Designing a Simple Loss Function for the Fed: Does the Dual Mandate Make Sense?

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Indiana University (January 21, 2016)
Motivation

Reviving the world economy

"Stand back, I'm a central banker"
Motivation
Motivation
Conduct of monetary policy delegated to central banks

- Variable and high rates of price inflation in the 1970s and 80s caused many economies to delegate the conduct of monetary policy to independent central banks.
- Advances in academic research—Rogoff (1985), Persson and Tabellini (1993), and Woodford (2003)—supported a strong focus on price stability.
  - As documented in Svensson (2010), many central banks became “inflation targeters” to strengthen credibility and facilitate accountability.
Motivation
Fed puts large weight on economic activity

- One exception to common central banking practice is the Fed’s “Dual Mandate” which stipulates it to “promote maximum employment in a context of price stability”
  - In January 2012, the Fed adopted an explicit inflation target and clarified its intention to keep a balanced approach to mitigate deviations of inflation from target and deviations of employment from its sustainable level.

- However, from the point of view of maximizing the welfare of households inhabiting the economy, the large weight on resource utilization has little support, see e.g. the influential work of Woodford (2003) and EHL (2000)
  - But these papers were based on relatively small calibrated models - what is going in estimated DSGE models?
Study the design of simple mandates \((ad\ hoc\ loss\ functions)\) within the context of an estimated medium-scale model of the U.S. economy—the workhorse Smets and Wouters (2007) model.

Specifically, we examine how to design a simple objective to maximize welfare of households.

- For instance, does the Fed’s strong focus on resource utilization improve (households’) welfare relative to a simple mandate focused solely on inflation?

Assume Fed is able to commit to the simple mandate. We make this assumption since:

1. it is supported by the evidence in Bodenstein, Hebden and Nunes (2012) and Debortoli, Maih and Nunes (2012) and Ilbas (2012).
2. it puts comparison of simple mandate on equal footing to Ramsey (which assumes commitment).
3. it puts comparison of simple mandate on equal footing to simple interest rate rules (which assumes commitment) as implemented in Kim and Henderson (2005), and Levin, Wieland and Williams (2003).
Key findings

- A large weight on resource utilization is warranted
  - For a standard inflation-output gap loss function, we find $\lambda$ about 1
  - More ad hoc utilization measures—like detrended output or output growth—also get a large weight
  - Note: Absolute welfare gains/losses small (Lucas, 1987, and Otrok, 2001)

- Results hold up when we introduce interest rate smoothing to capture the observed gradualism in policy behavior and ensure that the probability of FFR hitting ZLB is very low
- Taylor (1993, 1999) rules do not mimic Ramsey policy well; but suitably designed simple interest rate rules do
- Given the similarity of parameters in estimated models of other advanced economies, our results should be relevant for other CBs (e.g. ECB and Riksbank)
Presentation outline

- Model and parameterization
- Our exercise
- Benchmark results
- Robustness of results
- Simple rule results
- Concluding remarks
Model

Key features of model structure

- We use the estimated in Smets and Wouters (2007), SW07 henceforth. This model features monopolistic competition in both goods and labour markets.

- Nominal price and wage stickiness:
  - Calvo price contracts, indexation of non-optimizers
    \[ P_t^{NO} = \Pi_{t-1}^{i_p} \Pi_{t-1}^{1-i_p} P_{t-1}^{NO} \]
  - Calvo wage contracts, indexation of non-optimizers
    \[ W_t^{NO} = \gamma \Pi_{t-1}^{i_w} \Pi_{t-1}^{1-i_w} W_{t-1}^{NO} \]
  - Kimball (1995) aggregator; lower slope of price and wage schedules for a given Calvo parameter

- Real rigidities as in CEE (2005):
  - External habit persistence in consumption
  - CEE-type investment adjustment costs
  - Variable capital utilization
Model

Shock structure

Four structural shocks that we assume affect potential output:
- Total factor productivity ($\varepsilon^a_t$), Investment specific ($\varepsilon^i_t$), Risk shock on financial assets ($\varepsilon^b_t$), Government-NX ($\varepsilon^g_t$),

Two “inefficient” shocks:
- $\varepsilon^p_t$ - “price markup” shock
- $\varepsilon^w_t$ - “wage markup” shock
- pay particular attention to what extent the two cost-push shocks drive our results

SW07 also included a monetary policy shock, but we drop it here since we consider optimized simple mandates and rules
Parameterization
Parameters adopted from Smets and Wouters

- We use the posterior mode parameters from SW07 (Tables 1.A-B in their paper, Table 1 in our paper)
- Make functional-form assumptions on adjustment functions and how we introduce the shocks so that linearized representation of our model coincides exactly with SW07
Benigno and Woodford (2006) showed that the households’ utility function could be written as:

\[
\sum_{t=0}^{\infty} E_0 \left[ \beta^t U(X_t) \right] \sim constant - \sum_{t=0}^{\infty} E_0 \left[ \beta^t X_t' W_{society} X_t \right]. \tag{1}
\]
Our Exercise
Quadratic approximation of utility and Ramsey policy

- Benigno and Woodford (2006) showed that the households’ utility function could be written as:

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- Define Ramsey policy as a policy which maximizes (1) subject to the constraints of the economy.
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\[
\sum_{t=0}^{\infty} E_0 [\beta^t U(X_t)] \simeq \text{constant} - \sum_{t=0}^{\infty} E_0 [\beta^t X'_t W^{society} X_t]. \tag{1}
\]

- \(X'_t W^{society} X_t\) on the RHS is the quadratic approximation of utility.
- Define Ramsey policy as a policy which maximizes (1) subject to the constraints of the economy.
- We do not allow for subsidies that undo the steady-state distortions in the economy—that is, our Ramsey policy is a “second-best” as the LQ approximation is computed around an inefficient steady state.
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$$\sum_{t=0}^{\infty} E_{0} [\beta^{t} U(X_{t})] \approx \text{constant} - \sum_{t=0}^{\infty} E_{0} [\beta^{t} X^{t}_{t} W^{society} X_{t}] . \quad (1)$$

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We do not allow for subsidies that undo the steady-state distortions in the economy—that is, our Ramsey policy is a “second-best” as the LQ approximation is computed around an inefficient steady state.

We adopt unconditional expectations operator for welfare evaluation, so the loss under Ramsey optimal policy is defined as:

$$Loss^{Ramsey} = E \left[ \left( X^{Ramsey}_{t} \left( W^{society} \right) \right)^{'} W^{society} \left( X^{Ramsey}_{t} \left( W^{society} \right) \right) \right]$$
Our Exercise
Simple Mandate approximation to policy behavior

- We assume (arguably realistically) that the CB minimizes:
  \[ E_0 \sum \beta^t X'_t W^{CB} X_t. \]
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- Given \( W^{CB} \), the expected loss for the society is:
  \[ \text{Loss}^{obj} = E \left[ \left( X_t^{obj} (W^{CB}) \right)' W^{society} \left( X_t^{obj} (W^{CB}) \right) \right]. \] (2)
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- We measure welfare costs of the simple mandate relative to Ramsey:
  \[ \text{CEV} = 100 \left( \frac{\text{Loss}^{obj} - \text{Loss}^{Ramsey}}{\bar{C}(\frac{\partial U}{\partial C} | s.s.)} \right), \tag{3} \]
  where \( \bar{C}(\partial U/\partial C) \) measures how welfare increases when consumption is increased by 1%.
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    where \( \bar{C} \left( \frac{\partial U}{\partial C} \mid \text{s.s.} \right) \) measures how welfare increases when consumption is increased by 1%.
    - Hence, CEV is the increase in steady-state \( C \) that would make households indifferent between the simple mandate and Ramsey.

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Our Exercise
Two alternative assumptions about mandate

- We explore two alternative assumptions about the specificity of the law (or mandate) that governs the behavior of the central bank.

1. We assume that the law specifies both the variables and the weights. For example, the law could specify:

\[ L_t = (\pi_t^a - \pi^a)^2 + 0.25x_t^2. \]

2. We assume the law specifies the objective function but not the weights; the central bank determines \( W^{CB} \) by maximizing welfare:

\[
W^*(\Omega) = \arg \min_{W^{CB} \in \Omega} \left[ \left( X_t^{optimal} \left( W^{CB} \right) \right)' W^{society} X_t^{optimal} \left( W^{CB} \right) \right]
\]

where \( \Omega \) denotes the set of simple mandates consistent with the law. A simple example is

\[ L_t = (\pi_t^a - \pi^a)^2 + \lambda^a x_t^2 \]
Benchmark results
CEV for simple mandates with alternative utilization measures

Benchmark results in Table 2:

<table>
<thead>
<tr>
<th>Simple Mandate</th>
<th>$x_t$: Output gap</th>
<th>$x_t$: Output</th>
<th>$x_t$: Out. gr. (Ann.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\lambda^a$</td>
<td>CEV</td>
<td>$\lambda^a$</td>
</tr>
<tr>
<td>Woodford (2003)</td>
<td>0.048</td>
<td>0.471</td>
<td>0.048</td>
</tr>
<tr>
<td>Dual Mandate</td>
<td>0.250</td>
<td>0.140</td>
<td>0.250</td>
</tr>
<tr>
<td>Optimized Weight</td>
<td>1.042</td>
<td>0.044</td>
<td>0.542</td>
</tr>
</tbody>
</table>
Benchmark results
CEV-curvature for simple mandates with alternative utilization measures
Benchmark results
Volatility trade-offs for alternative utilization measures

Output Gap in Loss Function
- Opt. value ($\lambda^a = 1.042$)
- $\lambda^a = 0.01$
- $\lambda^a = 5$

Output in Loss Function
- Opt. value ($\lambda^a = 0.542$)
- $\lambda^a = 0.01$
- $\lambda^a = 5$

Annualized Output Growth in Loss Function
- Opt. value ($\lambda^a = 2.943$)
- $\lambda^a = 0.01$
- $\lambda^a = 5$
Key findings:

1. Optimal weight on resource utilization is about 1.05. This value is substantially higher than Woodford’s (2003) value of 0.048 and Yellen’s (2012) value of 0.25.
2. There is a volatility trade-off between inflation and the output gap (at odds with Justiniano, Primiceri and Tambalotti, 2013).

Two questions:

1. Why do we get such a large $\lambda^a$?
2. Why do we get important volatility trade-offs?

Are the shocks or deep parameters driving our results?
Benchmark results

Drivers of our results

- We first examine the influence of dynamic indexation and cost-push shocks.
Benchmark results
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  - $\lambda^a$ is above or close to unity even when either \( \text{var}(\varepsilon^p_t) \) or \( \text{var}(\varepsilon^w_t) \) is set to nil.
We first examine the influence of dynamic indexation and cost-push shocks.

- $\lambda^a$ is above or close to unity even when either $\text{var}(\varepsilon_t^p)$ or $\text{var}(\varepsilon_t^w)$ is set to nil.
- We find that dynamic indexation is important; $\lambda^a$ drops to 0.32 for $y_t^{gap}$ when $\iota_p = \iota_w = 0$ – but still 6 times larger than Woodford’s value.
Benchmark results
Sensitivity of results w.r.t. parameters and shocks
We now turn to the second question, namely why we get an important trade-off between stabilizing the output gap and inflation.
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But, JPT omit wage markup shocks - allow for labor supply shocks and measurement errors in the wage series to fit wage data.

Moreover, JPT omit price markup shocks - allow for persistent shocks to the inflation target to fit inflation dynamics in estimation, but removes this shock in their policy analysis.
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- But, JPT omit wage markup shocks - allow for labor supply shocks and measurement errors in the wage series to fit wage data.
- Moreover, JPT omit price markup shocks - allow for persistent shocks to the inflation target to fit inflation dynamics in estimation, but removes this shock in their policy analysis.

Therefore, we study the influence of the price and wage markup shocks and our assumption of dynamic indexation in wage and price setting for variance frontiers following Taylor (1979), EHL (1998), and CGG (1999).
Benchmark results
Variance frontiers for alternative calibrations
While we do not necessarily disagree with JPT, our analysis makes clear that their “no trade-off” result is a special case in the sense that it applies only if BOTH price and wage markup shocks are irrelevant.
Robustness of results

- Importantly, we find that our results hold up when we put restrictions on $\text{std}(r^a_t)$:

**Results for loss function with interest rate term**

<table>
<thead>
<tr>
<th>Loss Function</th>
<th>$\lambda^a - y_{t}^{gap}$</th>
<th>$\lambda_r$</th>
<th>CEV (%)</th>
<th>std($r^a_t$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodford</td>
<td>0.048</td>
<td>—</td>
<td>0.471</td>
<td>8.92</td>
</tr>
<tr>
<td>Optimized</td>
<td>1.042</td>
<td>—</td>
<td>0.044</td>
<td>9.00</td>
</tr>
<tr>
<td>Optimized* : $r^a_t - r^a$</td>
<td>1.161</td>
<td>0.0770*</td>
<td>0.076</td>
<td>2.24</td>
</tr>
<tr>
<td>Optimized* : $\Delta r^a_t$</td>
<td>1.110</td>
<td>1.0000*</td>
<td>0.084</td>
<td>2.04</td>
</tr>
</tbody>
</table>

- Obviously, commitment assumption important here
Robustness of results

- Also study the merits of an alternative mandate with nominal wage inflation and a labor market gap \((l_t - l_t^{pot})\):

\[
L_t = (\Delta w_t^a - \Delta w^a)^2 + \lambda^a (l_t - l_t^{pot})^2
\]
Robustness of results

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$$L_t = (\Delta w^a_t - \Delta w^a)^2 + \lambda^a (l_t - l_t^{pot})^2$$

- Find that labor market variables warrant further attention; not surprising given that the model features nominal wage frictions.
Robustness of results
On the importance of labor market variables
Simple rule results
Rule and basic results

- We also study the performance of simple rules on the form

\[ r_t^a = (1 - \rho_r) \left[ r^a + \varphi_\pi (\pi_t^a - \pi^a) + \varphi_y y_t^{gap} + \varphi_{\Delta y} \Delta y_t^{gap} \right] + \rho_r r_{t-1}^a \quad (4) \]

- Look at Taylor (1993) and (1999) and coefficients that minimize CEV

<table>
<thead>
<tr>
<th>Parameterization</th>
<th>$\varphi_\pi$</th>
<th>$\varphi_y$</th>
<th>$\varphi_{\Delta y}$</th>
<th>$\rho_r$</th>
<th>CEV (%)</th>
<th>std($r_t^a$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylor (1993)</td>
<td>1.50</td>
<td>0.50</td>
<td>-</td>
<td>-</td>
<td>0.399</td>
<td>5.43</td>
</tr>
<tr>
<td>Taylor (1999)</td>
<td>1.50</td>
<td>1.00</td>
<td>-</td>
<td>-</td>
<td>0.768</td>
<td>7.53</td>
</tr>
<tr>
<td>Optimized, Taylor</td>
<td>2.23</td>
<td>0.49</td>
<td>-</td>
<td>-</td>
<td>0.254</td>
<td>4.30</td>
</tr>
<tr>
<td>Optimized, $\varphi_{\Delta y} = 0$</td>
<td>11.78</td>
<td>5.76</td>
<td>-</td>
<td>0.99</td>
<td>0.216</td>
<td>2.08</td>
</tr>
<tr>
<td>Optimized, uncon.</td>
<td>20.20</td>
<td>0.40</td>
<td>56.52</td>
<td>0.48</td>
<td>0.033</td>
<td>7.81</td>
</tr>
<tr>
<td>Optimized, constr.</td>
<td>29.28</td>
<td>0.79</td>
<td>54.81</td>
<td>0.99</td>
<td>0.082</td>
<td>2.08</td>
</tr>
</tbody>
</table>
We find that optimized rule is characterized by:

- High degree of interest rate smoothing ($\rho_r$)
- Large response coefficients for inflation ($\varphi_\pi$) and growth rate of the output gap ($\varphi_\Delta y$)
- Coefficient on the level of the output gap ($\varphi_y$)

CEV for optimized rule (4) is about the same as CEV for optimized simple mandate.
Simple rule results

Interpretation of findings

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- CEV for optimized rule (4) is about the same as CEV for optimized simple mandate
  - So rules only work as well as simple mandates for particular parameterizations
Concluding remarks

- Our analysis suggest that resource utilization should carry a large weight in formulation of monetary policy, consistent with the spirit of the dual mandate and recent papers by Reifschneider et al. (2013) and English et al. (2013)
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Our results warrant further work to check robustness in models with financial frictions, imperfect information, and plausible transmission lags of monetary policy