Commodity Price Fluctuations and Monetary Policy in Small Open Economies

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October 2014
Motivation

- Increased volatility in world prices of commodities
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- Some are basic imports, such as oil and food
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- Immediate questions for small open economies: How should monetary policy adjust? Should it try to stabilize the CPI, or rather an index of producer prices? Should it react to the exchange rate?
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- Increased volatility in world prices of commodities
- Some are basic imports, such as oil and food
- Immediate questions for small open economies: How should monetary policy adjust? Should it try to stabilize the CPI, or rather an index of producer prices? Should it react to the exchange rate?
- The answers are quite important in practice (Chile is an excellent example)
The New Keynesian model balances two considerations:
Lessons of Recent Literature

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**Nominal Rigidities**

- Policy should address domestic distortions and price setting behavior
- Favors stabilizing the PPI
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- Policy should address domestic distortions and price setting behavior
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**International relative prices (terms of trade externality)**
- Policy can stabilize the real exchange rate or the terms of trade
- Suggests stabilizing the CPI
Recent Related Studies


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1. Gali and Monacelli (2005): small open economy, finds PPI stabilization optimal for a special case


3. Catão-Chang (2013,14, henceforth CC): focus on international relative price shocks, extends analysis in several directions, CPI stabilization beats PPI stabilization under realistic assumptions
"But what price index should inflation targeting ideally refer to? Recent work...has emphasized that, from a welfare point of view, monetary policy should stabilize sticky prices rather than flexible prices...These results can be interpreted as favoring a core CPI or domestic inflation targeting...
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Svensson (2008), Comments on Frankel (2008)
Objective of This Paper

A simple version of CC with two objectives:

1. Review main lessons of CC, especially conditions under which PPI stabilization is optimal
2. Reexamine the question of what objectives or targets are appropriate to assign to the central bank
Main Takeaways

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- The appropriate welfare criterion and target rules to assign to the central bank can be chosen in many alternative ways.

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Main Takeaways

- PPI stabilization will be optimal only under very special assumptions.
- Elasticities of demand matter, but also other aspects of the economy, such as the degree of international risk sharing.
- The appropriate welfare criterion and target rules to assign to the central bank can be chosen in many alternative ways.
- To say, for example, that the central bank "should react to the exchange rate" can be as correct, or incorrect, as saying that the central bank should "stabilize domestic inflation".
The Analytical Framework

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- Relative world prices of imports are exogenous.
- Perfect International Risk Sharing, but also Portfolio Autarky
Households

- Representative agent that maximizes the expected discounted value of

\[ \mathcal{W} = \frac{C^{1-\sigma}}{(1 - \sigma)} - \frac{\zeta N^{1+\varphi}}{1 + \varphi} \]
Households

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- Consumption is a C.E.S. aggregate of a home good $C_h$ and imports $C_m$
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- Consumption is a C.E.S. aggregate of a home good $C_h$ and imports $C_m$
- The home good is a C.E.S aggregate of a continuum of varieties.
Relative Prices

Our specification implies that

$$1 = (1 - \alpha) \left( \frac{P_h}{P} \right)^{1-\eta} + \alpha X^{1-\eta} Z^*^{1-\eta}$$

where $P$ is the CPI, $P_h$ the price of the home good, $X$ the real exchange rate and $Z^*$ the world relative price of the imported good.
Relative Prices

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where \( P \) is the CPI, \( P_h \) the price of the home good, \( X \) the real exchange rate and \( Z^* \) the world relative price of the imported good.

- \( Z^* \) is exogenous
This implies that (in a log linear approximation):

\[ x = (1 - \alpha)\tau - z^* \]

where \( \tau \) denotes the \textit{terms of trade}. 
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Hence the terms of trade and the real exchange rate can move in opposite directions (in contrast with most of the literature).
The household’s optimal choice of labor effort is given by

\[
\frac{\nu'(N)}{u'(C)} = \zeta N^\phi C^\sigma = \frac{W}{P}
\]

where \( W \) is the nominal wage.
I allow for either perfect international risk sharing:

\[ C = C^* X^{1/\sigma} \]

or portfolio autarky:

\[ PC = P_h Y \]
Variety $j$ is produced with labor

$$Y(j) = AL(j)$$
Domestic Production

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- If all prices were flexible, each variety producer would price as a fixed markup over marginal cost:
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- If all prices were flexible, each variety producer would price as a fixed markup over marginal cost:
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- To introduce nominal rigidities, assume instead that prices are set one period in advance, so:
  \[ \mathcal{E} \left[ C^{-\sigma} \frac{Y}{P} \left( P_h - \frac{\varepsilon}{\varepsilon - 1} \Psi \right) \right] = 0 \]
Equilibrium

Market Clearing for the home good requires

\[ Y_h = (1 - \alpha) Q^{-\eta} C + \alpha \left( \frac{X}{Q} \right)^{\gamma} C^* \]

where the real price of home output is

\[ Q = \frac{P_h}{P} \]
Equilibrium

- Market Clearing for the home good requires

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where the real price of home output is

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- To close the model, I assume that monetary policy controls nominal demand:

\[ M = PC \]
Valuable insight is obtained by characterizing the *Ramsey planning outcome* and the *flexible price (natural) outcome*.

Key observation: PPI stabilization will generally replicate the natural outcome, so it is optimal if the Ramsey and natural outcomes coincide.
Market Clearing for Home Goods:

\[ Y = AN = (1 - \alpha)Q^{-\eta}C + \alpha \left( \frac{X}{Q} \right)^\gamma C^* \]

\[ \equiv \Omega(X, Z) \]

since \( Q = Q(X, Z) \)

Risk Sharing:

\[ C = C^* X^{1/\sigma} \]

The *Ramsey Planner* maximizes \( u(C) - v(N) \), so the first order condition is:

\[ \frac{1}{\sigma} Cu'(C) = \frac{X \Omega X}{\Omega} Nv'(N) \]

\[ \Rightarrow \text{The *Ramsey outcome* is the solution } (C, N, X) \text{ to the previous equations} \]
Under flexible prices, (1) and (2) must hold, but also the *fixed markup* condition:

\[
\frac{\varepsilon - 1}{\varepsilon (1 - \nu)} Cu'(C) = \left[ \frac{C}{QY} \right] Nv'(N)
\]

\[\Rightarrow\] The preceding condition, together with (1) and (2), pin down the *natural* (flex price) outcome.
Remarks

The Ramsey and natural outcomes are the same if (at the common solution):

$$\varepsilon_1 = \varepsilon(1 + \nu) = QY = \sigma X \Omega X \Omega = \alpha$$

If they do, PPI stabilization is optimal. This happens if

$$\eta = \gamma = 1/\sigma$$

and:

$$\varepsilon_1 = \varepsilon(1 + \nu) = 1/\alpha$$

The previous case includes the example in Gali-Monacelli (2005) and Gali (2008). Likewise, if \( \nu \) can be chosen optimally, it can be adjusted so that the previous condition holds at all times, which makes PPI stabilization optimal (Hevia and Nicolini 2013).
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- Likewise, if \(\nu\) can be chosen optimally, it can be adjusted so that the previous condition holds at all times, which makes PPI stabilization optimal (Hevia and Nicolini 2013).
Implications of the Analysis

1. The particular structure of the economy matters (productive structure, parameters and elasticities, international risk sharing)

2. The result that PPI stabilization is optimal appears is quite special and fragile

3. But this analysis yields no presumption that an alternative rule, should as CPI targeting or an exchange rate peg, beats PPI targeting
Numerical Illustration (from CC)

- This is borrowed from Catao and Chang (2013)
- Calibration in that paper
- More involved model: Calvo pricing; imports are a factor of production; enclave exports sector
The Table gives the difference in welfare (in % of SS consumption) implied by the **PPI rule vis a vis an expected CPI rule**.

<table>
<thead>
<tr>
<th>$\sigma \backslash \eta$</th>
<th>0.75</th>
<th>1</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.001</td>
<td>-0.004</td>
<td>-0.007</td>
</tr>
<tr>
<td>4</td>
<td>-0.021</td>
<td>-0.026</td>
<td>-0.089</td>
</tr>
<tr>
<td>6</td>
<td>-0.029</td>
<td>-0.034</td>
<td>-0.095</td>
</tr>
</tbody>
</table>

- The expected CPI rule wins for most parametrizations
- The superiority of expected CPI increases with $\eta$ and $\sigma$
- The welfare differences are small
Impulse responses reveal that the Ramsey policy relies more than the PPI rule on exchange rate stabilization, \textit{and} that the expected CPI rule gets closer to Ramsey in this respect.

This is so especially if shocks to \textit{imports} prices dominate.
<table>
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<tr>
<td>2</td>
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</tr>
<tr>
<td>6</td>
<td>0.415</td>
<td>0.391</td>
<td>0.208</td>
</tr>
</tbody>
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$\Rightarrow$ PPI Targeting easily beats expected CPI targeting in this case

$\Rightarrow$ The impulse responses show that there are still sizable discrepancies between PPI targeting and Ramsey, but also that expected CPI targeting is even worse.
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One hopes, in particular, that such an approximation will identify appropriate objectives and targets for the Central Bank.
Approximating Welfare

Here, a second order approximation of the welfare of the representative agent is given by:

\[
\mathcal{W} = \mathcal{E} \left\{ c - n + \frac{1}{2} [(1 - \sigma) c^2 - (1 + \varphi) n^2] \right\} + \mathcal{O}^3
\]

where \( c = \log C - \log \bar{C} \), etc. and \( \mathcal{O}^3 \) includes a cubic residual (with terms like \( c^3, n^3, c^2 n, cn^2 \))
Approximating Welfare

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\[ W = \mathcal{E} \left\{ c - n + \frac{1}{2} \left[ (1 - \sigma)c^2 - (1 + \phi)n^2 \right] \right\} + \mathcal{O}^3 \]

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- The presence of the linear terms \( c \) and \( n \) is inconvenient, because one cannot use a *linear* approximation to the equilibrium to correctly evaluate \( W \)
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- The presence of the linear terms \( c \) and \( n \) is inconvenient, because one cannot use a linear approximation to the equilibrium to correctly evaluate \( \mathcal{W} \)
- One solution: use a quadratic approximation to the equilibrium to substitute out \( c \) and \( n \), and then write \( \mathcal{W} \) as a pure quadratic (Sutherland 2005)
Follow Sutherland (2005). Details in paper.
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Some insight is obtained about the role of uncertainty on expected values; for instance

\[ \rho_h = \mathcal{E} \left[ \varphi y + \sigma c + p + \lambda_p \right] \]

with

\[ \lambda_p = \frac{1}{2} \left\{ (1 + \varphi)^2 y^2 - (y - \sigma c - p)^2 \right\} \]
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with

\[ \lambda_p = \frac{1}{2} \left\{ (1 + \varphi)^2 y^2 - (y - \sigma c - p)^2 \right\} \]

Expected welfare can then be written in the form:

\[ \mathcal{W} = \mathcal{E} \left\{ (\phi_{cy} - \phi_{yy}) \lambda_y + (\phi_{cp} - \phi_{yp}) \lambda_p + (\phi_{cx} - \phi_{yx}) \lambda_x \right. \]

\[ \left. + \frac{1}{2} [(1 - \sigma)c^2 - (1 + \varphi)n^2] \right\} \]

where \( \phi_{cy}, \phi_{yy} \) etc. are functions of parameters
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In our case, the linear approximation is simple, and summarized by

$$x = \left(\frac{1}{\alpha} - 1\right)p - z$$

$$c = \frac{1}{\sigma}x = \frac{1}{\sigma} \left[\left(\frac{1}{\alpha} - 1\right)p - z\right]$$

$$y = \frac{\Theta}{\alpha}p - \Psi z$$
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Optimal policy is now of the form $p = \kappa z$
Targets, Gaps, and Rules

Alternatively, one can rewrite:

\[ \mathcal{W} = -\mathcal{E} \left[ \left( \frac{1}{2} \tilde{V}' D \tilde{V} + \tilde{V}' F z \right) + \frac{1}{2} \omega \rho p^2 \right] \]

where \( \tilde{V} = (y, c, q, x)' \) collects real variables.
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- This is useful, because one can express any three of the real variables in \( \tilde{V} \) as a function of the fourth one and the shock \( z \)
- For instance, one can write:

\[
\Phi_y \tilde{V} = \psi_y y + \psi_z z
\]
Then, in $\mathcal{V}$, one can eliminate all real variables except for $y$:

\[
\frac{1}{2} \tilde{V}' D \tilde{V} + \tilde{V}' F_z = \frac{1}{2} (N_y y + N_z z)' D (N_y y + N_z z) + (N_y y + N_z z)' F_z
\]

\[
= \frac{1}{2} (N'_y D N_y) y^2 + (N'_y D N_z + N'_y F) y z + t.i.p.
\]

\[
= \frac{1}{2} w_y [y^2 - 2\chi y z] + t.i.p.
\]
One finally obtains:

$$\mathcal{W} = -\frac{1}{2}\mathcal{E} \left[ w_y (y - y^T)^2 + w_p p^2 \right]$$
An Optimal Central Bank Objective

One finally obtains:

$$W = -\frac{1}{2} \mathcal{E} \left[ w_y (y - y^T)^2 + w_p p^2 \right]$$

- In this sense, monetary policy should seek to keep an inflation target of zero and to minimize an appropriately defined output gap.
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- \( y^T = \chi z \) is the "welfare relevant output target."
An Optimal Targeting Rule

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with \( \kappa = \alpha w_p / \Theta w_y \)
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- A "flexible targeting rule" in terms of inflation and an output gap (Svensson 2008)
The last expression for $\mathbb{W}$, as well as the preceding ones, are just transformations of the utility of the representative agent, which fundamentally depends on $c$ and $n$. Therefore, the weight $w_y$ and $w_p$ depend in many parameters of the economy, such as the degree of openness and trade elasticities. Likewise, the "target" $y_T = \chi z$ is a function of the world price shocks as well as of parameters (through $\varpi$). There is no presumption that $y_T$ is equal to the flexible price outcome (natural level of output).
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Implications

- The last expression for $V$, as well as the preceding ones, are just transformations of the utility of the representative agent, which fundamentally depends on $c$ and $n$.
- Hence the weight $w_y$ and $w_p$ depend in many parameters of the economy, such as the degree of openness and trade elasticities.
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- The last expression for $\mathcal{V}$, as well as the preceding ones, are just transformations of the utility of the representative agent, which fundamentally depends on $c$ and $n$.
- Hence the weight $w_y$ and $w_p$ depend in many parameters of the economy, such as the degree of openness and trade elasticities.
- Likewise, the "target" $y^T = \chi z$ is a function of the world price shocks as well as of parameters (through $\omega$).
- There is no presumption that $y^T$ is equal to the flexible price outcome (natural level of output).
In fact, $\mathcal{W}$ can be represented *in many other ways*: following the same derivation as before, but expressing $(c, q, y)$ in terms of $x$, one would arrive to an expression such as

$$
\mathcal{W} = -\frac{1}{2} \mathcal{E} \left[ w_x (x - x^T)^2 + w_p p^2 \right]
$$

and a target rule of the form

$$(x - x^T) + \kappa p = 0$$

where the *exchange rate target* is $x^T = \chi z$, but the parameters $\chi, w_x, w_p$, and $\kappa$ would be different in this case.
A Practical Lesson

Any statement such as:

- The central bank should react to domestic inflation rather than headline inflation

...can be correct in the context of this analysis, if one defines targets and social weights correctly. (In fact, all of them can be correct!)
Any statement such as:

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is neither right nor wrong.

Each of these statements can be correct in the context of this analysis, if one defines targets and social weights correctly. (In fact, all of them can be correct!)
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The analysis suggests that we might want to examine alternative reasons ("transparency ", "credibility", "communication ") that can justify why some variables may be better than others as objectives and targets of monetary policy.