Asset Price Dynamics in a New Keynesian Model of Optimal Monetary Policy

Tiziana Assenza,\textsuperscript{1} Michele Berardi,\textsuperscript{2} Domenico Delli Gatti\textsuperscript{3}

\textsuperscript{1}Catholic University of Milan and CeNDEF, University of Amsterdam
\textsuperscript{2}University of Manchester
\textsuperscript{3}Catholic University of Milan
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Introduction

- Debate over asset prices and monetary policy is almost ten years old
- Bernanke-Gertler vs Cecchetti and Borio
- Renewed interest due to the crisis
- Maybe be Cecchetti and Borio got their revenge.
Transmission mechanism of an asset price (AP) shock

\[
q \uparrow \left\{ \begin{array}{c}
Tobin's \ q \ effect \ \Rightarrow \ I \uparrow \\
Wealth \ effect \ \Rightarrow \ C \uparrow \\
Net \ \text{Worth} \ \text{effect} \ \Rightarrow \ I \uparrow
\end{array} \right.
\]

In all the cases the AP shock affects aggregate demand \( \Rightarrow "\text{Augmented}" \ IS \ curve \) (Bernanke-Gertler-Gilchrist, Airaudo-Zanna) which incorporates asset prices.

Impact on inflation only \textit{indirect} through changes in demand driven output gap changes.
Can AP shocks have a direct impact on inflation?

What should be the attitude of the central bank in this case?

We study this issue in a standard NK-DSGE model.

Don’t expect fancy technicalities on heterogeneous expectations for the moment but the framework is a promising fairly simple starting point for this type of analysis.
The environment

- Households and firms.
- Households decide on consumption, asset holdings (money, bonds, shares) and labour supply.
- Firms produce differentiated goods in a monopolistic setting à la Dixit-Stiglitz.
- Pricing decisions characterized by Calvo type nominal rigidity.
- This looks like Carlstrom-Fuerst but...
Firms have to anticipate wages before they can cash in sales proceeds. Therefore they need funds at the moment wages have to be paid.

This looks like Walsh-Ravenna, but...

For simplicity, we assume that firms do not accumulate internal funds and do not resort to bank loans: They have to issue new equities to raise external finance.
Households

There is a continuum of unit mass of infinitely lived identical households. Period utility is CRRA. Arguments: a bundle of differentiated consumption goods, real money supply and work effort:

The representative household maximizes:

$$E_t \sum_{s=0}^{\infty} \beta^s \left[ \frac{C_{t+s}^{1-\sigma}}{1-\sigma} + \frac{\gamma}{1-\delta} (m_{t+s})^{1-\delta} - \chi \frac{N_{t+s}^{1+\eta}}{1+\eta} \right]$$  \hspace{1cm} (1)

subject to a sequence of budget constraints of the type:

$$C_t + m_t + b_t + q_t A_t = w_t N_t + \frac{1}{1+\pi_t} \left[ m_{t-1} + (1 + i_{t-1}) b_{t-1} \right] + (q_t + d_t) A_{t-1}$$  \hspace{1cm} (2)
From the FOC, we get the consumption Euler equation which yields, through linearization, the *IS curve*

\[ x_t = E_t x_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}) + g_t \]  

(3)

where \( x_t \) is the output gap, \( g_t \) is an AR(1) demand shock.

Moreover we get an optimal (linearized) relation between the real interest rate and the capital gain – a no-arbitrage condition – that we interpret as the *asset pricing equation*:

\[ q_t = E_t q_{t+1} - (i_t - E_t \pi_{t+1}) \]  

(4)
Firms

- Standard assumptions:
  - $J$ firms produce differentiated goods in a monopolistically competitive setting à la Dixit-Stiglitz.
  - Each firm has a CRS technology: $Y_{jt} = Z N_{jt}$ where $Z$ is a technological shock. Therefore firms incur production cost represented by the wage bill.
We depart from the standard setting in assuming

1. Production takes time: firms hire workers *at the beginning* of period \( t \) and sell output *at the end* of the period itself. As a consequence firms cannot pay wages out of sales proceeds. At the beginning of each period they have to anticipate the wage bill to employees.

2. Firms do not accumulate internal funds – i.e. they distribute all the profits as dividends – so that they have to raise external finance to fill the financing gap, which – in the absence of internal finance – coincides with the wage bill.

3. The only source of external funds is the Stock market.
By means of assumptions 2. and 3. we get rid of the complications due to the accumulation of net worth and to the credit market. This is only a first step towards a more general framework.

From assumption 3. follows that the j-th firm raises funds issuing new shares and the amount of shares sold is equal to the wage bill:

$$w_t N_{jt} = q_t A_{jt}$$

Shareholders will be remunerated by means of dividends (distributed in t+1 on shares held in t), which represent the cost of external funds for the firm.
The firm’s total cost in $t$, therefore, is equal to the wage bill augmented by *expected dividends* (to be paid in $t+1$).

For the sake of simplicity we assume that dividends are proportional to the Stock price, the dividend yield $\varepsilon$ being constant and uniform across firms:

$$D_{t+1} = \varepsilon Q_{t+1}$$

Hence marginal cost depends on the expected stock price $E_{t}Q_{t+1}$:

$$\phi_{t} = (1 + \varepsilon E_{t}Q_{t+1}) \frac{w_{t}}{Z_{t}}$$
Taking into account the labour market equilibrium, the deviation of the marginal cost from the steady state turns out to be:

$$\hat{\phi}_t = (\eta + \sigma) \left( x_t + \frac{\varepsilon}{\eta + \sigma} E_t q_{t+1} \right)$$

Using (5), from the standard optimal pricing problem with nominal rigidity à la Calvo we get the "Augmented" NK Phillips curve

$$\pi_t = \lambda x_t + \nu E_t q_{t+1} + \beta E_t \pi_{t+1} + u_t$$

with $\lambda = k (\eta + \sigma)$ and $\nu = k \varepsilon$. The supply shock $u_t$ follows an AR(1) process.
Expected asset price inflation shows up as a factor “augmenting” the standard NKPC.

Therefore expected asset price inflation, together with expected inflation, has a \textit{direct} impact on current inflation.

The reason for this impact is the effect of expected future asset price inflation on dividends to be paid by the firm.

In a sense this is a variant of the \textit{cost channel} NK-DSGE model.
Optimal monetary policy

- The central bank’s preferences are represented by the usual quadratic loss function: 
  \[ L = E_t \sum_{s=0}^{\infty} \beta^s \left( \pi_{t+s}^2 + \alpha x_{t+s}^2 \right). \]

- Under discretion, the loss is minimized subject to the Augmented Phillips curve assuming that agents’ expectations are given.

- From the FOC of the problem above one gets the optimal relationship between \( x_t \) and \( \pi_t \), which we label the Social Expansion Path (SEP):
  \[ x_t = -\frac{\lambda}{\alpha} \pi_t \] (6)
The macroeconomic model in structural form is

\[
\begin{align*}
\pi_t &= -\frac{\lambda}{\alpha} \pi_t \\
q_t &= E_t q_{t+1} - (i_t - E_t \pi_{t+1}) \\
\pi_t &= \lambda x_t + v E_t q_{t+1} + \beta E_t \pi_{t+1} + u_t \\
x_t &= E_t x_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}) + g_t
\end{align*}
\]
Substituting the first three equations into the last one and rearranging, we get the *Expectations based Optimal Monetary Policy Rule*, which reads as follows:

\[
i_t = \gamma_x E_t x_{t+1} + \gamma_\pi E_t \pi_{t+1} + \gamma_q E_t q_{t+1} + \gamma_u u_t + \gamma_g g_t
\]

where the \(\gamma\)s are polynomials of deep parameters.

The central bank should respond to asset price inflation! There is a *direct* channel through which asset price changes impact on inflation.
"...policy should not respond to changes in asset prices, except *in so far as they signal changes in expected inflation*..." (Bernanke-Gertler, 2001)
Learning

- Carlstrom and Fuerst (2007) show that introducing asset prices in the Central Bank policy rule can make the problem of indeterminacy more acute.

- Airaudo et al. (2007), instead, introduce asset prices on the demand side of the economy through a wealth effect and find that a CB that responds to expected stock prices can induce multiple sunspot-driven equilibria and can increase the likelihood of the fundamental equilibrium being E-unstable.

- In the present setting we find that calibrating the model à la Clarida, Gali and Gertler, and setting $\varepsilon = 0.05$ equilibrium is indeterminate, a result consistent with what found previously in the literature (see Evans and Honkapohja, 2003).
In this sense, asset prices do not help solve the problem of determinacy of equilibria in the model when an optimal fundamental based policy rule is implemented by the CB.

Again, using the same parameterization proposed above, we find that the MSV REE is E-stable, i.e., learnable by agent using recursive least squares, when an optimal expectations based policy is implemented by the monetary authority.
Under mild restrictions on the process governing the shocks so that $E_t s_{t+1} = \nu s_t$; $0 < \nu < 1$ for each state variable $s$, we can reduce the system to three equations (NK-PC; SEP; AP) in three state variables: output gap, inflation and asset price inflation.

In the absence of shocks, equilibrium is in the origin.
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Asset Price Dynamics in a New Keynesian Model of Optimal Monetary Policy
Suppose a *demand shock* hits the economy. What happens?

The CB reacts by increasing the interest rate: $i \uparrow$. Hence the asset price goes down: $q \downarrow \downarrow$

This is necessary to make room for a large enough expected capital gain to fulfill the no-arbitrage condition

$$q_t = E_t q_{t+1} - (i_t - E_t \pi_{t+1})$$

Firms have to pay a lower dividend, hence inflation goes down: $\pi \downarrow$

The output gap goes up: $x \uparrow$. The economy moves to B.

So much for the impact effect. There is a second round effect, however.

A higher output gap makes the asset price go up: $q \uparrow$

This is a countervailing force...but the impact effect prevails...
Asset Price Dynamics in a New Keynesian Model of Optimal Monetary Policy
Suppose a *supply shock* hits the economy. What happens?

The CB reacts by increasing the interest rate: $i \uparrow$. The economy moves to B where $\pi \uparrow\uparrow, x \downarrow\downarrow$

So much for the impact effect. There is a second round effect, however.

A lower output gap makes the asset price go down: $q \downarrow$

Firms have to pay a lower dividend, hence inflation goes down: $\pi \downarrow$

This is a countervailing force...but the impact effect prevails...
Asset Price Dynamics in a New Keynesian Model of Optimal Monetary Policy
A demand shock yields an increase in the output gap – as expected – but also deflation and a decrease of asset prices.

A supply shock yields a reduction in the output gap and in inflation – as expected – but also a decrease of asset prices.