Optimal Monetary Policy and Real Time Signal Extraction from the Bond market

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Optimal Monetary Policy with Real Time Signal Extraction from the Bond Market

- Present a joint model of the macro economy, the term structure and monetary policy under imperfect information

- The question: Is there information in the term structure that can be used for quarter-to-quarter monetary policy?

What can the term structure tell policy makers?

- Does the term structure add predictive power to macro variables? A typical result is Ang, Piazzesi and Wei (2003): Orthogonal component of short rate negatively correlated with future growth.
  - This result is the transmission mechanism of monetary policy in disguise.

- This paper is concerned with what the term structure can tell us when we know the effect of policy.

What can the term structure tell policy makers?

- Is there information in the term structure about the state of the business cycle?

- If yes, how can we model the interaction between the macro economy and the the term structure when the central bank uses information in the term structure to set policy?

Potential benefits from observing the term structure

- Bond prices are observable every trading day, while aggregate data take time to collect

- Markets may be efficient aggregators of dispersed and incomplete information
  - Many participants
  - Forecasts "weighted" by subjective confidence in predictions

The set up

- Standard New Keynesian model

- Central Bank cannot observe the state of the economy perfectly

- Bond market reflects some information that is unknown to the central bank, but also noise

The Macro Model

- Households consume goods and supply labour

- Habits in consumption

- Firms set prices to maximize profits in monopolistically competitive markets.

- Price setting subject to the Calvo (1983) mechanism and a fraction of firms use lagged inflation rule-of-thumb.

The Central Bank

- The Central Bank sets interest rates to minimize the loss function

$$\mathbf{L}_t = E_t\left[\sum_{k=0}^{\infty} \beta^k \left[\lambda_y (y_{t+k} - \overline{y}_{t+k})^2 + \pi_{t+k}^2 + \lambda_i (i_{t+k} - i_{t+k-1})^2\right]\right]$$

- Certainty equivalence of optimal policy function

$$\begin{aligned} i_t &= F X_{1,t|t} \\ X_{1,t} &= \left[a_t, y_{t-1}, \pi_{t-1}, \varepsilon_t^y, \varepsilon_t^\pi, i_{t-1}, \Delta i_t, \mathbf{v}_t\right]' \end{aligned}$$

The Central Bank

- The Central Bank estimates the state using current bond yields and noisy observations of lagged output and lagged inflation

$$
\begin{aligned}
Z_t &= \begin{bmatrix} y_{t-1} \\ \pi_{t-1} \\ \mathcal{Y}_t \end{bmatrix} + \begin{bmatrix} v_t^y \\ v_t^\pi \\ \mathbf{0} \end{bmatrix} \\
X_{1,t|t} &= X_{1,t|t-1} + K \left[Z_t - L_1 X_{1,t|t-1} - L_2 X_{1,t|t} \right]
\end{aligned}
$$

A Dual Interpretation of the Term Structure

- Affine term structure model formally equivalent to a linear measure of the state

$$\mathcal{Y}_t = \overline{A} + \overline{B} X_t + \mathbf{v}_t^{\mathcal{Y}}$$

- Derived from households utility function

$$\begin{aligned} E_t M_{t+1} &\equiv E_t \beta \frac{U_{ct+1} P_t}{U_{ct} P_{t+1}} \\ E_t M_{t+1}(1 + i_t) &= 1 \end{aligned}$$

- In practise $\mathbf{v}_t^{\mathcal{Y}}$ are serially correlated so $\mathbf{v}_t^{\mathcal{Y}}$ included in state definition

A Dual Interpretation of the Term Structure

- The linear bond equation fits into existing signal extraction methodology of Svensson and Woodford (2003).

- Bond yields now a function of the state and the central bank's estimate of the state

$$\mathcal{Y}_t = \mathbf{q} + \begin{bmatrix} Q_1 & Q_2 \end{bmatrix} \begin{bmatrix} X_{1,t} \\ X_{1,t|t} \end{bmatrix}$$

The System

$$\begin{aligned} X_{1,t} &= HX_{1,t-1} + JX_{1,t-1|t-1} + C\varepsilon_t \\ X_{2,t} &= G^1 X_{1,t} + \left(G - G^1\right) X_{1,t|t} \\ X_{1,t|t} &= X_{1,t|t-1} + K\left[Z_t - L_1 X_{1,t|t-1} - L_2 X_{1,t|t}\right] \\ Z_t &= \mathbf{z} + L_1 X_{1,t} + L_2 X_{1,t|t} \\ \mathcal{Y}_t &= \mathbf{q} + Q_1 X_{1,t} + Q_2 X_{1,t|t} \end{aligned}$$

or

$$\begin{bmatrix} X_{1,t} \\ X_{1,t|t} \end{bmatrix} = M \begin{bmatrix} X_{1,t-1} \\ X_{1,t-1|t-1} \end{bmatrix} + N\varepsilon_t$$

Estimating the Model

- Bayesian methodology

- US sample 1982:Q1-2005:Q4,

- Australia sample 1991:Q1-2005:Q3

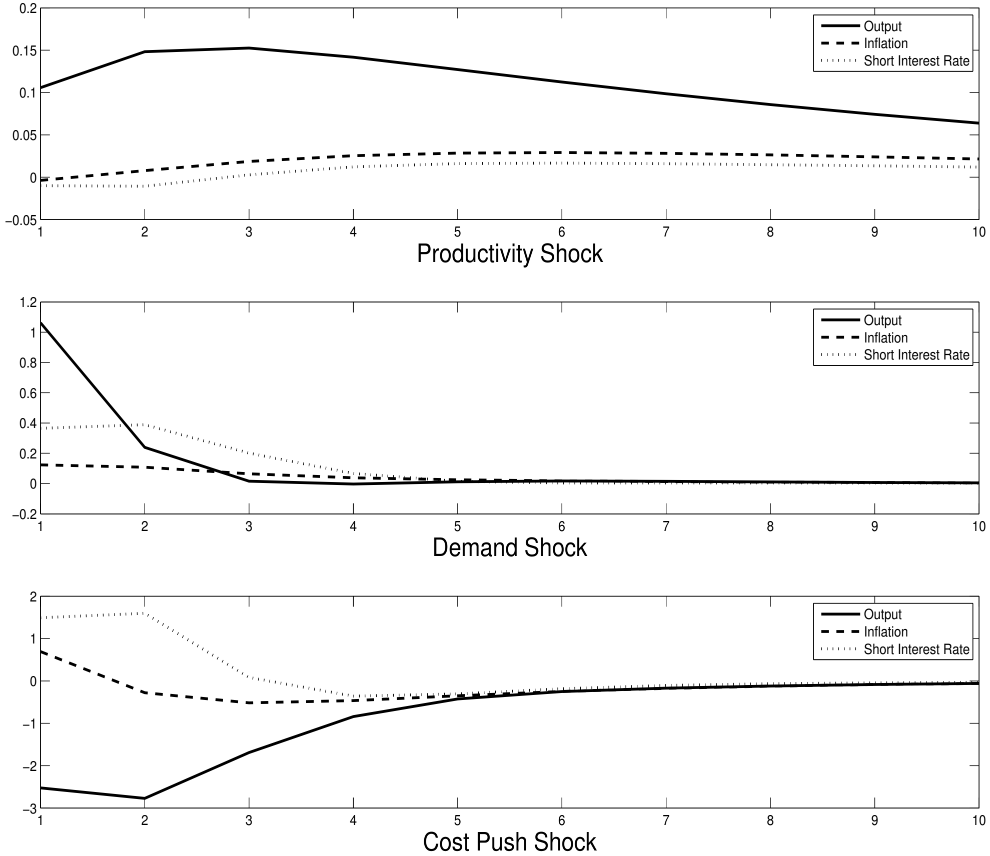
Z^{US} =Non-farm GDP, CPI Inflation (less food and energy), Fed Funds Rate, 6 month and 1 year T-Bill rates.

Z^{Oz} =Non-farm GDP, CPI Inflation (less food and energy), Cash Rate, 180 day Bank Bill Rate and 1 year T-Bond Rate.

Estimation results

- Behavior of households and firms similar in U.S. and Australia
- RBA puts relatively more weight on inflation in loss function than the Fed
- Bond market noise larger in Australia than in the U.S.

US impulse response functions



Australian impulse response functions

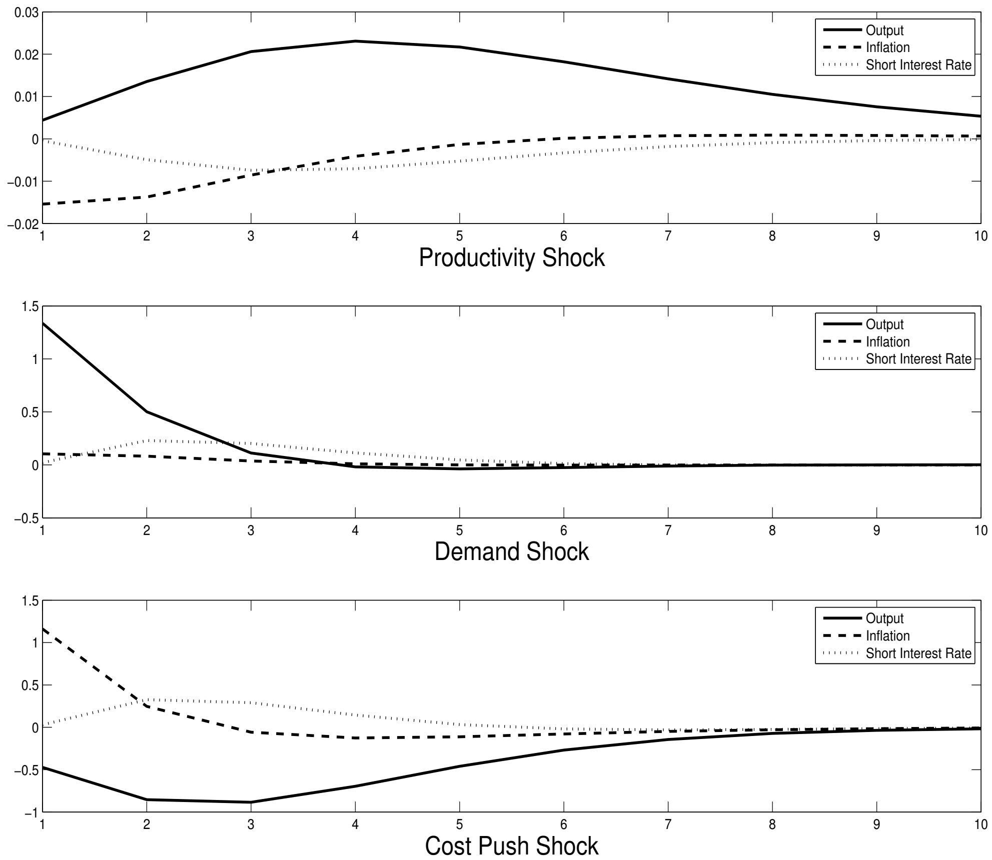


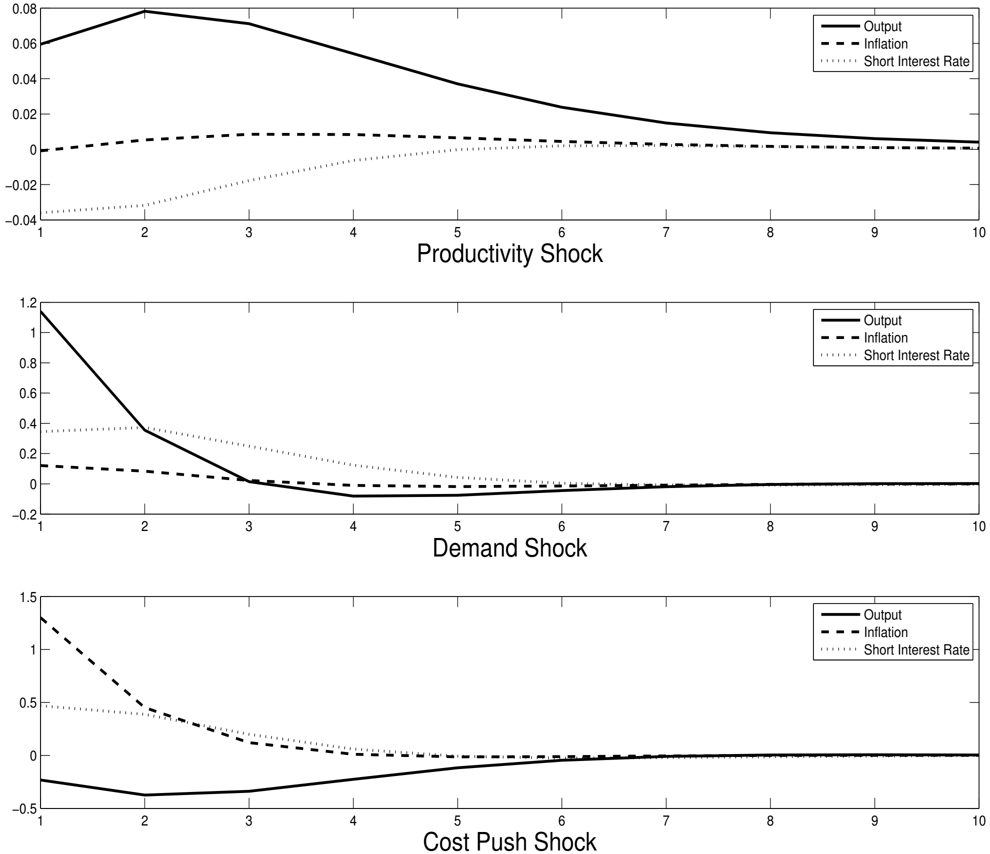
Table 3 Variance Decomposition US

	ε_t^a	ε_t^y	ε_t^π	v_t^{ycb}	$v_t^{\pi cb}$	$e_t^{v\mathcal{Y}2}$	$e_t^{v\mathcal{Y}4}$
y_t	0.79	0.12	0.01	0.07	0	0.01	0
π_t	0.63	0.05	0.01	**0.30**	0	0.01	0
i_t	0.17	0.51	0.05	**0.11**	0	**0.17**	0
$\mathcal{Y}_t^2$	0.15	0.38	0.03	0.06	0	**0.39**	0
$\mathcal{Y}_t^4$	0.03	0.07	0	0.01	0	0.01	**0.87**

Table 4 Variance Decomposition Australia

	ε_t^a	ε_t^y	ε_t^π	v_t^{ycb}	$v_t^{\pi cb}$	$e_t^{v\mathcal{Y}2}$	$e_t^{v\mathcal{Y}4}$
y_t	0.47	0.52	0	0	0	0.01	0
π_t	0.44	0.50	0	$\mathbf{0.04}$	0	0.02	0
i_t	0.42	0.51	0	$\mathbf{0.01}$	0	$\mathbf{0.06}$	0
$\mathcal{Y}_t^2$	0.06	0.07	0	0	0	$\mathbf{0.87}$	0
$\mathcal{Y}_t^4$	0.03	0.04	0	0	0	0	$\mathbf{0.93}$

Australia: No noise in the term structure



The information link between the term structure and the macro economy

1. A movement in term structure...

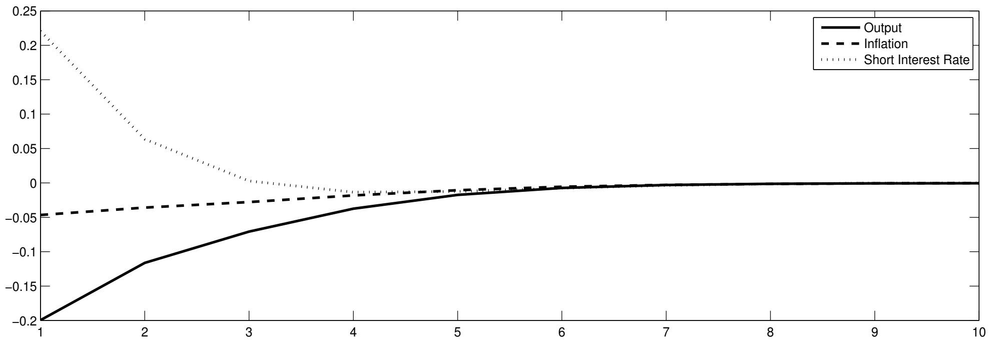
2. ...signals that a shock has hit the economy...

3. ...which alters the desired short interest rate...

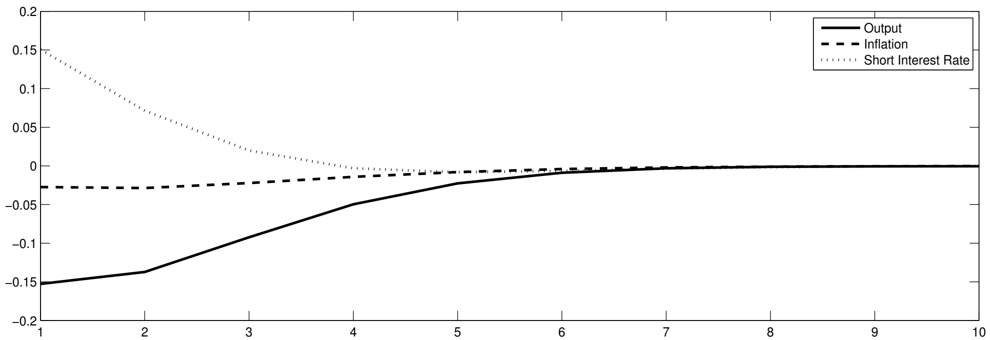
4. ...and changes aggregate demand through the Euler equation.

So far so good, but what about responding to noise?

Response to non-fundamental shock to 6 month yield



US Non−fundamental 6 Month Interest Rate Shock



Australia Non−fundamental 6 Month Interest Rate Shock

Some robustness checks

- Not imposing that the central bank actually uses the term structure information reduces the marginal likelihood for the U.S., but changes little for Australia

- Explicit interest rate smoothing objective or caution because of uncertainty?

  – For both U.S.and Australia, imposing $\lambda_i = 0$ causes very large reductions in marginal likelihoods

Conclusions

- We have an ”informational equilibrium” framework for analyzing and quantifying information in the term structure about the business cycle from a monetary policy perspective

- Data is consistent with US term structure being informative for policy, the Australian term structure less so

- Any business cycle relevant information that is interpretable using current models is most likely to be found in the short to medium maturity end of the term structure

  – Long rate movements still poorly understood (see Gurkaynak et al (2005))