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State-Level Variation in the Real Wage Response to Monetary Policy

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This paper investigates the disparate state-level responses of real wages to monetary policy shocks. We report evidence that the response of real wages to monetary policy shocks is slightly procyclical. Using state-level structural vector autoregression models, we find disparity even resulting in some states exhibiting strong procyclical responses and others countercyclical real wage responses. This heterogeneity can be explained by cross-state differences in unemployment, agriculture share in state GDP, the unionization rate, and the importance of intermediate goods in state production. This last effect confirms a hypothesis proffered by Huang, Liu, and Phaneuf (2004).

Key Words: Real wages; Monetary policy; SVAR models.
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1. INTRODUCTION

Traditionally, empirical business cycle research has focused on the properties of fluctuations at the national level without consideration of potentially disparate sub-national cyclical behaviors. In recent years, however,

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considerable evidence has shown that there is much business cycle heterogeneity across regions and states. Accordingly, studies that focus only on properties of the aggregate business cycle offer an incomplete, and potentially distorted, picture of economic fluctuations.

Carlino and Sill (2001) examine regional trends and cycle dynamics across seven regions of the U.S. and find considerable disparity in the volatility of regional cycles. They report that "the standard deviation of the cyclical component in the most volatile region (Southeast) is almost five times as great as that in the least volatile region (Far West)." Owyang, Piger, and Wall (2005) look at heterogeneity across states in output growth rates in recessions and expansions and the degree to which the timing of business cycle phases are in sync with each other and with the national economy. They find "significant differences across states in the growth rates within business cycle phases" and that state and national phases are not in sync. Using a dynamic factor model, Owyang, Rapach, and Wall (2009) examine the links between economies at the state and national levels. They report finding "a great deal of heterogeneity in the nature of links between state and national economies." In a recent paper, Strauss (2013) argues that an important factor in explaining the disparity of business cycle fluctuations of income and employment across states is differences in state-level housing investment. These and other studies suggest that there is much heterogeneity across regional and state business cycles that is masked when considering only aggregate fluctuations.

In addition to research looking at regional/state disparities in general business cycle properties, other studies have focused more particularly on the dissimilar effects of aggregate economic shocks across regions/states in the U.S. Carlino and DeFina (1998) use structural vector autoregression (SVAR) models to look at the differential effects of monetary policy shocks on real personal income and employment in eight regions of the U.S. They find that while some regions tend to respond in much the same way as the aggregate economy, other regions respond quite differently. Using state-level evidence, they suggest that the differential regional responses are associated with differences in the output share of manufacturing. In a related paper, Carlino and DeFina (1999) use state-level SVAR models to examine the differential effects of monetary policy on real personal income in the 48 contiguous U.S. states. Once again, they find substantial disparities and report evidence that states with more important manufacturing sectors exhibit larger responses to monetary policy shocks. Focusing on income and housing variables, Fratantoni and Schuh (2004) examine differential regional responses to monetary policy as a consequence not only of different regional sensitivity to policy shocks but also of differing regional economic conditions prevailing at the time of the shock. Finally, Owyang and Wall (2009) find evidence, not only of regional disparity in the response of personal income to monetary policy shocks, but strong evidence of a structural change in those responses corresponding to the Volcker-Greenspan era.

Our purpose is to complement this literature examining regional and state disparities in the response of income, employment, and other variables to monetary policy shocks. In particular, using state-level SVAR models, we offer evidence regarding heterogeneous effects of monetary policy on real wages across states in the U.S.[1] There is a substantial literature investigating the response of real wages to monetary policy shocks at the national level, which we review below, but no studies have looked at regional differences. Finding considerable heterogeneity in real wage responses, we attempt to explain it by exploiting cross-state variation in certain key economic variables. While pursuing this explanation, we accomplish an important secondary purpose of our research which is to test a hypothesis suggested by Huang, Liu, and Phaneuf (2004), HLP, that the sign and magnitude (cyclicality) of the response of real wages to a monetary policy shock depends on the input-output structure of the economy. Using a measure of state-level input-output structure, we find strong support for the HLP hypothesis. In addition, we find that state-level unemployment rates as well as a variable measuring unionization rates also help explain cross-state variation in the real wage response to monetary policy.

The next section of the paper briefly reviews the literature examining the real wage response to monetary policy using aggregate U.S. data. Section 3 establishes the aggregate U.S. evidence as a benchmark for comparison with our state-level analysis. We construct an economy wide SVAR that corresponds to the state-wide models estimated in Section 4. In Section 5, we consider explanations for the observed variation in state-level responses of real wages to monetary policy. In that section we discuss the HLP hypothesis and how we implement a test. The final section concludes.

2. LITERATURE REVIEW

There is a large empirical literature on the cyclicality of real wages in the U.S. beginning with Dunlop (1938) who found evidence of procyclical real wages which he interpreted as contradicting the implications of the fixed-wage theory of Keynes's General Theory. Numerous studies followed in the next several decades. Surveying the literature to that point, Fischer (1988) concluded that "the weight of the evidence by now is that the real wage is slightly procyclical." The studies he reviewed all looked at correlations (or similar measures) between U.S. real wages (variously measured) and indicators of U.S. aggregate economic activity.

[1] Our "states" include all 50 states in the U.S. and also the District of Columbia.

Studies since the Fischer survey have attempted to go beyond simple correlations. They recognize that such correlations do not necessarily reflect the cyclicality of the response of real wages to money shocks. For this more specific purpose, it is important to use methods that allow the researcher to isolate the specific effect of monetary policy shocks on real wages. A study by Silver and Sumner (1989) employed a clever strategy to identify years in which the economy was dominated by aggregate demand (presumably monetary) shocks. They showed that, in those years, real wages were strongly countercyclical.

Some more recent studies have constructed SVAR models and, imposing identifying restrictions, have isolated monetary (nominal demand) shocks in order to investigate the short-run effects of such shocks on real wages. Gamber and Joutz (1993), Spencer (1998), and Fleischman (1999) have taken this approach but do not reach a unified conclusion regarding the pro- or counter-cyclicality of the real wage response to monetary policy shocks. Our approach below comes closest to the approach of this line of research.

Other studies have examined how the cyclical response of real wages has changed over time in the U.S. and other countries. The consensus from this literature seems to be that real wages were mildly countercyclical in the interwar period but have become mildly procyclical during the post-World War II period.[2] Several explanations of this phenomenon have been proffered and investigated.[3] In a notable recent paper, Huang, Liu, and Phaneuf (2004), offered a novel explanation suggesting that, as the input-output structure of an economy becomes more dominated by final goods production, the response of real wages to an aggregate demand shock becomes more procyclical (less countercyclical) in an environment with both sticky wages and prices.

Though much effort has been expended to investigate the response of real wages to monetary policy at the national level, no previous study that we are aware of has looked at the regional or state level. Our purpose is to begin to fill that void with the expectation that a deeper understanding of variation across states can enhance our understanding of the relationship between real wages and monetary policy.

[2]See, for example, Bernanke and Powell (1986), Hanes (1996) and Basu and Taylor (1999).

[3]One explanation is that supply shocks in the form of oil price shocks became predominant in the post-war period leading to procyclical real wages. But, as Huang, Liu, and Phaneuf (2004) argue, this can't be the full explanation since, as shown by Basu and Taylor (1999), wages became procyclical before the major oil price shocks of the 1970s.

3. U.S. EVIDENCE

Although our primary interest is in the state-by-state response of real wages to an aggregate monetary shock, it is useful to examine the economy-wide results as a benchmark. Accordingly, we here construct a three-equation SVAR model for the U.S. economy that will allow us to examine how real wages respond to monetary policy shocks at the aggregate level. For transparency and clarity of comparison, our U.S. model will be the aggregate counterpart to the state-level SVAR models we estimate in the next section. Because of data limitations at the state level to be discussed below, we construct an annual model. The three variables[4] we choose are dictated by our interest in the effect of monetary policy on real wages and the kind of data available at the state level. Our interest in real wages causes us to focus on the labor market. As a result, the three variables include the (difference of the) log of the real wage rate, the (difference of the)[5] log of aggregate employment, and an exogenous aggregate monetary policy shock.[6] Corresponding to the specification we prefer for the state-level models, we include two lags in each equation.[7] As our measure of aggregate monetary policy shocks we employ annual averages of a measure developed by Romer and Romer (2004). This measure has been carefully constructed to purge the federal funds rate of endogenous and anticipatory movements.[8] Since the Romer and Romer series only extends to 1996, our sample period is constrained to annual data over the period 1969-1996. Following the approach of Christiano, Eichenbaum, and Evans (1996, 1999) and Romer and Romer (2004), we use a standard Cholesky (recursive) identification technique with the monetary policy shock last on the ordering. Our principal interest is in the impulse response function, IRF, corresponding to the response of the (log of the) real wage to a one percentage point shock to monetary policy. This is displayed in Figure 1 along with a 95% confidence band constructed using the degrees of free-

[4]Other SVAR models that have this same interest choose similar structures. They differ principally because these earlier studies apply the Blanchard and Quah (1989) strategy to identify monetary policy (nominal) shocks. See, e.g., Gamber and Joutz (1993), Spencer (1998) and Fleischman (1999).

[5]We first difference the logs of the real wage and employment to induce stationarity.

[6]See the data appendix for a detailed description of the data.

[7]Justification for this choice will be given when we discuss the state SVAR models in the next section.

[8]We use the Romer and Romer shock series they label SUMSHCK which reflects monetary shocks in terms of interest rate levels. We obtain our annual series by taking an annual average of their monthly data for each year. Furthermore, since the Romer and Romer shock series reflects shock to the federal funds rate, we actually take the negative of their shock so that our key impulse response function corresponds to the effect on the real wage of an expansionary monetary policy shock.

dom adjusted (DFA) bootstrapped estimates to avoid a bias pointed out by Phillips and Spencer (2011). We computed 10,000 bootstrap replications.

The IRF in Figure 1 indicates that the short-run response of real wages is slightly procyclical though it eventually falls to zero and then becomes slightly negative (though never significantly so). In other words, an expansionary monetary policy shock causes real wages to increase in the short-run. This is consistent with the weight of the evidence from previous studies of the U.S. economy. For later explanatory analysis, it will be important to obtain a single representative measure of the short-run real wage response to monetary policy shocks (which we will denote RWR for real wage response). It seems reasonable to take the first-period (one year) response of our measure of the real wage to a monetary policy shock. As we see from Figure 1, this effect (RWR) is positive but not quite statistically significant as indicated by the fact that the 95% confidence band includes zero for the first lag. The value of RWR ($\times$ 100) is 0.284 with corresponding 95% confidence band given by $(-0.027, 0.630)$.

These annual results serve as a baseline for the state-level SVAR models estimated in the next section which must be estimated annually due to data limitations. However, we can examine the robustness of our annual U.S. results and, furthermore, contribute more generally to the aggregate-level literature on this issue by specifying and estimating a monthly SVAR model for the U.S. As in the annual model, the three variables include the (difference of the) log of the real wage, the (difference of the) log of aggregate employment and monthly observation of the Romer and Romer direct measure of monetary policy.[9] As above, we continue to impose a Cholesky identification strategy with the monetary policy shock last in the ordering.

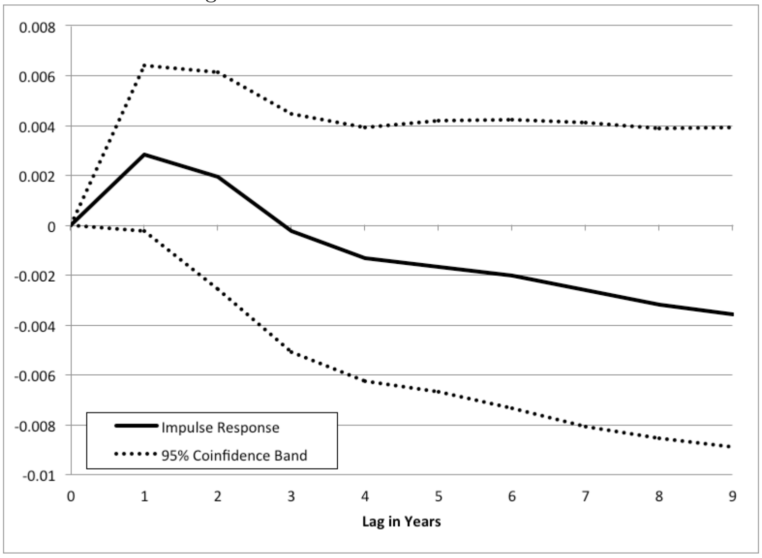
The results for the monthly U.S. model are given in Figure 2 which, once again, focuses on the IRF showing the effects of an expansionary monetary policy shock on the real wage rate with 95% confidence bands. The monthly results broadly confirm our annual results. The initial real wage response is slightly procyclical and then countercyclical as for the annual IRF. Furthermore, the U.S. IRF continues to be statistically insignificant as it was in Figure 1.

These results complement the previous aggregate U.S. literature reviewed above since we use the Romer and Romer direct measure of monetary policy rather than identifying monetary policy shocks using either a recursive model structure or by employing long-run restrictions following Blanchard

[9]The monthly real wage series is obtained by deflating the wage for total private production and nonsupervisory workers (FRED code: AHETPI) by the PPI for finished goods (FRED code: PPIFGS). Employment is total private industry employment (FRED code: USPRIV) and our measure of monetary policy is the Romer and Romer variable SUMSHCK as our direct measure of monetary policy.

and Quah (1989). We find that the short-run impact of a monetary policy shock on real wages is insignificantly countercyclical.

FIG. 1. The impulse response function for the U.S. showing the effect of a one percentage point monetary policy shock on (the log of) real wages with a DFA bootstrapped 95% confidence band using annual data.



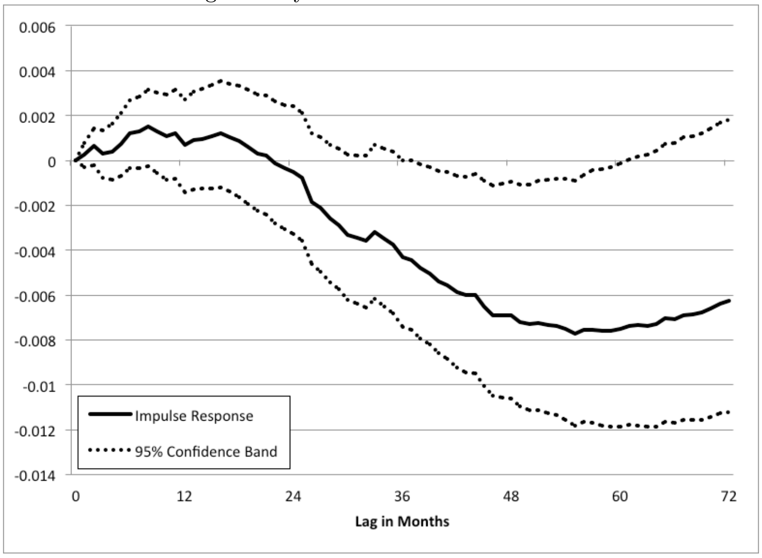
4. STATE EVIDENCE

Given the benchmark provided by the aggregate results of the previous section, we now use a similar approach to investigate the heterogeneity of the real wage response to monetary policy shocks across the 50 states and the District of Columbia. Using state data,[10] we construct 51 state-level three-equation SVAR models of the form estimated in the previous section for the U.S.[11] We are constrained to use annual data since employee compensation by state is only available on an annual basis. Furthermore, the sample period is constrained to the period 1969-1996 since the state employment series we use begins in 1969 and the monetary policy shock from the Romer and Romer series ends in 1996. We include two lags

[10]The data are described in the data appendix. For ease of terminology, we refer to the District of Columbia as a state.

[11]While the variables for real wages and employment are at the state-level, our monetary shock is, of course, the same aggregate shock used in the U.S. model based on the Romer and Romer series.

FIG. 2. The impulse response function for the U.S. showing the effect of a one percentage point monetary policy shock on (the log of) real wages with a DFA bootstrapped 95% confidence band using monthly data.



in the model equations in each state.[12] As with the aggregate model of the previous section, we use a Cholesky identification technique with the monetary policy shock last in the ordering.

As for the U.S. as a whole, we obtain a single representative measure of the short-run real wage response (RWR) to monetary policy for each state from the IRF of real wages with respect to the monetary policy shock. For each state, we take the first-period (one year) response. The results for each state are reported in Table 1 in the column labeled RWR $\times$ 100. We see that most states are characterized by a procyclical real wages response (i.e., a positive value of RWR) with the average ($\times$ 100) being 0.296. It is comforting to see that this is quite close to the aggregate value of RWR reported in the previous section. On the other hand, several states exhibit a countercyclical real wage response. The range of values of RWR $\times$ 100 is $(-0.417, 1.107)$ with a standard deviation of 0.279. This confirms the existence of considerable heterogeneity across states in the response of real

[12]With the objective of finding the "best" common SVAR specification for all states, we examined three criteria for choosing lag length: the Akaike Information Criterion (AIC), the Hannan-Quinn Criterion (HQC), and the Schwarz Criterion (SC). Considering one, two, and three lags, the results were slightly mixed. Both the AIC and HQC reflected a first choice for two lags and a second choice for three lags while the SC identified one lag as first choice and two lags as second choice. This suggests a best overall choice of two lags.

wages to an aggregate monetary policy shock. We also report the value of the importance of intermediate goods by state, denoted φ. We discuss the importance of this measure in section 5 below.

TABLE 1.

State values for RWR and φ

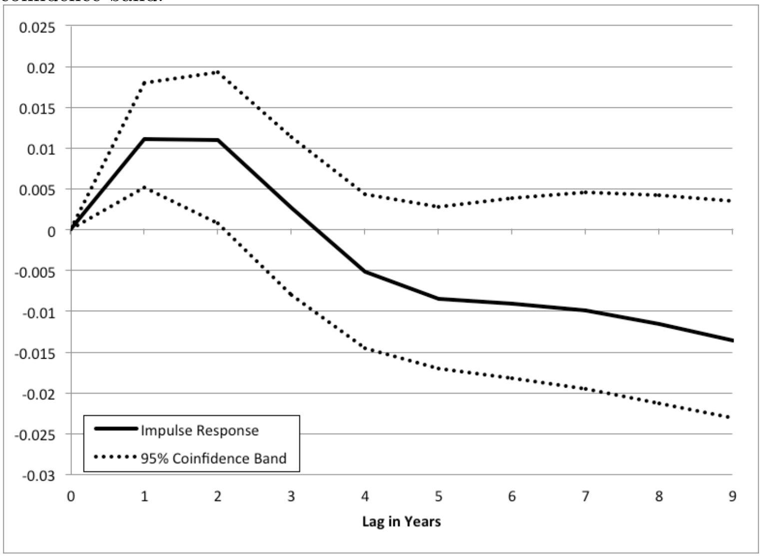
State	RWR × 100	φ	State	RWR × 100	φ
Alabama	0.624	0.589	Nevada	0.259	0.51
Alaska	−0.417	0.7	New Hampshire	0.084	0.473
Arizona	0.258	0.521	New Jersey	0.01	0.546
Arkansas	0.603	0.608	New Mexico	0.277	0.637
California	−0.007	0.529	New York	−0.209	0.478
Colorado	−0.022	0.554	North Carolina	0.315	0.555
Connecticut	0.005	0.456	North Dakota	0.19	0.739
Delaware	0.414	0.703	Ohio	0.624	0.552
District of Columbia	−0.041	0.395	Oklahoma	0.534	0.649
Florida	0.166	0.533	Oregon	0.302	0.552
Georgia	0.198	0.605	Pennsylvania	0.391	0.549
Hawaii	0.456	0.685	Rhode Island	0.241	0.501
Idaho	0.560	0.6	South Carolina	0.61	0.557
Illinois	0.392	0.568	South Dakota	0.471	0.634
Indiana	0.313	0.58	Tennessee	0.289	0.555
Iowa	0.635	0.617	Texas	0.16	0.685
Kansas	0.466	0.677	Utah	0.482	0.605
Kentucky	0.483	0.596	Vermont	0.292	0.451
Louisiana	0.384	0.786	Virginia	0.219	0.534
Maine	0.323	0.536	Washington	0.212	0.67
Maryland	0.054	0.529	West Virginia	0.136	0.584
Massachusetts	−0.187	0.459	Wisconsin	0.335	0.562
Michigan	1.107	0.601	Wyoming	0.907	0.814
Minnesota	−0.126	0.562			
Mississippi	0.596	0.594	Mean	0.298	0.589
Missouri	0.096	0.583	S.D.	0.279	0.09
Montana	0.492	0.803	Max	1.107	0.814
Nebraska	0.267	0.702	Min	−0.417	0.395

Although it would require too much space to report the IRFs for each of the 51 locations, we do report the IRFs for the two most extreme states in terms of RWR values (× 100): Michigan (1.107) and Alaska (−0.417). Interestingly, Carlino and DeFina (1999) find Michigan to have the most responsive real personal income in response to a monetary shock. Their least responsive state, Oklahoma, however ranks as the tenth most positively responsive on our list. The IRFs for Michigan and Alaska are given in

Figures 3 and 4 respectively. As before, the 95% bootstrapped confidence bands are constructed using the bias-reducing DFA approach and 10,000 bootstrap replications.

The Michigan results indicate that real wages behave with a strong procyclical short-run response to an aggregate monetary policy shock. Furthermore, the large positive one-year response is statistically significant since the corresponding values of the confidence band ($\times$ 100) does not include zero $(0.507, 1.795)$. The results for Alaska show a countercyclical short-run real wage response which turns out to be statistically insignificant at the 5% level.

FIG. 3. The impulse response function for Michigan showing the effect of a one percentage point monetary policy shock on (the log of) real wages with a DFA bootstrapped 95% confidence band.

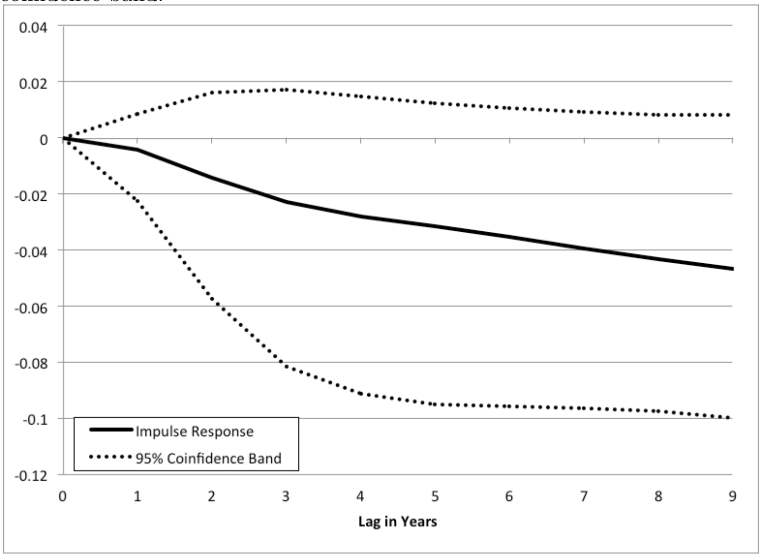


5. SEEKING AN EXPLANATION

What differences in state characteristics can explain this variation in RWR across states? We attempt to answer that question in this section by running a cross-section regression of RWR on potentially useful candidate explanatory variables. Three of these variables readily suggest themselves when we consider the importance of nominal wage stickiness while a fourth follows from the paper by Huang, Liu, and Phaneuf (2004), HLP. We discuss the HLP hypothesis first.

The Prediction of the HLP Model

FIG. 4. The impulse response function for Alaska showing the effect of a one percentage point monetary policy shock on (the log of) real wages with a DFA bootstrapped 95% confidence band.



Using insights from Basu (1995), Hanes (1996, 1999) and Basu and Taylor (1999), HLP construct a dynamic stochastic general equilibrium (DSGE) model with the principal purpose of investigating how the response of real wages to a monetary shock is affected by changes in the input-output structure of an economy characterized by both wage and price stickiness.

Their model has differentiated intermediate goods and differentiated labor. Each intermediate goods producer supplies a unique good and enjoys some degree of monopoly power. The same is true of households which supply unique forms of labor. Final goods producers combine intermediate goods into a final good which can be used for consumption, investment, or as an input in the production of intermediate goods. Similarly, the various unique forms of labor are aggregated into a labor composite which is also used in the production of intermediate goods.

Any particular intermediate good is produced using three inputs: capital, labor and an aggregation of all intermediate goods. The importance of this aggregated good in production is summarized by the key parameter φ, which is the Cobb-Douglas share of intermediate goods (as opposed to capital and labor) in the goods production function.

Suppliers of labor services and intermediate goods set prices using a staggered Taylor-style price setting arrangement; see Taylor (1980, 1999). That is, contracts are set for N periods and one-Nth of the households (firms) are allowed to set wages (prices) each period. Labor suppliers and intermediate goods producers solve two types of problems. First, given their fixed wage or price set previously, they choose the optimal amount to supply each period. Second, every N periods they choose what the fixed wage or price will be for the next N periods.

HLP focus on the parameter $\varphi \in (0,1)$, reflecting the importance of intermediate goods in the production function (with a value of zero reflecting a zero share of intermediate goods in production). They look at this in the context of three specific models: the first with staggered price-setting and flexible wages, the second with staggered wage-setting and flexible prices, and the third with both staggered price- and wage-setting. They show that, given a calibrated parameterization of the model, when prices are sticky and wages flexible, real wages respond procyclically to a monetary policy shock (i.e., RWR is positive) regardless of the value of φ. In the reverse situation with sticky wages and flexible prices, their model implies that real wages respond countercyclically to a monetary policy shock regardless of the value of φ.

In the model with both price and wage stickiness, however, the response of real wages to a monetary policy shock depends critically on φ. When φ is small so intermediate goods are not so important in the production process, real wages tend to be countercyclical in response to monetary policy shocks and, when φ is large, real wages are procyclical. The intuition for this result follows from the fact that, as the share of intermediate inputs increases, "the rigid intermediate input price becomes a more significant component of marginal cost; as a result, the price level becomes more rigid, making real wages more procyclical" (HLP, p. 838).

Though the HLP model was developed to think about an individual economy as the complexity of the input-output structure evolves over time, it also implies that real wages will be more procyclical in economies with more complex input-output structures, other things equal. Consequently, variation in input-output complexity, φ, across states of the U.S. can potentially help explain variation in RWR. The HLP hypothesis predicts that RWR will be positively related to φ. If we can obtain a measure of φ for each state, we can test the HLP hypothesis and also help achieve our objective of explaining state variation in RWR.

Empirical Evidence

In order to examine the HLP hypothesis empirically it will be necessary to obtain an empirical counterpart for φ, which "measures the share of payments to intermediate inputs in total production costs" (HLP, p. 844). For an approximate measure of φ for each state, we use the 1982 value of the cost of materials used in manufacturing divided by the value of total shipments taken from the 1982 Annual Survey of Manufacturers. We choose the 1982 value since that is the observable year close to the midpoint of the sample used to calculate RWR.[13] This value for φ for each state is reported in Table 1.

We note that while HLP refer to economies with higher φ as being more "complex," this description may not hold for U.S. states which are more akin to small open economies. In this context, a higher value of φ implies the state produces a greater number of final goods. However, the state economy could actually be less complex if all intermediate goods are produced elsewhere and imported.

In addition to φ, we consider three additional variables that could potentially influence the cyclicality of real wage in each state: the 1982[14] value of the state unemployment rate, the 1982 state share of agriculture, forestry, and fishing in state GDP, and the 1983[15] state degree of unionization.[16] Since macroeconomic theory suggests, other things equal, more flexible wages imply that real wages respond less countercyclically (more procyclically) to monetary policy shocks, we want to consider other variables that might affect the flexibility of wages in each state. We expect higher unemployment rates, a higher share of agriculture, and a lower degree of unionization to correspond to more flexible wages. Higher unemployment rates are likely to put downward pressure on wages resulting in greater flexibility of nominal wages. Of course, low unemployment should therefore put upward pressure on wages. However, we are not so concerned with the sign of this effect, but with controlling for any effect unemployment has on wage stickiness. If the agricultural labor market differs significantly from the market for non-agricultural labor, it will be important to control for these effects as well. We hypothesize that the supply of labor in agriculture is more elastic and that wages overall will therefore be more flexible in states with large agricultural sectors. Finally, a higher degree of unionization should lead to a larger percentage of workers' wages being subject to explicit wage contracts and therefore to more wage stickiness.

We examine the variation in RWR across states by estimating a cross-state regression of RWR on, φ, the rate of unemployment, the share of agriculture, forestry, and fishing in state GDP, and the union membership rate. The results are reported in Table 2. We see that each of the explanatory variables is significant at at least the 10% level with ? and union membership significant at the 5% level and unemployment significant at the 1% level. Consequently, all of these variables seem to help explain the heterogeneity of RWR across states.

[13]Furthermore, data for earlier periods are unavailable for one of the variables we later use in our cross-section models below.

[14]Once again, we take the 1982 value as being representative for each state over the 1969-1996 period.

[15]This series begins in 1983, thus the 1982 value is unavailable.

[16]Please see the Data Appendix for precise descriptions of the data.

TABLE 2.
OLS Regressions of RWR (Real Wage Response to a Monetary Policy Shock) on the Indicated Variables

φ-Measure	0.0100^{**}
	(0.004)
Unemployment	0.0005^{***}
	(0.0003)
Agricultural Share of GDP	0.0199^{*}
	(0.012)
Union Membership	-0.0110^{**}
	(0.005)
R^2	0.356
Adjusted R^2	0.300

Note: $N = 51$. Standard errors are given in parentheses. ***, **, and * denote statistical significance at 1%, 5%, and 10% levels.

Returning specifically to the HLP hypothesis, we focus on the importance of the HLP variable φ. The regression results suggest that values of φ are positively and significantly associated with variation in RWR across states. This is consistent with the prediction of the HLP model and thus provides a successful empirical test of that hypothesis. This result is of independent empirical interest.

6. CONCLUSION

Recent research has made us increasingly aware that business cycle properties are quite disparate across regions and states of the U.S. In particular, considerable evidence has documented much heterogeneity across regions and states in the response of output, employment, and housing variables to monetary policy shocks.

While a substantial literature has investigated the nature of the response of real wages to monetary policy shocks at the national aggregate level, none to this point have considered the disparity of responses across states of the U.S. Using SVAR models, we report evidence that there is much variation in state-level real wage response to an aggregate monetary policy shock. While our results indicate that the U.S. economy seems to produce a slightly procyclical response of real wages to monetary shocks, there is much variation across states. Some states exhibit a strong procyclical response while others are characterized by a countercyclical response.

Furthermore, we offer evidence that this variation can be explained by cross-state differences in the rate of unemployment, the share of agriculture in state GDP, the unionization rate, and a variable (φ) which captures the importance of intermediate goods in state production. The relevance of this last variable is of particular interest since it provides a statistical test confirming the fundamental prediction of the model due to Huang, Liu, and Phaneuf (2004).

Though it is beyond the scope of this study, our findings that the monetary policy shocks will cause real wages to temporarily rise in some states and temporarily fall in others has implications for the effects of monetary policy of regional inequality.

APPENDIX: DATA APPENDIX

Data series for the annual SVAR models (for the U.S. and states over 1969-1996):

- Romer & Romer (2004) SUMSHCK 12-month average for 1969-1996
- Log differenced **real wage** where

  – Nominal wage — private nonfarm compensation from BEA Regional Data / GDP by State / SIC (see http://www.bea.gov/regional/index.htm); Table SA06, line 90.

  – Price level — national implicit price deflator for GDP (same for all states) (see Table 1.1.9 of the BEA NIPA tables)

- Log differenced **employment** — private nonfarm wage and salary employment from BEA Regional Data / State Quarterly Personal Income & Employment / Full-time and part-time wage and salary employment by industry / SIC / Private nonfarm wage and salary employment (see ttp://www.bea.gov/regional/index.htm); Table SA27, line 90.

Regressions are performed using the following data series (by state):

- Measure of real wage cyclicality is derived from structural VAR results as described in the body of the paper.
- φ-1982 measure of the cost of materials in manufacturing / value of total shipments (from Economic Census — Annual Survey of Manufacturers, Census Bureau http://www.census.gov/manufacturing/asm/). Data collected from scanned reports is available upon request.
- Unemployment rate — seasonally adjusted unemployment rate in December 1982 (BLS see http://www.bls.gov/lau/data.htm).
- Share of agriculture, forestry, and fishing in state GDP in 1982 (BEA Regional Data / GDP by State / SIC — Industry Code 3 divided by Industry Code 1).

• Degree of unionization as measured by the CPS Merged Outgoing Rotation Groups, 1983 (http://www.nber.org/morg/annual). The variable we use is "unionmme."

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