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Oil Prices, Monetary Policy, and Counterfactual Experiments

by Charles T. Carlstrom and Timothy S. Fuerst

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Recessions are associated with both rising oil prices and increases in the federal funds rate. Are recessions caused by the spikes in oil prices or by the sharp tightening of monetary policy? This paper discusses the difficulties in disentangling these two effects.

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1. Introduction.

Oil price increases have preceded every recession since 1971. Each of these recessions has also been preceded by an increase in the federal funds rate. (See Figure 1.) Are these recessions caused by the spikes in oil prices or by a sharp tightening of monetary policy? How can we disentangle these two effects? What does it mean to disentangle the two effects?

Bernanke, Gertler, and Watson (1997, 2004), hereafter BGW, tried to answer these questions empirically using a VAR analysis.[1] Using Hamilton's (1996) measure of oil price shocks, BGW (2004) report that a 10% oil price increase is associated with a 150 basis point increase in the funds rate and a peak output decline of 0.7%. Presumably this funds rate behavior reflects the endogenous tightening of policy in response to such an inflationary shock. BGW use this VAR analysis to answer the following counterfactual question: How much would output have declined if the funds rate had remained constant for, say, four quarters in the wake of the oil shock?

BGW answer this question by adding unexpected monetary policy innovations to the VAR analysis of the exact magnitude needed to keep the funds rate stable in the wake of an oil shock. Because this counterfactual experiment is related to previous work by other authors (Sims and Zha 1996), BGW call it the "Sims-Zha" experiment. The result of BGW's (2004) Sims-Zha experiment was that if the Fed had kept the funds rate constant, output would have fallen by only about half of its actual decline. BGW thus conclude that the endogenous tightening of monetary policy accounted for a substantial portion of the negative impact of oil shocks on the economy.

One potential problem with BGW's Sims-Zha experiment is the Lucas critique: is the VAR stable under such changes in monetary policy?[2] BGW assert that "it seems plausible to us that a purely transitory deviation from the usual policy rule would not significantly affect the structure of the economy (that is, the quantitative effect of the Lucas critique should be small)." This paper's first contribution is to use the standard New-Keynesian model to assess the quantitative relevance of the Lucas critique. What would happen if these unanticipated policy shocks were actually anticipated? In contrast to the assertion of BGW, within this model the Lucas critique problem is quite severe. In particular, if the Sims-Zha experiment were anticipated by the public, then output would actually *increase* in the wake of an oil shock. Hence, an anticipated version of Sims-Zha experiment would lead one to conclude that oil price shocks actually increase output.

This conclusion brings up a broader question. What does it mean to keep policy constant? The above results suggest that BGW's experiment may not really be holding policy constant. The paper's second contribution is therefore to expand this counterfactual question more broadly. To isolate the impact of an oil shock we need to ask what effect would oil have on the economy if monetary policy were constant or neutral. But what exactly does "neutral" mean? In addition to the Sims-Zha and anticipated Sims-Zha experiments, we consider several other alternatives including a money growth peg, an interest rate peg, and a "Wicksellian" interest rate policy. The latter is a policy that adjusts the funds rate so that the real economy behaves as if there

[1] There are, of course, numerous studies that analyze the effect of monetary shocks and oil shocks in isolation. See BGW (1997) for references.
[2] The theoretical relevance of the critique is noted by BGW (1997, 2004) and Sims and Zha (1996).

were no nominal rigidities.[3] The behavior of output and inflation are quite different under all of these possible versions of neutral policy.

Leduc and Sill (2004) conduct a related analysis of systematic monetary policy and oil price shocks. There are several relevant differences between their work and the current paper. First, they do not consider the Sims-Zha experiment conducted by BGW, nor the quantitative significance of the Lucas Critique. Instead, their focus is entirely on systematic monetary policy. Second, while our analysis is built around a model with nominal rigidities, their principle focus is on a flexible price model with a limited participation constraint. They do report results with small nominal rigidities, an average contract duration of one quarter. We assume a longer contract duration, and also assume that capital is immobile across firms. Taken together, the nominal rigidities in our model are sixty times larger than in Leduc and Sill (2004). Third, Leduc and Sill (2004) also consider the case of an interest rate peg, but deal with the equilibrium determinacy problem in a way quite different than our approach, and this difference leads to quantitatively different conclusions. Finally they never consider a Wicksellian monetary policy.

The next section outlines the basic model and clarifies the nature of the monetary experiments. Section 3 and 4 present the principle results. Section 5 concludes.

2. The Model.

The theoretical model is a marriage of the now-standard Dynamic New Keynesian models of monetary policy (eg. Woodord (2003), Walsh (2003)), and the earlier real

[3] The use of the modifier "Wicksellian" is suggested by Woodford (2003).

business cycle models that explicitly included oil prices (eg., Kim and Loungani (1992)). In this section, we will sketch the basic framework. The theoretical model consists of households and firms. We present the decision problems of each in turn.

Households.

Households are infinitely lived, discounting the future at rate β. Their period-by-period utility function is given by

$$U(C_t, L_t, \frac{M_{t+1}}{P_t}) \equiv \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\gamma}}{1+\gamma} + \frac{(M_{t+1}/P_t)^{1-\varepsilon}}{1-\varepsilon} \quad , \tag{1}$$

where $\sigma > 0$, $\gamma > 0$, $\varepsilon > 0$, L_t denotes labor, $\frac{M_{t+1}}{P_t}$ denotes real cash balances that can facilitate time-t transactions and C_t denotes the consumption aggregator where

$$C_t = \left[\left(\frac{1}{b}\right)^{\frac{1}{\theta_p}} \int_0^b \left(C_t(j)\right)^{\frac{\theta_p - 1}{\theta_p}} dj \right]^{\frac{\theta_p}{\theta_p - 1}} . \tag{2}$$

The household begins period t with M_t cash balances and B_{t-1} one-period nominal bonds that pay R_{t-1} gross interest. With w_t denoting the real wage, P_t the price level, and X_t the time-t monetary injection, the household's intertemporal budget constraint is given by

$$P_t C_t + B_t + M_{t+1} \leq M_t + R_{t-1} B_{t-1} + P_t w_t L_t + X_t \, . \tag{3}$$

The household's portfolio choice is given by

$$\frac{(M_{t+1}/P_t)^{-\varepsilon}}{C_t^{-\sigma}} = \frac{R_t - 1}{R_t} \tag{4}$$

$$C_t^{-\sigma} = R_t \beta E_t C_{t+1}^{-\sigma} / \pi_{t+1} \, . \tag{5}$$

From equation (4), we have that the money demand curve is given by

$$\frac{M_{t+1}}{P_t} = C_t^{(\sigma/\varepsilon)} (\frac{R_t - 1}{R_t})^{-(1/\varepsilon)}, \tag{6}$$

so that the transactions elasticity is (σ/ε) and the interest elasticity is 1/ε.

Following Erceg, Henderson, and Levin (2000), we assume that households are monopolistic suppliers of labor and that firms employ a CES aggregator of household labor with an elasticity of substitution equal to $\theta_w > 1$. In particular, the labor aggregator is symmetric with (2):

$$L_t = \left[\left(\frac{1}{d} \right)^{\frac{1}{\theta_w}} \int_0^d \left(L_t(j) \right)^{\frac{\theta_w - 1}{\theta_w}} dj \right]^{\frac{\theta_w}{\theta_w - 1}}. \tag{7}$$

Nominal wages are adjusted as in Calvo (1983). In this case labor supply behavior is given by

$$C_t^{\sigma} L_t^{\gamma} = Zh_t W_t .$$

For a given level of Zh_t, the Frisch labor supply elasticity is 1/γ. The variable Zh_t is the monopoly distortion as it measures how far the household's marginal rate of substitution is from the real wage. In the case of perfectly flexible but monopolistic wages, $Zh_t = Zh$ is constant and less than unity. The smaller is Zh, the greater is the monopoly power. In the case of sticky nominal wages, Zh_t is variable and moves in response to the real and nominal shocks hitting the economy. Erceg et al. (2000) demonstrate that in log deviations *nominal* wage adjustment is given by:

$$\pi_t^W = \lambda^W zh_t + \beta E_t \pi_{t+1}^W ,$$

where π_t^W is time-t net nominal wage growth, zh_t denotes the log deviation from steady-state, and $\lambda_w \equiv \frac{(1-\eta_w)(1-\eta_w\beta)}{\eta_w(1+\gamma\theta_w)}$, with η_w denoting the fraction of households that cannot adjust their nominal wages in the current quarter.[4]

Firms.

There are a continuum of firms producing different varieties of consumption goods (see the consumption aggregator (2)). The typical firm utilizes labor services, L_t, from households, and energy, En_t, from external sources to produce its unique final good using the CES technology:

$$Y = f(K, L, En) \equiv \left[(1-a)(K^\alpha L^{1-\alpha})^{1-\rho} + a(En)^{1-\rho}\right]^{1/(1-\rho)}.$$

The typical firm has a fixed and immobile level of capital given by K = 1. Labor input and energy is perfectly mobile across firms. The real energy price is equal to P_t^e so that a firm's nominal profits are given by

$$profits = P_t(Y_t - w_t L_t - P_t^e En_t).$$

The firm is a monopolistic producer of these goods, implying that labor will be paid below its marginal product. Let Z_t denote marginal cost so that we have

$$w_t = Z_t f_L(t)$$

$$P_t^e = Z_t f_E(t).$$

The variable Z_t is the monopoly distortion as it measures how far the firm's marginal products differ from the real factor prices. In the case of perfectly flexible but

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4 See page 224 of Woodford (2003) for details.

monopolistic prices, $Z_t = Z$ is constant and less than unity. The smaller is Z, the greater is the monopoly power. In the case of sticky prices, Z_t is variable and moves in response to the real and nominal shocks hitting the economy. Yun (1996) demonstrates that in log deviations *nominal* price adjustment is given by:

$$\pi_t = \lambda z_t + \beta E_t \pi_{t+1}$$

where π_t is time-t nominal price growth (as a deviation from steady-state nominal price growth) lower case z_t denotes the log deviation from steady-state, and

$\lambda \equiv \dfrac{(1-\eta_p)(1-\eta_p\beta)}{\eta_p(1+\varpi\theta_p)}$, with η_p denoting the fraction of firms that cannot adjust their nominal prices in the current quarter, and ϖ denoting the firm's elasticity of marginal cost with respect to firm-level output.[5,6]

Monetary policy.

For our first three experiments (baseline, unanticipated and anticipated Sims-Zha) we use a Taylor-type interest rate rule of the form:

$$i_t = \tau\pi_t + \tau_y y_t + \eta_t .$$

[5] See page 224 of Woodford (2003) for details.
[6] Let $V(Y,w,P^e)$ denote the firm's cost function where the capital stock is fixed at unity. ϖ is the elasticity of V_Y with respect to Y, for a fixed level of wages and energy prices.

where y_t denotes log deviations in real output, π_t is the linear deviation of inflation from its steady state, and η is an i.i.d. policy shock.

Equilibrium.

There are four markets in this theoretical model: the labor market, the goods market, the bond market, and the money market. The respective market-clearing conditions include: $C_t = Y_t - P_t^e En_t$ and $B_t = 0$. The money market clears with the household holding the per capita money supply intertemporally.

Calibration.

Before proceeding with the analysis, we need to set parameter values at levels consistent with empirical estimates for a quarterly model. Preference parameters are given by $\beta = .99$ (implying a 4% annual steady-state real rate of return), $\sigma = 2$, and $\gamma = 3$. The latter values are consistent with micro evidence of fairly inelastic savings and labor supply behavior. We set $\varepsilon = 2$ implying a unit transactions elasticity for money demand and an interest elasticity of -.5.[7] We set $\theta_w = 8$ implying a steady-state mark-up of wages of 14%, and $\eta_w = 0.5$ implying that wages are fixed on average for two quarters. These choices imply $\lambda_w = 0.020$.

As for firms, the elasticity of substitution between oil and the capital-labor input is equal to 1/ρ. Consistent with empirical estimates, we set this elasticity to .59, or ρ = 1.7 (Kim and Loungani (1992)). The share parameter a is set to a = .02. This implies a share of energy in total output of 4%. The capital parameter in the production function is set to $\alpha = 1/3$. We set $\theta_p = 8$ implying a steady-state mark-up of 14%, and $\eta_p = 0.5$ implying that firms re-set prices on average every two quarters. These choices imply $\varpi = 0.46$ and $\lambda_p = 0.107$. Notice that the assumption of capital immobility leads to a relatively small value for λ_p.

Leduc and Sill (2004) model the nominal rigidities with a convex adjustment cost to nominal prices and wages. Since all firms face symmetric adjustment costs, the issue of capital mobility is irrelevant as there is essentially a representative firm. Leduc and Sill report that for technical reasons (see their footnote 15), they calibrate their model to imply very frequent price and wage adjustment, an average duration of 1.14 quarters for prices, 1.01 quarters for wages. This short contract duration as well as the representative firm implies very little nominal rigidity. For example, in our Calvo environment, the Leduc and Sill (2004) calibration corresponds to a price adjustment parameter of $\lambda_p = 6.2$, 60 times larger than our calibrated value of $\lambda_p = .107$. Their value of $\lambda_p = 6.2$ is quite close quantitatively to a flexible price model.

The logged real price of oil is given by an exogenous AR(2) process:

$$p_t^e = a_1 p_{t-1}^e + a_2 p_{t-2}^e + \nu_t \, .$$

Where $p_t^e = \ln(P_t^e / \overline{P_e})$ and $\overline{P_e}$ is the mean real price of oil since 1974. Estimating this process since 1974 yields $a_1 = 1.12$ and $a_2 = -.15$. In all the experiments below we report impulse response functions for a one-time, exogenous 10% increase in the price of oil ($\nu_t = .10$).

[7] This calibration is only relevant for the constant money growth experiment.

The calibration of the Taylor rule comes from Kozicki (2002) who suggests that since 1983 the coefficients in this monetary policy rule are $\tau = 1.53$ and $\tau_y = .27$.

3. Sims-Zha Experiments and the Lucas Critique.

Recall that the Taylor-type interest rate rule is of the form:

$$i_t = \tau\pi_t + \tau_y y_t + \eta_t .$$

For the baseline experiment, we set η_t=0. In the (unanticipated) Sims-Zha experiment interest rates are held constant for 4 quarters or equivalently,

$$\eta_t = -\tau\pi_t - \tau_y y_t \text{, for t = 1 to 4.}$$

Note the systematic surprises here: The Sims-Zha experiment assumes that households anticipate η_t to be white noise when, in fact, it is a function of inflation and output. In the anticipated Sims-Zha experiment the policy rule is given by

$$i_t = \tau\pi_t + \tau_y y_t + \eta_t$$

where η_j (for j = 1 to 4) are chosen to zero out the interest rate for four periods, but these values are forecastable by the public for j = 2 to 4. The public understands that for four quarters that monetary authority is going to deviate from the endogenous tightening under the Taylor rule and instead keep interest rates constant.

Figure 2 reports the impulse response functions for a 10% increase in the price of oil ($\nu = .10$). It is instructive to compare our baseline and unanticipated Sims-Zha numbers to those obtained by BGW in their econometric estimation. BGW estimated that a 10 percent oil price shock is associated with a 150 basis point increase in the funds rate and a peak output decline of 0.7%. Our model suggests that interest rates would increase by around 112 basis points and output would decline by 0.3%. Both estimates are somewhat smaller than estimated by BGW. However, the model predicts that this decline would essentially be cut in half under the Sims-Zha experiment (0.17% versus 0.3%). This is essentially the conclusion of BGW's (2004) VAR analysis.

In all three scenarios there is a sustained decline in consumption and the real wage. This reflects the negative welfare consequences of the increase in the price of oil. The consumption decline is significantly mitigated for the first four quarters in the unanticipated and anticipated Sims-Zha experiments. This reflects the stimulative effect on output of the constant interest rate for these first four quarters. This is especially pronounced in the anticipated Sims-Zha experiment.

But the magnitude of the Lucas Critique is quite clear. In sharp contrast to BGW's hunch, the Lucas effect is quantitatively relevant. If the stable interest rate had been anticipated, output would have *increased* by 0.23%! Compared to the baseline interest rate movement, the anticipated decline in the interest rate (in the first four quarters) is much more simulative than the unanticipated decline in the interest rate. This arises because the anticipated interest rate stability leads to a much larger effect on inflation, and thus a larger decline in the real rate of interest.

When anticipated, the stimulative impact of lower interest rates are brought forward in comparison to the unanticipated Sims-Zha experiment. This implies that the level of consumption during the four quarters that interest rates are held constant is always higher for the anticipated experiment. The increase in consumption for the anticipated experiment implies that money growth must be higher to keep interest rates pegged during the first four quarters.

This result is reminiscent of recent Federal Reserve policy decisions. After decreasing the funds rate to an unprecedented 1 percent in June 2003, the FOMC introduced a dramatic change in language starting with the August 2003 meeting: “the Committee believes that policy accommodation can be maintained for a considerable period.” The goal of this language was to condition expectations that the funds rate would stay unusually accommodative. It was believed that this would lead to higher inflation and output than if the same sequence of interest rates occurred, but were unanticipated. Here a series of announced shocks to keep interest rates from rising in response to oil price increases has a much bigger impact than a series of unanticipated shocks.

4. Other Neutral Policies.

While the previous experiments provided potential answers to the question, “how would the economy have behaved if interest rates were kept constant in the wake of an oil shock,”, these experiments do not seem to answer the question originally posed by BGW: “how much of output’s decline in response to an oil price shock is due to oil and how much is due to monetary policy?” In fact the anticipated scenario suggests that oil’s impact on the economy would be positive! The next series of experiments try to answer BGW’s counterfactual question by asking how would the economy behaved in response to an oil price shock if monetary policy were neutral. The question then is what does it mean to keep monetary policy neutral?

The remaining monetary policy experiments do not have the form of a simple Taylor rule but are all plausible versions of neutral monetary policy. One idea of neutral is a monetary policy rule that holds the labor market distortion (the “output gap”) constant, $z_t + zh_t = 0$. We call this the Wicksellian policy.[8] In this case, the impulse response functions are identical to the corresponding real business cycle model, i.e., a model with no nominal stickiness. These results are thus analogous to Kim and Loungani (1992).

Another candidate for neutral policy is where the money growth rate is held constant. In this case, the money demand curve is used to determine the endogenous behavior of the nominal interest rate. This is Leduk and Sill's (2004) definition of neutral.

The final statement of neutral policy is an interest rate peg. In contrast to the previous experiments that held interest rates constant for four quarters, this is a rule in which interest rates are always constant and this behavior is anticipated. As is well-known, there is real indeterminacy in this case. The decision rules can be expressed as functions of two lags in the real wage, two lags of the exogenous oil price, and mean-zero sunspot shocks. For the simulations below we eliminate the sunspot shock so that the impulse response functions represent fundamental behavior only, i.e., this is the minimum state vector (MSV) equilibrium. Below we will discuss Leduk and Sill's (2004) alternative way of supporting the interest rate peg.

Figure 3 reports the impulse response functions for a 10% increase in the price of oil ($\nu = .10$). Since the Wicksellian policy causes real behavior to mimic the real business cycle model it is a natural place to start. The hump-shaped behavior in output and consumption reflect the hump-shape in oil prices. These dynamics in consumption

[8] The Wicksellian policy is equivalent to a Taylor-type rule with a very large coefficient on the output gap. In this linearized model, this policy mimics the real behavior of the RBC model. However, this policy is not optimal as it ignores the higher order losses due to Calvo pricing. For the purposes of this paper, the nature of optimal policy is irrelevant.

correspond to an initial decline in the real rate (-38 basis points), followed by a jump in the real rate above steady-state.

Note that output and consumption behavior for the Wicksellian policy are quite comparable to the benchmark Taylor-rule model. While the real behavior of the Wicksellian and benchmark Taylor-rule model are similar, the benchmark model delivers substantially more inflation than the Wicksellian rule. This occurs even though the spike in nominal interest rates is much greater under the benchmark Taylor-rule. The key to this puzzle lies in the real interest rate. In the earlier periods it is much lower (or more expansionary) for the Wicksellian policy but there is a very long-period of time in which it is slightly less expansionary than the benchmark Taylor-rule. Surprisingly this distant behavior is enough to drive the higher inflation rates observed under the benchmark rule.

If we accept the Wicksellian policy as “neutral” then the answer to the original counterfactual question is quite surprising. Despite the fact that interest rates in the baseline model increase over 100 basis points with respect to a 10 percent oil price shock, the real output response is very similar to Wicksell. This suggests that essentially all of output’s decline in the baseline Taylor rule scenario is due to oil.

Another interpretation of neutral policy is an interest rate peg. An interest rate peg leads to a sharp increase in the inflation rate and thus a decline in the real interest rate (142 basis points). The low real rate implies a surge in output, consumption, and inflation. The nominal rate peg is anticipated by the public so these results are a natural extension of the anticipated Sims-Zha experiment in which the interest rate is held constant for four quarters. The longer period of time (forever!) in which interest rates are held constant results in larger output gains for the interest rate peg (0.6%) compared to the anticipated Sims-Zha (0.22%) experiment. This version of neutral suggests that oil price increases have a stimulative impact on the economy.

Finally our last version of neutral is a constant money growth peg. The key observation with the money growth peg is that the decline in consumption leads to a decline in real money demand. Simultaneously the increased price level lowers the real money supply. The consumption effect tends to lower interest rates, the price effect tends to increase interest rates. For this calibration the consumption effect dominates so that the oil shock leads to an endogenous decline in the nominal interest rate. Despite this decline in interest rates, output and inflation are lower than with an interest rate peg. The reason is that while nominal interest rates are lower for a money growth peg, real interest rates are higher.

Both the interest rate peg and the money growth peg are more expansionary and lead to higher levels of output and consumption (relative to the baseline scenario) in the short run. A money growth peg suggests that a 10 percent oil shock would initially increase output slightly but then eventually lead to a 0.22 percent decline in GDP, slightly less than the immediate 0.30 percent decline predicted by the benchmark.

Table 1 summarizes the results of this section. We report the eight-quarter cumulative output decline from an oil price shock under alternative monetary policies. The second row of Table 1 measures the output decline relative to the output decline under the baseline Taylor rule. This percentage can be viewed as the fraction of the output decline due to oil under various definitions of neutral monetary policy. For example, if the money growth peg is considered neutral, 1.23 percentage points of the 1.61 percentage point decline in output is attributed to oil (76%), the remainder to nonneutral monetary policy (24%). However, if we define neutral as the Wicksellian policy, then the baseline monetary policy is stimulative so that over 100% of the output decline is a result of the oil shock. This implies that the baseline Taylor Rule formulation of monetary policy slightly off-sets oil price fluctuations in output compared to a RBC economy.

We report two versions of the interest rate peg. The first is the peg supported by the R = 0 policy rule in which we pick the MSV solution. This corresponds to the impulse response functions reported above. In this case the oil shock causes an output boom. If we treat this policy as neutral, the decline in output following an oil shock is entirely caused by the monetary tightening under the Taylor rule.

In contrast, Leduc and Sill (2004) the interest rate peg is supported by positing the following interest rate rule:

$$i_t = \varphi i_{t-1} + \tau \pi_t + \tau_y y_t ,$$

where τ and τ_y are very small and $\varphi = 1.0001$ (see their footnote 9). This policy rule implies equilibrium determinacy and near constancy of the interest rate in their model. (This is also the case in the model of this paper.) If we model the interest rate peg as do Leduc and Sill (2004), then output falls with the oil shock. Because of space considerations we do not report these impulse response functions but do summarize the output behavior in Table 1. There are two peculiar characteristics of this rule. First, the decline in output is surprising given the results in the previous section for the anticipated Sims-Zha experiment. One interpretation of an interest rate peg is an infinitely-long anticipated Sims-Zha experiment. Second, although the realized interest rate process is constant, equilibrium determinacy results because the out-of-equilibrium behavior is explosive, $\varphi > 1$. It is not clear that agents could learn φ since interest rates do not move in equilibrium.

5. Conclusion.

In two influential papers BGW (1997, 2004), tried to answer the question: how much of GDPs decline with respect to oil price increases is due to oil, and how much is due to the fact that interest rates also tend to rise sharply as well. They reported that a 10% oil price increase is associated with a 150 basis point increase in the funds rate and a peak output decline of 0.7%. BGW then use this VAR analysis to conclude that approximately half of this decline is due to oil and approximately half is due to the increase in the funds rate.

The first contribution of this paper is to use the standard New Keynesian model to assess the accuracy of their hunch that the Lucas critique is not quantitatively relevant. We show that if interest rates were expected to be kept constant for four quarters that output would actually *increase* in the wake of an oil shock. Hence, within this theoretical model the Lucas critique is quantitatively relevant.

While BGW designed a sensible experiment it is not clear that it really answers the posed question: holding monetary policy constant (or neutral) what impact would an oil price shock have on the economy? The paper's second contribution is therefore to expand this counterfactual question more broadly. In addition to the Sims-Zha and anticipated Sims-Zha experiments, we consider several other versions of "neutral" policy including a money growth peg, an interest rate peg, and a "Wicksellian" interest rate policy. The latter is a policy that adjusts the funds rate so that the real economy behaves as if there were no nominal rigidities.

The behavior of output and inflation are quite different under all of these possible versions of neutral policy. But arguably the Wicksellian policy corresponds most closely with what is typically meant by a neutral policy as real behavior mimics the real business cycle model. In contrast to BGWs conclusion, this version of neutral suggests that all of the output decline associated with oil prices is due to oil, and none of the decline is attributable to monetary policy.

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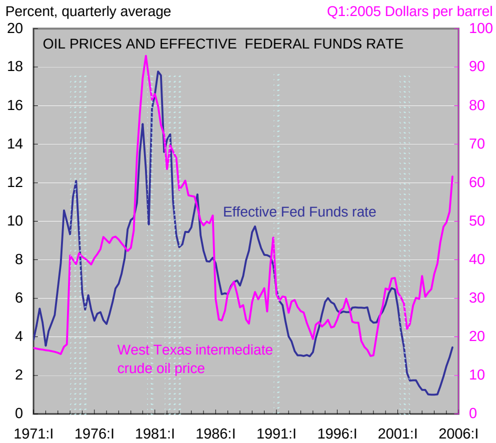
Table 1: Eight quarter cumulative output decline

Monetary Policy					
	Baseline Taylor Rule	Wicksell	M Peg	R Peg*	R peg**
8 q cum output decline	-1.60761	-1.74898	-1.22702	1.520911	-1.16044
% output decline relative to Taylor rule	100%	108.79%	76.33%	NA	72.18%

Row one is the eight quarter cumulative output decline under the corresponding policy rule. The second row is the ratio of the output decline under a given policy rule relative to the output decline under the baseline Taylor rule.
*The interest rate peg is defined as the policy rule R = 0 and the MSV solution that supports this peg.
**The interest rate peg is defined as in Leduc and Sill (2004): $i_t = \varphi i_{t-1} + \tau\pi_t + \tau_y y_t$, with φ=1.0001, where τ and τ_y are small.

FIGURE 1



Percent, quarterly average
Q1:2005 Dollars per barrel
OIL PRICES AND EFFECTIVE FEDERAL FUNDS RATE
Effective Fed Funds rate
West Texas intermediate
crude oil price
20
18
16
14
12
10
8
6
4
2
0
100
90
80
70
60
50
40
30
20
10
0
1971:I
1976:I
1981:I
1986:I
1991:I
1996:I
2001:I
2006:I

FIGURE 2: Impulse Response to a 10% Oil Price Shock

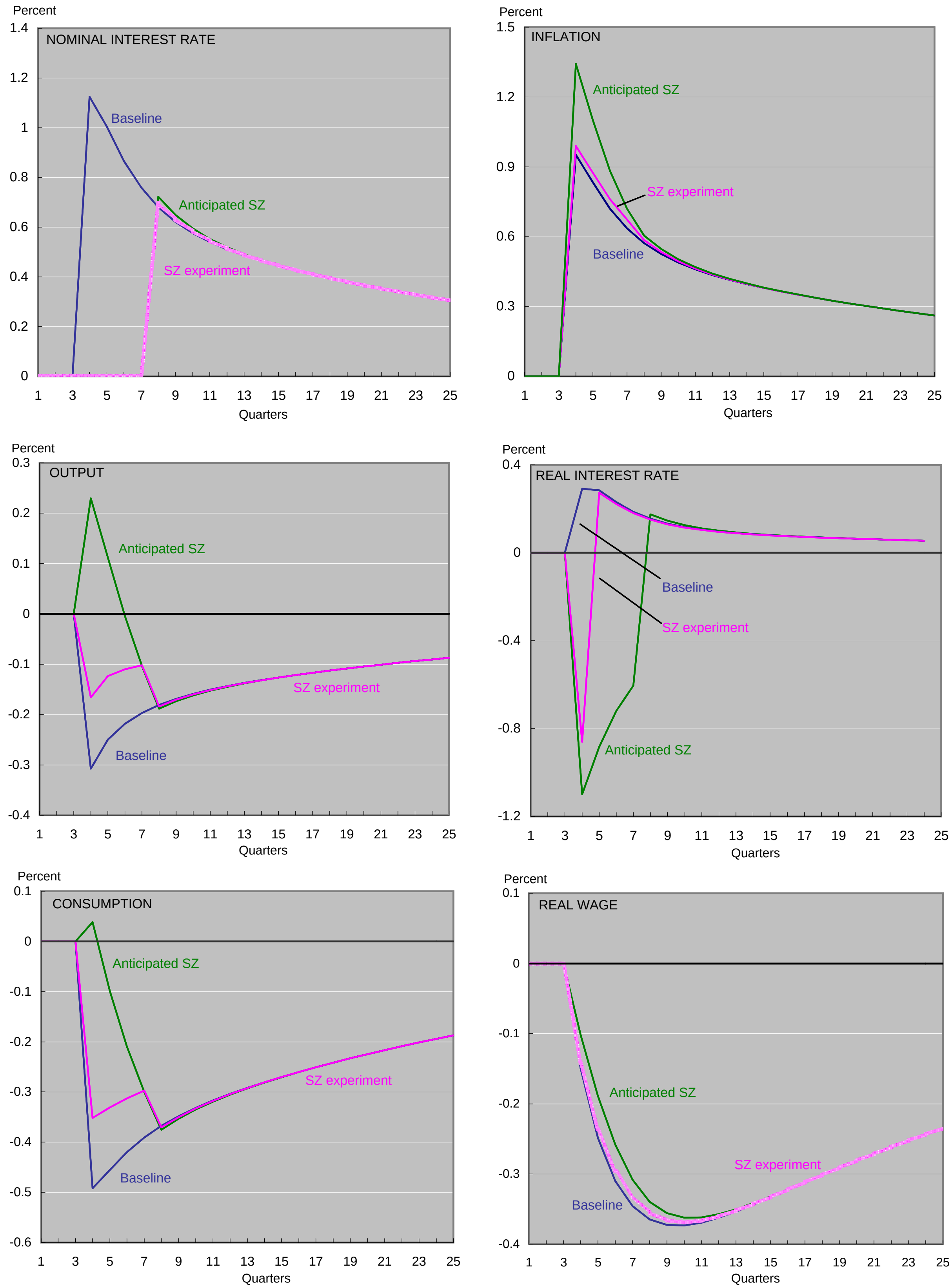
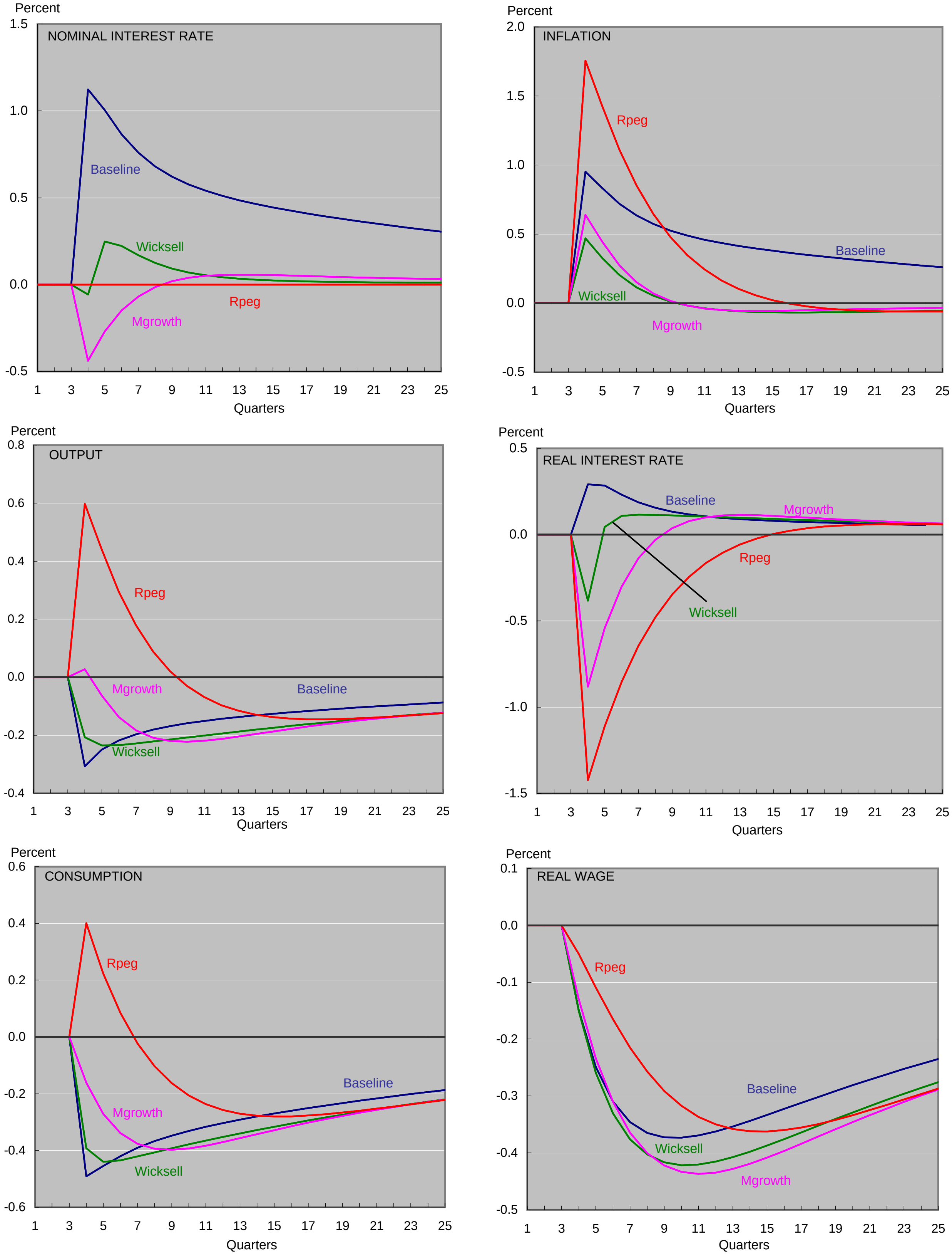


FIGURE 3: Impulse Response to a 10% Oil Price Shock



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