RELATIVE WAGE VARIABILITY: MONETARY POLICY AND THE LABOR MARKET

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INTRODUCTION

Over the past twenty years the economics profession has spent considerable human capital investigating the linkages between monetary policy and relative price behavior. The significance and consequences of such a causal relationship have been well documented in the literature. The impact such policy has on the behavior of relative wages has received less attention.

The efficiency wage literature argues it is possible that artificially altering relative wages will lead to an inefficient readjustment of the labor supply decision. For example, both Clark and Oswald [1996] and Hamermesh [1975] introduce the relative wage directly into the representative individual's utility function. In such models, economic decisions are hypothesized to be influenced not only by the absolute level of the wage but also by the relative counterpart, (i.e., a change in the level of the relative wage requires the individual to readjust his/her optimal labor-leisure decision or effort decision). Therefore, monetary policy may have an additional effect: resources could be misallocated not only from demand-side effects of altering relative prices, but also from supply-side effects as workers adjust labor supply decisions in response to the artificial alteration of relative wages.[1]

While these adjustments are harmful to workers, if the responses to relative wage movements are symmetric, their aggregate consequences are minimal. Interestingly, most efficiency wage models have failed to differentiate between positive and negative movements and, therefore, implicitly assume that worker reactions are symmetric: an increase in the relative wage (income), increases productivity (satisfaction), while a reduction in the relative wage (income) elicits a similar but opposite response in productivity (satisfaction). Since any relative wage change requires a corresponding and opposite change in another's relative wage, the aggregate implications are limited.

Unfortunately, such symmetry is inconsistent with the literature of other disciplines. Both the psychological and sociological literatures, as well as that of management, maintain that negative relative wage movements have a greater influence on workers than positive relative wage movements. If the responses differ, the aggregate consequences are more severe. Specifically, monetary changes that alter relative

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wages would produce a socially inefficient reduction in productivity. Therefore, the present work has the following line of inquiry: if relative wages influence worker behavior asymmetrically and monetary policy alters relative wages, then monetary policy may ultimately affect productivity. This requires two related lines of investigation: one that explores the nature of worker responses to relative wage movements and the second that measures the relationship between monetary policy and relative wage behavior.

The initial analysis follows Wadhwani and Wall [1991] and Levine [1992] who investigate the importance of relative wages within industry/firm production functions. However, in order to explicitly examine the symmetry assumption, their approach is modified to include a variance of wages measure rather than the relative wage. The intuition behind adding the variance measure is that as wages become more variable, representative workers must move farther apart. Furthermore, the variance measure captures the notion that workers are concerned not only with their own relative wage movements but also with changes in other workers' relative wages. Within numerous models, such changes may alter worker behavior and therefore, alter industry/firm output levels. However, if these responses are symmetric, then including a variance measure provides little additional information. In contrast, if responses are asymmetric, then a significant positive coefficient suggests that positive movements elicit stronger responses, while a negative sign would suggest the opposite.

The latter question revolves around analyzing the impact of the monetary process on the variance of wages. It also serves to further motivate the importance of the possible lack of symmetry in the responses of workers to changes in relative wages. In order to examine the effect of monetary policy on the variance of wage measure, the present analysis modifies the general methodological approach by Barro [1978] and Mishkin [1982]. Barro examined the impact of expected and unexpected monetary changes on aggregate output and found that only unexpected shocks have significant effects. However, Cover [1992] maintains that these analyses are misspecified by assuming that the impact of positive and negative monetary shocks are symmetric, when in fact they are not. The present analysis extends these analyses by investigating the impact of both the expected and unexpected components, as well as the implied symmetry assumption, on relative wage variability.

As the description above indicates, the data required for each question are somewhat different. The investigation of relative wage changes on production suggests a micro orientation; aggregate data may remove much of the individual variation that is so much a part of the efficiency wage literature. In contrast, the investigation of the effect of monetary shocks on relative wages suggests a macro orientation; firm-level data would provide too much individual variation to highlight specific monetary responses. Fortunately, a compromise is offered by the National Bureau of Economic Research (NBER) manufacturing database. The database provides a rather lengthy and complete history of value added, capital stock, production wages, production workers, as well as production hours, and more for a set of 450 similar industries. Also, as efficiency wage discussions require, workers within the data set are more substitutable than in more aggregate data. Finally, the data represent the entire manufacturing sector and should be aggregate enough to investigate the effects of monetary changes. Therefore, the data provide a reasonable mix of macro and micro data.

In general, the paper finds evidence of both linkages. Specifically, a rise in the variance of wages is associated with a reduction in industry production levels, suggesting that workers respond to relative wage changes, which provides additional support for efficiency wage concerns and workers fail to react symmetrically to negative and positive wage movements

The results are also consistent with much of the economic literature showing that only unexpected monetary shocks impact economic variables. However, this result only becomes apparent once monetary shocks are separated into positive and negative movements. If symmetry is assumed, the unexpected component also fails to alter the variance measure. This result is expected if both positive and negative shocks increase the variability of wages since they would tend to cancel each other out.

Overall, then, the monetary authority may need to concern itself with this supply-side influence. The paper is organized as follows: the next section briefly describes the relationship between relative wages and the labor market. In particular, the symmetry of adjustment is discussed. This is followed by a description of the empirical methodology and data utilized to test the symmetry and the results. We then examine the impact of monetary policy on the variance measure.

EFFICIENCY WAGE MODELS AND LABOR MARKET ASYMMETRY

The Relative Wage Approach

In general, the efficiency wage class of models highlights conditions under which worker/firm production levels are influenced by the level of wages. The relative wage variant modifies the approach to highlight the importance of relative wages and maintains that firms find it in their interest to pay workers higher relative wages to increase production levels. The avenues by which relative wage movements alter production have been characterized in at least three related ways [Akerlof and Yellen, 1986].

One of the better-known arguments for firms to pay efficiency wages is the shirking model [Shapiro and Stiglitz, 1984]. Under this model, workers have discretion over their effort while on the job. In place of effort, workers enjoy leisure by shirking. Therefore, where the costs of shirking are high, the firm may have an incentive to pay increased relative wages. Similarly, the gift exchange models maintain that workers have control their effort. To increase production levels, firms may pay higher relative wages. In gratitude, workers increase their effort. Finally, the labor turnover model also follows a similar structure [Stiglitz, 1985]. Given that the costs of labor turnover are high, firms have an incentive to pay increased relative wages to maintain their workforce.

Interestingly, one aspect of this literature yet to be addressed is whether the hypothesized responses are symmetric. For example, under shirking concerns, sym-

metry would require not only that workers who receive higher relative wages are encouraged to shirk less, while workers who receive lower relative wages are motivated to shirk more, but that these responses be of similar magnitude. Such symmetry, however, is incompatible with the literatures of other disciplines.

Worker Responses

Not surprisingly, interest in the relationship between work performance and wage premia has not been solely the domain of economics. Rather, considerable literatures in psychology, sociology and management have also examined both the theoretical and empirical impact of relative wage movements on worker behavior. While none may be considered a rigid theory or test of efficiency wage models, their conclusions are obviously relevant to the issues at hand.

Perhaps one of the most relevant models concerns equity theory [Adams, 1963; 1965]. At its core, equity theory models transactions and describes how the perception of fairness may alter market solutions.[2] A labor market application describes how workers determine the fairness of their labor-wage exchange and how changes in the perceived fairness of these exchanges alter workers' behavior. Specifically, to determine whether their particular exchange is fair, workers are hypothesized to compare the inputs (human capital, effort, etc.) and the outcomes they receive (both wages and other perceived benefits) with the inputs and outcomes for jobs (or workers) they choose as referents. Furthermore, workers who find themselves over- or undercompensated relative to their referents desire to correct the inequity. Such inequity may be corrected by adjusting effort inputs (e.g., shirking, gift-exchange), leaving the job (e.g., labor turnover), or rationalizing the discrepancy (e.g., choosing a different comparison).

Furthermore, equity considerations have been the subject of numerous experimental tests. Interestingly, while many of these investigations have confirmed that workers reduce their effort when undercompensated [Pritchard, Dunnette, and Jorgenson, 1972; Evan and Simmons, 1969], it has proven more difficult to demonstrate they increase their effort when overcompensated. Adams and Freeman sum up the experimental evidence as follows:

> At a fairly macro level of prediction it has been stated that advantageous inequity produces feelings of guilt, whereas disadvantageous inequity induces anger, . . . Direct evidence of guilt feelings among persons who are advantaged is lacking. [1976, 45]

Where overcompensated (guilt) inequity exists other means seem more plausible. For example, Lawler, Koplin, Young and Fadem [1968] describe how workers who were paid a wage above what was equitable altered their perceptions of their qualifications at the expense of increased effort levels, while equitably-paid subjects made no such adjustment. Similarly, Moore and Baron [1973] found that overcompensated subjects perceived their rate of pay as more *fair* than equitably-paid subjects, even though

both were led to believe that the equitably-paid subjects' pay was standard. The subjects justified the increased wages by changing their perception of the importance of their job or the strength of their qualifications. Finally, Gergen, Morse and Bode [1974] found that workers who were overcompensated perceived their tasks to be more difficult and felt the higher wages was the result of being overworked. Overall, the experimental evidence suggests that overcompensated workers choose alternative means to correct the inequity.[3]

In addition to the experimental evidence, two further economic justifications for the asymmetry seem relevant. One is an intuitive argument that focuses on utility maximization, while the other focuses on loss aversion [Tversky and Kahneman, 1991]. If the perceived inequity is assumed to create disutility, utility maximization requires that workers adjust on the least costly margin.[4] If one accepts the disutility of effort, the least costly margin in the case of undercompensation may be to reduce effort levels or to quit, rather than to accept that the relative wage adjustment is fair. However, in the case of overcompensation the least costly margin may be to adjust perceptions of fairness rather than to increase effort levels.

Finally, the asymmetry is also suggested by the literature surrounding "loss aversion". Loss aversion models suggest that being a certain distance below the reference point produces greater disutility than being equidistant above. By analogy, workers would be more concerned about wage reductions than about wage increases and would, therefore, react more strongly to relative wage decreases than to relative wage increases.

INDUSTRY OUTPUT AND RELATIVE WAGE

A Simple Efficiency Wage Model

To capture efficiency wage effects, it has become common to introduce a relative wage variable within a firm's or industry's production function. Specifically, Levine [1992] and Wadhwani and Wall [1991] augment the standard Cobb-Douglass production function to include an effort (or equity) function $E(*)$:

$$Y_{it} = A_{it} K_{it}^{\alpha} (E_{it}(w_{it}/w_t^r)^{\gamma} N_{it}^{\beta}) \tag{1}$$

where Y represents value added, K represents the capital stock, and N represents the level of employment (the number of employees, as well as the utilization of those employees). The subscript delineates the individual firm or industry (i) and the time period (t). The effort function, $E(*)$, is assumed to augment the behavior of labor productivity and is a direct function of the relative wage, w_{it}/w^r_t. Finally, the A term is included to capture the many firm-and industry-specific factors that cause a particular firm, or industry, to be more or less productive than another. Taking the log of equation (1) and then differencing the result yields the following equation:

$$\Delta \ln Y_{it} = \Delta \ln A_i + \alpha \Delta \ln K_{it} + \beta \Delta \ln N_{it} + \gamma \Delta \ln E_{it}(w_{it}/w_t^r) \tag{2}$$

Interestingly, the results of estimating equations similar to equation (2) have been robust to different levels of aggregation, time periods and cross-sections. Wadhwani and Wall [1991], using quarterly U.K. firm-level data, find a statistically stronger fit once a relative wage measure is included within firm production equations. Similarly, Levine [1992], using annual U.S. firm-level data, finds that the relative wage measure increases predictive power. Finally, Huang, et al. [1998] extend these results to include two-digit quarterly SIC data.

A Variance of Wage Variable

While each of these studies introduced the relative wage variable directly into the production function, the present paper has a somewhat different concern. As the earlier discussion highlighted, there is some evidence that worker responses to relative wages differ depending on the direction of relative wage movements. To examine whether these adjustments are symmetric, we replace the relative wage in the above analysis with a measure of the variance of wages. The intuition follows the fact that as relative wage variability increases, workers' wages must move farther apart, and resulting in relative wage increases for some and relative wage decreases for others. Following the equity theory cited earlier, each of these movements, *ceteris paribus,* requires workers to adjust their optimal decisions. In addition, the variance measure captures the notion that workers are concerned not only with direct changes in their relative wage, but also with indirect changes in referents' relative wages.

Finally, it should be pointed out that the significance of the variance measure is not in itself a direct test of efficiency wage concerns. It is rather a test of the symmetry of efficiency wage responses. Thus, even if including the variance measure is found to be inappropriate, this need not indicate a rejection of the efficiency wage hypothesis. Rather, it indicates that relative wage changes fail to produce markedly different responses. However, if the variance measure is found to be significant, this would provide additional aggregate support for the experimental results cited earlier.

The choice of variance measure is straightforward. Specifically, let w_{it} be the average wage for workers in the ith industry in time period t.[5] In addition, let W_t represent a weighted average of these individual wages. Therefore, W_t is defined as:

$$W_t = \sum_{i=1}^{n} l^*_{it} w_{it} \tag{3}$$

where l^*_{it} represents the average proportion of the labor force employed in the *ith* industry. The weights are employed to capture the likelihood that the industry's wage is used by a representative worker. If the choice of referent is random, then the probability that a representative worker chooses a referent worker from one industry should follow the level of employment in that industry. The variance measure, VW_t, is then defined as:

$$VW_t = \sum_{i=1}^{n} l^*_{it} (w_{it} - W_t)^2 \tag{4}$$

where VW_t measures the relative movements of wages in period t. Therefore, equation (2) is modified as follows:

$$\Delta \ln Y_{it} = \Delta \ln A_i + \alpha \Delta \ln K_{it} + \beta \Delta \ln N_{it} + \gamma \Delta \ln E_{it} (VW_t) \tag{5}$$

Equation (5) represents the basic equation to be estimated.

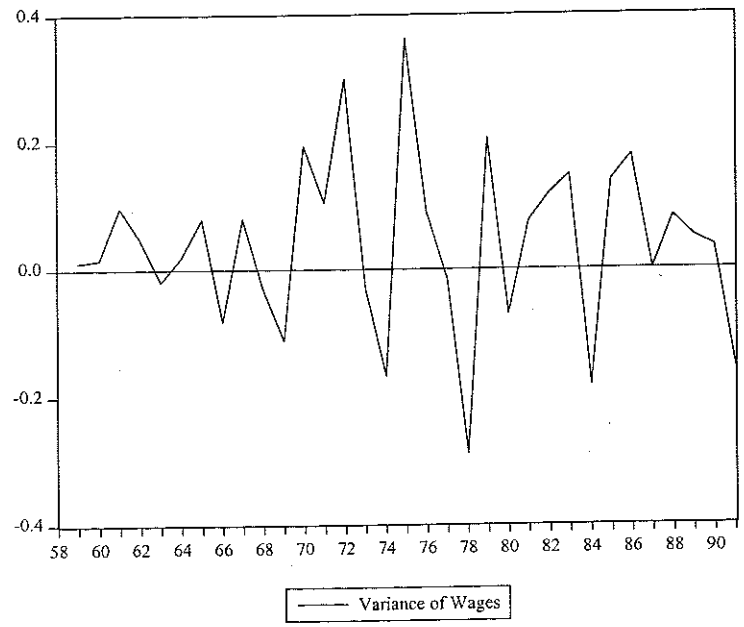
The NBER Manufacturing Database

The NBER manufacturing database provides a compromise between macro and micro data. The database contains annual data for nearly 450 four-digit manufacturing industries from 1958-1991. The data is attractive for efficiency wage concerns (micro-level) for several reasons. First, it provides a rather lengthy and complete history for a set of similar industries. With data on value added, capital stock, investment, inventories, energy consumption, production wages, production workers, as well as production hours, most of the relevant data is provided. Also, as the earlier discussion requires, the production workers within this data set are more substitutable than in more aggregated data. Finally, the database provides a middle ground in which to examine the efficiency wage behavior. While Levine [1992] and Wadhwani and Wall [1991] incorporate firm-level data, Huang, et al. [1998] argue that self-selection biases may exist within such disaggregated data and, therefore, a more aggregate data set may be more appropriate. However, it is possible that a two-digit SIC setting may remove much of the individual variability that plays such a role in the above analysis. In this way, using NBER data provides a middle ground and completes the earlier studies.

While the specific details of the database are provided in Bartelsman and Gray [1996], a short description is warranted. The database is comprised of information provided almost exclusively by the Annual Survey of Manufactures. The survey consists of some 60,000 manufacturing firms categorized into 450 four-digit industries, and contains information on the core variables: value added, the capital stock, employment, and wages.[6] For example, the survey provides two possible proxies for the wage level within a industry: (1) total payroll compensation and (2) total production worker compensation. In addition, both total employment and total production worker employment is provided. Therefore, two measures for the industry's average wage rate are available.

However, there are several reasons for opting for the production worker measure. The first is that the number of production hours is provided, while no such data exist for the payroll measure. Clearly, when computing the industry's average wage we would like to have a measure of the overall worker input. The second reason is that while production workers are not perfectly substitutable, they would seem more comparable than total workers. Specifically, then, w_{it} is computed by deflating each of the industry's total production wage compensation by the industry's total worker usage (total production worker employment and total production worker hours). In addition, l^*_{it} was computed by dividing the industry's total production worker usage by the

FIGURE 1
The Variance of Wages



The variance of wage measure represents a weighted average of average production worker wages obtained from the NBER manufacturing database. In addition, the weighted measure has been logged and differenced.

entire sample's total. Since the variance measure is at the heart of the present analysis, Figure 1 shows the (differenced) variance of wage measure.[7]

In addition to the employment and variance measures, data on real value added and real capital are required. Unfortunately, while the database provides information on the nominal value of valued added and of the value of shipments, it only provides a direct deflator for the value-of-shipments measure. Rather than opting for the less attractive solution of using real value of shipments, it would seem that the value-of-shipments deflator would be a reasonable proxy for the value-added deflator. As for the real capital measure, equation (5) is in differenced form and, therefore, the relevant capital stock measure is real investment. Fortunately, the database provides both investment expenditures and its associated deflator.

Finally, the rate of unemployment is also relevant. In particular, the measure reflects the opportunity set for workers and is thought to limit the behavioral response to relative wage changes. Unfortunately, the database does not provide specific data on industry unemployment rates, and therefore an alternative measure is required. In order to capture overall changes in the opportunities for workers, the U.S. unemployment rate is used (DRI database - LHUR).[8]

TABLE 1
GLS Estimates of Manufacturing Industries' Production Functions
Cross-Section Weights & Fixed Effects

Dependent Variable - Real Value Added
Sample : 1958 - 1991

Independent Variables	(a)	(b)	(c)	(d)	(e)	(f)	(g)
total worker usage$_{it}$	—	0.457[a] (0.029)	—	—	—	—	—
real plant & equipment$_{it}$	—	—	0.050[a] (0.012)	—	—	—	—
real energy expenditures$_{it}$	—	—	—	0.028[a] (0.004)	—	—	0.021[a] (0.004)
real material expenditures$_{it}$	—	—	—	—	0.177[a] (0.007)	—	0.174[a] (0.007)
real inventory$_{it}$	—	—	—	—	—	0.012[a] (0.002)	0.009[a] (0.001)
employ$_{it}$	0.675[a] (0.016)	—	0.669[a] (0.016)	0.668[a] (0.016)	0.466[a] (0.021)	0.677[a] (0.016)	0.542[a] (0.016)
hours$_{it}$	0.320[a] (0.014)	—	0.322[a] (0.014)	0.321[a] (0.013)	0.179[a] (0.009)	0.317[a] (0.014)	0.214[a] (0.013)
capital$_{it}$	0.027[b] (0.015)	0.067[a] (0.015)	0.026[c] (0.015)	0.023[c] (0.015)	0.006 (0.014)	-0.004 (0.014)	−0.018 (0.014)
un_t	0.011[a] (0.001)	0.006[a] (0.001)	0.013[a] (0.001)	0.012[a] (0.001)	0.007[a] (0.001)	0.009[a] (0.001)	0.006[a] (0.001)
vw_t	−0.146[a] (0.028)	−0.099[a] (0.028)	−0.142[a] (0.028)	−0.162[a] (0.028)	−0.122[a] (0.026)	−0.140[a] (0.028)	−0.126[a] (0.027)
adjR^2	0.684	0.670	0.684	0.684	0.698	0.685	0.698
s.s.e.	0.109	0.110	0.108	0.108	0.107	0.108	0.107

All variables, excluding real investment and unemployment, are in log-difference form. In addition, each equation contains a contemporaneous average real wage variable and an additional lag on real value added and real investment.
a. Significant at the 1 percent level.
b. Significant at the 5 percent level.
c. Significant at the 10 percent level.

ESTIMATION AND RESULTS

Following Levine [1992], various formulations of equation (5) were estimated using weighted generalized least squares, the results of which are reported in Table 1. In order to further control for the unique differences among industries, some of human capital origin, equation (5) was estimated allowing each industry a separate fixed effect - the intercepts within the individual equations.[9] Finally, in order to control for possible heteroskedasticity, White-consistent standard errors are reported.

Overall, the results reported in Table 1 suggest that negative relative wage changes elicit stronger responses. In addition, the results are similar those obtained in previous studies, and therefore provide additional evidence of the robustness of efficiency

wage effects. Specifically, the coefficient on employment (0.68) is only slightly higher, while the coefficients on the hours measure (0.32), capital (0.04) and unemployment (0.01) are only slightly lower than those obtained by Wadhwani and Wall (0.65; 0.41; 0.15; 0.05, respectively).

Robustness Tests

Since the variance measure utilized total production worker usage, column (b) removes the total employment and total production hours variables and replaces these with this measure. As might be expected, the coefficient is slightly smaller. However, the asymmetric result still remains. The next three columns reflect an attempt to investigate whether the variance measure is capturing the effect of additional non-labor resources; (e.g., real plant and equipment, real energy expenditures or real material expenditures). As suggested by Levine [1992], additional resources should increase output without the necessary efficiency wage effects. Therefore, the variance effects may reflect the asymmetric accumulation of these non-labor resources. The NBER database provides the nominal values and the associated deflators for these three variables. As is shown in columns (c) through (e), incorporating the variables only affects the variance measure marginally and never affects the sign or the significance.

In addition, Clark [1982] maintains that estimating production functions that neglect the possible effects of labor hoarding and/or short-run increasing returns to scale that may occur as the industry approaches capacity may produce biased estimates. Unfortunately, the NBER data set does not provide a direct measure for capital utilization for each industry. It does, however, provide a proxy for utilization rates by providing information on each industry's inventory level. The real level of inventory is produced by deflating the measure by its associated price deflator. As column (f) reports, real inventory levels are significant. However, the measure still remains significant and negative. Finally, column (g) reports the result of including most of the additional variables simultaneously. Overall, the asymmetry result seems to be quite robust.

MONEY CHANGES AND RELATIVE WAGE VARIABILITY

A natural extension of the preceding analysis is to ask what role if any monetary policy plays in the process. If monetary changes alter relative wage variability, the preceding section suggests that it would also influence output, in which case the monetary authority may need to concern itself with the additional supply-side effects of policy choices.

A conventional starting point to examine the impact of monetary policy on the variance measure is to distinguish between expected and unexpected monetary components. As has been suggested frequently in the macroeconomic literature and by the numerous macroeconomic models where the expected component of monetary policy fails to alter real macroeconomic variables, it is possible that the expected component fails to alter relative wage rates and therefore fails to alter the variance measure.[10] However, much of the same literature suggests that the unexpected component may alter relative wages and ultimately the variance measure.

While numerous methods for estimating the two monetary components have been proposed within the literature, a common and rudimentary representation of the expected and unexpected monetary policy follows Karras [1996]:

$$m_t = \delta_0 + \sum_{i=1}^{N} \delta_i^m m_{t-i} + \sum_{i=1}^{M} \delta_i^y y_{t-i} + u_t \tag{6}$$

where m represents the money growth rate, y represents the rate of growth of output, and u represents the monetary disturbance. The explained portion of equation (6) represents the expected component of monetary policy, m^e, while u is defined as its unexplained counterpart. While this formulation is significantly less complicated than many formulations, including Barro [1978] and Cover [1992], more complicated formulations produced very similar results to those reported here, and these would seem too elaborate to explain yearly movements in the monetary supply.[11]

An analysis of the variance of wages measure in Figure 1 reveals two large swings associated with the oil price shocks of the 1970s which suggests the importance of real oil price movements (DRI - PU803/PUXE). In order to capture these effects, as well as any persistence in the variance measure, the following equation was estimated to measure the impact of the monetary policy components:

$$vw_t = \pi_0 + \sum_{i=1}^{Q} \pi_i^{vw} vw_{t-i} + \sum_{i=0}^{R} \pi_i^{o} o_{t-i} + \sum_{i=0}^{S} \pi_i^{m^e} m_{t-i}^{e} + \sum_{i=0}^{T} \pi_i^{u} u_{t-i} + \nu_t \tag{7}$$

where the variables are defined as before except that o represents the growth rate in the real price of oil and v represents the variance shock.[12]

The system of equations (6) and (7), was estimated in two different ways. The first follows Barro [1978] who uses a two-step OLS approach. In particular, Barro first estimates equation (6) to return both the expected and unexpected components of monetary policy. The two components are then placed into equation (7) to estimate their separate effects on the variance measure. The second approach follows Mishkin [1982], who proposes the use of NLS, in order to allow for the joint estimation of the equations. Intuitively, Mishkin maintains that estimating the system of equations jointly produces efficiency gains, since the cross equation restrictions, which are implicit in the OLS approach, are explicitly taken into account. Since both approaches produced similar results, only NLS results are reported in Table 2 column (a).

Overall, the results do not seem very promising, since neither the expected nor the unexpected components influence the behavior of the variance measure. However, as has been recently recognized by numerous authors, equation (6) assumes that both positive and negative monetary shocks produce opposite and yet offsetting effects. Given recent empirical results, such an assumption seems tenuous at best. For example, both Cover [1992] and Morgan [1993] report results consistent with negative monetary shocks altering aggregate output. However, both also report that the effects of positive shocks are usually minimal and often insignificant. Therefore, a

TABLE 2
Monetary Effects on Variance of Wage Measure
Non-Linear Least Squares

Sample : 1958 - 1991

(a) Expected & Unexpected				(b) Positive & Negative			
Indep Var	Equation (6) (m_t)	Indep Var	Equation (7) (vw_t)	Indep Var	Equation (6) (m_t)	Indep Var	Equation (7) (vw_t)
constant	0.033[a]	constant	0.001	constant	0.035[a]	constant	−0.001
	(0.010)		(0.001)		(0.009)		(0.001)
m_{t-1}	0.870[a]	vw_{t-1}	0.021	m_{t-1}	0.825[a]	vw_{t-1}	0.092*
	(0.175)		(0.048)		(0.144)		(0.054)
m_{t-2}	-0.371[b]	$poil_t$	-0.005	m_{t-2}	-0.269[b]	$poil_t$	−0.004
	(0.160)		(0.004)		(0.117)		(0.004)
y_{t-1}	-0.216[b]	$poil_{t-1}$	0.006	y_{t-1}	-0.557[a]	$poil_{t-1}$	0.0002
	(0.166)		(0.005)		(0.155)		(0.006)
y_{t-2}	0.216	m_t^e	-0.012	y_{t-2}	0.216	m_t^e	−0.012
	(0.165)		(0.018)		(0.158)		(0.015)
		u_t	0.011			u_t^+	0.033[c]
			(0.015)				(0.019)
						u_t^-	−0.093[a]
							(0.035)
				Wald Test -		$u_t^+ = u_t^-$	2.81[c]
$adjR^2$	0.394	$adjR^2$	0.919	$adjR^2$	0.394	$adjR^2$	0.919
s.s.e	0.020	s.s.e	0.002	s.s.e	0.020	s.s.e	0.002

All variables are in log-differenced form.
a. Significant at the 1 percent level.
b. Significant at the 5 percent level.
c. Significant at the 10 percent level.

possible explanation for the impotence of monetary shocks in Table 2 column (a) is the implied symmetry in the effects of monetary shocks.

The assumption that monetary shocks produce opposite effects is also in question. For example, a positive monetary shock is expected to raise nominal wage rates. If the adjustment is not instantaneous and complete, it is possible that some wages will rise relative to others and therefore, increase the variance measure. However, a negative monetary shock may also produce an increase in the variance measure. Again, if the adjustment is not instantaneous and complete, it is possible that some wages fall relative to others thereby producing a rise in the variance measure. Therefore, the results in Table 2 column (a) may also reflect these effects canceling one another out.

In order to examine the symmetry assumption, positive and negative monetary shocks are defined as:

$$u_t^+ = max\,(u_t, 0), \; u_t^- = min\,(u_t, 0)$$

where u_t^+ and u_t^- are positive and negative shocks, respectively.[13] Modifying equation (7) to incorporate both u_t^+ and u_t^-, rather than u_t, yields:

$$(8) \qquad vw_t = \pi_0 + \sum_{i=1}^{Q} \pi_i^{vw} vw_{t-i} + \sum_{i=0}^{R} \pi_i^{o} o_{t-i} + \sum_{i=0}^{S} \pi_i^{m^e} m^e_{t-i} + \sum_{i=0}^{T} (\pi_i^+ u^+_{t-i} + \pi_i^- u^-_{t-i}) + \nu_t$$

The results of estimating equation (8) are presented in Table 2 column (b).

The results continue to report the ineffectiveness of the expected monetary term. However, the division of monetary shocks into their positive and negative components does alter the earlier results. In particular, both positive and negative shocks are estimated to increase the variance measure. However, the significance of the positive shock coefficient is sensitive to the particular representation for expected money and to the lag structure. No such sensitivity exists for negative shocks. In addition, Table 2 column (b) suggests that the two shocks produce markedly different results, i.e., the Wald test finds a significant difference at the 10 percent level. In the end, the results indicate that unexpected monetary changes influence the behavior of the variance of wages.[14]

CONCLUSION

Under the relative wage variant of the efficiency wage literature a rise in relative wages leads some marginal workers to increase effort levels and thereby increase their productivity. However, as a rise in one relative wage requires an equal and opposite fall in other relative wages, similar marginal workers may reduce effort levels and thereby decrease their productivity. Therefore, the aggregate consequences of relative wage changes depend on the relative magnitude of these responses. The results of the paper suggest that negative relative wage movements produce significantly larger responses. In which case, an overall rise in the variability of wages produces a reduction in aggregate productivity, and therefore an overall reduction in the level of output.

Additionally, it was shown that an unanticipated monetary shock may alter the behavior of the variability in relative wages. The combination of these two results indicates that monetary policy through the alteration of relative wages can influence the natural rate of output, in much the same way as oil prices, technology and any of the numerous factors may change the productivity of a marginal worker. In this event, the prescription for the monetary authority is a monetary rule along the lines of Friedman [1969].

Finally, the following analysis may help to explain the findings of Bomberger and Makinen [1993]. A secondary aspect of their analysis was to investigate the effects of unanticipated inflation on the variance of output. They found a significant negative relationship between the two variables. This is inconsistent with much of the economic literature, where an increase in unanticipated inflation causes the variability of output to rise as firms react differently to the aggregate demand disturbance. The present analysis provides the following explanation: unanticipated inflation causes some wages to increase, while others do not. The associated increase in the variability of wages decreases aggregate productivity and therefore aggregate output.

NOTES

The author would like to thank Harvey Cutler and two anonymous referees for helpful comments. Of course, all remaining errors are the sole responsibility of the author.

1. Artificially altering relative prices, given relative wages, causes given labor and other resources, to be redistributed in a socially inefficient manner (a labor demand effect). Artificially altering relative wages, given prices, causes households' labor supply decisions to be altered in a socially inefficient manner (a labor supply effect).
2. Recently, Kahneman, Knetsch, and Thaler [1986] have shown that perceptions of fairness limit profit-maximizing pricing behavior of firms.
3. Real-world cursory evidence of cognitive adjustment was provided by Blinder [1988, p. 54], citing results reported in the *Survey of Consumer Finances* for the years 1968-1970:

   > With inflation running at around 5 percent and wages increasing by 7 percent per year, inflation was responsible for 70 percent of the increase in money wages. But when families who reported rising money incomes were asked why their wages had increased, only 6 percent said that their wages increased because of inflation. By contrast, a full 44 percent gave answers that attributed their higher income to their own efforts or merits.

4. It should be clear from the previous discussion that a worker who experiences a reduction in the level of his/her relative wage is put into a negative equity situation. Such a move requires that the worker adjust his/her decisions. Along, similar lines, a worker who experiences an increase in the level of his/her relative wage is put into a situation of positive inequity. However, it is hypothesized under equity theory that such a movement also reduces utility, and therefore also requires an adjustment in his/her optimal decisions.
5. Since the firm's/industry's average nominal wage is, in turn, deflated by the entire sample's weighted average nominal wage, the price effect is taken into account and, therefore, there is no need to be concerned with a wage deflator.
6. Due to some odd behavior after 1987, both industries 2794 and 3332 have been removed.
7. Following Abraham and Haltiwanger [1995], it is possible that the use of the weighted variance measure introduces a concern over identification. (I thank an anonymous referee for raising the issue.) As the calculation of the variance measure includes the relative weights of the individual industries, changes in demand may alter these weights and therefore change the variance measure without any change in the underlying wage structure. In order to investigate the potential impact of such changes on our analysis, the empirical portion was re-estimated with an alternative variance measure which weighted the individual industries equally. These estimates were almost identical to those reported. Furthermore, the sole significant impact was to the estimated variance coefficient on the variance measure which was nearly 5 times larger (-0.730) than the weighted measure. This result suggests that any bias which may exist in effect decreases the estimated variance impact. Finally, the identification concern provides a further justification for incorporating the production worker wage measure rather than the total industry wage measure. One might expect these changes to be less significant within the smaller sample.
8. As is described in Bartlesman and Gray [1996], some of the incorporated data represent average values for 4 quarterly reports, i.e., March, May, August and November. Therefore, the yearly unemployment rate contains information which was not available to workers. Therefore, the lag of unemployment was included within the analysis. Furthermore, the lag allows for the fact that workers may gain knowledge of labor market conditions slowly, due to informational rigidities.
9. The results were robust to excluding the fixed effects.
10. For example, Parks [1978] finds that the expected component of monetary policy fails to influence relative prices.
11. It is possible that the use of a monetary aggregate overstates the Federal Reserve's position and that the Federal funds rate may be a more appropriate measure. In order to investigate the robustness of the results to the change in monetary policy indicator, we re-estimated equations (6) and (7) with the Federal funds rate. The results were consistent with those reported. Furthermore, the robustness of the two measures has recently been highlighted by Morgan [1993] and Garibaldi [1997]. These are available from the author upon request.
12. While removing the oil price shocks reduces the predictive power of the equations, it does not change the importance of any of the monetary variables.
13. Specifically, Cover [1992] defines: $u_t^+ = ½ [\text{abs}(u_t) + u_t]$ and $u_t^- = -½ [\text{abs}(u_t) - u_t]$.
14. Following the advice of an anonymous referee, I investigated whether the earlier variance of wages impact on value added was the result of omitting the direct effect of the monetary residuals from equation (5), rather than the indirect effect through the variance measure. Equation (5) was re-estimated with both the earlier variance measure and with the two monetary residuals. Interestingly, while the magnitude and significance of the variance measure increased marginally, both positive and negative residuals returned positive and significant coefficients. Furthermore, a Wald test could not distinguish between the two coefficients. This contrasts with the earlier result where the residuals returned opposite coefficients. In which case, the results suggest that while an additional impact may exist, the impact is separate from the one discussed above.

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