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NOMINAL CONTRACTING THEORIES OF UNEMPLOYMENT: EVIDENCE FROM PANEL DATA

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This paper examines the response of real wages and employment probabilities to nominal shocks using micro-panel data from the National Longitudinal Survey of Young Men. Both economy-wide and sector-specific responses to nominal shocks are examined. The observed response patterns are inconsistent with nominal contract based theories of unemployment. These theories predict that nominal surprises should be negatively correlated with real wages in sectors with nominal contracting. In fact, inflation surprises are found to be essentially uncorrelated with real wages in all sectors, while money growth surprises are positively correlated with real wages in manufacturing and uncorrelated with real wages elsewhere. The positive real wage-money growth correlation in manufacturing is robust to controls for real shocks and business cycle conditions, so it does not appear to be explicable by real business cycle models with endogenous money. The type of model described by McCallum (1980, 1986), in which commodity prices are more rigid than wages, is consistent with the result.

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1. Introduction

The goal of this paper is to determine whether nominal contracting theories of unemployment are consistent with the observed dynamics of employment and wages. Theories of unemployment based upon long term nominal contracts assert that inflation during the life of such contracts will affect real wages, labor demand and employment. In models which incorporate rational expectations, such as Gray (1976) and Fischer (1977), only the unanticipated component of inflation during the contracting interval affects real wages. In these models, unanticipated inflation reduces real wages and increases labor demand, imparting a countercyclical pattern to real wage movement.

In fact, in any model where nominal contracts are the key mechanism, and nominal shocks the driving force, behind employment fluctuations, real wages must move countercyclically. This is because firms still operate on their labor demand curves, as in Keynes (1936). Thus, the failure of aggregate real wages to move countercyclically (documented by Geary and Kennan [1982], Keane, Moffitt and Runkle [1988] and others) has been taken by many as strong evidence against nominal contracting models. However, as was pointed out by Leiderman (1983), there may be important real shocks to the economy which induce procyclical real wage movements. When real shocks are introduced, nominal contracting models no longer predict countercyclical real wage movement, but only that nominal shocks, such as unanticipated inflation or money growth, should be negatively correlated with real wages.

The present paper provides further tests of the prediction that nominal surprises are negatively correlated with real wages. Micro-data are used to test the proposition both for the aggregate economy and in selected industries. The existing studies that directly estimate the effect of nominal shocks on real wages can be divided into two groups: (1) the aggregate data studies by Sims (1980), who finds that inflation surprises have little effect on real wages while money surprises induce procyclical real wage movement, by Sargent and Sims (1977), who find that inflation surprises induce countercyclical real wage movements while money surprises have a negligible effect, and by Leiderman, who finds countercyclical real wage movement in response to monetary surprises, and (2) the industry level study by Kretzmer (1989) who finds that real wages move procyclically in response to monetary disturbances.[1]

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[1]Many additional papers have tested the predictions of nominal contracting theories by means other than directly estimating effects of nominal quantities on real wages. Barro (1977, 1978), Barro and Rush (1980), Mishkin (1982a) and Rush (1986) focus on the implication that only unanticipated changes in money growth should affect output and employment, while Mishkin (1982b) tests the

One potential source of these differing results of existing studies is that they use differing controls for real shocks. While Kretzmer uses residuals from aggregate wage equations, Leiderman uses a post-1973 oil shock dummy and Sims and Sargent-Sims consider inflation and money innovations that are orthogonal to past information.[2] These differences are important because, if money growth is endogenous, responding positively to favorable real shocks, a negative real wage-money growth correlation will necessarily exist in contracting models only after one controls for real shocks. In this paper I use the real price of refined petroleum as the principal control for real shocks, since this variable explains 81% of the variance around trend in the Bureau of Labor Statistics CPI deflated average hourly wage series over the 1964-88 period.[3] Additionally, since in real business cycle models without nominal rigidities the business cycle is driven entirely by real shocks, I consider business cycle indicators as additional controls. A key feature of the present paper is that I evaluate the sensitivity of the estimated effects of nominal quantities on real wages to various controls for real shocks (i.e., 1) no controls, 2) control for oil prices only, and 3) controls for oil prices and a business cycle indicator).

Another potential source of the differing results of existing studies is aggregation bias. None of the existing studies deals with the aggregation bias that may exist in estimates of offer wage movements based on movements in aggregate wages. Such bias will arise when shocks affect labor force composition, so that the mean offer wage and the average wage of employed workers do not move together. For example, if it is high wage workers who tend to become unemployed in recessions

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prediction that only unanticipated inflation should affect these quantities. However, verification that only nominal surprises are correlated with output is neither necessary nor sufficient to confirm the relevance of nominal contracting models. Two papers which study union contract provisions are Ahmed (1987) and Card (1990). Ahmed tests for the presence of nominal wage rigidity by examining whether the degree of contract indexation in an industry affects the correlation between industry output and monetary surprises. He finds it does not. Card finds that the part of unexpected CPI inflation during the life of contracts that is not adjusted for by indexation is negatively correlated with consumption wages and positively correlated with employment at the end of the contract. Ashenfelter and Card (1982) test whether the time series properties of the aggregate wage are consistent with those implied by the long-term nominal contracting model of Taylor (1980). They do not find the moving average error components which the model predicts. An extensive summary of the empirical literature on nominal wage rigidity is contained in Kniesner and Goldsmith (1987).

[2]Except that, in Sims, who uses a VAR framework, inflation innovations are also orthogonal to current money, GNP and unemployment innovations.

[3]I find that a constant, trend and trend squared explain 69% of the variance of the wage series, while these variables plus the real price of refined petroleum explain 94%. The additional 25% of variance explained by oil prices is 81% of the 31% not explained by trends.

induced by negative monetary surprises, then movements in aggregate wage measures will be procyclically biased as estimates of movements in offer wages over monetary business cycles. This effect could lead to false rejection of nominal contracting models. Keane et al. find that it is indeed high wage workers who are most likely to become unemployed in a downturn (of unspecified cause), so the existing estimates of aggregate real wage movement in response to nominal shocks may well be procyclically biased.

Labor force composition (or "quality") may vary over time either due to systematic changes in observable or unobservable worker characteristics. One may deal with variation in observables by using micro-data and controlling for worker characteristics such as education, experience, etc. when estimating correlations of wages with macro variables. The first author to use micro-data in this manner appears to be Raisian (1979). As is discussed in Keane et al. it is also possible to control for systematic variation in unobservable worker characteristics by use of sample selectivity correction methods that condition the likelihood of the observed wage data on the differing probabilities of people with different unobservable characteristics actually being in the pool of employed workers. In the present paper, I use the Heckman (1974) sample selection correction technique to control for labor force quality variation when estimating the effects of unanticipated inflation and money growth on real wages and employment probabilities, using micro-data from the National Longitudinal Survey of Young Men (NLS).

There are two main findings. First, both unanticipated money growth and inflation have significant positive correlations with probability of employment. These effects are only significant in the manufacturing sector. The second finding is that no significant negative correlations of real wages with either unanticipated money growth or inflation appear in the data. In fact, unanticipated money growth is positively correlated with both the consumption and product wages in manufacturing.[4] This finding is strong evidence against the Gray and Fischer models.

The positive correlations of unanticipated money growth with real wages and output observed in manufacturing could emerge in two types of model. One is an equilibrium real business cycle model (with perfectly flexible wages and prices) in which the money supply increases in response to positive

[4]The consumption wage refers to the CPI deflated real wage, while the product wage refers to the real wage obtained using industry output price (i.e., the PPI) as the deflator.

productivity shocks. The other is a class of model in which nominal wages are not perfectly flexible but are more flexible than product prices. Such models are discussed by McCallum (1980, 1986). I find that the positive real wage-money growth correlation remains after attempts to control for real shocks, so that the later class of model appears more plausible.

2. Theoretical Issues and Review of the Literature

A large literature has developed which explains real wage rigidity as the result of optimal risk-sharing arrangements between risk-adverse workers and risk-neutral firms (see, for example, Azariadis [1975] or Baily [1974]), and which explains predetermined wages and unilateral employment determination by the firm as the closest possible approximation to an efficient contract when the firm faces demand shocks which are not public knowledge and labor supply is also stochastic (see Hall and Lilien [1979]). However, no satisfactory theory has yet emerged which would explain contracting in nominal terms.

It cannot be assumed, however, that nominal contracting does not exist because of the failure of theory to justify its existence (see Fischer [1977b] for a discussion of this issue). Branson and Rotemberg (1980) and Rotemberg (1982), for example, present evidence that nominal wage rigidity does exist in the United States. Similarly, in this paper the importance of nominal contracting as a mechanism inducing unemployment fluctuations is taken to be an empirical question. The remainder of this section describes the testable implications of the existence of nominal wage contracts for labor market behavior.

In the Keynesian theory of unemployment, the nominal wage rate is determined prior to the market period by contract, and employers unilaterally choose that level of employment which equates workers' marginal revenue product with the predetermined wage. When rational expectations are incorporated into the model, as in the work of Gray and Fischer, the nominal wage is set at that level which equates the anticipated real wage with the opportunity cost of workers' time as well as their anticipated marginal revenue product. Disequilibrium in the labor market then results from unanticipated nominal shocks which occur over the life of the labor contract. Given a fixed labor demand curve, either Keynesian or Gray-Fischer models imply countercyclical real wage movement (this issue is discussed by McCallum [1986]). However, if both real shocks and nominal surprises affect output and wages, with nominal surprises moving them in opposite directions and real shocks moving them in the same direction by shifting labor demand (i.e., increasing productivity and output and thereby generating deflation which increases real wages), then the cyclicality of the real wage is ambiguous.

The obvious solution to this problem, noted by Leiderman (1983), is to examine the response of real wages to specific nominal quantities rather than their movement over the cycle. However, an important point is that when looking at monetary quantities one must also control for contemporaneous real shocks. To see this, consider a situation in which the Federal Reserve increases the money supply in response to favorable real shocks in order to accommodate increased transactions demand for money. If the accommodation is not sufficient to prevent deflation, and if wages are set by long-term nominal contract, this will induce a positive correlation between monetary surprises and real wages. Thus, failure to control for contemporaneous real shocks when looking at wage effects of monetary quantities may lead to false rejection of Keynesian or Gray-Fischer type models. This problem cannot emerge in tests using inflation surprises, since they must be negatively correlated with real wages in these models.

Endogeneity of nominal quantities can also lead to false acceptance of Gray-Fischer type models, as discussed by Litterman and Weiss (1983). Suppose that in a real business cycle model the Federal Reserve reacts to unanticipated oil price increases by increasing the money supply in a misguided attempt to fight recession, creating money growth and inflation which would have been unanticipated before the oil price increase. Suppose further that wages are set in spot markets and that they fall because the oil price increase reduces labor productivity. Then we have a negative correlation between nominal surprises and real wages, even though nominal wages are completely flexible.[5] Now suppose the oil price increase and the Federal Reserve's reaction were both anticipated. This generates a negative correlation between anticipated inflation and real wages which is not causal. Hence, negative correlations between inflation or money growth and real wages are not necessarily indicative of nominal wage rigidity.

To summarize, we see that a negative real wage-inflation correlation necessarily exists in Keynesian and Grey-Fischer models, but that a negative real wage-money growth correlation need only appear

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[5]Even if money is constant, or falls less than proportionately to the output decline, there arises inflation and real wage declines. Given the Fed's actual responses to oil price increases in the '70s and '80s (i.e., moderately reduced M1 growth) we might expect negative inflation-real wage and positive M1-real wage correlations in models that do not control for oil prices.

conditional on controls for real shocks. Furthermore, negative correlations between nominal quantities and real wages are only sufficient grounds to reject real business cycle models in favor in rigid wage models if the effects of real shocks are fully controlled for. Since such a wide array of correlations between money, prices, wages and output may arise given different degrees of wage rigidity, real shock behavior and endogenous money behavior, a simple expository model in which all the possible scenarios may be simply catalogued is presented in Appendix A. It is helpful to refer to this appendix when reading the tables of results.

While the Keynesian and Grey-Fischer models discussed above are formulated for one sector-one good economies, the present paper examines industry level real wage responses to nominal shocks. As is pointed out by Duca (1987) there are two important issues concerning industry level wage movements that do not arise when dealing with aggregate wage movements. First, some industries may have rigid wages while others have flexible wages. Second, with multiple industries and goods, the distinction between consumption wages (i.e., CPI deflated wages) and product wages (i.e., the wage deflated by industry product price) becomes important. Duca considers a model with both a rigid wage sector and a flexible wage sector. The CPI is a weighted average of the two sectors' product prices, and the economy-wide average wage can also be viewed as an average of wages in the two sectors. In this model, product wages in both sectors are negatively correlated with inflation and money growth shocks. Consumption wages are, of course, negatively correlated with nominal shocks in the rigid wage sector. Surprisingly, however, they are positively correlated in flexible wage sector. This occurs because the wage rigidity damps product price responses to nominal shocks in the rigid wage sector, thereby damping the overall CPI movement. Also, positive nominal shocks induce an increase in flexible wage sector employment, since they raise the consumption wage while reducing the product wage. So, in an economy with some rigid wage industries (e.g., perhaps manufacturing) we will tend to see positive correlations of nominal surprises with both real consumption wages and output in flexible wage industries (e.g., perhaps services). It is important to notice however that both product wages in all industries and the economy-wide average consumption wage remain negatively correlated with nominal shocks in multisector models.

The only previous paper to estimate wage responses to nominal shocks on an industry level is that of Kretzmer, who finds that monetary surprises are positively correlated with real wages in most industries. Since estimating real wage-money growth correlations is not actually the goal of the Kretzmer paper, it is worth considering his methodology. Kretzmer estimates aggregate wage and hours equations that include monetary shocks but do not include controls for the real shocks and finds procyclical real wage movement, unanticipated money growth being positively correlated with real wages. The reason that controls for real shocks are not included in the aggregate equations is that the object is to use the residuals from these equations as proxies for aggregate real shocks in industry level wage and output equations. In the industry wage equations he also includes time effects (which are equal across industries) as additional proxies because the residual method only picks up the component of real shocks which is contemporaneously uncorrelated with money shocks. Although appropriate in his model, Kretzmer's use of residuals to construct proxies for real shocks is subject to the usual criticism that the source of these shocks is not identified (e.g., see Barro [1986]), and the use of time dummies is subject to the criticism that the sensitivities of different industries to contemporaneous aggregate shocks are constrained to be equal.[6] By directly controlling for observable real shocks in aggregate and industry wage equations and allowing their effects to differ by industry, the present paper avoids both these criticisms.

3. A Statistical Model of Employment and Wage Determination

This section outlines a statistical model which will enable us to consistently estimate the effects on offer wages of real and nominal shocks which induce high or low wage workers to enter or leave employment. The proper framework is a model of the joint determination of employment and wages of the self-selection type proposed by Heckman (1974).

Given a panel of N individuals who choose employment or unemployment in each of T_i time periods, we write the model as:

$$\ln w_{it} = X_{it}\beta + \epsilon_{it}$$

$$\text{observed iff } d_{it} = 1$$

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[6]Kretzmer's actual object is to test whether the effect of aggregate nominal disturbances on output in an industry is positively related to the variance of the real <u>relative</u> demand disturbance in the industry, as predicted in the Lucas (1973) island model. The aggregate shocks must have the same effect on all industries in such a model -- motivating Kretzmer's construction.

$$d_{it} = \begin{cases} 1 \text{ if } u_{it} \geq 0 \\ 0 \text{ otherwise} \end{cases}$$

$$u_{it} = Z_{it}\Gamma + \omega_{it}$$

Here u_{it} is a latent index that determines whether individual i chooses to work at time t. It can, if desired, be interpreted as utility. Utility in the non-market sector is normalized to 0. d_{it} is a binary indicator equal to 1 only if individual i is employed at time t. $\ln w_{it}$ is the log of the hourly offer wage rate of individual i at time t. It is only observed if d_{it} is equal to one. Z_{it} is a row vector of regressors which affect the latent index, and Γ is the associated coefficient vector. X_{it} is a row vector of regressors which affect the offer wage, and β is the associated coefficient vector. Since the wage is a determinant of the utility of employment, all elements of X_{it} should be included in Z_{it}. The error terms in the choice and wage equations are assumed to have the bivariate normal distribution with correlation ρ and respective standard deviations 1 and σ_ϵ. The restriction that ω_{it} have unit variance is necessary to identify the model.

Suppose that the particular nominal surprise variable of interest is included as the kth element of X_{it} and Z_{it}. Then an OLS estimate of β_k (the effect of the surprise on the mean of the log offer wage distribution) using data on employed workers only will be biased. This bias can be easily seen, because under our distributional assumptions we have:

$$\frac{\partial E(\ln w_{it} | d_{it} = 1)}{\partial x_{itk}} = \beta_k - \rho\sigma_\epsilon m_{it}\Gamma_k$$

where $m_{it} \equiv \lambda_{it}(\lambda_{it} + Z_{it}\Gamma)$ and λ_{it} is the Mill's Ratio (i.e., $\lambda_{it} = f(-Z_{it}\Gamma)/(1 - F(-Z_{it}\Gamma))$ where $f(\cdot)$ and $F(\cdot)$ are the unit normal density and distribution functions, respectively). It can be shown that $m_{it} > 0$, so that the OLS estimate of the effect of the nominal surprise on log offer wages is biased upward (downward) if ρ and Γ_k have opposite (the same) signs.

To give a concrete example, suppose $\Gamma_k > 0$, so that a positive surprise increases employment. Further, suppose $\rho < 0$, so that it is workers with high unobserved wage components who are most likely to become employed (unemployed) following a positive (negative) surprise. Then an OLS estimate of β_k using employed workers only will be biased upward -- the OLS estimate of the response of offer wages to the surprise is procyclically biased. In order to obtain consistent estimates of β, the log wage equation will be estimated jointly with the employment choice equation using full information maximum likelihood. In this framework the estimated value of ρ is used to adjust the wage equation estimates for the effects of selection bias.

Although the entire discussion in this section has been conducted within the context of movements between employment and unemployment, we can use exactly the same selection model to analyze sectoral offer wage movements when workers are moving in or out of a particular sector. Simply redefine d_{it} to be equal to 1 if worker i is employed in the sector of interest at time t and to be equal to 0 if he is not (meaning he is either unemployed or employed in a different sector), and redefine w_{it} to be the offer wage in the sector of interest.

Finally, since panel data are used in this study, serial correlation of ω_{it} and ϵ_{it} may be an important issue. Robinson (1982) has shown that, in the type of models estimated here, parameter estimates will be consistent regardless of the serial correlation properties of the errors if the errors are assumed independent over time. Estimates of standard errors will, however, be biased. The estimation results obtained below reveal that the signs of correlations between nominal quantities and real wages are inconsistent with the nominal contracting theories under study (i.e., where the theories predict significant negative correlations between nominal surprises and real offer wages, positive or near zero correlations are found). Thus, no correction of standard errors will change our rejection of these models. However, if individual fixed effects are present in panel data, and if they are correlated with the regressors, then parameter estimates as well as their standard errors will be biased. Thus, fixed effects wage equation estimates are reported below.

4. Data

The data set used in this study is the National Longitudinal Survey of Young Men (NLS). This is a nationally representative sample of 5,225 males aged 14 to 24 which was drawn in 1966. These individuals were interviewed in 12 of the 16 years from 1966 to 1981, with data collected on their employment status, wage rates and sociodemographic characteristics. The sample was stratified by race and other characteristics (with an oversampling of blacks), so sampling weights are used in all analysis. The sample is restricted to those at least 21 years of age at the interview date, who had completed their schooling and military service, and who had available data for all variables used in the study. The final analysis sample contains 4,439 males and 23,927 person-year observations, giving an average of 5.4 observations per person. This sample is identical to that used by Keane et al. except that they used a random half sample while here the full sample is used. A detailed description of the number of observations lost due to each data screen can be found in appendix B of Keane et al.

A complete listing of the variables in the analysis sample is in table 1. Table 2 reports sample means of the individual specific variables. The consumption wage measure (whose log is denoted WCPI) is an hourly straight-time measure in 1967 consumer price index dollars. This is a point-in-time wage measure, taken as of the date of the interview, rather than an annual measure (i.e., annual earnings divided by annual hours). Keane et al. describe the biases that can result from using annual wage measures. Because of these biases, it is preferable to use point-in-time wage measures such as those contained in the NLS rather than annual measures such as those in the Michigan PSID. A straight-time wage measure was used because it is not possible to construct a wage measure which includes overtime for every year of the data (see Keane et al. on this point).

A product wage measure for manufacturing (whose log is denoted WPPI) was also constructed, using the producer price index for manufacturing product prices as the deflator (1967 = 100). However, the overall PPI is not used to construct product wages for all workers or for other sectors, because the overall PPI is dominated by manufacturing products. Thus, I only report product wage results for manufacturing. Real GNP is denoted GNP.

Twelve month CPI inflation, PPI inflation and M1 growth rates were constructed using data from the Citibase. These time series are decomposed into anticipated and unanticipated parts using a procedure similar to that used by Barro (1977) and Rush (1986). The procedure is described in detail in section 5. Three other series are taken from the Citibase. The producer price index for refined petroleum products divided by the producer price index (both equal to 100 in 1967) is the measure of the real price of oil (and is denoted OIL). The unemployment rate (denoted U-RATE) is the monthly national rate for all civilian workers 16 years and older (seasonally adjusted).

Coleman (1984) has pointed out that inclusion of aggregate time series, which have no cross-sectional variation, in micro-data regressions will give downward biased standard errors if there are unobserved time-specific error components. This problem is somewhat mitigated in the NLS data because within each survey wave there is cross-sectional variation in interview month and the aggregate time series used are monthly. Furthermore, Keane (1989) shows that approximately 80% of the variance of the wage equation time effects in these data are explained by a time trend and the OIL variable, so that additional procedures to control for time effects have little effect.

The specification of the statistical model is based on the assumption that the log wage equations should contain only variables that directly affect an individual's offer wage, and that the utility indices should include all these variables (since the wage enters the utility and is a determinant of employment status) plus additional ones that may affect hours of work and employment status independent of the wage. The anticipated and unanticipated components of the nominal quantities (either CPI inflation, PPI inflation or M1 growth), as well as a time trend and any controls for real shocks (e.e., OIL or U-RATE), are included in both X_{it} and Z_{it}. Of the individual specific variables, education, experience, experience squared and a race dummy are included in the X_{it} vector and, additionally, the number of children and marital status are included in the Z_{it} vector. Results were not found to be sensitive to additions or deletions of individual specific variables from this specification.

For the purposes of examining sector specific wage movements, the workers are classified into manufacturing, services or construction, transportation and utilities (CTU) sectors on the basis of 3-digit census industrial classification codes. The codes for manufacturing are 279-459, those for services are 579-998 (this includes wholesale and retail trade, FIRE, services and government), and all other codes are grouped under the CTU heading (which is dominated by the construction, transportation and utilities industries but which also contains a few smaller industries).

5. Results

In order to estimate the relations between anticipated and unanticipated inflation and money growth, real wages and employment, it is first necessary to decompose the annual rates of CPI inflation, PPI inflation and M1 growth into anticipated and unanticipated parts. The forecasting equations in table 3, based on monthly data from 1949-1988, are used to perform this decomposition.[7] The variables

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[7]Note that while I always refer to inflation or growth rates in the text, I actually use differences in logs in the data. Differences in logs are approximations to rates of change.

included in the information set used for forecasting are lagged annual inflation (either CPI or PPI), lagged annual M1 growth, lagged annual changes in the real price of refined petroleum and industrial production, and the contemporaneous annual change in government purchases of durable goods.[8] The Durbin-Watson statistics in these equations are naturally very poor because the use of monthly data makes the forecast errors MA (11) by construction. However, forecasting equations using annual data (also reported in table 3) exhibit acceptable Durbin-Watson statistics, so I assume the 12th and higher autocorrelations of the monthly equation residuals are acceptably small.

The fitted values from the forecasting equations are used to proxy for the *anticipated quantities*, while the residuals are used to proxy for the unanticipated quantities. Anticipated components of CPI inflation, PPI inflation and M1 growth are denoted AICPI, AIPPI and AM1 respectively, while the unanticipated components are denoted UICPI, UIPPI and UM1 respectively. In table 2, note that the mean of unanticipated CPI inflation in the NLS data is positive (0.67%) while that of unanticipated M1 growth is negative (−0.33%). These do not equal zero because the forecasting equations are estimated over the entire 1949-88 period while the NLS data only cover the 1966-81 period, and because the means are taken over person-year observations rather than over years.

A positive mean inflation surprise is to be expected over the 1966-81 period, because it is dominated by two large positive oil price shocks. Referring to Appendix B, we see unanticipated annual increases in the real price of refined petroleum of 25.7% in 1974, 11.2% in 1979 and 16.4% in 1980. These years also saw substantial unanticipated PPI inflation of 10.9%, 5.2% and 5.0% respectively, and unanticipated CPI inflation of 4.5%, 3.9% and 3.9% respectively. Another interesting feature of the aggregate data (see Appendix B) is that M1 growth has very low variance relative to the variances of CPI and PPI inflation.[9] Clearly, fluctuations in inflation over the 1966-81 were primarily driven by oil price changes rather than money growth. Also, we observe that there were unanticipated M1 growth rate reductions during both oil shocks, reflecting the Federal Reserve policy of fighting the

[8]The change in government purchases I assume to be known a year in advance because these purchases must be budgeted. This assumption is also made in the Barro and Rush articles cited earlier.

[9]Readers may be surprised by the low varibility of annual M1 growth rates reported in Appendix B. Recall that these are year to year growth rates of annual average M1 levels. Twelve month rates of change were much more variable over the sample period.

inflation these shocks produced. These data features highlight why it is essential to control for oil prices in order to estimate effects of nominal shocks on real wages.

Using the proxies for anticipations obtained from the monthly equations in table 3, the effects of anticipated and unanticipated CPI inflation, PPI inflation and M1 growth in the twelve months prior to the interview date on the real wage and employment probabilities of NLS respondents are examined. I first consider the relations between employment, CPI inflation and M1 growth. The results of linear probability estimates of employment probability equations are reported in table 4. As in most earlier aggregate data studies, unanticipated M1 growth has a significant positive correlation with probability of employment. Unanticipated CPI inflation is also found to have a significant positive correlation. These results are actually strengthened by the inclusion of the oil price control. The point estimates imply that 1 standard deviation M1 growth and CPI inflation surprises (which are 1.8 percent and 1.7 percent respectively) are associated with increases in employment probability of approximately 1 percentage point and 0.6 percentage points respectively. Looking at individual sectors, a significant positive correlation between employment probability and nominal surprises exists <u>only</u> in manufacturing. The same 1 standard deviation positive surprises in M1 growth and CPI inflation are both associated with increases in probability of employment in manufacturing of approximately 0.85 percentage points. Since 30.4% of the workers are in manufacturing, this translates into a substantial 2.8 percent increase in manufacturing employment.

The results for anticipated M1 growth and CPI inflation are more complex. Anticipated M1 growth is found to be positively related to employment probability, while anticipated CPI inflation is negatively related. Since anticipated changes in nominal quantities may very well result from anticipated changes in real quantities, a causal interpretation should not be put on these estimates. The results here are consistent with a model in which the monetary authority responds to anticipated favorable real shocks (other than oil price shocks) by increasing money growth but not by enough to prevent a deceleration of inflation. It is difficult to rationalize, however, why the negative anticipated inflation effect only appears in services and why it is substantially strengthened by the oil price control.

Whether a causal interpretation can reasonably be put on the estimated positive employment effects of positive nominal surprises depends on whether there also exists a negative correlation between these surprises and real wages, as is predicted by nominal contracting models where their effect is causal. A positive correlation of both unanticipated money growth and inflation with employment can exist in real business cycle models if the monetary authority increases the money supply in response to unanticipated favorable real shocks sufficiently to generate inflation. However, there will also exist a positive correlation between nominal surprises and real wages in such a model (see Appendix A, Table A1).

The estimated relations of anticipated and unanticipated M1 growth and CPI inflation with real consumption wages are reported in table 5. This table presents only the main coefficient estimates of interest. The OIL variable, a time trend and a set of individual specific regressors are also included in all models. The OLS wage equation results indicate that CPI inflation, whether anticipated or unanticipated, has no significant correlation with consumption wages either in the aggregate or in any individual sector. Unanticipated M1 growth actually has a significant positive correlation with the consumption wage in manufacturing, and this induces a marginally significant positive correlation in the aggregate. Anticipated M1 growth has a strong positive correlation with the consumption wage in every sector except services.

After correcting for selection bias using the selection model described in section 3, the estimated correlations between unanticipated CPI inflation and the consumption wage remain small and insignificant. Unanticipated M1 growth remains positively correlated with the real wage in manufacturing, but the effect is weakened. The OLS coefficient (.0098) indicates that a 1% unanticipated increase in M1 corresponds to a 1% increase in the manufacturing consumption wage, but the selection adjusted coefficient (.0066) shows only an 0.66% increase. After correcting for selection bias, anticipated M1 growth remains positively correlated with the consumption wage.

The results for anticipated money growth are not necessarily evidence for non-neutrality. They are consistent with a situation in which this quantity is uncorrelated with real offer wages but positively correlated with real shocks (other than oil price shocks) that increase labor productivity. The finding of a weaker positive correlation between unanticipated money and real wages after correcting for selection indicates that these surprises either cause, or are positively correlated with real shocks (other than oil price shocks) that cause, an upward shift in the offer wage distribution along with an increased hiring of high wage workers that exaggerates this upward shift.

These findings are clearly at variance with the predictions of Keynesian and Gray-Fischer type models. The required negative correlations between consumption wages and CPI inflation do not appear in the data. Neither do negative correlations with unanticipated M1 growth. In fact, unanticipated M1 growth is positively correlated with consumption wages and employment probabilities in manufacturing. Thus, it does not appear that monetary surprises increase employment by reducing the real wage.[10] The money growth result by itself is not conclusive however, because it would be consistent with nominal contracting if monetary surprises are predominantly responses of the Federal Reserve or banking system to real productivity shocks that are not controlled for here (i.e., real shocks other than oil price shocks). Then, the positive unanticipated M1 growth-real wage correlation emerges if M1 increases in response to positive productivity shocks but the increases are insufficient to prevent deflation and, hence, real wage increases. Thus, this evidence does not rule out the possibility that real wages are reduced by purely idiosyncratic positive money supply movements. It should be noted, however, that in this scenario: 1) real shocks and not monetary shocks are the main source of cyclical fluctuations, and 2) a negative real wage-unanticipated CPI inflation correlation ought also to emerge.

Both the lack of a negative inflation surprise-consumption wage correlation and the positive M1 surprise correlation can plausibly be explained by a real business cycle model with flexible wages in which money increases in response to unanticipated real shocks (other than the oil price shocks control for here) by an amount roughly proportional to the output increase, so as to keep the price level roughly fixed (see (W_t, P_t) and (W_t, M_t) correlations under "partial control for real shock" in Appendix A, Table A1). In general, in real business cycle models without nominal rigidities, positive M1 surprise-real wage correlations are generated to the extent that the banking system increases the money supply to accommodate increases in output generated by favorable real shocks. Thus, in the real business cycle scenario, the positive M1 surprise-real wage correlation should not persist after controlling for real business cycle conditions (see Appendix A).

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[10]It is interesting that the point estimates imply that unanticipated M1 growth raises the wage in manufacturing relative to that in both services and the CTU sector, while increasing manufacturing employment relative to that in the other sectors. Here, the M1 surprises (or real shocks for which they proxy) are acting as sectoral shocks, and the employment response to wage changes is consistent with what an equilibrium sectoral model would predict, since workers move into the sector with increased relative wages.

Table 6 reports results for all workers and manufacturing workers obtained with and without controls for a business cycle indicator and oil prices. In manufacturing, after controlling for U-RATE in addition to OIL, the unanticipated CPI inflation coefficient remains insignificantly negative. However, the U-RATE control strengthens the significant positive correlation between unanticipated M1 growth and manufacturing consumption wages, the UM1 coefficient increasing to .0094 (standard error .0040). *If the cycle is entirely driven by real shocks, it is difficult to explain why this* positive correlation should remain after controlling for real business cycle conditions.[11]

Given these results, a more plausible explanation for both the positive real wage-unanticipated M1 growth correlation and the insignificant real wage-unanticipated CPI inflation correlations is provided by the type of model discussed by McCallum (1980, 1986), in which nominal rigidities in commodity prices are greater than those in wages. Then, unanticipated money growth can cause nominal wages to rise more than nominal prices, inducing a positive real wage-unanticipated money correlation. The more rigid are prices, the smaller is the real wage-unanticipated inflation correlation, and if prices are completely predetermined this correlation is zero (See Blinder and Mankiw [1984]).

Table 6 also makes clear the importance of controlling for oil price shocks when estimating correlations of nominal quantities with real wages. Comparing columns (2) and (3) for all workers and for manufacturing workers, we see that strong negative correlations that exist between anticipated CPI inflation and consumption wages without the OIL control appear to be entirely due to correlations of oil prices with anticipated inflation and real wages. The positive unanticipated M1 growth correlation for all workers also appears to be solely due to oil price effects (compare columns (5) and (6)). The importance of the oil price controls arises because of the large real wage effects of the oil shocks. According to the point estimates in table 6, a one standard deviation around trend increase in OIL (equal to 0.28 compared to the mean OIL value of 1.531) produces a roughly 3.4% consumption wage decline for all workers and a 2.2% decline in manufacturing.

I now turn to the issue of how PPI inflation and M1 growth effect product wages and employment in manufacturing. Although the inextensive coverage of non-manufacturing goods in the producer price index series limits the analysis to manufacturing (see section 4), it is manufacturing where long-term

[11]Very similar results are obtained using cyclical indicators other than U-RATE (such as real GNP, the index of coincident indicators, employment and capacity utilization).

nominal contracts are most likely to be important. Results from product wage regressions and linear probability models for probability of manufacturing employment are reported in table 7. Unanticipated PPI inflation has a positive correlation with probability of manufacturing employment that is strengthened by control for oil prices. The point estimate of .0017 implies that a 1 standard deviation PPI inflation surprise (which is 3.63%) is associated with an increase in probability of manufacturing employment of 0.6%. Since 30.4% of the workers are in manufacturing, this translates into a 2% increase in manufacturing employment.

Again, these positive correlations between PPI inflation surprises and manufacturing employment do not give support to Grey-Fischer type models unless negative correlations of nominal surprises with product wages are also found. The estimated relations of anticipated and unanticipated PPI inflation and M1 growth with real product wages, reported in the top panel of table 7, give no support to Grey-Fischer type models. The estimated unanticipated PPI inflation coefficients are small and insignificant. The estimated correlation between M1 growth and the manufacturing product wage is strongly positive. The point estimate for unanticipated M1 growth is reduced from .0120 to .0086 by the selection correction, but the smaller figure implies that a 1 standard deviation M1 growth surprise (which is 1.8%) is associated with a 1.5% increase in the manufacturing real product wage. This lack of negative correlations between nominal quantities and real product wages is consistent with the consumption wage results.

Also consistent is the finding of a positive real wage-anticipated money correlation. However, in contrast to the lack of correlation between consumption wages and anticipated CPI inflation, a strong negative correlation is found between the manufacturing product wage and anticipated PPI inflation. Of course, this negative correlation is not necessarily indicative of non-neutrality of anticipated nominal disturbances, as it may emerge simply because anticipated adverse productivity shocks (other than oil price shocks) both increase product prices and reduce product wages. It is interesting that the manufacturing product wage is negatively correlated with anticipated PPI inflation while the manufacturing consumption wage is unaffected by anticipated CPI inflation. This is consistent with the view, advocated by Raisian (1979), of manufacturing as a sector where implicit contracts protect workers from fluctuations in their consumption wages.

It is interesting to examine the role of controls for real shocks in obtaining these results. Table 8 reports results obtained with and without the U-RATE and OIL controls. Observe that the estimated correlations between PPI inflation and product wages are not very sensitive to the controls. The estimated unanticipated M1 growth-product wage relationship is lessened by the oil price control (the UM1 coefficient drops from .0149 to .0086), but remains strong. They key result in table 8 is that the positive unanticipated M1 growth-product wage correlation is strengthened by the control for business cycle conditions. Thus, a scenario where this positive correlation arises solely due to banking system accommodation to changes in real activity in a real business cycle model with endogenous money appears untenable. Overall then, both the consumption and product wage results appear inconsistent with the predictions of Grey-Fischer type models, yet also inconsistent with the predictions of real business cycle models. The positive correlations between M1 growth surprises and real wages (both consumption and product) are most easily explained by a model where wages are more flexible than prices.

The final issue to be addressed is the robustness of these results to controls for individual fixed effects. If individual effects are present in panel data, and if they are correlated with the regressors, then both parameter estimates and their standard errors will be biased. Table 9 presents fixed effects estimates of the log consumption wage equations for all workers and manufacturing workers, and of the log product wage equations for manufacturing workers. These results are basically consistent with the OLS results. Again, no negative CPI inflation-consumption wage correlations appear in the data. Positive correlations between unanticipated M1 growth and both product and consumption wages again appear in manufacturing. Also consistent are the positive real wage-anticipated M1 growth correlations and the negative PPI inflation-product wage correlation in manufacturing. The only differences in results are than a weak negative anticipated CPI inflation-consumption wage correlation appears in manufacturing, along with a positive unanticipated PPI inflation-product wage correlation (both correlations are essential zero in the OLS results). The later result is an additional contradiction of the predictions of Keynesian and Grey-Fischer models.

6. Aggregate Data Comparisons

The results in Section 5 indicate that changes in unobserved labor force quality have the principal effect of overstating the positive correlations of manufacturing consumption and product wages with positive M1 surprises.[12] However, it would be inappropriate to conclude that aggregate wage measures are necessarily procyclically biased over monetary cycles. The NLS data contain only young men, and the effect of nominal surprises on labor force quality may differ by demographic group (e.g. the sign of ρ may differ for different groups). Perhaps more importantly, the aggregate data are affected by important demographic changes -- such as changes in the gender or racial composition of the labor force -- whose effect cannot be discerned from the NLS panel because of its time variant gender/racial mix. Thus, the only way to discern how use of micro rather than macro data affects results is to directly compare the micro data results with macro data results. This section presents such a comparison.

The specific aggregate data I examine are Bureau of Labor Statistics (BLS) annual data on average wages and employment for production and nonsupervisory workers on nonagricultural payrolls for the 1964-88 period.[13] The basic model used in the aggregate data regressions is the same as that used on the micro-data, except that real government purchases of durable goods (DUR) and a squared time trend are included (these variables are not significant in the micro-data regressions). Also, GNP replaces U-RATE as the cyclical indicator, and all variables are annual averages with a 1967 = 100 base.

The aggregate consumption wage results are reported in table 10 (only the main coefficients of interest are reported). In the specification that controls for oil prices, unanticipated CPI inflation is not significantly correlated with the consumption wage, either for all workers or in manufacturing. This is consistent with the NLS results. In contrast to the NLS results, however, anticipated CPI inflation is negatively correlated with the consumption wage, both for all workers and in manufacturing. It is not clear why such negative correlations should appear in the aggregate but not the NLS data, other than compositional effects where labor force quality was lower when anticipated inflation was high (i.e.,

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[12]That the only important effect is in manufacturing results from the fact that only manufacturing employment is strongly correlated with these shocks (see Table 4).

[13]These are the standard aggregate wage and employment data available in the BLS Handbook of Labor Statistics.

the high unemployment years of 1975, 80, 81). The estimates in section 5 are consistent with such a compositional effect, but whether its magnitude is sufficient to generate the discrepancy is unclear.

Significant positive correlations of unanticipated M1 growth with consumption wages appear in the aggregate data, both in manufacturing and for all workers. This is consistent with the NLS result in manufacturing, but for all workers the positive M1 growth-consumption wage correlation was small and insignificant in the NLS. According to the point estimates in table 10, a one standard deviation M1 growth surprise (which is 1.85%) corresponds to consumption wage increases of 0.76% in manufacturing and 0.49% for all workers at the mean of the data (wage index mean is 104.5 in manufacturing and 102.4 for all workers).

Controlling for business cycle conditions by including real GNP in the model does not affect the money growth results. However, given this control, unanticipated CPI inflation is negatively correlated with the consumption wage both for all workers and in manufacturing. In contrast, inclusion of a business cycle indicator does not generate a negative correlation in the NLS data.

Aggregate product wage results for manufacturing are reported in table 11. Negative correlations are found with anticipated PPI inflation and insignificant, but large positive, correlations are found with anticipated M1 growth. These findings are consistent with the NLS results (except that the positive anticipated M1 correlation is significant in the NLS). An important consistency is that the positive unanticipated M1 growth-product wage correlation found in the NLS is also found here. In fact, it is stronger in the aggregate data. According to the point estimates in table 11, a one standard deviation M1 growth surprise (which is 1.85%) corresponds to a product wage increase of 1.58% at the mean of the data (wage index mean is 105.7). Kretzmer also finds positive unanticipated M1 growth-real product wage correlations in aggregate and industry level data.

A fundamental inconsistency is that a negative unanticipated PPI inflation-product wage correlation is present in the aggregate data, while no correlation is found in the NLS (positive unanticipated PPI inflation-employment correlations are present in both). This negative correlation is precisely what nominal contracting theories predict. Still, it would be mistaken to conclude that the aggregate data are consistent with the predictions of Gray-Fischer type models for two reasons. First, the positive real wage-M1 surprise correlations are implausible in such models.[14] Second, these models predict that if nominal wage rigidity exists in manufacturing, then both the consumption wage in manufacturing and that for all workers should be negatively correlated with CPI inflation (see discussion of Duca in section 2) -- and this is clearly not true in the aggregate data.

7. Conclusion

This paper has analyzed the responses of both economy-wide and sector-specific real wages and employment probabilities to real and nominal shocks using micro-panel data from the NLS Survey of Young Men. The observed response patterns do not appear consistent with nominal contracting theories of unemployment. It was found that both unanticipated inflation and money growth in the year prior to respondents' interview dates increase their probability of employment, with almost the entire effect coming in manufacturing. However, there is essentially no correlation between inflation surprises and real wages in the NLS data. Furthermore, money growth surprises are positively correlated with both consumption and product wages in manufacturing. These are clear contradictions of models in which nominal contracting is the mechanism through which nominal shocks affect employment. In these models, the real wage-inflation surprise correlation must be negative. The correlations between real wages and money growth surprises should also be negative, given controls for real shocks. Endogenous money growth in a real business cycle model does not appear able to explain the positive real wage-money growth correlation in manufacturing, because this correlation is actually strengthened by controls for business cycle conditions. A model which is consistent with a positive real wage-money growth correlation is that described by McCallum (1980, 1986) in which nominal goods prices are more rigid than nominal wages, so that nominal surprises can increase both real wages and employment.

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[14]As was mentioned in Section 5, both the positive real wage -- unanticipated money growth and negative real wage -- unanticipated inflation correlations are consistent with a real business cycle model in which positive real shocks (other than oil price shocks) are accommodated by increased money growth, but this increase is insufficient to prevent decelerating inflation. As in the NLS data, however, this explanation does not appear plausible either because the real wage -- unanticipated money growth correlation is not weakened by controls for business cycle conditions.

The NLS results were compared to results obtained using aggregate wage and employment data from the Bureau of Labor Statistics. In the aggregate data, significant positive correlations exist not only between unanticipated M1 growth and product wages but also between that and consumption wages (the later correlation was positive but insignificant in the NLS). Also unfavorable for Keynesian and Grey-Fischer models is that *unanticipated CPI inflation is not significantly correlated with consumption wages given controls for real shocks.* However, a negative correlation does appear between unanticipated PPI inflation and the manufacturing product wage -- as well as between unanticipated CPI inflation and consumption wages (both for all workers and manufacturing workers) in models that control for business cycle conditions. An important avenue for future research is to determine how/whether aggregation bias accounts for this difference in micro and aggregate data results.

Appendix A: An Expository Model

The purpose of this appendix is to present a simple expository model in which all the correlations patterns discussed in section 2 can be derived. Since there are so many alternative scenarios leading to different partial correlations among wages, output and nominal shocks, a table of correlations implied by the alternative scenarios is presented as an aid to the reader. The model below is almost identical to that used by Blinder and Mankiw (1984) to illustrate various types of wage and price rigidity. The only essential difference is that I consider the role of endogenous money.

Let L_t^D = log of labor demand at time t, W_t = log of the real wage, Y_t = log of real output, X_t = log of real productivity, and M_t = log of the money supply. Assume all variables have equilibrium values of one, so that their logs have equilibrium values of zero.[1] Consider the simple four equation model:

$$Y_t = X_t + \beta L_t^D \qquad 0 < \beta < 1$$

$$L_t^D = -\gamma W_t + \gamma X_t \qquad \gamma \equiv (1-\beta)^{-1} \qquad \Rightarrow \gamma > 1$$

$$W_t = (1-\alpha) X_t - \alpha P_t \qquad 0 \le \alpha \le 1$$

$$P_t = M_t - Y_t$$

$$L_t^s = 0$$

where X_t and M_t are serially uncorrelated stochastic processes such that $X_t \sim (o,\sigma_X^2)$, $M_t \sim (0,\sigma_M^2)$ and $EM_tX_t = \sigma_{MX}$. In this model labor supply is completely inelastic but employment is determined by $L_t = L_t^D$ if $L_t^s \neq L_t^D$.

The key parameter is α. If $\alpha = 0$, then $W_t = X_t$, which sets $L_t^D = 0$ so the labor market clears continuously. If $\alpha = 1$ the nominal wage is fixed at $P_t + W_t = 0$. If $0 < \alpha < 1$ then wages respond partially (but incompletely) to both productivity shocks and price changes.

Table A1 gives the signs of the correlations between W_t, Y_t, P_t and M_t predicted in the polar cases of $\alpha = 0$ and $\alpha = 1$. For both models I present the predicted unconditional correlations, the predicted partial correlations given controls for X_t, and the effect on these partial correlations of using only an imperfect control for X_t (this may only increase (↑) or decrease (↓) the partial correlation without giving

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[1] For consistency, it is necessary to define $Y_t \equiv \ln$ (Real Output) + $\ln\beta$ (see below).

a clear sign). Ambiguous cases are indicated by a question mark (?). In these cases I report "plausible" signs, and report the assumption that generates the sign.[2]

Note that very few unambiguous predictions are obtained without perfect control for X_t. Specifically, we must have $cov(W_t,P_t) < 0$ in the rigid nominal wage model and $cov(W_t,Y_t) > 0$ in the real business cycle model. Given perfect controls for the real shock, we expect partial correlations $cov(W_t,M_t) < 0$, $cov(Y_t,P_t) > 0$, and $cov(Y_t,M_t) > 0$ in the rigid wage model. In the real model, all partial correlations with nominal quantities should be zero.

In the rigid wage model, failure to perfectly control for X_t will (plausibly) have the effect of biasing upward the positive $cov(Y_t,M_t)$, while biasing both the negative $cov(W_t,M_t)$ *and positive* $cov(Y_t,P_t)$ toward 0. In the real model failure to control perfectly for X_t will (plausibly) bias $cov(W_t,P_t)$ and $cov(Y_t,P_t)$ in a negative direction and $cov(W_t,M_t)$ and $cov(Y_t,M_t)$ in a positive direction. Given imperfect *controls, the main (plausible) distinction between the two models is that the rigid wage model* generates $cov(W_t,M_t) < 0$ while the real model generates $cov(W_t,M_t) > 0$.

However, a crucial point is that it is simple to control for real shocks in the real model, even if X_t *is unobserved. Since* Y_t *is driven only by real shocks, it is a sufficient statistic for these shocks.* Thus, by controlling for Y_t, we obtain zero partial correlations $cov(W_t,P_t)$ and $cov(W_t,M_t)$ in the purely real model. This can be simply seen by deriving the coefficients on P_t and M_t in regressions of W_t on Y_t and P_t or of W_t on Y_t and M_t.

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[2]These assumptions are: 1) $\sigma_{MX} > 0$, 2) $\sigma_{MX} < \sigma_x^2$, 3) $\sigma_x^2 > (1-2\beta)\ \sigma_{MX}^2$, 4) $\sigma_{MX} < (1-2\beta)\ \sigma_M^2$, 5) $\sigma_x^2 > \beta(1-\beta)\sigma_M^2 + (1-2\beta)\sigma_{MX}$.

Assumption 1, that money is positively correlated with real shocks, and assumption 2 and 3, that increases in money are less than proportional to output increases induced by positive real shocks (in the real and rigid wage models respectively), are quite reasonable given Federal Reserve behavior over the sample period.

Assumption 4, needed to generate $cov(W_t,M_t) < 0$ in the contracting model, is problematic (dependent on σ_M^2), perhaps explaining the wide range of $cov(W_t,M_t)$ estimates obtained by various authors. It says that money does not co-move with real shocks sufficiently to generate a <u>positive</u> $cov(W_t,M_t)$ in the *rigid wage model.*

Assumption 5, which generates $cov(W_t,Y_t) > 0$ in the rigid wage model, is clearly problematic, depending on relative magnitudes of σ_M^2, σ_x^2, and σ_{MX}. It says that enought of the variance in real wages in the rigid wage model is due to real shocks to general procyclical wages.

Appendix A:

Table A1

	Rigid Nominal Wage Model			Real Business Cycle Model		
	No Controls	Control for Real Shock	Partial Control for Real Shock	No Controls	Control for Real Shock	Partial Control for Real Shock
W_t, Y_t	? (+ if A5)	−	? (↑ if A4)	+	+	+
W_t, P_t	−	−	−	? (− if $\sigma_{mx}<\sigma_x^2$)	0	? (− if $\sigma_{mx}<\sigma_x^2$)
W_t, M_t	? (− if $\sigma_{mx}<\gamma^{-1}\sigma_m^2$)	−	? (↑ if $\sigma_{mx}>0$)	? (+ if $\sigma_{mx}>0$)	0	? (+ if $\sigma_{mx}<0$)
Y_t, P_t	? (− if A5)	+	? (↓ if A4)	? (− if $\sigma_{mx}<\sigma_x^2$)	0	? (− if $\sigma_{mx}<\sigma_x^2$)
Y_t, M_t	? (+ if $\sigma_{mx}>-\beta\sigma_m^2$)	+	? (↑ if $\sigma_{mx}>0$)	? (+ if $\sigma_{mx}>0$)	0	? (+ if $\sigma_{mx}>0$)

NOTE: Table contains sign predictions for the correlations of the specified variables, obtained from the model in Appendix A. A (?) indicates that the sign is ambiguous. A ↑ or ↓ indicates direction of movement of coefficient (rather than sign). A4 denotes Assumption 4 in Appendix A, which is $\sigma_{mx} < (1-2\beta)^{-1}\sigma_x^2$. A5 denotes Assumption 5, which is $\sigma_x^2 > \beta(1-\beta)\sigma_m^2 + (1-2\beta)\sigma_{mx}$.

Appendix B:

Macro Time Series with Anticipated/Unanticipated Decompositions

Year	WCPI	CPI Inflation			M1 Growth		
		Actual	AICPI	UICPI	Actual	AM1	UM1
1966	98.3	2.82	3.04	-0.22	4.49	3.88	0.61
1967	100.0	2.84	3.54	-0.70	3.90	4.20	-0.30
1968	102.1	4.11	3.14	0.98	6.74	4.02	2.72
1969	103.3	5.23	4.43	0.81	5.77	5.97	-0.19
1970	103.6	5.75	4.43	1.32	3.75	5.95	-2.20
1971	106.1	4.21	3.69	0.52	6.48	4.79	1.69
1972	110.2	3.24	4.95	-1.71	6.88	5.45	1.43
1973	110.5	6.04	4.57	1.47	6.99	5.48	1.51
1974	107.1	10.41	5.91	4.50	4.91	5.96	-1.05
1975	104.9	8.75	8.73	0.02	4.43	4.93	-0.50
1976	106.4	5.61	5.71	-0.10	5.46	6.00	-0.54
1977	107.9	6.25	5.44	0.81	7.39	5.02	2.37
1978	108.7	7.38	6.76	0.61	7.90	5.96	1.94
1979	105.7	10.67	6.73	3.94	7.40	7.16	0.24
1980	100.7	12.68	8.79	3.90	5.98	6.87	-0.88
1981	99.3	9.87	9.60	0.27	7.09	6.27	0.82

NOTE: Actuals are year-to-year rates of change of annual average price index and M1 levels. They are calculated by taking differences in logarithms, which is an approximation to the rate of change. Fitted values for the inflation and M1 growth series are obtained using the forecasting equations in Table 3.

Appendix B (continued)

Year	WPPI	Manufacturing PPI Inflation			Real Price of Refined Petroleum		
		Actual	AIPPI	UIPPI	Actual	AOIL	UOIL
1966	97.1	0.72	2.56	-1.84	-0.88	1.06	-1.94
1967	100.0	3.05	2.28	0.77	2.02	0.75	1.28
1968	104.6	2.57	2.97	-0.40	-3.58	0.91	-4.49
1969	106.7	3.45	3.62	-0.17	-1.73	-0.83	-0.90
1970	108.0	3.70	3.59	0.11	1.14	-0.68	1.82
1971	112.0	3.30	2.87	0.43	4.42	-0.49	4.92
1972	115.8	3.45	4.23	-0.77	-0.68	1.79	-2.48
1973	112.4	9.08	4.30	4.77	0.12	0.60	-0.48
1974	101.8	17.64	6.71	10.92	26.62	0.94	25.67
1975	100.2	10.47	10.70	-0.23	7.43	9.28	-1.86
1976	104.0	4.52	6.26	-1.74	3.66	1.61	2.05
1977	106.0	6.07	4.45	1.62	6.86	2.21	4.64
1978	107.3	7.15	6.04	1.12	-1.02	3.38	-4.40
1979	104.2	11.37	6.21	5.16	11.70	0.53	11.17
1980	98.8	13.36	8.37	4.99	20.93	4.53	16.40
1981	99.4	8.92	9.02	-0.10	10.30	7.21	3.09

NOTE: The anticipated changes in the real price of refined petroleum are obtained from the equation:

$$\Delta \ln OIL = \underset{(.201)}{-.832} + \underset{(.164)}{.387^{**}} \Delta \ln OIL(-1) + \underset{(.485)}{.341} \Delta \ln GNP(-1).$$

This forecasting equation had an $R^2 = 0.131$, a DW = 2.04, and a first order autocorrelation of -0.042. Variables other than $\Delta \ln OIL(-1)$ are not significant predictors, and the low R^2 indicates that real oil price changes are very difficult to predict (the quantity $\ln OIL$ is close to a random walk for '48-'88). The variable WPPI is the wage in manufacturing deflated by the PPI for manufactured products.

Table 1:

Variable Definitions

Variables in NLS Analysis Sample		
WCPI	–	Log of real hourly straight time wage in 1967 CPI dollars.
WPPI	–	Log of real hourly straight time wage in 1967 manufacturing PPI dollars.
AICPI	–	Anticipated annual CPI inflation at 12 months prior to interview date.
UICPI	–	Unanticipated annual CPI inflation during 12 months prior to interview date.
AIPPI	–	Anticipated annual PPI inflation at 12 months prior to interview date.
UIPPI	–	Unanticipated annual PPI inflation at 12 months prior to interview date.
AM1	–	Anticipated annual M1 growth rate at 12 months prior to interview date.
UM1	–	Unanticipated annual M1 growth rate during 12 months prior to intervew date.
OIL	–	Real price of refined petroleum in month of interview (1967 = 1), equal to producer price index for refined petroleum products divided by producer price index for all commodities.
U-RATE	–	National employment rate in percentage points in month of interview.
EDUC	–	Years of eduction.
EXPER	–	Years of labor market experience (interview date minus completion date of schooling or military service, which ever was later).
WHITE	–	Dummy variable equal to 1 if respondent is white.
WIFE	–	Dummy equal to 1 if wife is present in the home.
KIDS	–	Number of children in household.
Variables Used in Forecasting Equations		
M1	–	M1 money supply, annual average or monthly (in billions of dollars).
CPI	–	Consumer price index, annual average or monthly (1967 = 100).
PPI	–	Producer price index for manufacturing products, annual average or monthly (1967 = 100).
OIL	–	Real price of refined petroleum, annual average or monthly (1967 = 1), equal to producer price index for refined petroleum products divided by producer price index for all commodities.
GNP	–	Real gross national product, annual average (1967 = 100).
IND	–	Industrial Production Index, monthly (1967 = 100).
DUR	–	Real government purchases of durable goods, annual average or monthly (1967 = 100).

NOTE: The aggregate time series included in the NLS analysis sample are taken or derived from series taken from the Citibase dataset. The series used in the forecasting equations are also taken from Citibase, except for OIL and DUR, which are taken from the Board of Governors FAME database. *Note that the annual data are 12 month averages of the monthly data.*

Table 2: Descriptive Statistics of Variables

Individual Specific Variables in NLS Data			
Variable	Mean		
WCPI	1.065		
WPPI	1.065		
EDUC	12.57		
EXPER	7.90		
$EXPER^2$	87.05		
WHITE	0.74		
WIFE	0.69		
KIDS	1.30		
Aggregate Time Series Variables in NLS Data (Monthly) 1966-81			
Variable	Mean	Standard Dev.	Standard Dev. Around Trend
U-RATE	6.384	1.678	1.088
OIL	1.531	0.623	0.280
AICPI	6.656	2.554	1.394
UICPI	0.672	1.718	—
AIPPI	6.263	3.174	2.372
UIPPI	0.291	3.655	—
AM1	6.336	1.217	0.727
UM1	-0.342	1.799	—
Aggregate Data (Annual) 1949-1988			
AICPI	3.980	2.464	1.842
UICPI	0.000	2.123	—
AIPPI	3.516	2.637	2.184
UIPPI	0.000	3.633	—
AM1	4.875	2.361	1.264
UM1	0.000	1.852	—
Percentages of Workers in Each Sector			
Manufacturing	30.40		
Nonmanufacturing	58.22		
Services	37.61		
Construction, Transportation, and Utilities	20.61		
Unemployed	11.38		

NOTE: Variable definitions are given in Table 1. CIC codes for the various industries are given in the text. The means of time series variables in the NLS data are taken over all person-year observations. The mean for WPPI is taken only over manufacturing workers.

Table 3:

Forecasting Equations

	Annual 1949-1988			Monthly 1950-1988		
Annual 1949-88	Δ ℓn CPI	Δ ℓn PPI	Δ ℓn M1	Δ ℓn CPI	Δ ℓn PPI	Δ ℓn M1
Constant	-.3038 (.8500)	-.1687 (1.3970)	2.0351** (.7700)	.3888* (.2056)	1.0387** (.3811)	2.2086** (.2289)
Δ ℓn OIL(-1)	.1039 (.0714)	.0652 (.1294)	-.0878 (.0641)	.0318** (.0102)	.0744** (.0212)	-.0558** (.0113)
Δ ℓn CPI(-1)	.4270** (.1748)		.1556 (.1642)	.5706** (.0430)		.2903** (.0479)
Δ ℓn PPI(-1)		.4115** (.2099)			.2618** (.0567)	
Δ ℓn M1(-1)	.3909** (.1521)	.3916* (.2259)	.6524** (.1401)	.2179** (.0366)	.3140** (.0644)	.4438** (.0408)
Δ ℓn GNP(-1)	.1750 (.1465)	.0801 (.2525)	-.2868* (.1496)			
Δ ℓn IND(-1)				.0593** (.0165)	.0078** (.0311)	-.1181** (.0184)
Δ ℓn DUR			.0205 (.0176)	.0276** (.0052)	.0335** (.0104)	.0245** (.0058)
R^2	.5740	.3451	.6192	.5971	.2616	.4554
DW	1.458	1.636	1.675	.072	.047	.125
ρ	.173	.126	.035	.963	.976	.936

NOTE: Standard errors in parenthesis. A ** indicates significance at the 5% level. A * indicates the 10% level. DW denotes the Durbin-Watson statistic and ρ is the first autocorrelation of the error. *Annual Data:* Sample begins in 1949 because data before 1948 was not available. *Monthly Data:* Data are 12 month rates of change recorded every month (i.e., 12-month moving averages) from 49-1 to 88-12. There are 468 observations (monthly data was not available before 1949).

Table 4:

Correlations of Inflation and Money Growth with Employment Probabilities--Linear Probability Model Estimates

	Inflation		M1 Growth	
	Anticipated	Unanticipated	Anticipated	Unanticipated
With Control for OIL				
All Workers	-.0069**	.0033**	.0090**	.0054**
	(.0018)	(.0013)	(.0035)	(.0016)
Nonmanufacturing	-.0048	-.0017	.0026	.0006
	(.0030)	(.0020)	(.0058)	(.0025)
Manufacturing	-.0021	.0050**	.0063	.0047**
	(.0050)	(.0019)	(.0054)	(.0024)
Services	-.0071**	-.0038*	.0044	.0020
	(.0029)	(.0020)	(.0056)	(.0025)
Construction, Transportation, and Utilities	.0023	.0021	-.0018	-.0014
	(.0025)	(.0017)	(.0047)	(.0021)
No Control for OIL				
All Workers	-.0018	.0029**	.0086**	.0041**
	(.0015)	(.0013)	(.0035)	(.0015)
Nonmanufacturing	-.0039	-.0017	.0027	.0009
	(.0025)	(.0020)	(.0058)	(.0024)
Manufacturing	.0021	.0047**	.0059	.0032
	(.0024)	(.0019)	(.0054)	(.0023)
Services	-.0047*	-.0040**	.0043	.0016
	(.0024)	(.0020)	(.0055)	(.0024)
Construction, Transportation, and Utilities	.0007	.0023	-.0016	-.0007
	(.0021)	(.0017)	(.0047)	(.0020)

NOTE: Standard errors are in parenthesis. A ** indicates significance at the 5% level. A * indicates significance at the 10% level. All regressions also include the individual regressors EDUC, EXPER, $EXPER^2$, WHITE, WIFE, and KIDS as well as a time trend and the real price of refined petroleum (OIL).

Table 5:

Correlations of CPI Inflation and Money Growth with Log Real Consumption Wage

	CPI Inflation		M1 Growth	
	Anticipated	Unanticipated	Anticipated	Unanticipated
OLS Wage Equations				
All Workers	.0011 (.0051)	.0012 (.0018)	.0194** (.0050)	.0038* (.0022)
Nonmanufacturing	.0018 (.0035)	.0014 (.0024)	.0131* (.0068)	-.0000 (.0030)
Manufacturing	-.0001 (.0039)	-.0009 (.0026)	.0303** (.0068)	.0098** (.0030)
Services	.0039 (.0042)	.0015 (.0029)	.0059 (.0083)	.0012 (.0036)
Construction, Transportation, and Utilities	-.0070 (.0060)	-.0011 (.0040)	.0282** (.0113)	-.0014 (.0050)
Selected Adjusted Wage Equations				
All Workers	.0041 (.0035)	.0001 (.0023)	.0166** (.0057)	.0014 (.0028)
Nonmanufacturing	.0005 (.0045)	.0032 (.0029)	.0138* (.0073)	.0008 (.0036)
Manufacturing	.0004 (.0056)	-.0039 (.0034)	.0275** (.0079)	.0066* (.0036)
Services	.0009 (.0054)	.0006 (.0036)	.0104 (.0090)	.0029 (.0042)
Construction, Transportation, and Utilities	-.0099 (.0069)	-.0005 (.0045)	.0181* (.0106)	-.0006 (.0052)

NOTE: Standard errors are in parenthesis. A ** indicates significance at the 5% level. A * indicates significance at the 10% level. All models also include the individual regressors EDUC, EXPER, $EXPER^2$, and WHITE in the wage equation. The variables WIFE and KIDS are also included in the choice equation. A time trend and the real price of refined petroleum (OIL) are included in both equations.

Table 6:

Selection Adjusted Log Consumption Wage Equations

	(1)	(2)	(3)	(4)	(5)	(6)
All Workers						
AICPI	.0033 (.0036)	.0041 (.0035)	-.0109** (.0029)			
UICPI	.0023 (.0037)	.0001 (.0023)	.0012 (.0023)			
AM1				.0188** (.0060)	.0166** (.0057)	.0188** (.0056)
UM1				.0029 (.0030)	.0014 (.0028)	.0083** (.0027)
OIL	-.1201** (.0156)	-.1249** (.0128)		-.1176** (.0111)	-.1179** (.0107)	
U-RATE	.0042 (.0056)			.0042 (.0036)		
Manufacturing						
AICPI	.0012 (.0057)	.0004 (.0056)	-.0106** (.0046)			
UICPI	-.0065 (.0057)	-.0039 (.0034)	-.0031 (.0033)			
AM1				.0315** (.0084)	.0275** (.0079)	.0293** (.0078)
UM1				.0094** (.0040)	.0066* (.0036)	.0109** (.0036)
OIL	-.0947** (.0234)	-.0888** (.0182)		-.0787** (.0163)	-.0790** (.0156)	
U-RATE	-.0049 (.0083)			.0083* (.0048)		

NOTE: Standard errors are in parenthesis. A ** indicates signficance at the 5% level. A * indicates the 10% level. All models also include the individual specific regressors EDUC, EXPER, $EXPER^2$, and WHITE in the wage equation, and these plus WIFE and KIDS in the choice equation. TREND is included in both equations.

Table 7:

Correlations of Product Price Inflation and Money Growth with Log Real Product Wage and Employment in Manufacturing

	PPI Inflation		M1 Growth	
	Anticipated	Unanticipated	Anticipated	Unanticipated
Product Wage				
OLS Wage Equation	-.0073** (.0022)	.0011 (.0015)	.0524** (.0068)	.0120** (.0031)
Selected Adjusted Wage Equation	-.0083** (.0030)	-.0004 (.0020)	.0492** (.0079)	.0086** (.0036)
Employment - Linear Probability Model				
Control for OIL	-.0023** (.0010)	.0017** (.0007)	.0063 (.0054)	.0047** (.0024)
No Control for OIL	.0007 (.0016)	.0016* (.0011)	.0059 (.0054)	.0032 (.0023)

NOTE: Standard errors are in parenthesis. A ** indicates significance at the 5% level. A * indicates the 10% level. All models also include the individual specific regressors EDUC, EXPER, $EXPER^2$, and WHITE in the wage equation, and these plus WIFE and KIDS in the choice equation. TREND and OIL are included in both equations. The PPI for manufacturing industry output is used to deflate manufacturing worker wages and to construct PPI inflation.

Table 8:

Selection Adjusted Log Product Wage Equations for Manufacturing Workers

Variable	(1)	(2)	(3)	(4)	(5)	(6)
AIPPI	-.0078**	-.0083**	-.0097**			
	(.0031)	(.0030)	(.0031)			
UIPPI	.0029	-.0004	.0016			
	(.0030)	(.0020)	(.0019)			
AM1				.0508**	.0492**	.0519**
				(.0084)	(.0079)	(.0077)
UM1				.0096**	.0086**	.0149**
				(.0040)	(.0036)	(.0035)
OIL	-.0796**	-.0893**		-.1150**	-.1153**	
	(.0193)	(.0151)		(.0163)	(.0156)	
U-RATE	.0122*			.0028		
	(.0073)			(.0048)		

NOTE: Standard errors are in parenthesis. A ** indicates signficance at the 5% level. A * indicates the 10% level. All models also include the individual specific regressors EDUC, EXPER, EXPER^2, and WHITE in the wage equation, and these plus WIFE and KIDS in the choice equation. TREND is included in both equations. The PPI for manufacturing industry output is used to deflate manufacturing worker wages and to construct PPI inflation.

Table 9:

Fixed Effects of Estimates of Log Wage Equations

	CPI Inflation		M1 Growth	
Consumption Wage	Anticipated	Unanticipated	Anticipated	Unanticipated
All Workers	.0014 (.0016)	.0009 (.0011)	.0093** (.0031)	.0007 (.0014)
Manufacturing	-.0039* (.0024)	-.0010 (.0016)	.0114** (.0043)	.0032** (.0019)
	PPI Inflation		**M1 Growth**	
Product Wage	Anticipated	Unanticipated	Anticipated	Unanticipated
Manufacturing	-.0074** (.0013)	.0018** (.0009)	.0317** (.0044)	.0052** (.0019)

NOTE: Standard errors are in parenthesis. A ** indicates significance at the 5% level. A * indicates significance at the 10% level. All models also include the individual regressors EDUC, EXPER, $EXPER^2$, WHITE, an SMSA residence dummy and a Southern state residence dummy in the wage equation. A time trend and the real price of refined petroleum (OIL) are also included.

Table 10:

Aggregate Data Comparisons 1964-1988
BLS Production and Nonsupervisoring Workers on Nonagricultural Payrolls

	Consumption Wage (1967 = 100)				Employment (1967 = 100)	
All Workers						
AICPI	-.5116** (.1768)	-.5874** (.1091)			.6878 (.3991)	
UICPI	-.1200 (.1317)	-.3816** (.0933)			1.0853** (.2973)	
AM1			.1526 (.2591)	.1893 (.2407)		-.1141 (.7389)
UM1			.2779** (.1284)	.2840** (.1190)		-.2408 (.3662)
OIL	-.0701** (.0077)	-.0471** (.0063)	-.0791 (.0081)	-.0676** (.0094)	-.0472** (.0175)	-.0362 (.0230)
GNP		.3202** (.0575)		.1632** (.0817)		
Durbin-Watson	1.510	2.133	1.590	1.511	1.484	1.010
Manufacturing						
AICPI	-.5334* (.2630)	-.6371** (.1839)			.5385 (.6355)	
UICPI	-.1544 (.1959)	-.5121** (.1573)			1.4970** (.4734)	
AM1			.0429 (.3236)	.0951 (.2899)		.0233 (1.0706)
UM1			.4300** (.1603)	.4383** (.1433)		-.2794 (.5306)
OIL	-.0315** (.0115)	-.0001 (.0106)	-.0428** (.0101)	-.0265** (.0114)	-.0417 (.0278)	-.0322 (.0334)
GNP		.4378** (.0969)		.2323** (.0985)		
Durbin-Watson	.992	1.302	1.250	1.337	1.666	1.234

NOTE: Standard errors are in parenthesis. A ** indicates significance at the 5% level. A * indicates the 10% level. All models also include TREND, $TREND^2$, and DUR. The Durbin-Watson lower and upper limits with 25 observations are (.87, 2.0) with 6 independent variables and (.78, 2.14) with 7.

Table 11:

Aggregate Data Comparisons 1964-1988
BLS Production and Nonsupervisory Workers on Nonagricultural Payrolls

	Product Wage (1967 - 100)				Employment (1967 - 100)	
Manufacturing						
AIPPI	-1.3220**	-1.3193**			.0914	
	(.3028)	(.3105)			(.4429)	
UIPPI	-.3571**	-.3953*			.8963**	
	(.1664)	(.2032)			(.2435)	
AM1			.8103	.7708		.0233
			(.7486)	(.7624)		(1.0706)
UM1			.9085**	.9019**		-.2794
			(.3710)	(.3768)		(.5306)
OIL	-.1307**	-.1263**	-.1348**	-.1472**	-.0103	-.0322
	(.0179)	(.0223)	(.0233)	(.0299)	(.0261)	(.0334)
GNP		.0799		-.1756		
		(.2308)		(.2591)		
Durbin-Watson	.854	.792	.881	.966	1.705	1.234

NOTE: Standard errors are in parenthesis. A ** indicates significance at the 5% level. A * indicates the 10% level. All models also include TREND, $TREND^2$, and DUR. The Durbin-Watson lower and upper limits with 25 observations are (.87, 2.0) with 6 independent variables and (.78, 2.14) with 7.

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