Monetary policy implications for an oil-exporting economy of lower long-run international oil prices

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Outline

The policy question and the problem

Small scale Bewley Models
  Single-good Economy
  Two-good Economy
  Oil Exporting Economy

Monetary policy models
  Simple New Keynesian
  Sectoral Financial Accelerator
  Sectoral financial accelerator model

Final Remarks
Motivation
The question and the problem

- Small, open and commodity exporting economies are subject to large and sudden commodity price swings.
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- How does monetary policy in an oil-exporting economy cope with a sudden and long-lasting reversal of international oil prices?
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- How does monetary policy in an oil-exporting economy cope with a sudden and long-lasting reversal of international oil prices?
- We conduct a quantitative assessment of the impact of an unexpected permanent change in oil prices in an oil-exporting economy and derive its monetary policy implications.
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- How does monetary policy in an oil-exporting economy cope with a sudden and long-lasting reversal of international oil prices?
- We conduct a quantitative assessment of the impact of an unexpected permanent change in oil prices in an oil-exporting economy and derive its monetary policy implications.
- Our approach: first, understand the consequences on the economy’s NFA, usually assumed exogenous by many models which rely on approximation solution methods. Then, couple it with monetary policy models.
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The problem

A small open economy representative agent chooses consumption to maximize:

\[
E_0 \left[ \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right]
\]

subject to

\[
c_t = y_t - b_{t+1} + Rb_t.
\]

- \( y_t \) is stochastic with \( E[y] = \bar{y} \) and \( V[y] = \eta \).
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- \( b_{t+1} \in [-\phi, 0] \) with \( R \) given: incomplete financial markets and net debtor economy.
- If \( \beta R < 1 \) then, \( b \) has a LR distribution (PS/BAH model).
A global solution: discrete dynamic program

Let \( e = (y, b) \), discretize it and find optimal rule \( b_{t+1} = \tilde{b}(e) \) such that

\[
\nu(e) = \max_{\tilde{b}(e) \in [-\phi, 0]} \frac{(y - b' + Rb)^{1-\sigma}}{1 - \sigma} + \beta P(\tilde{b}(e))\nu(e). \tag{1}
\]

where \( P(\tilde{b}(e)) \) is the OTPM and depends on \( \beta, R, \sigma, \phi, E[y] \) and \( V[y] \).

**Experiment:** expected income \( E[y] \) falls unexpectedly and permanently from \( \bar{y} \) to \( y \), keeping \( V[y] \) constant.
Transitional dynamics

- Under high oil prices $\bar{e} = (\bar{y}, \bar{b})$ there is a $\bar{P}$ with ergodic distribution $\bar{f}$. Oil prices fall unexpectedly, implying a fall in expected income to $\bar{y}$. 

Agents reoptimize and solve problem (1), find a new set of optimal rules, $\bar{P}$, ergodic distribution, $\bar{f}$, and long run value of expected debt, $E[b] = f \cdot b = b$. Thus, the economy falls from $\bar{e} = (\bar{y}, \bar{b})$, previously, to wake up at $e = (y, \bar{b})$ and eventually settle at $e = (y, b)$. The evolution of the economy can be characterized by a sequence of probability functions, $\{f_t\}_{t=0}$ which can be computed iteratively $f_{t+1} = P \cdot f_t$ and starting from $f_0$. Since $P$ is a well behaved Markov chain, the sequence of distributions eventually converges to $f$. We use this sequence of distributions to compute the expected path of debt, $\{E_t[b] = f_t \cdot b\}_{t=0}$. 


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- We use this sequence of distributions to compute the expected path of debt, $\{E_t[b] = f_t \times b\}_{t=0}^{\infty}$. 
Calibration

- We set $E[y] = 1$ and $V[y] = 0.026^2$ to match annual (HP-filtered) Colombian annual GDP moments. Fix $R = 1.035$ and take $\sigma = 4$ from estimated models at CB. And set $\beta = 0.96$ and $\phi = 0.4$ to match 30% external debt to GDP ratio and a fraction of international financial exclusion of 16%.
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- Consumption is procyclical and highly autocorrelated, as in the data, but is about one-third smoother. The current account and the trade balance are also highly correlated in the model as in the data, however the model results are at odds with a well-documented fact which is that both are counter-cyclical in emerging economies.
Macro response to a permanent fall in income
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The model

\[ v(y^T, b) = \max_{b' \in [-\phi, 0]} \frac{c^{1-\sigma}}{1-\sigma} + \beta E_{y^T} \left[ v((y^T)', b') \right] \]  

\[ c_t = \left[ a \left( c_t^T \right)^{-\mu} + (1-a) \left( c_t^N \right)^{-\mu} \right]^{-\frac{1}{\mu}} \]

\[ c_t^T = y_t^T + p_t^N y_t^N - b_{t+1} + Rb_t + A^T \]

\[ c_t^N = y_t^N + A^N \]

\[ p_t^N = \frac{1-a}{a} \left( \frac{c_t^T}{c_t^N} \right)^{1+\mu} \]
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Oil prices and reserves
Oil sector

Economy has a stock of oil $s \in [0, \bar{s}]$ and every year $d$ units can be discovered randomly. A representative oil firm can extract $x \in [0, s]$ units of oil at a cost $C(s, x)$ to sell internationally at the relative price $p_x$ (in units of tradable). The stock of oil evolves as $s' = s - x + d$, and the firm seeks to:

$$
\nu(s) = \max_{x \in [0,s]} \left\{ p_x x - C(s, x) + \delta E_d [\nu(s - x + d)] \right\}.
$$

Optimality requires that

$$
p_x = C_x(s, x) + \delta E_d [\lambda(s - x + d)]
$$

and

$$
\lambda(s) = C_s(s, x) + \delta E_d [\lambda(s - x + d)].
$$
Non-oil economy

Associated with this program there is an optimal oil extraction policy, $\tilde{x}(s)$, which the rest of the economy takes as given, thus the resource constraint of the economy becomes:

$$c_t^T = y_t^T + p^x\tilde{x}(s) + p^N_t y^N_t - b_{t+1} + Rb_t + A^T$$

and

$$c_t^N = y^N_t + A^N.$$

Thus, with two assets, optimal borrowing is $\tilde{b}'(s, b)$, and at any given point in time, NFA are not only the summary of debt history but also of oil reserves history.
Calibration I

![Graph showing the Reserves to Production Ratio (Years) from 1927 to 2013. The graph includes two mean lines, one for the period 1927-1958 and another for 1959-2013. The mean for 1927-1958 is 41.76 years, and the mean for 1959-2013 is 11.55 years. The graph also highlights the years 1927, 1957, 1977, and 1987 with significant events or changes in the ratio.]
Calibration of discoveries
Macro response to a permanent fall of oil prices

- **Optimal Reserves**
- **Net Foreign Assets**
- **Consumption**
- **Oil extraction**
- **Trade Balance**
- **Real Exchange Rate**
- **Oil profits**
- **Current Account**
- **Price of Nontradables**
Main takeaways from small scale models

- The financial and real structure of the economy are important when studying the net foreign position of the economy.
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- However, these models leave aside many features of reality that are of interest to policy makers and central banks.
- We now turn to the reaction of monetary economies to unexpected permanent changes in oil prices, taking as given the NFA adjustment of the oil economy.
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A channel outside the previous models

*January 2000 = 100
Key elements of the model

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- Key: country risk premium depends on both $b$ and $p^x_s$.
Macro response to a permanent fall of oil prices

- Extraction
- Reserves (years)
- Reserves
- GDP
- Consumption
- External debt
- Employment
- Non tradable output
- External interest rate
- Policy rate
- Total inflation

Monetary policy   New Keynesian
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- Key: financial accelerator (BGG) in both sectors where net worth is influenced by valuation effects.
Key 1: Financial accelerator
tradable and nontradable \((j = N, T)\)

- Perfectly competitive banks make commercial loans to entrepreneurs, \(b^j_t\), by taking deposits from households, \(d_t\), and borrowing from international financial markets, \(b^*_t\).
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- Financial intermediation subject to frictions (CSV problem) on the side of the asset side of the banks. Thus, spreads depend on firms’ net worth, \(n^j_t\) and the value of capital, \(p^k^j_t k^j_t\).

\[
\mathbb{E}_t \left[ r_{t+1}^k^j \right] = \left( \frac{n^j_t}{p^k^j_t k^j_t} \right)^{-v_t^j} \left( 1 + r_t \right) (r_p^t)
\]
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\mathbb{E}_t \left[ r_{t+1}^{k^j} \right] = \left( \frac{n_{jt}^j}{p_{kt}^j k_t^j} \right)^{-v_t^j} (1 + r_t)(rp_t)
\]

- We define a “regulation premium”, \(rp_t\), as any policy that increases credit costs.
Key 2: Conventional and unconventional tools

- Monetary policy rule: reacts to deviations of total inflation relative to the target $\bar{\pi}$

$$i_t = i^\rho_{t-1} \left( \bar{i} \left( \frac{\pi_t}{\bar{\pi}} \right)^{\varphi_{\pi}} \right) \exp(\varepsilon_t)$$
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\[
i_t = i_t^{\rho_i} \left( i \left( \frac{\pi_t}{\bar{\pi}} \right) \phi_i \right) \exp \left( e_t^\mu \right)
\]

- Regulation premium rule: reacts to credit deviations from its long-run value

\[
 rp_t = \exp \left( \mu rp \left( \frac{c r_t}{c r} - 1 \right) \right)
\]
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Macro response to a permanent fall of oil prices I
Monetary policy

Macro response to a permanent fall of oil prices II

Financial Frictions  W/o Financial Frictions
What if the central bank targets NT inflation?
Monetary policy

What if the central bank targets NT inflation?
Final Remarks

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- To do: fiscal implications. May be relevant if one drops Ricardian equivalence
Supplementary figures I