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Narrative and VAR approaches to monetary policy: Common identification problems

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Abstract

Romer and Romer [Romer, C.D., Romer, D.H., 1989. Does monetary policy matter? A new test in the spirit of Friedman and Schwartz. In: Blanchard, O.J., Fischer, S. (Eds.), NBER Macroeconomics Annual 1989. MIT Press, Cambridge, MA, pp. 121–170; Romer, C.D., Romer, D.H., 1994. Monetary policy matters. Journal of Monetary Economics 34, 75–88] adopted a narrative approach to address the identification problems in time series models of monetary policy. Based on Federal Reserve documents, the Romers created a dummy variable equal to one in periods when the Federal Reserve contracted in response to perceived inflationary pressures. This paper shows: (1) the dummy variable is predictable from past macroeconomic variables, reflecting the endogenous response of policy to the economy; (2) unpredictable changes in the dummy do not generate dynamic responses that look like the effects of monetary policy. The identification problems that plague time series models also afflict the narrative approach.

Keywords: Monetary policy; Narrative approach; Identification
JEL classification: E30; E40; E41; E50

1. Introduction

It is by now well-documented that time series models that identify statistical innovations in a monetary aggregate or a short-term interest rate with monetary

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policy shocks produce dynamic responses of some variables to such shocks that are inconsistent with the predictions of traditional theories of monetary policy (Eichenbaum, 1992; Leeper and Gordon, 1992; Sims, 1992; Gordon and Leeper, 1994; Leeper et al., 1996; Cushman and Zha, 1997). In an influential paper, Romer and Romer (1989) adopted a 'narrative approach' to address the identification problems highlighted by time series models. Based on their reading of Federal Reserve documents, the Romers created a dummy variable for periods when the Federal Reserve contracted to offset inflationary pressures. They argued that the responses of output and unemployment to such identified monetary policy contractions demonstrate that monetary policy has strong and persistent real effects on the economy, an interpretation other authors have adopted (for example, Ball, 1991; Fortin, 1991; Eichengreen, 1993; Shapiro, 1994; Ball and Mankiw, 1995).

The Romers' measure of contractionary monetary policy shocks has rapidly gained acceptance as a standard indicator of monetary policy. Bernanke and Blinder (1992) argued that the tendency for the federal funds rate to peak around dates that the Romers identify as monetary policy contractions suggests that the Federal Reserve systematically raises interest rates in response to inflationary pressures. Romer and Romer (1990), Kashyap et al. (1993), and Oliner and Rudebusch (1995, 1996) used the Romers' policy variable to analyze the transmission mechanism of monetary policy. Gertler and Gilchrist (1994) used the Romers' dummy, along with other indicators of monetary policy, to study the differential impact of policy on small versus large manufacturing firms. Boschen and Mills (1995) compared the Romers' dummy to other narrative indicators of monetary policy and argued that a shock to the Romers' dummy implies responses of monetary aggregates and the federal funds rate that are consistent with the existence of a liquidity effect from monetary policy.

Narrative approaches along the lines of the Romers' and time series methods employed in the identified vector autoregression (VAR) literature have developed largely independently.[1] The lack of interaction is surprising, as the two approaches address the same set of economic questions. It is also unfortunate because the approaches can learn from each other. This paper embeds the Romers' monetary policy dummy in a conventional VAR analysis, revealing striking similarities between the two methods of estimating monetary policy behavior. Hard identification problems arise in both approaches.

Any effort to quantify policy effects must separate the regular response of policy behavior to the economy from the response of the economy to policy. If the Romers' narrative approach has successfully separated endogenous policy responses from exogenous contractionary policy disturbances, then their results

[1] Bernanke and Blinder (1992) and Gertler and Gilchrist (1994) are exceptions.

ought to be robust to embedding the dummy variable in a more general macro model that includes a behavioral equation for policy that determines the dummy. This paper constructs two relatively unrestricted models containing the monetary policy dummy and six macro time series. One model respects the dichotomous nature of the dummy variable and estimates a logit equation for it, along with linear equations for the macro series. The logit equation implies the dummy can be predicted from past macro conditions, reflecting the systematic dependence on the economic state of the decision to contract monetary policy. It turns out the dynamic responses of macro variables to a disturbance in the logit equation are very similar to those produced by a model including a linear equation for the dummy variable. Much of the analysis, therefore, is conducted in a vector autoregression. The analysis shows that: (1) conditional on the history of a few macro variables, unpredictable changes in the dummy do not generate dynamic responses that look like the effects of monetary policy; and (2) the dummy variable appears to be contaminated by endogenous responses of monetary policy. Findings (1) and (2) are similar to the identification problems that emerge when innovations in interest rates are identified with monetary policy shocks. These results cast doubt on the Romers' claim to have identified the effects of contractionary monetary policy.[2] The results should also generate discomfort among researchers who use the Romers' dummy as a measure of monetary policy and interpret regressions of macro variables on the dummy as reporting the effects of monetary policy.

2. Why a narrative approach?

Some of the difficult identification problems that plague time series models of monetary policy are summarized in a six-variable VAR. Many researchers have identified statistical innovations in a short-term interest rate with monetary policy shocks (Sims, 1980; Bernanke and Blinder, 1992). Fig. 1 reports the responses of industrial production (Y), consumer prices (P), the three-month Treasury bill rate ($R3$), the 10-year US Treasury bond yield ($R10$), total reserves (TR), and commodity prices (PCM) to a one-standard deviation innovation in the short-term interest rate.[3] The solid lines are point estimates of the responses

[2] Dotsey and Reid (1992) and Hoover and Perez (1994a,b) presented several reasons why the Romers' methodology may be incapable of quantifying the effects or strength of monetary policy. The arguments in both papers differ from those in this paper.

[3] Appendix A describes the data. This and subsequent VARs include a constant term, seasonal dummies, and 18 lags of each variable and are estimated from July 1948 to June 1996, with January 1947 to June 1948 as initial conditions. This adds recent data to the period that Romer and Romer (1994) studied in their updated paper. Y, P, TR and PCM are measured in logs and interest rates are measured in percentage points. $R3$ is treated as predetermined in the system.

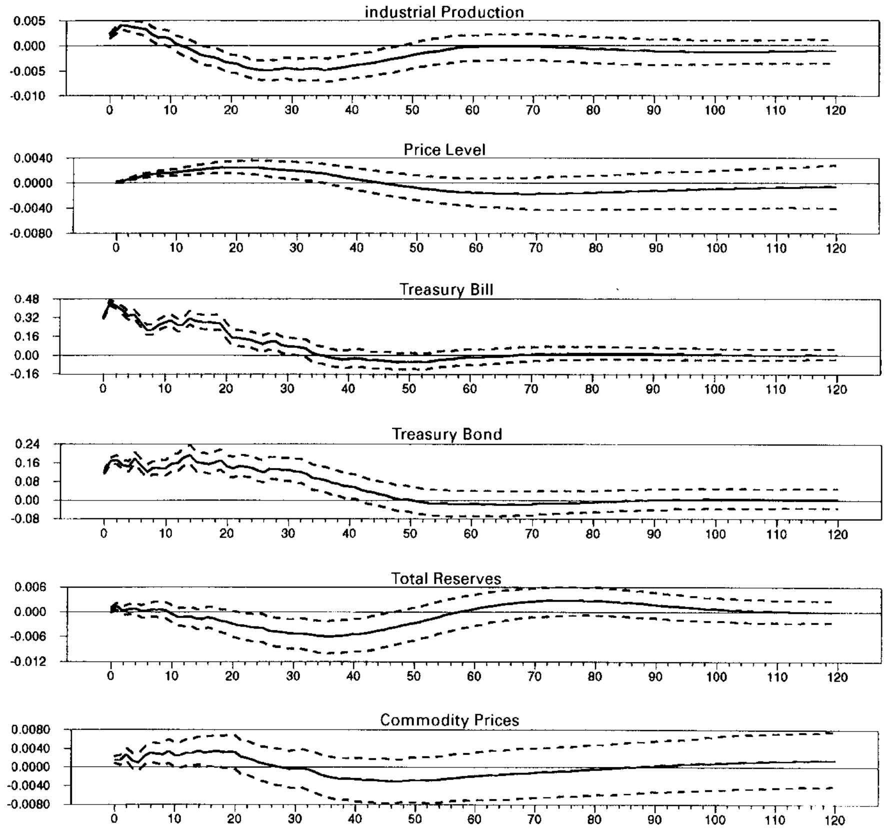

Fig. 1. Responses over 120 months to one-standard deviation innovation in $R3$. Solid lines are point estimates, dashed lines are 68% probability bands estimated point by point. VAR specification described in footnote 3.

over a 10-year horizon and the dashed lines are 68% probability bands estimated point by point.[4]

The sharp decline in production, which reaches a trough two-to-three years following the $R3$ innovation, is characteristic of the response pattern found by Sims (1980), Litterman and Weiss (1985) and others. This pattern has been widely interpreted as evidence that monetary policy contractions reduce

[4] The probability bands are calculated using the Bayesian Monte Carlo procedure in RATS and are based on 1000 draws. The 68th percentile bands correspond to one standard deviation, which is what the Romers report.

nominal aggregate demand and lower output when prices adjust sluggishly (Bernanke and Blinder, 1992). The decline in total reserves is consistent with interpreting the positive $R3$ innovation as a contractionary monetary policy shock.

The price level rises significantly for almost three years after the shock. Eichenbaum (1992) dubbed this the 'price puzzle' because it seems inconsistent with interpreting the positive innovation as a monetary contraction.[5] Prices begin to decrease after four years, but the error band continues to place high probability on zero or positive responses. The long-term interest rate rises strongly for four years before returning to its original level. This pattern of long-rate responses, combined with both price level and short-rate responses that are not significantly different from zero after three years, is difficult to reconcile with the expectations theory of the term structure.

The identification can be saved by telling a story, such as in Sims (1992), which reverses the direction of causality between interest rates and prices. The monetary authority bases its decisions on more information than is contained in small VARs, so what appear as unforecastable increases in prices in VARs are to some extent predictable to policy authorities. Monetary policy contracts to dampen the foreseen inflationary pressures and actual prices rise less than they would have had policy not contracted. The interest rate innovation is not an 'exogenous' policy shock, of course, because it is contaminated by the endogenous response of policy to anticipated inflationary pressures generated by non-monetary policy disturbances. If the inflationary pressures are generated by bad future supply conditions, for example, the contamination may mistakenly attribute the output effects of supply shocks to monetary policy. As surveyed in Leeper et al. (1996), much recent work in the VAR literature has attempted to address the anomalies appearing in Fig. 1.

The Romers' approach can be understood as a reaction to the 'reverse causation' explanations of the data that time series methods appear to require. Romer and Romer (1989) adopted a "narrative approach [which] allows a vast body of information that cannot be employed in conventional statistical tests to be brought to bear on this question. And it is this additional information that can solve the problem of identifying the direction of causation between monetary factors and real economic developments" (p. 167). They argue that the reason statistical techniques like VARs "probably have not played a crucial role in forming most economists' views about the real effects of monetary disturbances is that such procedures cannot persuasively identify the direction of causation" (p. 121).

[5] This pattern is robust across data frequencies, interest rate measures, sub-periods of the US sample, and different countries (Sims, 1992; Gordon and Leeper, 1994; Cushman and Zha, 1997).

In the place of formal econometric methods, the Romers relied exclusively on Federal Reserve records to identify monetary policy. The Romers identified contractionary policy shocks as "episodes in which the Federal Reserve attempted not to offset perceived or prospective increases in aggregate demand but to actively shift the aggregate demand curve back in response to what it perceived to be 'excessive' inflation. Or ... we look for times when concern about the current level of inflation led the Federal Reserve to attempt to induce a recession" (p. 134).

The Romer dummy was constructed to reflect times when the Federal Reserve tightened monetary policy in response to information about current or expected inflation. The dummy is expected, therefore, to be correlated with past economic conditions. Based on their criterion, in an updated paper Romer and Romer (1994) identified seven times since World War II when the Fed attempted to reduce inflation by inducing a recession: October 1947, September 1955, December 1968, April 1974, August 1978, October 1979, and December 1988. The Romers' monetary policy shock series consists of ones in these months and zeroes elsewhere.

3. Econometric preliminaries and the Romers' estimation

The Romers estimated the following regression, where x_t is the variable of interest (for example, the growth rate of output) and D_t is their monetary contraction dummy variable:[6]

$$x_t = c(L)D_t + d(L)x_{t-1} + u_t, \tag{1}$$

and they report the dynamic response of x to D computed as

$$\frac{c(L)}{1 - d(L)L}. \tag{2}$$

Although the Romers referred to Eq. (2) as the 'impulse response function' of x with respect to D, it is actually the impulse response function only under certain assumptions on the bivariate representation of x and D. Suppose that x and D have the vector autoregressive representation

$$\begin{aligned} D_t &= a(L)D_{t-1} + b(L)x_{t-1} + v_t, \\ x_t &= c(L)D_t + d(L)x_{t-1} + u_t, \end{aligned} \tag{3}$$

[6] They also included a constant and seasonal dummies, which are excluded from this analytical discussion but included in the empirical work.

where $a(L)$, $b(L)$, $c(L)$, and $d(L)$ are scalar polynomials in non-negative powers of the lag operator L and the innovations, u and v, have covariance matrix Σ.[7] To mimic the Romers' specification, Eq. (3) assumes that D is predetermined for the x equation, so the innovations are orthogonalized disturbances and Σ is diagonal. Predeterminedness amounts to assuming monetary policy does not respond to any information within the month. The moving average representation of Eq. (3) is

$$\begin{bmatrix} D_t \\ x_t \end{bmatrix} = \begin{bmatrix} 1 - a(L)L & -b(L)L \\ -c(L) & 1 - d(L)L \end{bmatrix}^{-1} \begin{bmatrix} v_t \\ u_t \end{bmatrix}. \tag{4}$$

For expositional ease, suppose that $a(L) = 0$, then the response of x to an innovation in D is

$$\frac{c(L)}{1 - d(L)L - b(L)c(L)L}. \tag{5}$$

Sufficient conditions for the expansions in Eqs. (2) and (5) to be equal are that either $b(L) = 0$ or $c(L) = 0$ for all L. When $b(L) = 0$ and there are no cross-equation restrictions, D is weakly exogenous in the x equation and OLS estimation of Eq. (1) will give consistent estimates of the structural relationship between D and x; when $c(L) = 0$, D has no effect on x. Thus, assuming $c(L) \neq 0$, the Romers' econometric techniques will be appropriate only under the restriction that $b(L) = 0$.

Results from estimation of Eq. (1) for each of six macro variables appear in Fig. 2.[8] The responses from the expansion in Eq. (2) to a unit shock in the monetary policy dummy, along with their 68% probability bands, are graphed over a 10-year horizon. The response of Y is much like that reported by the Romers, with production apparently about 5% lower even 10 years after the

[7] x can be thought of as a vector of macro time series, with the polynomials in Eq. (3) matrix polynomials in L. Although the empirical work that follows adopts this more general representation, the bivariate case makes the analytical points clearer.

[8] Following the Romers, Y, P, TR and PCM are estimated as changes in logs and the responses are cumulated to produce the result for the log level; the interest rates are in percentage points and the responses are not cumulated. The results are essentially unchanged when the first three variables are estimated in log levels and the responses are not cumulated, as in the specification underlying Fig. 1. To be consistent with the Romers' work, Eq. (1) is estimated with 36 lags of D and 24 lags of x, so the estimation period is January 1949 to June 1996, using as initial conditions data on the regressor from January 1947 to December 1948 and data on the monetary policy dummy from January 1946 to December 1948. To generate error-bands for the impulse responses that impose the assumption that the monetary policy dummy is an exogenous stochastic process, I apply the methods developed by Zha (1996). The methods ensure that the Monte Carlo simulations take draws from the exact posterior probability distribution of the model parameters, while taking account of the exogeneity restrictions.

shock. Except for the impact effect and the persistence, this response is similar to the response of output to an $R3$ innovation. The 'price puzzle' documented in Fig. 1 becomes more puzzling when the Romers' dummy is shocked. The price level never falls and is a significant 5% higher four or more years after the shock.[9] The Romers' dummy raises the short-term interest rate significantly for two years before the rate returns to its pre-shock level; the short rate is about two percentage points higher for six months. Although reserves decline and are persistently lower at more distant horizons, they do not fall significantly during most of the period that short rates are significantly higher. The response of the long-term interest rate is striking: It rises significantly over the entire forecast horizon, peaking at a little under two percentage points higher 18 months after the shock, and remains 50 basis points higher after ten years.[10]

If the Romers' narrative approach successfully isolated contractionary monetary policy shocks, then the responses in Fig. 2 report how a monetary contraction affects future output, prices, interest rates, and reserves. A straightforward reading of the results that does not resort to 'reverse causation' stories says that the levels of output and reserves are persistently lower, while the levels of prices and long rates are persistently higher after the Fed contracts to offset current inflationary pressures. In addition to the obvious inconsistency of the responses with the predictions of traditional monetary theories, the persistent increase in long rates seems difficult to reconcile with a temporary increase in short rates, a once-and-for-all increase in the price level, and a once-and-for-all decrease in the level of output.

4. Is the Romers' dummy exogenous?

The previous section emphasizes that the dynamic responses of, say, output, to a Romer dummy depend not only on the coefficients in the output equation,

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[9] When estimated over the entire sample period, the price response is robust to the elimination of any one Romer date except August 1978, when it is insignificant for four years before rising steadily. The perverse price response is sensitive to the starting date of the sample. When estimated over periods starting in January 1950 or later, there is no persistent increase in prices, although prices do tend to rise significantly for almost two years before becoming insignificantly different from zero. Results from the shortened samples accord with the findings of Shapiro (1994) for his 'inflation stationary' model. The unstable responses of consumer prices hold across different price level measures, including CPI commodities only, CPI less shelter, and producer prices for consumer goods. Responses of the other four variables are qualitatively similar across sample starting dates. The pronounced instability of the price response in the Romers' specification does not carry over to the responses to an $R3$ innovation in the unrestricted VAR. When the estimation period is January 1954 to December 1992, prices rise significantly for almost three years and fall significantly about five years after the initial shock. Leeper (1994) reports these robustness checks.

[10] The path of $R10$ is robust to eliminating any Romer date but August 1978 (Leeper, 1994).

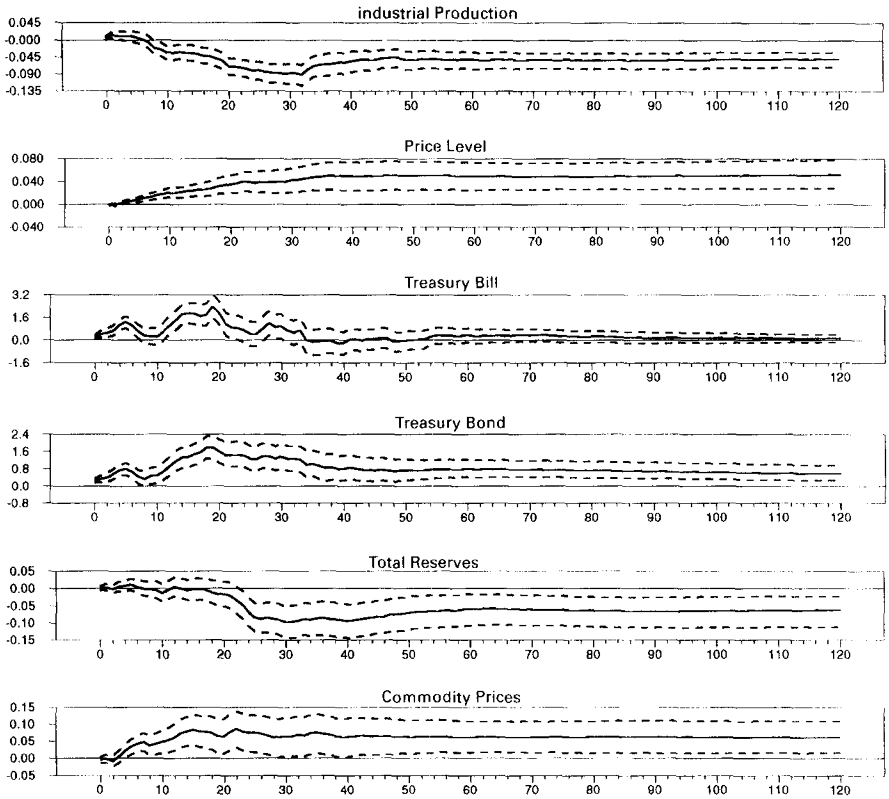

Fig. 2. Responses over 120 months to a unit disturbance in Romer dummy variable. Dummy treated as exogenous and stochastic. Solid lines are point estimates, dashed lines are 68% probability bands estimated point by point. Econometric specification described in footnote 8.

but also on the specification of the dummy variable equation. To check the robustness of their results, the Romers add a variety of variables to their estimated Eq. (1). This procedure tests the fragility of their estimates of the $c(L)$ coefficients, but it cannot address the sensitivity of the results to the assumption that the dummy variable is exogenous.

Shapiro (1994), recognizing that monetary policy choices and the Romers' dummy depend on economic conditions, posited a behavioral relationship determining the dummy variable. He estimated a probit equation that describes the decision to contract monetary policy as a function of the expected discounted present values of inflation and unemployment. The two forward-looking variables contain significant explanatory power for the monetary policy dummy.

Missing from Shapiro's analysis is the construction of a multivariate time series model to estimate the macroeconomic effects of dummy variable changes that do *not* arise from endogenous responses of policy to the economy. I adopt a less parsimonious but more agnostic discrete choice model for the dummy variable and, in Section 6, combine that equation with a system of VAR equations describing the evolution of macro variables. Denoting the list of macro variables by $\boldsymbol{x}_t = (Y_t, P_t, R3_t, R10_t, TR_t, PCM_t)'$ the expectation of the dummy variable conditional on the information set Ω_t is given by

$$E(d_t \mid \Omega_t) = F(\alpha, \beta(L)x_t), \tag{6}$$

where $F(\cdot)$ is specialized to be the logistic function, $\beta(L) = \beta_1 L + \dots + \beta_m L^m$, and α is a constant term. Eq. (6) is more agnostic than Shapiro's approach by conditioning on a larger and more diverse information set and by not imposing particular assumptions about expectations formation.[11] By including only variables dated $t-1$ and earlier in Ω_t, the specification (Eq. (6)) errs on the side of ascribing too little information to the Federal Reserve and tends to understate the degree of endogeneity of the dummy.

Fig. 3 plots the predicted values of the dummy from Eq. (6).[12] Vertical lines mark the dates of the actual Romer dummies. The equation places probabilities exceeding 0.5 on three of the seven dates, and probabilities over 0.25 on two additional dates. The predictability of the April 1974 contraction, on which the model places probability 0.86, accords with a reading of the FOMC's Record of Policy Actions for that date. A recent history of rising commodity and consumer prices, as well as rapid money growth, were all cited as reasons for tightening reserve market conditions.[13] Eq. (6) allows this history to influence the decision to contract. Even the Volcker 'regime switch' in October 1979 is well predicted by the equation. Evidently, the dummy is strongly predicted by past information, suggesting it contains a substantial endogenous component.[14] Previous work, including the specification underlying Fig. 2 – which corresponds to the

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[11] Eq. (6) is estimated with $m = 6$ from July 1947 to June 1996, using January–June 1947 as initial conditions.

[12] The large number of free parameters in $\beta(L)$ relative to the small number of non-zero elements in the $\boldsymbol{D}$ vector implies the individual coefficients in $\beta(L)$ are imprecisely estimated. The individual coefficients also have no clear behavioral interpretations. Fig. 3 suggests, however, that taken jointly the regressors are informative about $\boldsymbol{D}$.

[13] Board of Governors of the Federal Reserve System (1974).

[14] Because the data vector, $\boldsymbol{x}$, includes trending variables one might wonder why the predicted values of D do not converge to 0 or 1. Letting $X\beta$ denote the regressors in Eq. (6), the fitted process $X\hat{\beta}$ appears to be stationary. Augmented Dickey–Fuller tests performed over lag lengths ranging from 1 to 48 months imply the null hypothesis of a unit root can be rejected at significance levels well below 0.01. It appears that the logit algorithm estimated a cointegrating vector among the regessors.

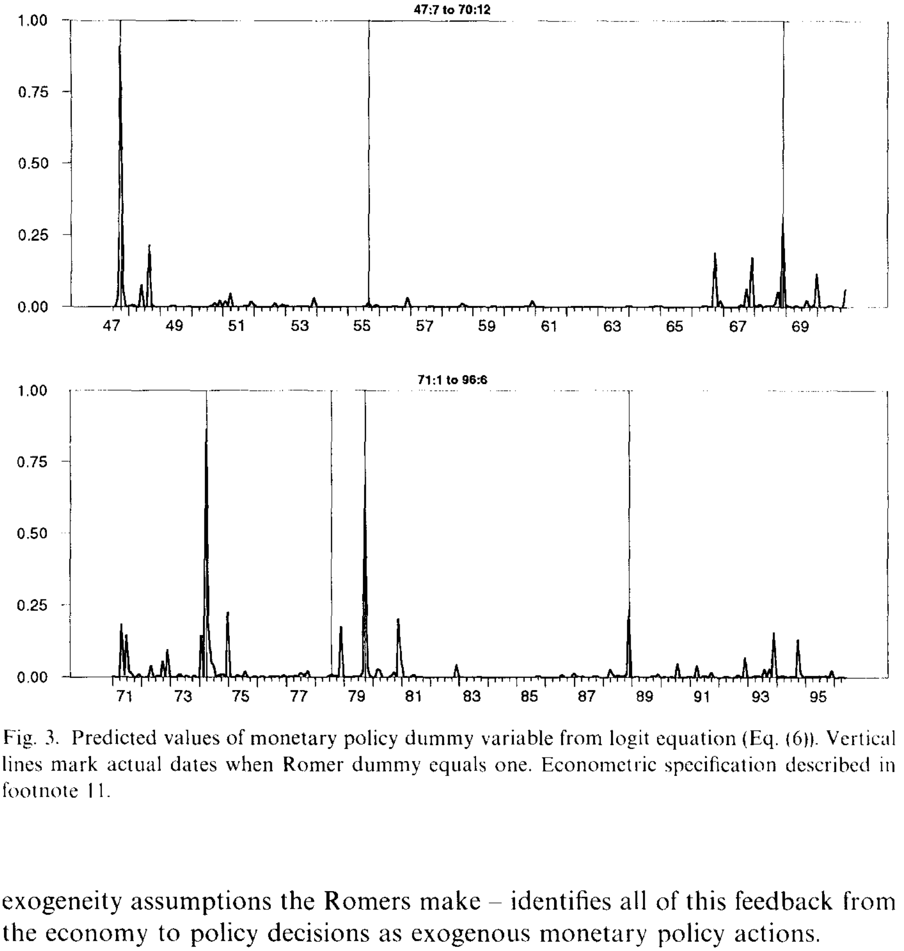

Fig. 3. Predicted values of monetary policy dummy variable from logit equation (Eq. (6)). Vertical lines mark actual dates when Romer dummy equals one. Econometric specification described in footnote 11.

exogeneity assumptions the Romers make – identifies all of this feedback from the economy to policy decisions as exogenous monetary policy actions.

5. The implications of an endogenous policy shock

It is possible that the monetary policy dummy is endogenous but the bias introduced by failing to model the endogeneity is small. In that case the policy effects reported in Fig. 2 would be robust. As it happens, modeling the endogeneity of policy dramatically alters the inferences about policy effects, implying there is substantial omitted variables bias in the regressions that find large impacts of changes in the monetary policy dummy. The endogenous dummy proxies for omitted variables. Moreover, accounting for policy endogeneity ameliorates the anomalous policy effects depicted in Fig. 2. It also reduces the estimated real effects of policy disturbances.

Before combining the logit equation for $\boldsymbol{D}$ with a system of equations determining the macro variables in $\boldsymbol{x}$, it is instructive to estimate a fully linear system that treats $\boldsymbol{D}$ and $\boldsymbol{x}$ symmetrically. Fig. 4 plots the responses of x to a unit innovation in the dummy variable. Point estimates are solid lines and 68% probability bands are short-dashed lines. The maximum decline in output is 3.5% whereas it was 9% when the dummy variable was treated as exogenous. In addition, the output decline is less persistent, with high probability of no output effects after four years. Overall prices and commodity prices, which rose persistently in Fig. 2, never rise significantly. The point estimate has P falling after three years, while PCM falls in most months. Long-term interest rates, which

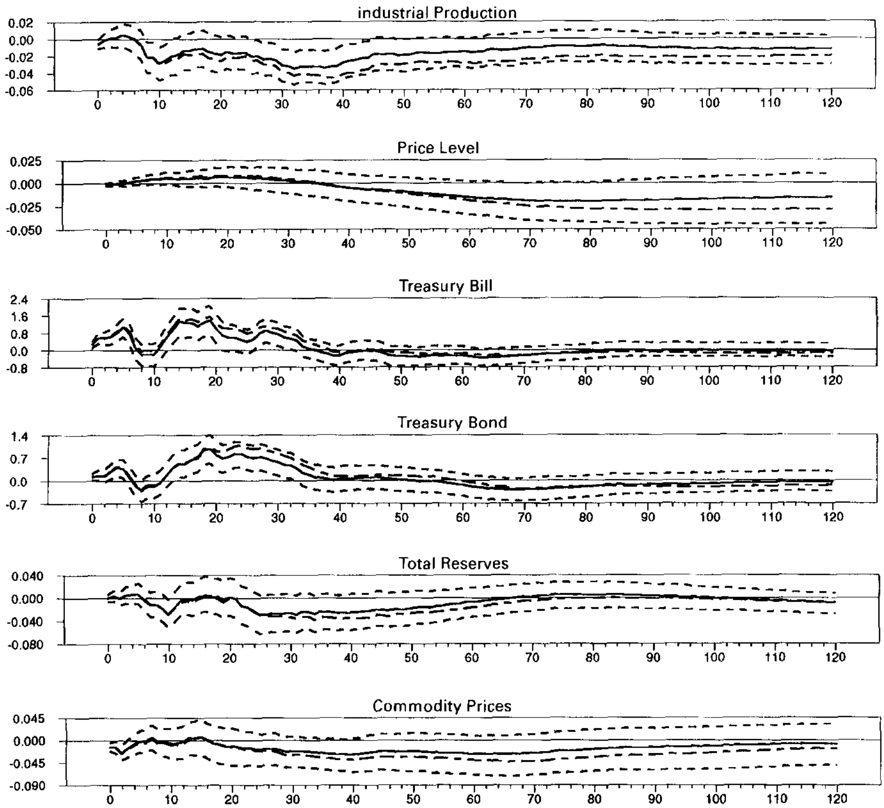

Fig. 4. Responses over 120 months to a unit disturbance in Romer dummy variable. Dummy treated as endogenous. Solid lines are point estimates from VAR, short-dashed lines are 68% probability bands from VAR, long-dashed lines are dynamic simulations from model with logit equation for dummy variable. Dynamic simulations condition on sample mean of data as initial conditions. Econometric specifications described in footnotes 8 and 11.

also rose and stayed high in Fig. 2, now are essentially unchanged after three years. Innovations in the dummy variable account for less than 4% of the forecast error variance in Y, 2% of P, 5% of $R3$ and $R10$, and about 1% of TR and PCM. Disturbances in the dummy that are unrelated to past economic performance are a trivial source of fluctuations in all six macroeconomic time series.

The contrasts between Fig. 2 and Fig. 4 correspond well to the contrasts found in the identified VAR literature. Identifications of policy behavior that tend to imply large real effects also tend to generate responses of some nominal variables that are inconsistent with the predictions of monetary theory. Explicitly modeling the endogeneity of policy acts both to resolve the anomalous responses and to decrease the size of the real effects of policy disturbances [see Leeper et al. (1996) for a survey].

To further explore the similarities between the narrative and VAR approaches to modeling policy, consider creating a new contractionary monetary policy dummy variable, which equals unity in periods when an $R3$ innovation is 'big' and positive, and zero elsewhere. Using the residuals from the $R3$ equation in the six-variable VAR that produced Fig. 1, the $R3$ dummy is set to one in every period that a positive realization exceeds one standard deviation (0.31 in the sample).[15] Eq. (1) is reestimated using the $R3$ dummy in place of the Romers' dummy and the resulting dynamic responses are graphed in Fig. 5. The qualitative patterns of dynamic responses to a shock in the $R3$ dummy are identical to those to a shock in the Romers' dummy in Fig. 2. Production falls with no tendency to return to its pre-shock level, while prices and long-term interest rates remain significantly higher 10 years after the initial shock. Short rates are significantly higher for two years before dying out. These results suggest that the information contained in the Romers' dummy is remarkably similar to that in short-term interest rate innovations. The latter measure of policy disturbances, however, is widely believed to be contaminated by endogenous responses of policy to non-policy shocks (see, for example, Eichenbaum, 1992; Sims, 1992; Gordon and Leeper, 1994; Leeper et al., 1996).

6. Incorporating non-linearity

Dynamic responses reported in Fig. 4, although they do allow the monetary policy dummy to evolve endogenously, do not respect the dichotomous nature of the dummy variable. It is also possible that the VAR equation for D implies

[15] The $R3$ dummy equals unity in 66 of the 576 months in the sample. The econometric specification is described in footnote 3.

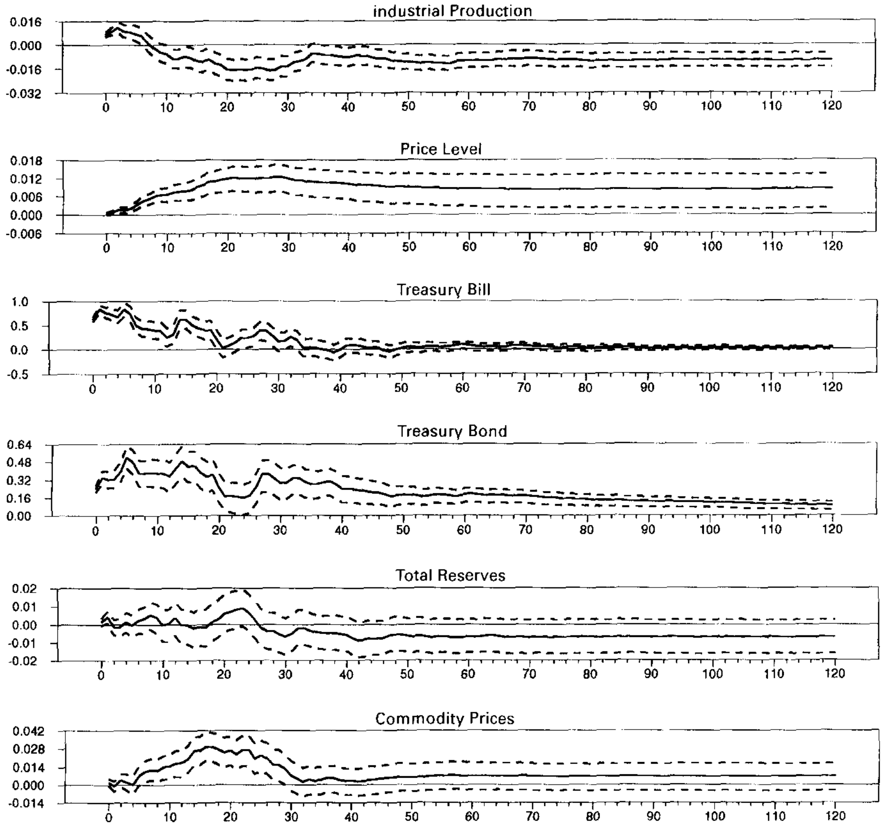

Fig. 5. Responses over 120 months to a unit disturbance in $R3$ dummy variable. Dummy treated as exogenous and stochastic. Solid lines are point estimates, dashed lines are 68% probability bands. Econometric specification described in text.

predicted values that lie outside the [0, 1] interval. If non-linearities are important in the determination of the dummy, the linear approximation may give misleading inferences. To address these concerns, the VAR equation for D is replaced by Eq. (6) and the resulting system is simulated dynamically.[16]

[16] The logit equation is estimated as described in footnote 11 and the linear equations for x are estimated as described in footnote 3. The dynamic simulation compares the time path of x when $D = 1$ in the initial period to the path of x when $D = 0$ initially, using the VAR equations for x and the logit equation for D to generate the simulated time paths. The long-dashed line in Fig. 4 reports the difference between the two simulated x paths.

Dynamic simulations of the non-linear model can be used to generate the model's predicted path of the vector $\boldsymbol{x}$ following a disturbance in $\boldsymbol{D}$. Because the predicted path depends on the initial conditions of the simulation, there is no obvious analog to the impulse response functions of a VAR. The long-dashed lines in Fig. 4 report the simulated effects of a monetary policy dummy when the model starts from the mean of the sample data. Simulated paths for the non-linear model lie within the 68% probability bands from the VAR over the full 10-year forecast horizon. This suggests that the linear equation for the monetary policy dummy does not greatly distort the dynamic impacts of the dummy.[17]

7. Concluding remarks

The Romers adopted a narrative approach to solve the identification problems inherent in time series models, where standard measures of policy shocks produce dynamic responses of macro variables that are inconsistent with the predictions of traditional monetary theories. Before declaring the success of the Romers' identification, it is useful to check if their new measure overcomes the shortcomings of time series models. The Romers' approach does not overcome these shortcomings: their new measure of monetary policy shocks contains a substantial endogenous component and it generates dynamic responses of prices and long-term interest rates that are inconsistent with the predictions of traditional monetary theories. The same inconsistencies emerge from time series models that identify policy shocks with statistical innovations in short-term interest rates. These results imply that the Romers' policy shock is contaminated by endogenous responses of monetary policy of the sort that contaminate unanticipated changes in short rates. This conclusion is corroborated by the fact that the qualitative features of the responses to the Romers' dummy are identical to those of a dummy variable created from big positive short-term interest rate innovations. Thus, the additional information introduced by a narrative reading of monetary policy does not obviate resorting to the sorts of 'reverse causation' stories used to reconcile anomalous response patterns that emerge from time series models.

Neither narrative nor time series approaches can avoid directly confronting the difficult identification issues endemic to the study of monetary policy.

[17] Simulations that condition on data in the months preceding the dates when the Romer dummy equals one display somewhat stronger responses than those in Fig. 4 (results available upon request). Because of the non-linearities, it is not obvious what sort of conditioning set yields 'typical' responses to the monetary policy dummy.

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Appendix A. Data Appendix

All data series are monthly from January 1947 to June 1996.

- *Y* — Industrial production, total index, not seasonally adjusted, Federal Reserve Board;
- *P* — Consumer price index, all urban consumers, not seasonally adjusted, Bureau of Labor Statistics;
- *R*3 — Three-month Treasury bill rate, quoted on discount basis, secondary market, average of business day figures, in percent per year, Federal Reserve Board;
- *R*10[18] — Ten-year US Treasury bond yield, constant maturity, average of business day figure, Federal Reserve Board;
- *TR* — Total reserves, not adjusted for reserve requirement changes, not seasonally adjusted, Federal Reserve bank of St. Louis.
- *PCM* — Producer price index, crude materials, not seasonally adjusted, Bureau of Labor Statistics.

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[18] Actual data available beginning April 1954. For January 1947 through March 1954, the series is spliced by fitting a bivariate VAR with Moody's AAA Bond yield and backcasting conditional on actual AAA yield data. The VAR was estimated with a constant term and 18 lags.

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