Monetary Policy Responses to Oil Price Fluctuations

Martin Bodenstein
Asian Development Bank

Luca Guerrieri
Federal Reserve Board

Lutz Kilian
University of Michigan and CEPR

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Our Questions

How do the different shocks underlying fluctuations in oil prices affect key macroeconomic aggregates such as inflation and real output?

Taking the estimated policy rule as given, how does the source of the oil price shock affect the response of monetary policy?

What is the optimal monetary policy response to these shocks from a welfare point of view, if we are free to choose the coefficients of the policy rule?

What are the welfare gains from international monetary policy coordination in a world with trade in crude oil compared with the competitive Nash equilibrium outcome?

Our Framework

We answer these questions using an estimated two-country DSGE model that encompasses trade in oil and nonoil goods.

The model is borrowed from Bodenstein and Guerrieri (2011) who, in turn, build on Backus and Crucini (1998) and Smets and Wouters (2007).

There are two countries with symmetric structure: U.S. and foreign bloc. Country-specific values for the parameters allow for differences in population size, oil intensities, oil endowments, and in nonoil and oil trade flows.

The model is estimated by the method of maximum likelihood on data running from 1984:Q1 to 2008:Q3.

Production and Trade

In each country, a continuum of firms produces differentiated varieties of an intermediate good under monopolistic competition.

These firms use capital, labor, and oil as factor inputs.

Goods prices are determined by Calvo-Yun staggered contracts.

Both oil and nonoil goods are traded across countries.

Households

Households consume oil, the nonoil consumption good, save and invest, and supply differentiated labor services under monopolistic competition.

Wages are determined by Calvo-Yun staggered contracts. For ease of exposition, we assume competitive bundlers as in Smets and Wouters (2007).

While asset markets are complete at the country level, asset markets are incomplete internationally.

The two country-blocs are endowed with a nonstorable supply of oil each period.

Monetary Policy

Monetary policy follows a modified version of the interest rate reaction function suggested by Taylor (1993):

$$\begin{aligned} i_{1,t} &= \bar{i}_1 + \gamma_1^i (i_{1,t-1} - \bar{i}_1) \\ &\quad + (1 - \gamma_1^i) \left[(\pi_{1,t}^{core} - \bar{\pi}_1^{core}) + \gamma_1^\pi (\pi_{1,t}^{core} - \bar{\pi}_1^{core}) + \gamma_1^y y_{1,t}^{gap} \right] + \epsilon_{1,t}^i . \end{aligned}$$

The terms $\bar{i}_1$ and $\bar{\pi}_1^{core}$ are the steady-state values for the nominal interest rate and inflation, respectively.

The inflation rate $\pi_{1,t}^{core}$ is expressed as the logarithmic percentage change of the core price level

The term $y_{1,t}^{gap}$ denotes the log deviation of gross output from the value of gross output in a model that excludes nominal rigidities, but is otherwise identical to the one described.

The estimated coefficients are $\gamma_1^i = .65$, $\gamma_1^\pi = 0.19$, $\gamma^y = 0$.

Figure 1: The Effects of Different Shocks on the Real Dollar Price of Oil and U.S. Interest Rates (the shocks are sized at 1 standard deviation)

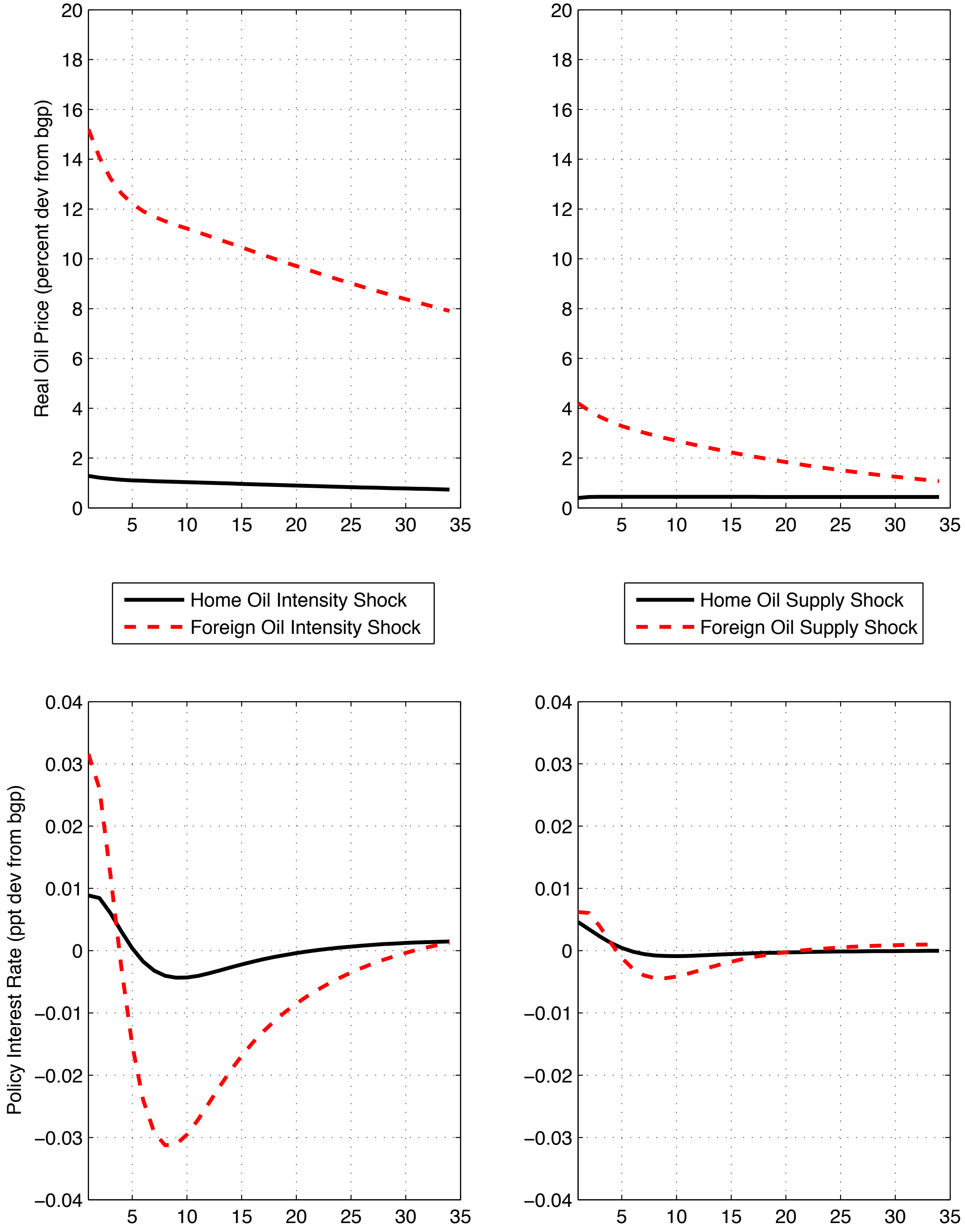
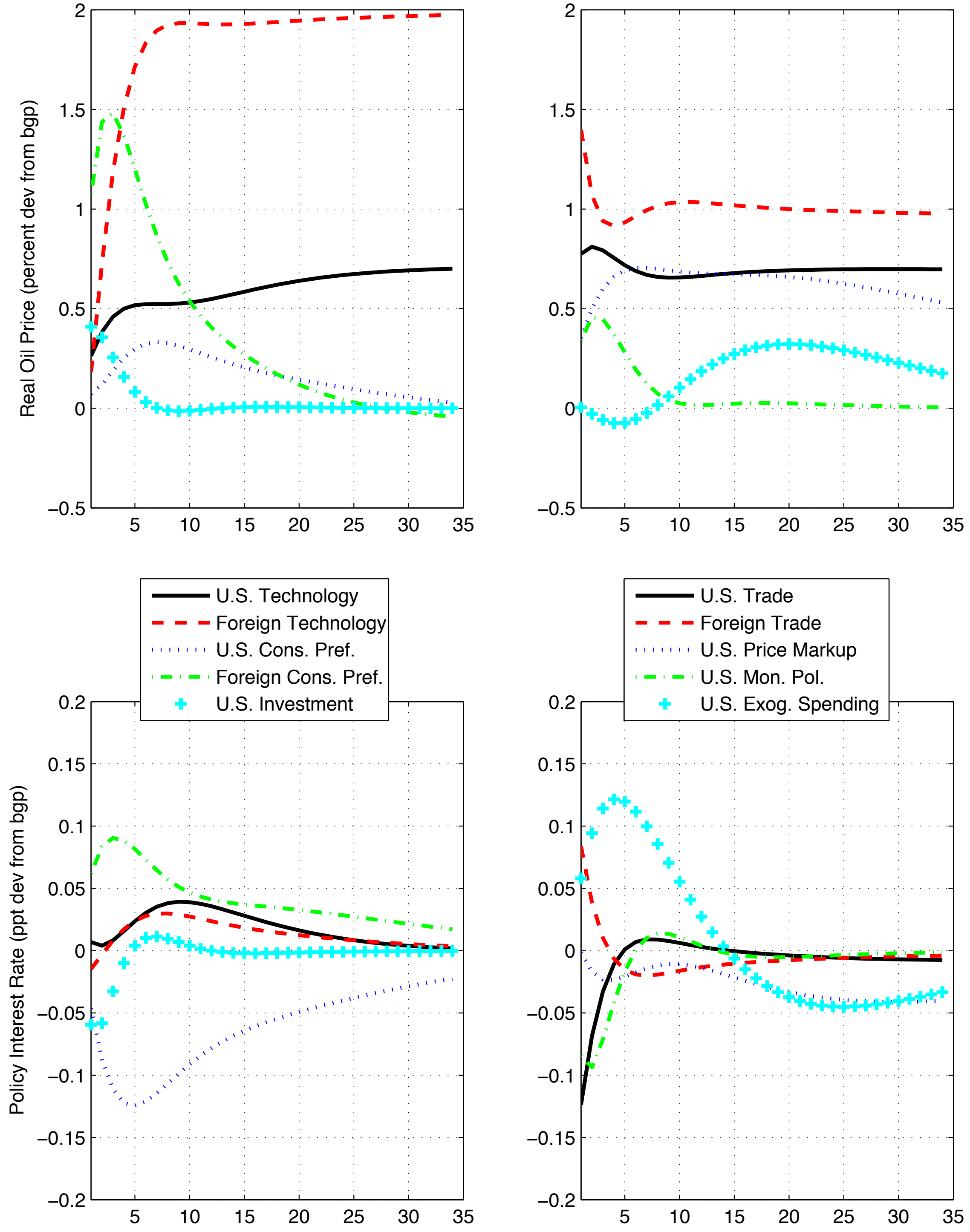


Figure 2: The Effects of Different Shocks on the Real Dollar Price of Oil and on U.S. Interest Rates (the shocks are sized at 1 standard deviation)



Optimizing the Monetary Policy Rule

Choose γ_1^i, γ_1^π, γ_1^y in

$$\begin{aligned} i_{1,t} &= \bar{i}_1 + \gamma_1^i (i_{1,t-1} - \bar{i}_1) \\ &\quad + (1 - \gamma_1^i) \left[(\pi_{1,t}^{core} - \bar{\pi}_1^{core}) + \gamma_1^\pi (\pi_{1,t}^{core} - \bar{\pi}_1^{core}) + \gamma_1^y y_{1,t}^{gap} \right] + \epsilon_{1,t}^i, \end{aligned}$$

so as to maximize the expected utility of the representative household.

Optimized Coefficients

The optimized rule eliminates interest rate smoothing – $\gamma_1^i = 0$

The optimized rule does not respond to inflation – $\gamma_1^\pi = 0$

The optimized rule closes the output gap completely – $\gamma^y = 9.95 \times 10^5$

These findings are in line with previous results in Bodenstein, Erceg, and Guerrieri (2008). For a stylized model, they showed that the optimal policy is well approximated by rules that target the output gap.

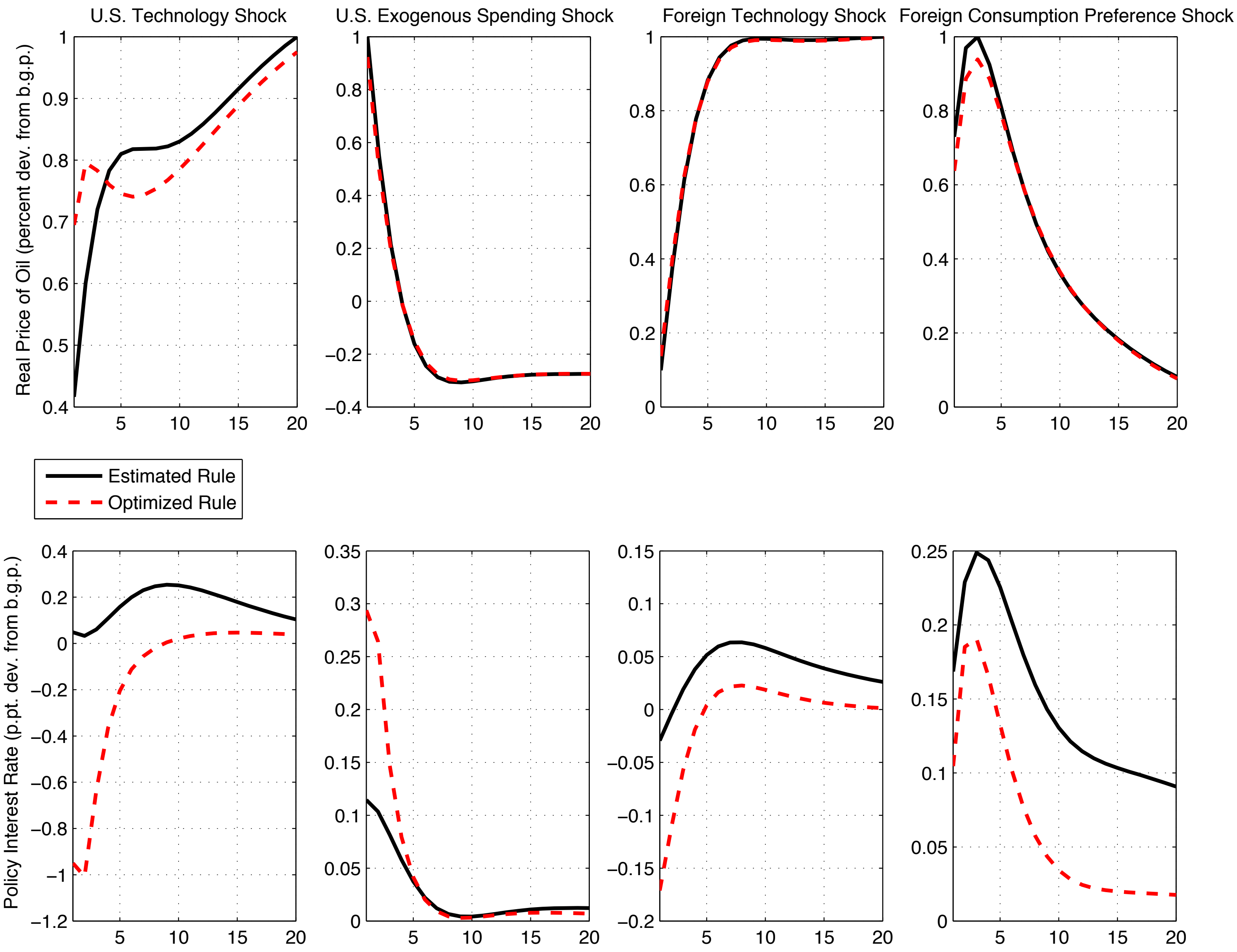
Our results confirm that their previous analysis translates to instrument rules and applies to a large-scale empirically-validated model.

Comparing Welfare Losses

Rule	U.S. Welfare Loss (change from optimized)	Foreign Welfare Loss (change from optimized)
Benchmark Model		
Estimated	2.99	-0.07
4-quarter Calvo Contracts and No Price and Wage Markup Shocks		
Estimated	0.12	0.01

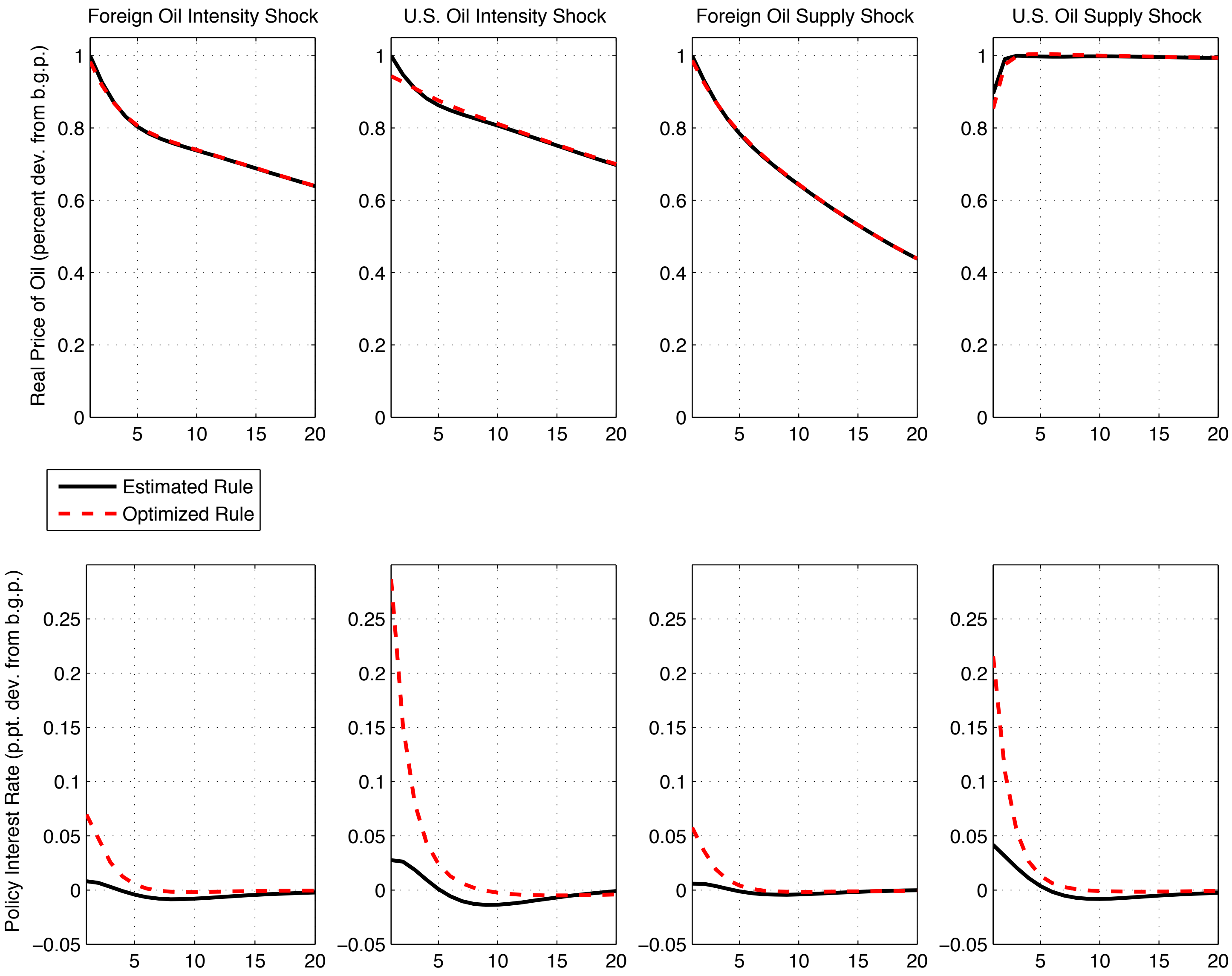
Losses expressed as a percent of steady state consumption.

Figure 3: A Comparison of the Effects of Key Shocks Affecting Oil Prices under Alternative Policy Rules* (the shocks are scaled to induce a one percent increase in real price of oil at peak)



* The scale of the U.S. technology shock is 1.5632 standard deviations The scale of the U.S. autonomous spending shock is 2.0453 standard deviations. The scale of the foreign technology shock is 0.51361 standard deviation. The scale of the foreign consumption preference shock is 0.66794 standard deviation.

Figure 4: A Comparison of the Effects of Key Shocks Affecting Oil Prices under Alternative Policy Rules* (the shocks are scaled to induce a one percent increase in the real price of oil at peak)



* The scale of the foreign oil intensity shock is 0.06584 standard deviation. The scale of the U.S. oil intensity shock is 0.78125 standard deviation. The scale of the foreign oil supply shock is 0.23862 standard deviation. The scale of the U.S. oil supply shock is 2.264 standard deviations.

Comparing Welfare Losses

Rule	U.S. Welfare Loss (rel. to optimized)	Foreign Welfare Loss (rel. to optimized)
Estimated	2.99	-0.07
Taylor with Core	2.45	-0.07
Core Infl. Only	2.44	-0.07
Taylor with Headline	2.50	-0.06
Headline Infl. Only	2.52	-0.05

Losses expressed as a percent of steady state consumption.

Nash and Cooperative Equilibria

The large gains relative to simple rules highlighted above remain sizable also when the foreign economy is allowed to choose coefficients in the foreign policy rule that maximize expected foreign welfare – we consider the best response to the best response.

We follow Obstfeld and Rogoff (2002) and consider a cooperative equilibrium in which the coefficients of the domestic and foreign rule are chosen to maximize the joint domestic and foreign welfare.

Cooperative and Competitive Equilibria

Rule	Joint Welfare Loss (rel. to cooperative)
Benchmark Model	
Nash	0.11
Model Without Oil Inputs	
Nash	0.02

Losses expressed as a percent of steady state consumption.

Conclusion

We showed that a large array of shocks influence oil prices and that each source implies a different response of monetary policy, even when policy follows an estimated simple instrument rule.

The optimized simple rule is aggressive in closing the output gap.

We found unusually large gains from optimizing the monetary policy rule relative to commonly used simple rules. Some of these gains were related to oil trade, but most of them stemmed from sizable markup shocks.

Explicit modelling of oil trade across countries produced gains from cooperation relative to competition at least an order of magnitude larger than typically reported.