How to forecast ECB and Fed interest rate

Jean-Charles Bricongne and Jean-Marc Fournier

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Banque de France, CREST-INSEE and Paris I  CREST-INSEE and PSE
Central banks’ policies

Institutional framework and goals
Interest rate is a key instrument
Taylor rules
Understanding the central banks’ communication
Specifications
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- Interest rate is a key instrument
- Taylor rules
- Understanding the central banks’ communication
- Specifications

Empirical results

- Data used in the computation
- Variable selection
- Central bank reaction’s function
- Central banks’ interest rates simulated in 2009H1
Central banks’ goals

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- Aversion for deflation (Bernanke, 2002).
Independence of Central banks

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Transparency of Central banks in practice

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ECB: positive inflation below 2% and close to 2%.
Fed minutes and ECB’s chairman speeches: qualitative information about the central bank’s goals, its appreciation of current situation and likely next decisions.

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- Since Volcker’s policy, the monetary is not used as an instrument.
- Tinbergen (1952) rule: no more objectives than instruments.
- Central banks may have to make a balance between contradictory objectives.
Central banks’ committees

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- Predictability of central banks is also an issue (Perez-Quiros & Sicilia, 2002).
- We can propose an approximation of such a process.
Taylor rules

Interest rate depends on inflation and output gap


\[ i - i^* = 0.5(\pi - \pi^*) + 0.5(y - y^*) \]  

where \( i \) is the nominal short-run interest rate, \( i^* \) the nominal short-run equilibrium interest rate, \( \pi \) and \( \pi^* \) current and target inflation respectively, and \( (y - y^*) \) the output gap.
Taylor rules
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where \( i \) is the nominal short-run interest rate, \( i^* \) the nominal short-run equilibrium interest rate, \( \pi \) and \( \pi^* \) current and target inflation respectively, and \( (y - y^*) \) the output gap.

- Several policy rules may be used by a central bank (Taylor, 1999 or Orphanides, 2007).
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Central banks need to talk to improve the efficiency of their policy (Blinder, 2001 and Blinder & al., 2008).

Grüner (2002) argues that uncertainty of central banks’ decision leads to more wage discipline.

All in all, Central banks give no more than partial information.
Taylor rules

Estimated Taylor rule:

\[ i_t = \beta_0 + \beta_1 \pi_t + \beta_2 (y_t - y_t^*) + \varepsilon_t \]  \hspace{1cm} (2)

where \( \beta_0 \) is a constant (in this specification, \( \beta_0 = i^* - \beta_1 \pi_t^* \))
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\[ i_t = \beta_0 + \beta_1 E_{t+k}(\pi_t) + \beta_2 (E_{t+k}(y_t) - y^*_t) + \varepsilon_t \]  \hspace{1cm} (3)
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\[ i_t = \beta_0 + \beta_1 \mathbb{E}_{t+k}(\pi_t) + \beta_2 (\mathbb{E}_{t+k}(y_t) - y_t^*) + \varepsilon_t \quad (3) \]

Preference for smooth reaction:

\[ i_t = \beta_0 + \rho i_{t-1} + \beta_1 \mathbb{E}_{t+k}(\pi_t) + \beta_2 (\mathbb{E}_{t+k}(y_t) - y_t^*) + \varepsilon_t \quad (4) \]
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\[ \Delta i_t = \beta_0 + (\rho - 1) i_{t-1} + \beta_1 \mathbb{E}_{t+k}(\pi_t) + \beta_2 (\mathbb{E}_{t+k}(y_t) - y_t^*) + \varepsilon_t \]  \hspace{1cm} (5)
Central banks follow a wide array of indicators

- No *a priori* about explanatory variables:

\[
i_t = \beta_0 + \rho i_{t-1} + \beta x_t + \varepsilon_t \quad (6)
\]

\[
\Delta i_t = \beta_0 + (\rho - 1) i_{t-1} + \beta x_t + \varepsilon_t \quad (7)
\]

where \(x_t\) are the most relevant indicators the central bank can observe.
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\[ \Delta i_t = \beta_0 + (\rho - 1)i_{t-1} + \beta x_t + \epsilon_t \]

where \( x_t \) are the most relevant indicators the central bank can observe.

- Communication as a measure of the gap between current interest rate and the result of a Taylor rule:

\[ c_t = \alpha i_{t-1} + \beta_0 + \beta x_t + \epsilon_t \]

where \( c_t \) is the index of communication stance at date \( t \).
Actual variation of interest rate is discrete

- If we exclude very rare large variation, we observe:

\[ \Delta i_t \in \{-1/2, -1/4, 0, 1/4, 1/2\} \]
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- Ordered logistic regression.
- Such an estimation is fragile if a given modality is rare.
- Finally, we consider three modalities: upside, stable and downside.
Interest rates and key historical events

- Mini stock market crash
- Kuweit’s invasion, First Gulf War and US recession
- Bursting of the dot-com bubble
- Russian crisis and LTCM bankruptcy
- September 11, 2001 attacks
- Lehman Brothers bankruptcy
- U.S. subprime mortgage crisis

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Federal funds target rate
ECB’s repurchase agreements’ rate
Codification of communication

- ECB: unidimensional codification of Rosa & Verga (2007) with 5 modalities: \{-2, -1, 0, 1, 2\}. 
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- Positive (respectively negative) value: tightening (respectively softening) communication.
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- Codification rules to reduce influence of subjective appreciation.

- Authors’ codification after 1999 (Fed) or 2004 (ECB) with the same codification rules as before.
Variable selection

- We optimize an information criteria (AIC or BIC give similar results) to avoid successive tests.
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- We also consider Durbin (1970) test to check that residuals are not autocorrelated in models with lagged interest rates.
### Data used in the computation

<table>
<thead>
<tr>
<th>ECB</th>
<th>Fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-month interbank spread</td>
<td>3-month interbank spread</td>
</tr>
<tr>
<td>Spread during Asian crisis</td>
<td>Spread during 1987 crisis</td>
</tr>
<tr>
<td>Public securities flows</td>
<td>Spread during Asian crisis</td>
</tr>
<tr>
<td>M3</td>
<td>M3</td>
</tr>
<tr>
<td>Underlying inflation</td>
<td>Underlying inflation</td>
</tr>
<tr>
<td>Headline inflation</td>
<td>Headline inflation</td>
</tr>
<tr>
<td>Stock markets index</td>
<td></td>
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<tr>
<td>European unemployment</td>
<td></td>
</tr>
<tr>
<td>Real estate prices</td>
<td>US IPI</td>
</tr>
<tr>
<td>US unemployment</td>
<td>US output gap</td>
</tr>
<tr>
<td>US capacity utilization rate</td>
<td>Real estate prices</td>
</tr>
<tr>
<td>US output</td>
<td>European unemployment</td>
</tr>
<tr>
<td>US inflation forecast</td>
<td>European capacity utilization rate</td>
</tr>
<tr>
<td></td>
<td>European output</td>
</tr>
<tr>
<td></td>
<td>European inflation forecast</td>
</tr>
</tbody>
</table>

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Explanatory variables (1)

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- GDP growth (Orphanides, 2003a), GDP forecast or output gap?
Unemployment may be regarded both as a goal and as a leading variable for inflation and output gap.
Explanatory variables (2)

- Unemployment may be regarded both as a goal and as a leading variable for inflation and output gap.
- Stock market is a leading indicator according to Estrella & Mishkin (1998) or Gautier (2006). Smoothed indicator: the last month average compared to the last six months average.
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- Spreads during financial crisis.
Sampling period

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For the ECB: estimation from 1999, January (first decision) to 2009, March.

We consider as many observations as decision (a decision to keep the rate stable is a decision).
### OLS estimations (ECB)

<table>
<thead>
<tr>
<th>dependent variable</th>
<th>$i_t$</th>
<th>$i_{t-1}$</th>
<th>$i_{t-2}$</th>
<th>$i_{t-3}$</th>
<th>$i_{t-4}$</th>
<th>$i_{t-5}$</th>
<th>$i_{t-6}$</th>
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</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.070</td>
<td>0.073</td>
<td>0.074</td>
<td>-2.723</td>
<td>-2.67</td>
<td>-4.42</td>
<td>-4.63</td>
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<tr>
<td></td>
<td>(1.64)</td>
<td>(1.68)</td>
<td>(1.64)</td>
<td>(-2.36)</td>
<td>(-2.36)</td>
<td>(-4.62)</td>
<td>(-4.87)</td>
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<tr>
<td>$i_{t-1}$</td>
<td>0.965</td>
<td>0.963</td>
<td>0.963</td>
<td>0.858</td>
<td>0.896</td>
<td>0.890</td>
<td>0.88</td>
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<tr>
<td></td>
<td>(74.0)</td>
<td>(71.3)</td>
<td>(68.4)</td>
<td>(31.4)</td>
<td>(30.0)</td>
<td>(29.2)</td>
<td>(30.0)</td>
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<tr>
<td>$i_{t-2}$</td>
<td>0.073</td>
<td>0.064</td>
<td>0.063</td>
<td>0.041</td>
<td>0.036</td>
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<tr>
<td></td>
<td>(7.46)</td>
<td>(2.94)</td>
<td>(2.85)</td>
<td>(3.35)</td>
<td>(3.00)</td>
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<tr>
<td>$i_{t-3}$</td>
<td>0.011</td>
<td>0.009</td>
<td>0.009</td>
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<td>(0.34)</td>
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<td>Inflation forecast</td>
<td>0.154</td>
<td>0.144</td>
<td>0.172</td>
<td>0.182</td>
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<td></td>
<td>(1.95)</td>
<td>(1.87)</td>
<td>(2.33)</td>
<td>(2.46)</td>
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<tr>
<td>$(y_t - 3 - y_t^*)$</td>
<td>0.050</td>
<td>0.029</td>
<td>0.031</td>
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<td></td>
<td>(3.18)</td>
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<td>Capacity util. rate</td>
<td>0.034</td>
<td>0.033</td>
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<td>Subprime crisis</td>
<td>-0.109</td>
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<td>-2.84</td>
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<td>Fed funds' variation</td>
<td>0.072</td>
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<tr>
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<td>(1.51)</td>
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<table>
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<td>$N$</td>
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<td>Adj. $R^2$</td>
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<td>RMSE</td>
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<td>0.144</td>
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<td>0.146</td>
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<td>0.133</td>
<td>0.136</td>
<td>0.136</td>
<td>0.136</td>
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<td>AIC</td>
<td>-605.2</td>
<td>-598.8</td>
<td>-592.2</td>
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<td>-624.4</td>
<td>-624.1</td>
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<tr>
<td>Durbin</td>
<td>-0.19</td>
<td>-0.07</td>
<td>-0.11</td>
<td>-0.10</td>
<td>-1.30</td>
<td>-0.63</td>
<td>-0.31</td>
<td>-0.31</td>
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<th>$\Delta i_t$</th>
<th>$\Delta i_t$</th>
<th>$\Delta i_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.048</td>
<td>-0.0062</td>
<td>-0.050</td>
<td>-0.051</td>
<td>-2.69</td>
</tr>
<tr>
<td></td>
<td>(-2.22)</td>
<td>(-0.12)</td>
<td>(-2.32)</td>
<td>(-2.35)</td>
<td>(-3.14)</td>
</tr>
<tr>
<td>$i_{t-1}$</td>
<td>-0.0089</td>
<td>0.21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-0.89)</td>
<td>(2.77)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$i_{t-2}$</td>
<td></td>
<td></td>
<td>-0.33</td>
<td></td>
<td>(-5.10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-5.10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$c_{t-1}$</td>
<td>0.094</td>
<td>0.096</td>
<td>0.078</td>
<td>0.076</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>(4.69)</td>
<td>(4.75)</td>
<td>(3.34)</td>
<td>(3.16)</td>
<td>(1.68)</td>
</tr>
<tr>
<td>$c_{t-2}$</td>
<td>0.03</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.28)</td>
<td>(0.96)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$c_{t-3}$</td>
<td></td>
<td></td>
<td>0.01</td>
<td></td>
<td>(0.56)</td>
</tr>
</tbody>
</table>

- square inflation forecast: 0.027 (3.30)
- Smoothed Stock index: 0.99 (2.87)
- Square unemployment: -0.0084 (-2.50)
- Subprime crisis: -0.27 (-2.06)

<table>
<thead>
<tr>
<th>$N$</th>
<th>172</th>
<th>172</th>
<th>172</th>
<th>172</th>
<th>173</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adj. $R^2$</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.39</td>
</tr>
<tr>
<td>RMSE</td>
<td>0.279</td>
<td>0.280</td>
<td>0.279</td>
<td>0.280</td>
<td>0.236</td>
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</table>
### IV regressions

<table>
<thead>
<tr>
<th>dependent variable</th>
<th>$i_t$ OLS ECB</th>
<th>$i_t$ IV ECB</th>
<th>$i_t$ OLS Fed</th>
<th>$i_t$ IV Fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-6.19 (-5.85)</td>
<td>-5.27 (-4.75)</td>
<td>-3.165 (-3.93)</td>
<td>-2.41 (-2.95)</td>
</tr>
<tr>
<td>$i_{t-1}$</td>
<td>0.83 (27.3)</td>
<td>0.83 (19.8)</td>
<td>1.20 (15.73)</td>
<td>1.31 (18.72)</td>
</tr>
<tr>
<td>$i_{t-2}$</td>
<td></td>
<td></td>
<td>-0.34 (-5.18)</td>
<td>-0.43 (-6.62)</td>
</tr>
<tr>
<td>Inflation forecast</td>
<td>0.26 (3.61)</td>
<td>0.28 (2.78)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$y_{t-3} - y_{t-3}^*$</td>
<td>0.049 (2.88)</td>
<td>0.054 (2.26)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>capacity util. rate</td>
<td>0.075 (5.55)</td>
<td>0.064 (4.34)</td>
<td>0.047 (4.35)</td>
<td>0.036 (3.33)</td>
</tr>
<tr>
<td>square inflation forecast</td>
<td>0.032 (3.91)</td>
<td>0.027 (3.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoothed Stock index</td>
<td>1.13 (3.38)</td>
<td>0.93 (2.16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Square unemployment</td>
<td>-0.0109 (-3.57)</td>
<td>-0.00905 (-2.68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subprime crisis</td>
<td>-0.135 (-3.50)</td>
<td>-0.100 (-1.81)</td>
<td>-0.26 (2.04)</td>
<td>-0.38 (-2.97)</td>
</tr>
<tr>
<td>$N$</td>
<td>155</td>
<td>155</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.98</td>
<td>0.98</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Synthetical indicator combining communication and interest rate

- Central banks use communication for fine tuning, an indicator of monetary policy should include this information.
Synthetical indicator combining communication and interest rate

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- A synthetical indicator can take the following form:

\[ \Delta i_t + \delta c_t \]

\( c_t \) is equivalent to an interest rate variation

\[ \delta c_t = \mathbb{E}(\Delta i_{t+1} | i_t, c_t) \]
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\[ \delta c_t = \mathbb{E}(\Delta i_{t+1}|i_t, c_t) \]

- We suggest for the ECB: \( \bar{i}_t = \Delta i_t + 0.05 \times c_{t-1} \)
- We suggest for the Fed: \( \bar{i}_t = \Delta i_t + 0.1 \times c_{t-1} \)
Decisions’ simulation

Jean-Charles Bricongne and Jean-Marc Fournier

How to forecast ECB and Fed interest rate
End-of-sample instability test (Andrew, 2003)
tested breakpoint: 2009, march.

- The ECB does not follow the same rule as before.
Conclusion

- Both ECB and Fed follow a Taylor rule, but these are different rules.
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Communication significantly improve the short-term forecast of interest rates.

Our main results are robust to specification choices.

Central banks have had a specific reaction to the subprime crisis, beyond the reaction suggested by ordinary determinants.