Monetary policy transmission channels and policy instruments

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May 29, 2014
Modern theories emphasize the effects of monetary policy on the intertemporal price of consumption – the real interest rate.
The monetary policy transmission mechanism and policy instruments

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  - But this restriction is seldom (never) tested, even though it is central to policies such as forward guidance.

- Models used for policy analysis during the Great Moderation assumed balance sheet policies were irrelevant.
  - But such policies seem to matter and we do not yet have a clear understanding of why they do.
Outline
What I discuss in the paper:

- Real interest rates and forward guidance:
  - Is it the real interest rate that matters?
  - Are future expectations an effective instrument?
  - Is it better to simply anchor expectations?

- Balance sheet policies and quantitative easing:
  - Which spreads should such policies attempt to affect?
  - Which spreads have QE policies affected?
Evidence from VARs, a DSGE model, and a backward-looking model suggest nominal rates and expected inflation have effects that differ by more than just their sign.

Balance sheet policies have focused primarily on reducing the spread between long- and short-term interest rates;

- Empirical evidence implies lower term spreads are associated with lower future economic growth and higher unemployment;
- It is lower risk spreads that are associated with higher future growth and lower unemployment.
The role of inflation-adjusted interest rates
The conventional framework

- At the heart of modern policy models is the intertemporal price of consumption:
  \[ c_t = E_t c_{t+1} - \sigma (r_t - r^n_t). \]

- Variations in the real interest rate affect aggregate demand, and variations in aggregate demand lead to changes in output as nominal rigidities prevent prices or wages (or both) from immediately adjusting.
The conventional framework

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- Variations in the real interest rate, affect aggregate demand, and variations in aggregate demand lead to changes in output as nominal rigidities prevent prices or wages (or both) from immediately adjusting.

- Solving forward under the assumption that the economy converges to its steady state equilibrium (so \( c_{t+T} \to 0 \) as \( T \to \infty \)),

\[ c_t = -\sigma E_t \sum_{i=0}^{\infty} (r_{t+i} - r^n_{t+i}) = -\sigma E_t \sum_{i=0}^{\infty} (i_{t+i} - \pi_{t+1+i} - r^n_{t+i}). \]
The conventional framework: implications

- Key role of current and future real interest rate gaps.
- Persistent policy actions more effective than transitory rate changes.
  - Hence, affecting expectations about the future path of rates is always critical, not just at the ZLB.
- Because it is the real rate that matters, changes in expected inflation have the same effect (with opposite sign) as changes in nominal interest rates.
  - This implies strong effects of expected inflation at the ZLB.
  - Modern DSGE policy models seldom test such theoretical restrictions.
Basic vector autoregression:

\[ Z_t = A(L)Z_{t-1} + BX_t + e_t, \]

where \( Z'_t = [x_t \ \pi_t \ i_t \ \pi^e_t \ q_t] \).

- \( x \) is either GDP or one of its components (consumption, investment, etc.), each expressed in log per capita real terms.
- \( \pi^e \) is the one-year ahead expected inflation rate of the GDP deflator from the Survey of Professional Forecasters.

The data are quarterly and the estimation period is 1970:2 - 2007:4; lag length is four.
VAR: impulse responses

Responses to the one-year nominal rate

Responses to expected inflation

log real GDP

log real consumption

log real investment

log real exports

log real imports

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VAR: disaggregating consumption and investment

Nominal rate response (blue) and expected inflation responses (red)
VAR: ordering

- If the Fed has responded contemporaneously to expected inflation, then $\pi_e$ should be ordered first.
  - And in this case, an innovation to expected inflation should have a contractionary, not an expansionary, impact on output.

- Suppose the policy rule takes the form
  \[ i_t = r_t^n + \phi E_t \pi_{t+1} + e_t; \quad \phi > 1. \]

- Substituting this into Euler equation yields
  \[ c_t = E_t c_{t+1} - \sigma (\phi - 1) E_t \pi_{t+1} - \sigma e_t, \]
  with $(\phi - 1) > 0$. 

VAR: expected inflation ordered before the nominal rate
Does expected inflation do anything?

- Response to the nominal rate
- Response to expected inflation

- Log real GDP vs. inflation

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A backward-looking model
Rudebusch and Svensson (1999)

- Simple backward looking Phillips curve and IS curve:

\[ \pi_{t+1} = a_1 \pi_t + a_2 \pi_{t-1} + a_3 \pi_{t-2} + a_4 y_{t}^{cbo} + \varepsilon_{t+1} \]

\[ y_{t+1}^{cbo} = b_1 y_{t}^{cbo} + b_2 y_{t-1}^{cbo} + b_3 (\bar{i}_t - \bar{\pi}_t^e) + \eta_{t+1} \]

- Output gap measured using CBO estimate of potential real GDP.
A backward-looking model
Rudebusch and Svensson (1999)

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\[
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- Why use a backward looking model?
A backward-looking model
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\[
\pi_{t+1} = a_1 \pi_t + a_2 \pi_{t-1} + a_3 \pi_{t-2} + a_4 y_{cbo}^{t} + \epsilon_{t+1}
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\[
y_{cbo}^{t} = b_1 y_{cbo}^{t} + b_2 y_{cbo}^{t-1} + b_3 (\bar{I}_t - \bar{\pi}_t^e) + \eta_{t+1}
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  - Parsimonious fit to the data;
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  - May be more consistent with interpretation of Taylor Principle;
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- Simple backward looking Phillips curve and IS curve:
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  \]
  \[
  y^{cbo}_{t+1} = b_1 y^{cbo}_t + b_2 y^{cbo}_{t-1} + b_3 (\bar{\pi}_t - \bar{\pi}_t^e) + \eta_{t+1}
  \]
- Output gap measured using CBO estimate of potential real GDP.
- Why use a backward looking model?
  - Parsimonious fit to the data;
  - May be more consistent with interpretation of Taylor Principle;
  - Robustness check (Levin and Williams 2003, Walsh 2003).
A backward-looking model
Rudebusch and Svensson (1999)

Dependent variable: $y_t^{cbo}$

<table>
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<tr>
<th></th>
<th>1</th>
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Standard errors below coefficient estimates.
### A backward-looking model

Rudebusch and Svensson (1999)

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Standard errors below coefficient estimates.
IRF to expected inflation
Rudebusch-Svensson 1999 model

IRF to an expected inflation shock: updated parameters
Real rate restriction imposed
Separate est. coeff. for i and $\pi_e$
A DSGE model

- VARs summarize data correlations but do not exploit structural restrictions provided by theory.
- Backward-looking models not consistent with theory.
- Modern DSGE models impose restrictions but seldom test them.
A DSGE model
Iacoviello and Neri (AEJ: Macro 2011)

- Two types of households: patient and impatient households.
- Replace $i_t - E_t \pi_{t+1}$ with $i_t - (1 + \gamma_j) E_t \pi_{t+1}$.
Two types of households: patient and impatient households.

Replace \( i_t - E_t \pi_{t+1} \) with \( i_t - (1 + \gamma_j) E_t \pi_{t+1} \).

Case 1: both households still face same adjusted real interest rate.

Case 2: households face different adjusted real rate: \( i_t - (1 + \gamma_1) E_t \pi_{t+1} \) for patient households; \( i_t - (1 + \gamma_2) E_t \pi_{t+1} \) for impatient households.
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Table 1: Iacoviello and Neri model (AEJ Macro 2011)

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<tr>
<th>Parameter</th>
<th>Prior Distribution</th>
<th>Mean</th>
<th>S.D.</th>
<th>Posterior Distribution</th>
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</thead>
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<td>1</td>
<td>$-0.0721$</td>
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<tr>
<td>$\gamma_1$</td>
<td>Normal</td>
<td>0</td>
<td>1</td>
<td>$-0.0809$</td>
</tr>
<tr>
<td>$\gamma_2$</td>
<td>Normal</td>
<td>0</td>
<td>1</td>
<td>$-0.2610^*$</td>
</tr>
</tbody>
</table>

* Significant at the 10% level.
Why nominal rates and expected inflation might have different effects

- It’s after-tax rates that matter – goes in wrong direction.
- Presence of nominal debt:
  - Flow effect: long-term nominal debt with fixed nominal repayment schedules;
- Nominal cost or working capital channel as in Chari, Christiano, and Eichenbaum (1995), Ravenna and Walsh (2006).
Forward guidance
Why it matters

- The real interest rate channel central to policy recommendations at the ZLB.
- With nominal rate expected to be at zero until $t + S$:

$$c_t = -\sigma E_t \sum_{i=S}^{\infty} i_{t+i} + \sigma E_t \sum_{i=0}^{\infty} \pi_{t+1+i} + \sigma E_t \sum_{i=0}^{\infty} r_{t+i}^n.$$ 

- Bernanke, Krugman, and Svensson to the Bank of Japan – raise expectations of inflation!
- Promising to keep nominal rate at zero for an extended period has a powerful effect on inflation and output (Carlstrom, Fuerst, and Paustian 2012).
Expected inflation as an instrument

- Forward-looking models yield a large role for forward guidance.
  - Forward guidance involves using expectations as instruments.
  - Consistent with optimal policy under commitment which treats future expectations as policy instruments.

- Is this realistic?
  - If policy is implemented in a systematic manner that is understood by the public, forward guidance would only be effective if the central bank planned to deviate in the future from this systematic behavior.
  - But a tool used only when policy will deviate from its customary path is, almost by definition, not a tool that can be used on a regular basis.
Expected inflation as an anchor

- Alternatively, a more modest approach is to view inflation expectations as an form of anchor.
- Simple NK model with an inflation target of $\pi^T$:

$$x_t = E_t x_{t+1} - \sigma \left( i_t - \pi^e_{t+1} - r^n_t \right);$$

$$\pi_t - \pi^T = \beta \left( \pi^e_{t+1} - \pi^T \right) + \kappa x_t + u_t;$$

$$i_t = r^n + \pi^T + \phi_{\pi} \left( \pi_t - \pi^T \right) + \phi_x x_t.$$

- Suppose

$$\pi^e_{t+1} = \left( 1 - \delta \right) E_t \pi_{t+1} + \delta \pi^T.$$

- The parameter $\delta$ controls the degree to which expectations are anchored at the inflation target.
Expected inflation as an anchor
Outcomes under a Taylor rule

Variances relative to RE (δ=0)

percent
output gap
inflation

δ

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Expected inflation as an anchor

Eggertsson and Woodford (2003) example

Output gap at the ZLB
Rational expectations ($\delta=0$) -- solid line, Anchored ($\delta=1$) -- circles

Inflation at the ZLB
Rational expectations ($\delta=0$) -- solid line, Anchored ($\delta=1$) -- circles
Expectations as automatic stabilizers

- Or, they can serve as automatic stabilizers.
- This requires adopting a policy regime such as price level targeting.
Has forward guidance been effective?

- Yes.
  - Raskin (2013) using options-based estimates of distribution of interest rate forecasts;
  - Bauer and Rudebusch (2013) argue much of the effect of QE policies is via a signally channel;
  - Krishnamurthy and Vissing-Jorgensen (2013) attribute sizable fraction of reactions to QE announcements to a signally effect;
  - Del Negro, Giannoni and Patterson (2012) – “forward guidance puzzle.”
  - Christiano, Eichenbaum, and Trabandt (2014) find large effects on output in an estimated DSGE model.
Balance sheet policies
Non-LOLR balance sheet policies

The unconventional part

Traditional Security holdings
Mortgage Backed Securities
L-T Treasuries

billions of $
Pre-crisis theoretical consensus:

- Whether open market operations were conducted in short-term or long-term government (or private) debt did not matter for asset prices and yields.
- So altering the composition of assets held by the Fed was irrelevant.

But the Fed’s LSAP policies (or their announcements) have affected yields:

- Gagnon, et. al (2010), Krishnamurthy and Vissing-Jorgensen (2011, 2013);
- Christensen and Rudebusch (2012), Hamilton and Wu (2012), D’Amico, et. al. (2012);
- Gilchrist and Zakrajšek (2013).
Pricing wedges: simple example with money, one- and two-period bonds

- The household’s intertemporal budget constraint can be written as

\[
E_t \sum_{s=t}^{\infty} M_{t,s} (y_s + T_s) + W_t = E_t \sum_{s=t}^{\infty} M_{t,s} c_s + \Omega_t, \tag{1}
\]

where \( M_{t,s} = \beta^{s-t} \frac{\lambda_s}{\lambda_t} \) and

\[
\Omega_t \equiv -E_t \sum_{s=t}^{\infty} M_{t,s} (\Delta_{1,s} b_{1,s} + \Delta_{2,s} b_{2,s} + \Delta_{m,s} m_s). \tag{2}
\]

- The \( \Delta \)'s are pricing wedges. Standard (pre-crisis) models assumed they were zero (except \( \Delta_m \)).
- Understanding where they come from is critical for evaluating balance sheet policies.
Implementability constraint

- In the presence of preferred habit preferences and a positive nominal interest rate, (2) becomes

\[
\Omega_t = -E_t \sum_{s=t}^{\infty} M_{t,s} \left[ \left( \frac{U_{b,s}}{U_{C,s}} \right) b_{2,s} + \left( \frac{U_{m,s}}{U_{C,s}} \right) m_s \right]. \tag{3}
\]

- This formulation represents the primary approach to the Ramsey optimal tax problem in which the household’s first order conditions have been used to eliminate prices (the wedges) from the intertemporal budget constraint.

- In general, different theories (moral hazard, segmented markets, transaction costs, ...) are alternative means of modeling the wedges.
Spreads and forecasting equations

- Is reducing the long-term rate on U.S. Treasuries sufficient for stimulating economic activity?

- Or is it more important to reduce risk premiums reflected in corporate bond rates?

\[ Y_t + h = \sum_{i=1}^{k} (Y_t^i \cdot Y_t^1) + \gamma_1 RFF_t + \gamma_2 \cdot 10yr_t^{10} + \gamma_3 Aaa_t^{10} + \gamma_4 Baa_t^{Aaa_t} \]

where \( Y_t \) is the measure of economic activity. (See Rudebusch, Sack, and Swanson 2007, Gilchrist and Zakrajšek 2012.)
Spreads and forecasting equations

- Is reducing the long-term rate on U.S. Treasuries sufficient for stimulating economic activity?
- Or is it more important to reduce risk premiums reflected in corporate bond rates?
- Consider a forecasting equation of the form

\[ Y_{t+h} - Y_{t-1} = \sum_{i=1}^{k} (Y_{t-i} - Y_{t-1-i}) + \gamma_1 \text{RFF}_t + \gamma_2 \left( i_t^{10yr} - i_t^{3mon} \right) \\
+ \gamma_3 \left( i_t^{Aaa} - i_t^{10yr} \right) + \gamma_4 \left( i_t^{Baa} - i_t^{Aaa} \right) \]

where \( Y \) is the measure of economic activity. (See Rudebusch, Sack, and Swanson 2007, Gilchrist and Zakrajšek 2012.)
### Forecasting equations: Unemployment rate 3-month horizon

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<tr>
<td>Baa - Aaa</td>
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Absolute t-statistics in brackets. Constants and four lags of the dependent variable included in each equation.
## Forecasting equations: Unemployment rate 12-month horizon

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<td>( \bar{R}^2 )</td>
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<td>0.37</td>
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Absolute t-statistics in brackets. Constants and four lags of the dependent variable included in each equation.
What spreads were affected by QE announcements? Two-day window

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<tr>
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<td>0</td>
<td>1**</td>
<td>1**</td>
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<td>12/18/13</td>
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<td>-15**</td>
<td>-8**</td>
<td>7**</td>
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</tbody>
</table>

†, *, ** sig. at 10, 5 and 1% levels. Sample: 2008:01:07-2014:03:11.
Effects of QE announcements on spreads

QE events: Two day change

C. E. Walsh (UCSC)
Assessment

- QE policies have been effective in reducing term spreads. Less clear they have significantly lowered risk spreads.
  - Risk spreads seem more important for future economic activity.
- But these types of policies are unlikely to be used in normal times:
  - No clear reason to do so.
  - We don’t understand the wedges.
  - And MEP type policies can and should be done by the Treasury.
Conclusions
Conclusions

- Current models impose strong restrictions governing how nominal interest rates and expected inflation affect aggregate demand.
  - Understanding the empirical veracity of these restrictions is important, particularly at the ZLB.

- Role of forward guidance as a separate instrument when away from the ZLB is not clear.
  - Anchoring inflation expectations may be a more modest but important goal.

- Risk premiums rather than term premiums seem to be of primary importance for future real economic activity.

- We need a better understanding of how asset pricing wedges depend on endogenous monetary policy actions.