Should Unconventional Monetary Policies Become Conventional?

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Disclaimer

The views expressed are those of the authors do not necessarily represent those of the Deutsche Bundesbank or the International Monetary Fund.
Motivation

“In pre-crisis days, policymakers assumed that tweaking short-term interest rates was enough to influence all important financial decision-making. This was wishful thinking, based on a couple of decades of atypical US experience. Other economies still needed extra policy instruments, as has the US since the crisis.”

Adam Posen, Financial Times, August 23, 2016
Motivation

▶ literature usually focuses on unconventional monetary policies (UMP) employed during crisis periods (e.g. Del Negro et al. 2011; Chen et al. 2011)
  ▶ zero lower bound is binding
  ▶ economy hit by large financial shocks
▶ we evaluate the usefulness of LSAPs in normal times
▶ possible trade-off of UMP:
  ▶ avoid “Greenspan conundrum”
  ▶ potential distortions
  ▶ diminishing returns to UMP (QE1 vs. QE2, QE3)
  ▶ smaller revenues for fiscal authority
Our Contribution

- extend Gertler and Karadi (2013) with long-term debt
- estimate the model over the Great Moderation period
- counterfactual exercises with UMP in place
Main Results

- under an estimated Taylor rule, welfare gains from using UMP policies can be up to 1.45 percent of steady-state consumption
- UMP is useful to address financial shocks but does not help with “normal business cycle” (supply and demand) shocks
- direct credit to firms or purchases of government bonds deliver similar results
Summary of the Model

- households: workers and bankers
- producers:
  - retail goods.
  - final goods
  - intermediate goods
  - capital goods
- financial intermediaries
- central bank
- fiscal policy
Key Frictions

- “standard” DSGE model frictions:
  (Smets and Wouters, 2003; Justiniano et al., 2013)
  - Sticky prices and wages
  - habit formation, adjustment costs to investment
- financial frictions: agency problem by bankers
  (Gertler and Karadi, 2011)
- lumpy investment decisions
  (Sveen and Weinke, 2002; Andreasen et al., 2013)
Intermediate Goods Producers

Lumpy investment decisions

- every period a fraction $\theta_K$ of intermediate goods producers adjust its capital stock $K_t$

- these firms purchase capital financed by a credit obtained from financial intermediaries at a constant rate $\bar{r}_t^L$ over the contract period
Financial Intermediaries

- **bank balance sheet:**

  \[ len_t^p + b_t^p = n_t + d_t \]

- **real lending and revenues to the private sector:**

  \[ len_t = (1 - \theta_k) \frac{\mathcal{P}_t^K K_t}{P_t} + \theta_k \frac{P_{t-1}}{P_t} len_{t-1} \]

  \[ rev_t = (1 - \theta_k) \frac{\mathcal{P}_t^L \mathcal{K}_t}{R_t} + \theta_k \frac{P_{t-1}}{P_t} rev_{t-1} \]

- **average return:**

  \[ R_t^L = \frac{rev_t}{len_t} \]
**Financial Intermediaries**

Agency problem as in Gertler and Karadi (2011)

- The value of a bank $V_t$ must exceed the amount a banker can divert:
  \[ V_t \geq \lambda_t \left( len_P^t + \Delta_t b^P_t \right) \]

- With a binding participation constraint:
  \[ \left( R_L^t - R_t \right) > 0 \]

- And:
  \[ \left( R_G^t - R_t \right) = \Delta_t \left( R_L^t - R_t \right) \]
Introducing UMP

Purchases of corporate bonds

aggregate lending is given by:

$$len_t = len^P_t + len^{cb}_t,$$

central bank lending reduces corporate spreads, increases investment and employment

Purchases of government bonds

the central bank reduces government bonds spreads, which in turn reduces corporate spreads.
GMM Estimation

- seven variables (from JPT, 2013):
  - real GDP, consumption, investment per capita growth
  - GDP deflator and the federal funds rate
  - hours
  - nominal wage growth
- Two additional variables:
  - corporate BAA-FFR spread
  - 10Y-FFR spread
- GMM estimation for the 1964q2-2009q4 period (same as JPT, 2013)
GMM Estimation

- estimation by taking a **2nd order approximation** to the equilibrium conditions (Andreasen et al., 2016)
- matching 63 moments in the data:

\[
M_t \equiv \begin{bmatrix}
data_t 
vech(data_t data_t') 
diag(data_t data_t' - 1)
\end{bmatrix}
\]

- counterpart in the model: \( \mathbb{E}[M(\Theta)] \)
- GMM estimator:

\[
\hat{\Theta}_{GMM} = \arg \min \left( \frac{1}{T} \sum_{t=1}^{T} M_t - \mathbb{E}[M(\Theta)] \right) \cdot W \left( \frac{1}{T} \sum_{t=1}^{T} M_t - \mathbb{E}[M(\Theta)] \right)
\]
Effects of UMP

Policy Simulations
Optimal UMP Policy

we take a 2nd order approximation to the utility function and maximize over the coefficients of the rule:

\[
\text{len}_t^{cb} = \rho \Psi \text{len}_{t-1}^{cb} + \gamma \Psi (\frac{R_t^L}{R_t} - \frac{R^L}{R})
\]

\[
b_t^{cb} = \rho \Psi b_{t-1}^{cb} + \gamma \Psi (\frac{R_t^L}{R_t} - \frac{R^L}{R})
\]

<table>
<thead>
<tr>
<th>Policy</th>
<th>$\rho \Psi$</th>
<th>$\gamma \Psi$</th>
<th>$W_t$</th>
<th>C.E. (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corp., $\overline{R}_t^L - R_t$</td>
<td>0.972</td>
<td>3142.9</td>
<td>-577.72</td>
<td>1.41</td>
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<td>Corp., $R_t^L - R_t$</td>
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<td>65934.6</td>
<td>-577.56</td>
<td>1.45</td>
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<tr>
<td>Gov., $\overline{R}_t^B - R_t$</td>
<td>0.767</td>
<td>65934.6</td>
<td>-577.56</td>
<td>1.45</td>
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<tr>
<td>Gov., $R_t^B - R_t$</td>
<td>0.953</td>
<td>37985.4</td>
<td>-577.66</td>
<td>1.43</td>
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</table>
Optimal UMP Policy, Conditional

<table>
<thead>
<tr>
<th>Demand shocks</th>
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</thead>
<tbody>
<tr>
<td>Policy</td>
<td>$\rho_\psi$</td>
<td>$\gamma_\psi$</td>
<td>$W_t$</td>
<td>C.E. (in %)</td>
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<tr>
<td>Gov., $R_t^B - R_t$</td>
<td>0.05</td>
<td>14067.2</td>
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<table>
<thead>
<tr>
<th>Supply Shocks</th>
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<tr>
<td>Policy</td>
<td>$\rho_\psi$</td>
<td>$\gamma_\psi$</td>
<td>$W_t$</td>
<td>C.E. (in %)</td>
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<tr>
<td>Gov., $R_t^B - R_t$</td>
<td>0.11</td>
<td>1136.9</td>
<td>-577.12</td>
<td>0.07</td>
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</table>

<table>
<thead>
<tr>
<th>Financial Shocks</th>
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</thead>
<tbody>
<tr>
<td>Policy</td>
<td>$\rho_\psi$</td>
<td>$\gamma_\psi$</td>
<td>$W_t$</td>
<td>C.E.</td>
</tr>
<tr>
<td>Gov., $R_t^L - R_t$</td>
<td>0.971</td>
<td>9292.1</td>
<td>-575.74</td>
<td>1.34</td>
</tr>
</tbody>
</table>
IRF to a Bank Capital Shock

- Output $Y_t$
- Consumption $C_t$
- Labor $L_t$
- Investment $I_t$
- Inflation $\pi_t$
- Short-Term Rate $R_t$
- Spread $R^f_t / R_t$
- Spread $R^{ll}_t / R_t$
- Net Worth $N_t$
- Total Lending $l_{en_t}$
- Bank Lending to Firms
- Central Bank Stock of Assets / GDP

**Policy Simulations**
IRF to a Government Debt Supply Shock
IRF to a TFP Shock

- Output $Y_t$
- Consumption $C_t$
- Labor $L_t$
- Investment $I_t$
- Inflation $\pi_t$
- Short-Term Rate $R_t$
- Spread $R^f_t/R_t$
- Spread $R^d_t/R_t$
- Net Worth $N_t$
- Total Lending $len_t$
- Bank Lending to Firms
- Central Bank Stock of Assets / GDP

Graphs showing the response of various economic indicators to a TFP shock over a 12-period horizon.
## Some Robustness

- we repeat the same exercise under a strict inflation targeting rule:

<table>
<thead>
<tr>
<th>Shocks</th>
<th>Policy</th>
<th>( \rho_\Psi )</th>
<th>( \gamma_\Psi )</th>
<th>( W_t )</th>
<th>C.E. (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Corp., ( \bar{R}_t^L - R_t )</td>
<td>0.14</td>
<td>9.62</td>
<td>-553.83</td>
<td>1.45</td>
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<tr>
<td>Demand</td>
<td>Gov., ( R_t^B - R_t )</td>
<td>0.84</td>
<td>1000000</td>
<td>-576.16</td>
<td>0.31</td>
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<tr>
<td>Supply</td>
<td>All</td>
<td>0</td>
<td>0</td>
<td>-553.67</td>
<td>0</td>
</tr>
<tr>
<td>Financial</td>
<td>Gov., ( \bar{R}_t^L - R_t )</td>
<td>0.97</td>
<td>9163.7</td>
<td>-575.74</td>
<td>1.18</td>
</tr>
</tbody>
</table>

- gains are lower under an optimized rule that targets price and wage inflation
Conclusion

- we have examined if the Fed should keep UMP policies in place once interest rates normalize
- we have found that for financial shocks, the answer is yes, because the benefits are sizable
- under more normal business cycle shocks such as demand or supply shocks, UMP is likely not needed
- in normal times, large asset purchases with corporate or government bonds have similar effects
- caveat(?): we have not quantify any costs of implementing UMP policy
Households

- A fraction $f$ of household members are bankers and a fraction $1 - f$ are workers.
- Workers supply labor and bring wage income to the household.
- Bankers manage financial intermediaries and bring profits to the household.
- The household can save in deposits, but at financial intermediaries not owned by the household.
- In a given period, a banker stays in her job with probability $\theta_B$.
- Every period a mass $(1 - \theta_B)f$ of bankers become workers (and a similar mass of workers become bankers).
Households

Their utility function is given by

\[ E_0 \sum_{t=0}^{\infty} \beta^t \xi_t \left\{ \log (C_t - hC_{t-1}) - \psi_t \frac{L_{jt}^{1+\varphi}}{1 + \varphi} \right\} \]

and their budget constraint reads

\[ C_t + \frac{D_t}{P_t} = W_{jt}L_{jt} - AC_t^w + R_{t-1} \frac{D_{t-1}}{P_t} + \Pi_t \]
Households

Wages setting subject to Rotemberg (1982) quadratic costs

\[ AC^w_t = \frac{\theta_w}{2} \left( \frac{W_{jt}}{W_{jt-1}} \frac{P_t}{P_{t-1}} - \exp (\Lambda_{t-1})^{\chi_w} \exp (\Lambda)^{1-\chi_w} \pi_{t-1}^{\chi_w} \pi^{1-\chi_w} \right)^2 Y_t \]

subject to a downward sloping demand for their type of labor \( j \)

\[ L_{jt} = \left( \frac{W_{jt}}{W_t} \right)^{-\varepsilon_{L,t}} L_{t}^{D} \]

from labor packers that sell aggregate labor to intermediate goods producers
Intermediate Goods Producers

Cobb-Douglas technology to produce a homogeneous good

\[ Y_t^m = A_t^{(1-\alpha)} Z_t (K_{t-1})^\alpha (L_t^D)^{(1-\alpha)} \]

where

\[ \Delta \log (A_t) = (1 - \rho_A) \Lambda + \rho_A \Delta \log (A_{t-1}) + \epsilon_{A,t} \]
\[ \log (Z_t) = \rho_Z \log (Z_{t-1}) + \epsilon_{Z,t} \]
Intermediate Goods Producers

FOCs

\[ \mathcal{P}_t^M (1 - \alpha) \frac{Y_t^M}{L_t^D} = W_t \]

and

\[
E_t \sum_{j=1}^{\infty} (\theta_K)^{j-1} \beta^{\Xi_t+j} \mathcal{P}_t^M \alpha^{\Xi_t+j} \frac{Y_t^M}{K_t} \\
= E_t \sum_{j=1}^{\infty} (\theta_K)^{j-1} \beta^{\Xi_t+j} \left( \prod_{i=1}^{j} \frac{P_{t+i}}{P_{t+i-1}} \right)^{-1} \left( \bar{r}_t^L + \omega \right) \mathcal{P}_t^K
\]
Final Goods Producers

Aggregate the differentiated retail goods $Y_t^R (h)$ they buy from retailers according to the following CES function

$$Y_t = \left[ \int_0^1 Y_t^R (h) \frac{\varepsilon Y, t - 1}{\varepsilon Y, t} \, dh \right]^{\varepsilon Y, t / \varepsilon Y, t - 1}$$

demand function for retail goods

$$Y_t^R (h) = \left[ \frac{P_t (h)}{P_t} \right]^{\varepsilon Y, t} Y_t$$

where $P_t$ is the price index for final goods

$$P_t = \left\{ \int_0^1 [P_t (h)]^{1 - \varepsilon Y, t} \, dh \right\}^{1 / (1 - \varepsilon Y, t)}$$
Retailers

Purchase homogenous goods from intermediate goods producers, and differentiate them into retail goods $Y_t^R(h)$. Operate under monopolistic competition and set prices with Rotemberg adjustment costs

$$\max_{P_t(h)} E_t \sum_{\tau=0}^{\infty} (\beta)^{\tau} \frac{\Xi_{t+\tau}}{\Xi_t} \left\{ \left[ \frac{P_{t+\tau}(h)}{P_{t+\tau}} - P^M_{t+\tau} \right] Y_{t+\tau}^R(h) - AC_{t+\tau}^p \right\}$$

subject to

$$Y_{t+\tau}^R(h) = \left[ \frac{P_{t+\tau}(h)}{P_{t+\tau}} \right]^{-\varepsilon_{Y,t+\tau}} Y_{t+\tau}$$

and

$$AC_t^p = \frac{\theta_p}{2} \left( \frac{P_t(h)}{P_{t-1}(h)} - \pi_t^p \pi_t^{1-\chi_p} \right)^2 Y_t$$
Capital Goods Producers

Sell capital to intermediate goods producers, with an agreement to repurchase at the original price. Provide a service for maintenance of the capital stock for which they charge a fee.

\[
\max E_t \sum_{j=0}^{\infty} \beta^j \Xi_{t+j} \left( \frac{V_{t+j}}{P_{t+j}} - I_{t+j} \right)
\]

where

\[
V_t = \left(1 - \theta_K\right) \sum_{j=0}^{\infty} (\theta_K)^j \frac{P_{t-j}^K}{P_t} K_{t-j}
\]

demand for capital

\[
K_t = (1 - \theta_K) K_t + \theta_K K_{t-1}
\]

demand for capital
Financial Intermediaries

Real lending and revenues to the public sector

\[ B_t = (1 - \theta_g) \bar{B}_t + \theta_g \frac{P_{t-1}}{P_t} B_{t-1} \]

\[ \text{rev}_t^G = (1 - \theta_g) \bar{R}_t^G \bar{B}_t + \theta_g \frac{P_{t-1}}{P_t} \text{rev}_{t-1}^G \]

average return

\[ R_t^G = \frac{\text{rev}_t^G}{B_t} \]
Financial Intermediaries

Agency problem as in Gertler and Karadi (2011)

\[ \mathcal{V}_t \geq \lambda_t (\text{len}_t + \Delta_t B_t) \]

value of a bank

\[ \mathcal{V}_t = (1 - \tau_B) E_t \sum_{j=0}^{\infty} (1 - \theta_B) \theta_B^j \beta^{j+1} \frac{\Xi_{t+1+j}^{\infty}}{\Xi_t} \beta^{j+1} n_{t+j+1} \]

net worth evolves as

\[ n_t = (1 - \tau_B) [R_{t-1}^L \frac{P_{t-1}}{P_t} \text{len}_{t-1} + R_{t-1}^G \frac{P_{t-1}}{P_t} B_{t-1} - R_{t-1} \frac{P_{t-1}}{P_t} d_{t-1}] \]
Financial Intermediaries

Optimality conditions lead to the following equations

\[(1 - \tau_B)E_t\beta\frac{\Xi_{t+1}}{\Xi_t}\Omega_{t+1} \left( R^L_t - R_t \right) \frac{P_t}{P_{t+1}} = \lambda_t \frac{\Theta_t}{1 + \Theta_t} \]

where \(\Theta_t\) is the Lagrange multiplier associated with the participation constraint.

With a binding constraint, \((R^L_t - R_t) \geq 0\) and

\[\left( R^G_t - R_t \right) = \Delta_t \left( R^L_t - R_t \right) \]

where \(\Delta_t\) is an AR(1) process.
Monetary and Fiscal Policy

Taylor rule

\[ \frac{R_t}{R} = \left( \frac{R_{t-1}}{R} \right)^{\gamma_R} \left( \frac{\pi_t}{\pi} \right)^{\gamma_n(1-\gamma_R)} \left[ \frac{Y_t/Y_{t-1}}{\exp(\Lambda)} \right]^{\gamma_y(1-\gamma_R)} \exp(\epsilon_{m,t}) \]

government spending to GDP follows a stationary AR(2) process

\[ G_t = g_t Y_t \]

\[ \log g_t = (1 - \rho_{g1} - \rho_{g2}) \log(\bar{g}) + \rho_{g1} \log g_{t-1} + \rho_{g2} \log g_{t-2} + \epsilon_{g,t} \]

government debt is an AR(1) process

\[ \frac{B_t}{Y_t} = (1 - \rho_b) \frac{\bar{B}}{Y} + \rho_b \frac{B_{t-1}}{Y_{t-1}} + \epsilon_{b,t} \]
Closing the Model

Market clearing

\[ C_t + I_t + G_t + AC_t^p + AC_t^w = Y_t \]

\[ L_t^D = L_t \]

\[ Y_t = Y_t^M \]
GMM Estimation

A Few Comments

- Parameter estimates are reasonable and similar to others in the literature (but no priors!)
- Model specification J-test: p-value is 0.71
- Model fit to means, variances, correlations and autocorrelations is very good, sometimes better than similar models estimated with Bayesian methods
- TFP and preference shocks main drivers of fluctuations, financial (bank capital) shocks somewhat important: 15.8 of GDP growth, 28.4 of investment growth, and 18.2 of hours.
# GMM Estimation

Table 1: Calibrated Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varepsilon_L$</td>
<td>Elasticity of Substitution between Labor</td>
<td>5</td>
</tr>
<tr>
<td>$\varepsilon_Y$</td>
<td>Elasticity of Substitution between Goods</td>
<td>10</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Capital share of output</td>
<td>0.33</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation rate</td>
<td>0.025</td>
</tr>
<tr>
<td>$1/(1 - \theta_k)$</td>
<td>Average duration between capital stock changes</td>
<td>12</td>
</tr>
<tr>
<td>$1/(1 - \theta_g)$</td>
<td>Average duration of government debt</td>
<td>40</td>
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<tr>
<td>$g$</td>
<td>Government spending/output ratio</td>
<td>0.2</td>
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<tr>
<td>$\rho_{g_1}$</td>
<td>AR(1) coefficient for G/Y ratio</td>
<td>1.288</td>
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<tr>
<td>$\rho_{g_2}$</td>
<td>AR(2) coefficient for G/Y ratio</td>
<td>-0.299</td>
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<tr>
<td>$\sigma_g$</td>
<td>Standard deviation innovation G/Y Ratio</td>
<td>1.07%</td>
</tr>
<tr>
<td>$B/Y$</td>
<td>Debt to GDP ratio</td>
<td>0.45</td>
</tr>
<tr>
<td>$L$</td>
<td>Steady-state hours</td>
<td>1</td>
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## GMM Estimation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Standard Dev.</th>
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<tbody>
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<td>$h$</td>
<td>0.742</td>
<td>0.026</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>0.847</td>
<td>0.077</td>
</tr>
<tr>
<td>$1/\beta - 1$</td>
<td>0.241</td>
<td>0.025</td>
</tr>
<tr>
<td>$\log(R^L - R)$</td>
<td>0.388</td>
<td>0.011</td>
</tr>
<tr>
<td>$\log(R^B - R)$</td>
<td>0.144</td>
<td>0.006</td>
</tr>
<tr>
<td>$\Lambda$</td>
<td>0.425</td>
<td>0.015</td>
</tr>
<tr>
<td>$\eta_i$</td>
<td>8.43</td>
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<tr>
<td>$\theta_w$</td>
<td>175.33</td>
<td>17.78</td>
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<td>$\chi_w$</td>
<td>0.707</td>
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<tr>
<td>$\theta_p$</td>
<td>62.76</td>
<td>4.61</td>
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<tr>
<td>$\chi_p$</td>
<td>0.421</td>
<td>0.044</td>
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## GMM Estimation

Table 2: Estimated Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Standard Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\omega$ Capital Goods Producer Fees</td>
<td>0.0248</td>
<td>0.0009</td>
</tr>
<tr>
<td>$\theta_b$ Probability of banker survival</td>
<td>0.919</td>
<td>0.044</td>
</tr>
<tr>
<td>$\phi$ Steady-state Leverage ratio</td>
<td>15.96</td>
<td>1.35</td>
</tr>
<tr>
<td>$\gamma_{t1}$ Taylor rule coefficient: Inflation</td>
<td>1.255</td>
<td>0.071</td>
</tr>
<tr>
<td>$\gamma_R$ Interest Rate Smoothing</td>
<td>0.606</td>
<td>0.036</td>
</tr>
<tr>
<td>$\gamma_y$ Taylor rule coefficient: Output Growth</td>
<td>0.12</td>
<td>0.007</td>
</tr>
<tr>
<td>$\pi$ Inflation Target</td>
<td>0.972</td>
<td>0.097</td>
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## Model Fit

### Table 4: Model Fit

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data</th>
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<th>Model</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Dev.</td>
<td>Autocorr</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Autocorr</td>
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<tr>
<td>GDP Growth</td>
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<td>0.86</td>
<td>0.32</td>
<td>0.42</td>
<td>0.85</td>
<td>0.38</td>
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<td>0.50</td>
<td>0.52</td>
<td>0.47</td>
<td>0.42</td>
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<td>Investment Growth</td>
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<td>0.30</td>
<td>0.42</td>
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<tr>
<td>Wage Growth</td>
<td>1.35</td>
<td>0.73</td>
<td>0.46</td>
<td>1.33</td>
<td>0.71</td>
<td>0.68</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.95</td>
<td>0.60</td>
<td>0.87</td>
<td>0.91</td>
<td>0.62</td>
<td>0.89</td>
</tr>
<tr>
<td>Federal Funds Rate</td>
<td>1.54</td>
<td>0.84</td>
<td>0.95</td>
<td>1.56</td>
<td>0.76</td>
<td>0.87</td>
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<td>Hours</td>
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<td>0.98</td>
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<td>3.75</td>
<td>0.95</td>
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<tr>
<td>Spread BAA-FFR</td>
<td>0.71</td>
<td>0.53</td>
<td>0.90</td>
<td>0.61</td>
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<tr>
<td>Spread 10Y Bond-FFR</td>
<td>0.22</td>
<td>0.43</td>
<td>0.88</td>
<td>0.23</td>
<td>0.26</td>
<td>0.84</td>
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</tbody>
</table>
## Model Fit

### Table 5: Model Fit

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Data</th>
<th>Model</th>
<th>Correlation</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(GDP,C)</td>
<td>0.57</td>
<td>0.62</td>
<td>(INV,H)</td>
<td>0.03</td>
<td>0.02</td>
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<td>(GDP, INV)</td>
<td>0.88</td>
<td>0.85</td>
<td>(INV,BAA-FFR)</td>
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<td>0.01</td>
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<td>(GDP, W)</td>
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<td>-0.13</td>
<td>(INV,10Y-FFR)</td>
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<td>0.01</td>
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<td>(GDP, INFL)</td>
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<td>-0.38</td>
<td>(W, INFL)</td>
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<td>0.65</td>
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<td>(GDP, FFR)</td>
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<td>(W, FFR)</td>
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<td>0.10</td>
<td>(W, H)</td>
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<td>-0.24</td>
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<td>(GDP, BAA-FFR)</td>
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<td>0.06</td>
<td>(W, BAA-FFR)</td>
<td>-0.42</td>
<td>-0.03</td>
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<tr>
<td>(GDP, 10Y-FFR)</td>
<td>0.22</td>
<td>0.06</td>
<td>(W,10Y-FFR)</td>
<td>-0.43</td>
<td>-0.03</td>
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</table>
# Model Fit

## Table 5: Model Fit

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Data</th>
<th>Model</th>
<th>Correlation</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C, INV)</td>
<td>0.34</td>
<td>0.28</td>
<td>(INFL, FFR)</td>
<td>0.65</td>
<td>0.76</td>
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<td>(C, W)</td>
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<td>-0.06</td>
<td>(INFL, H)</td>
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<td>(INFL, BAA-FFR)</td>
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<td>-0.33</td>
<td>(INFL, 10YFFR)</td>
<td>-0.52</td>
<td>-0.07</td>
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<td>(C, H)</td>
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<td>0.13</td>
<td>(FFR, H)</td>
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<td>-0.42</td>
</tr>
<tr>
<td>(C, BAA-FFR)</td>
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<td>0.11</td>
<td>(FFR, BAA-FFR)</td>
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<tr>
<td>(C, 10Y-FFR)</td>
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<td>(FFR, 10YFFR)</td>
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<td>-0.24</td>
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<td>-0.13</td>
<td>(H, BAA-FFR)</td>
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<td>-0.26</td>
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<tr>
<td>(INV, INFL)</td>
<td>-0.11</td>
<td>-0.24</td>
<td>(H, 10Y-FFR)</td>
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<td>-0.26</td>
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<tr>
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<td>-0.11</td>
<td>(BAA-FFR, 10Y-FFR)</td>
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# Shock Decomposition

## Table 6: Shock Decomposition

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<tr>
<th>Variable</th>
<th>TFP</th>
<th>Inv</th>
<th>Pref</th>
<th>Fin</th>
<th>Mark-ups</th>
<th>Govt</th>
<th>Mon</th>
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<tbody>
<tr>
<td>GDP Growth</td>
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<td>9.7</td>
<td>19.0</td>
<td>15.8</td>
<td>2.6</td>
<td>3.8</td>
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<tr>
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<td>14.5</td>
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<td>28.4</td>
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<td>Wage Growth</td>
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<td>6.8</td>
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<td>2.2</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Inflation</td>
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<td>46.1</td>
<td>3.3</td>
<td>4.2</td>
<td>1.9</td>
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<td>2.5</td>
<td>1.9</td>
<td>22.6</td>
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<td>0.1</td>
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<td>Spread 10Y Bond-FFR</td>
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<td>1.4</td>
<td>85.6</td>
<td>0.4</td>
<td>0.1</td>
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