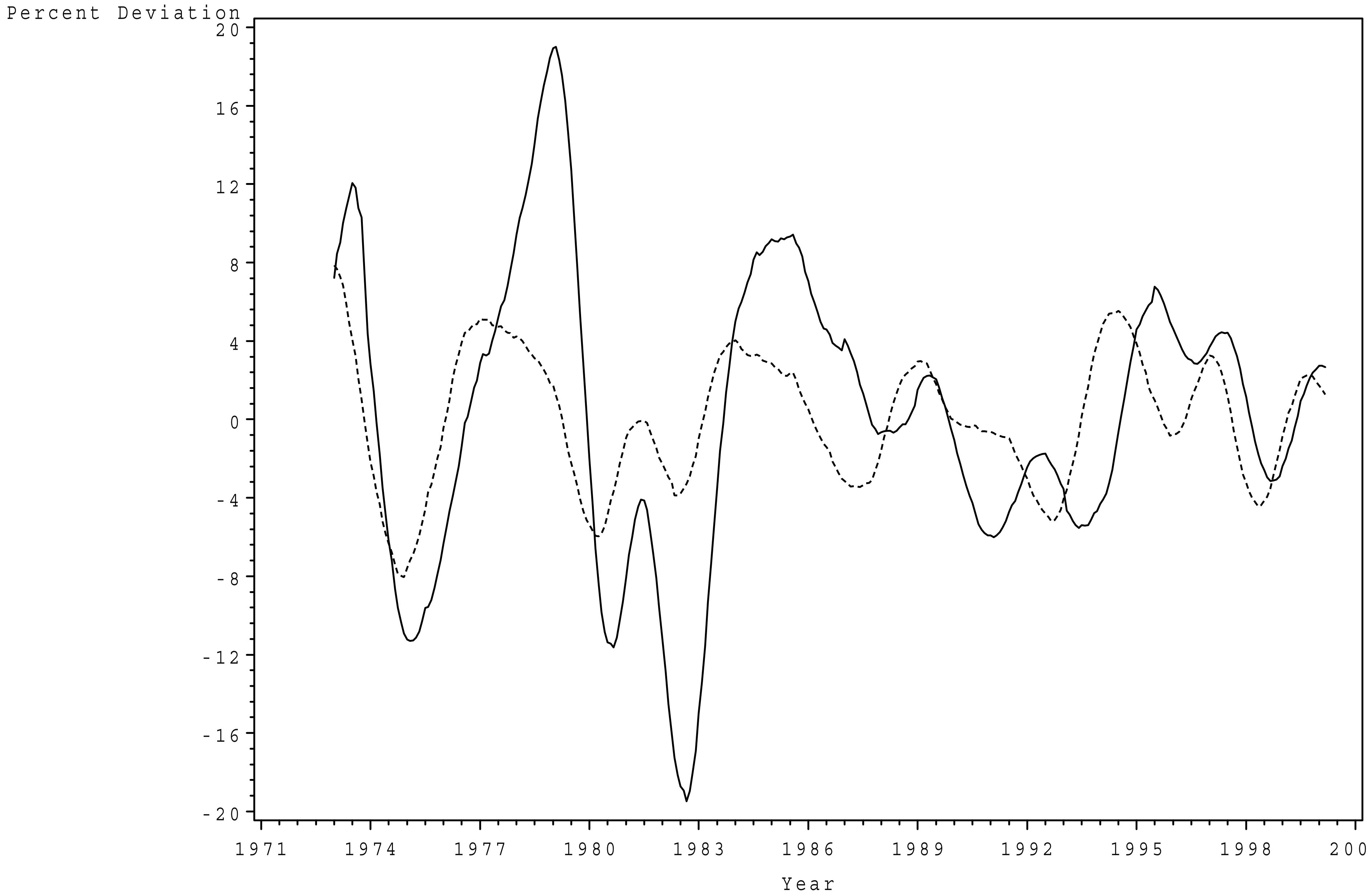


Figure 3

Cyclical Employment and the Workweek in the Motor Vehicle Assembly Industry



Workweek is dashed line. Employment is the solid line.