Fiscal Calculus in a New Keynesian Model with Matching Frictions

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Expansionary fiscal packages around the globe

Figure 1: Scope of the National Stimulus Packages. Source: Data from ILO (2009).

Source: Ahrens (2009)
Research question

Are expansionary fiscal packages able to fight rising unemployment in a recession?

- Seek to answer this question in a New Keynesian model with unemployment due to matching frictions
- Calculate fiscal multipliers for alternative fiscal packages:
  - Target for the fiscal stimulus: aggregate demand vs. labor market policy
  - Source of financing: lump-sum vs. distortionary taxation
Recent literature on fiscal multipliers

Optimistic view

- Romer and Bernstein (2009) find fiscal multipliers significantly larger than one
- Christiano, Eichenbaum and Rebelo (2009): multipliers are large when interest rate is at the zero lower bound

Pessimistic view

- Cogan, Cwik, Taylor and Wieland (JEDC forthcoming) employ Smets-Wouters (AER 2007) model for the US economy and find multipliers only 1/6 as large as the ones of Romer and Bernstein (2009).
- Cwik and Wieland (2009): same approach for the Euro area, find multipliers smaller than one
- Uhlig (2009) emphasizes the role of distortionary taxation ⇒ long-run multipliers may be even negative
Non-Walrasian labor markets are a crucial dimension in evaluating fiscal multipliers!

⇒ Stimulus of a demand shock might be lower than expected, hence we join the pessimists

⇒ Support for the optimists: If spending is used to finance labor market policies (hiring subsidies), fiscal multipliers may be well above one

Similar results are found by Faia, Lechthaler and Merkl (2010) in an open economy model with labor turnover costs
Outline

1. Literature and contribution
2. Model and calibration
3. A special case: flexible prices
4. Simulation results
   1. Demand stimulus
   2. Alternative forms of fiscal stimuli
   3. Robustness checks: interest rate peg, starting from recession scenario, ...
5. Summary and future work
The model structure at a glance

- New Keynesian model for a closed and cashless economy with unemployment due to matching frictions [Krause and Lubik (JME 2007)]
- Monopolistic competition on product markets
- Nominal price rigidity modeled by Rotemberg adjustment costs
- Labor market characterized by matching frictions, exogenous job separations, inelastic supply of labor hours (no intensive margin), individual Nash wage bargaining
- Government collects lump-sum taxes, levies taxes on consumption purchases and labor income and issues bonds to finance government expenditure (government consumption, hiring subsidies)
- Monetary policy is described by a Taylor rule
Model equations

\[ \lambda_t = c_t^{-\sigma} / (1 - \tau_t^c) \]
\[ \lambda_t = \beta E_t \left\{ \lambda_{t+1} (1 + r_t^n) / \pi_{t+1} \right\} \]
\[ y_t = c_t + g_t \]
\[ z_t n_t = y_t + \kappa v_t + \frac{\psi}{2} (\pi_t - 1)^2 y_t \]
\[ n_t = (1 - \rho) n_{t-1} + m u_t^\xi v_t^{1-\xi} \]
\[ \theta_t = v_t / u_t \]
\[ q(\theta_t) = m \theta_t^{-\xi} \]
\[ u_t = 1 - (1 - \rho) n_{t-1} \]
\[ \frac{\kappa (1 - \tau_t^k)}{q(\theta_t)} = m c_t z_t - w_t + \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} (1 - \rho) \frac{\kappa (1 - \tau_{t+1}^k)}{q(\theta_{t+1})} \right\} \]
\[ (1 - \tau_t^n (1 - \varsigma)) w_t = \varsigma m c_t z_t + \varsigma (1 - \rho) \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \kappa (1 - \tau_{t+1}^k) \theta_{t+1} \right\} + (1 - \varsigma) b \]
\[ \psi (\pi_t - 1) \pi_t - \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \psi (\pi_{t+1} - 1) \pi_{t+1} \frac{y_{t+1}}{y_t} \right\} = 1 - \varepsilon (1 - m c_t) \]
\[ \ln \left( \frac{1 + r_t^n}{1 + r_t^m} \right) = \left( \phi_\pi \ln \left( \frac{\pi_t}{\pi} \right) + \phi_y \ln \left( \frac{y_t}{y} \right) \right) \]
Government budget constraint:

\[ g_t + b(1 - n_t) + (1 + r_{t-1}^n) \frac{B_{t-1}}{p_t} + \tau_t^k \kappa v_t = \tau_t^c c_t + \tau_t^w w_t n_t + \frac{B_t}{p_t} + \tau_t \]

Following Uhlig (2009), assume the following tax rule:

\[ \tau_t^w w_t n_t = \phi \left( g_t + b(1 - n_t) + \tau_t^k \kappa v_t - \bar{\tau} + (1 + r_{t-1}^n) \frac{B_{t-1}}{p_t} - \bar{\tau}^c c_t \right) \]

\[ \Rightarrow \phi = 0: \text{lump-sum taxation} \]
\[ \Rightarrow \phi = 0.275 \text{ implying } \bar{B}/\bar{y} = 0.6 \]
\[ \Rightarrow \phi = 1: \text{pure distortionary taxation} \]
Fiscal stimuli

Traditional increase in aggregate demand

\[
\frac{g_t}{g} = \left( \frac{g_{t-1}}{g} \right)^{\rho^g} + \varepsilon_t^g
\]

Alternative forms of fiscal stimuli

- Increase in unemployment benefits
- Subsidies to the cost of posting vacancies
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>discount rate</td>
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</tr>
<tr>
<td>$\sigma$</td>
<td>2</td>
<td>CRRA</td>
<td>standard value</td>
</tr>
<tr>
<td>$\frac{\varepsilon}{\varepsilon - 1}^\psi$</td>
<td>0.2</td>
<td>mark up</td>
<td>Basu and Fernald (1997)</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>0.4</td>
<td>matching technology</td>
<td>Blanchard and Diamond (1991)</td>
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<tr>
<td>$\rho$</td>
<td>0.07</td>
<td>separation rate</td>
<td>Hall (1995)</td>
</tr>
<tr>
<td>$\bar{u}$</td>
<td>0.12</td>
<td>stst. unemployment</td>
<td>Krause and Lubik (2007)</td>
</tr>
<tr>
<td>$q(\bar{\theta})$</td>
<td>0.7</td>
<td>firm matching rate</td>
<td>den Haan et. al (2000)</td>
</tr>
<tr>
<td>$b$</td>
<td>0.5 $\bar{w}$</td>
<td>unemployment benefit</td>
<td>Nickell and Nunziata (2001)</td>
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<td>$\varsigma$</td>
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<tr>
<td>$\phi_p$</td>
<td>1.5</td>
<td>Taylor coefficient</td>
<td>Taylor (1993)</td>
</tr>
<tr>
<td>$\phi_y$</td>
<td>0.5/4</td>
<td>Taylor coefficient</td>
<td>Taylor (1993)</td>
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<td>$g$</td>
<td>0.15 $\bar{y}$</td>
<td>stst. government spending</td>
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<td>$\tau^c$</td>
<td>0.05</td>
<td>consumption tax</td>
<td>Trabandt and Uhlig (2009)</td>
</tr>
<tr>
<td>$\tau^n$</td>
<td>0.28</td>
<td>stst. labor tax</td>
<td>Trabandt and Uhlig (2009)</td>
</tr>
<tr>
<td>$\rho g, \rho_{\tau k}$</td>
<td>0.9</td>
<td>autocorrelation of shocks</td>
<td>standard value</td>
</tr>
</tbody>
</table>
A special case: Dynamics under flexible prices
Demand stimulus under lump-sum taxation

![Graphs showing dynamics under flexible prices](image_url)
Since $mc_t = (\varepsilon - 1)/\varepsilon$ and $mc_t = w_t$, the labor supply equation is given by

$$\frac{\varepsilon - 1}{\varepsilon}(1 - \tau^n_t) = N^\phi_t C^\sigma_t$$

- If $\tau^n_t$ is constant, an increase in $N$ is accompanied with a decrease in consumption, the more the higher $\eta$
  - Fiscal multiplier is always below one
- If $\tau^n_t$ increase, drop in consumption is larger the higher the increase in taxes
  - Financing with distortionary taxation reduces the fiscal multiplier
To prove that fiscal multipliers turn negative, assume that workers have zero bargaining power ($\varsigma = 0$). Combining the wage equation with the job creation condition yields

\[
\frac{\varepsilon - 1}{\varepsilon} - \frac{b}{1 - \tau^n} = \frac{\kappa (1 - \tau_k)}{m} \theta_t^{\xi} - (1 - \rho) \beta^{\kappa (1 - \tau_k)} m E_t \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \theta_{t+1}^{\xi} \right\}
\]

- To accommodate an increase in $G$, firms will have to post more vacancies $\Rightarrow \theta_t \uparrow$
- As we consider a temporary shock, we expect firms to post less vacancies in future periods, hence $\theta_{t+1} < \theta_t$.
- Thus, for $\theta_t \uparrow$, we need an increase (decrease) in the stochastic discount factor (the real interest rate) $\Rightarrow$ this requires an increase in current consumption
- However, the negative wealth effect leads to a decrease in consumption inducing a fall in vacancy posting
Distortionary taxation:

\[
\frac{\varepsilon - 1}{\varepsilon} - \frac{b}{1 - \tau_t^n} = \frac{\kappa(1 - \tau_k)}{m} \theta_t^\xi - (1 - \rho)\beta \frac{\kappa(1 - \tau_k)}{m} E_t \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\sigma} \theta_t^\xi \right\}
\]

⇒ If labor taxes are used to finance the increase in government spending, the left hand side decreases, thus requiring an even bigger reduction in vacancy posting.
Back to sticky prices
Demand stimulus under lump-sum taxation

AGGREGATE DEMAND
- Walrasian labor market
- Search frictions

CONSUMPTION

HOURS WORKED/ EMPLOYMENT

AGGREGATE DEMAND MULTIPLIER
IRF’s in the NK model with Walrasian labor market

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Fiscal Calculus in a New Keynesian Model with Matching Frictions
Fiscal multipliers

AGGREGATE DEMAND MULTIPLIER

GDP MULTIPLIER

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Fiscal multipliers

\[ \phi = 0 \]

\[ \phi = 0.275 \]

<table>
<thead>
<tr>
<th>Demand stimulus</th>
<th>( \phi = 0 )</th>
<th>( \phi = 0.275 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRM</td>
<td>LRM</td>
<td>SRM</td>
</tr>
<tr>
<td>Baseline model</td>
<td>0.0327</td>
<td>0.0327</td>
</tr>
<tr>
<td>Flexible prices (( \psi = 0 ))</td>
<td>-0.0173</td>
<td>-0.0324</td>
</tr>
<tr>
<td>Walrasian labor market</td>
<td>0.5501</td>
<td>0.5499</td>
</tr>
<tr>
<td>Walrasian / ( \psi = 0 )</td>
<td>0.5407</td>
<td>0.5407</td>
</tr>
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</table>

Short Run Multiplier = \( \frac{dGDP_0}{dG_0} \), Long Run Multiplier = \( \sum_{t=0}^{\infty} \beta^t \frac{dGDP_t}{dG_t} \)

⇒ Lump-sum taxation: Positive effect on aggregate demand due to price rigidity is barely enough to compensate for the negative labor demand effect

⇒ With distortionary taxation, multipliers turn negative
Robustness checks

Reassess government consumption multipliers

- for different degrees of nominal price rigidity
- when considering real wage rigidity $w_t = \gamma w_{t-1} + (1 - \gamma) w^*_t$
- when varying worker’s bargaining power
### Fiscal multipliers

Varying the degree of nominal price rigidity

**Demand stimulus**

<table>
<thead>
<tr>
<th></th>
<th>SRM</th>
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<th>LRM</th>
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</thead>
<tbody>
<tr>
<td><strong>Baseline model</strong></td>
<td>0.0327</td>
<td>0.0327</td>
<td>-0.1958</td>
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<tr>
<td><strong>Flexible prices (ψ = 0)</strong></td>
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<td><strong>Price rigidity ψ = 9.9010</strong></td>
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<tr>
<td><strong>Price rigidity ψ = 58.2524</strong></td>
<td>0.1207</td>
<td>0.0922</td>
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<td>-0.5554</td>
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<tbody>
<tr>
<td><strong>Walrasian labor market</strong></td>
<td>0.5501</td>
<td>0.5499</td>
<td>0.3687</td>
<td>0.1251</td>
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<td><strong>Walrasian / ψ = 0</strong></td>
<td>0.5407</td>
<td>0.5407</td>
<td>0.4690</td>
<td>0.1218</td>
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<td><strong>Walrasian / ψ = 9.9010</strong></td>
<td>0.5441</td>
<td>0.5440</td>
<td>0.4233</td>
<td>0.1173</td>
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<td><strong>Walrasian / ψ = 58.2524</strong></td>
<td>0.5579</td>
<td>0.5576</td>
<td>0.2651</td>
<td>0.2638</td>
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</tbody>
</table>

\[ \text{SRM} = \frac{dGDP}{dcost}, \quad \text{LRM} = \sum_{t=0}^{\infty} \beta^t dGDP_t / dcost_t \]

⇒ Higher price rigidity increases fiscal multipliers

⇒ Independently of the degree of price rigidity, matching frictions dampen fiscal multipliers
### Fiscal multipliers

Considering real wage rigidity

\[ \phi = 0 \]

\[ \phi = 0.275 \]

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<tr>
<td>Baseline model</td>
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<td>0.0327</td>
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<tr>
<td>Real wage rigidity ( (\gamma = 0.9) )</td>
<td>0.1412</td>
<td>0.0287</td>
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<tr>
<td>Walrasian labor market</td>
<td>0.5501</td>
<td>0.5499</td>
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SRM = \( \frac{dGDP_0}{dcost_0} \), LRM = \( \sum_{t=0}^{\infty} \beta^t \frac{dGDP_t}{dcost_t} \)

\[ \Rightarrow \] Aggregate demand \( \uparrow \rightarrow \) wages \( \uparrow \rightarrow \) vacancy posting \( \downarrow \)

\[ \Rightarrow \] Real wage rigidity dampens the upward pressure on wages \( \Rightarrow \) multipliers \( \uparrow \)

\[ \Rightarrow \] Effects still considerably smaller compared to Walrasian labor market model

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### Fiscal multipliers

Varying worker’s bargaining power

\[
\phi = 0 \quad \phi = 0.275
\]

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<tr>
<td>Baseline model</td>
<td>0.0327</td>
<td>0.0327</td>
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<tr>
<td>Bargaining power ( \varsigma = 0.9 )</td>
<td>0.0426</td>
<td>0.0500</td>
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<tr>
<td>Bargaining power ( \varsigma = 0.3 )</td>
<td>0.0108</td>
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<tr>
<td>Walrasian labor market</td>
<td>0.5501</td>
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SRM = \( \frac{dGDP_0}{dcost_0} \), LRM = \( \sum_{t=0}^{\infty} \beta^t \frac{dGDP_t}{dcost_t} \)

⇒ Insignificant changes
A brief summary of the findings so far

- Government consumption multipliers are nearly zero and turn even negative when financed with distortionary taxation
- True also for other forms of aggregate demand stimuli (decrease in consumption taxes)
- Other forms of fiscal stimuli
Increase in unemployment benefits:

⇒ Delivers negative multipliers since it raises wages
⇒ Increase in wages leads to a fall in labor demand and employment
⇒ Increase in unemployment benefits may be beneficial when frictions occur also along the labor supply schedule

Increase in hiring subsidies

\[
\frac{\tau_t^k}{\tau^k} = \left(\frac{\tau_{t-1}^k}{\tau^k}\right)^{\rho^{\tau^k}} + \varepsilon_t^{\tau^k}
\]
Impulse responses to an increase in hiring subsidies

AGGREGATE DEMAND

CONSUMPTION

EMPLOYMENT

VACANCIES

REAL INTEREST RATE

INFLATION

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Fiscal Calculus in a New Keynesian Model with Matching Frictions
Fiscal multipliers for an increase in hiring subsidies

AGGREGATE DEMAND MULTIPLIER

\[ \frac{\Delta Y}{\Delta G} \]

\[ \phi = 0 \]
\[ \phi = 0.275 \]
\[ \phi = 1 \]

GDP MULTIPLIER

\[ \frac{\Delta Y}{\Delta G} \]

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Fiscal Calculus in a New Keynesian Model with Matching Frictions
Robustness checks

Starting from a recession scenario

Compare effects of a persistent one percent drop in total factor productivity with and without policy intervention

Interest rate peg

Monetary authority keeps the nominal interest rate constant for one year

Does the result of Christiano, Eichenbaum and Rebelo (2009) survive when matching frictions are considered?
Starting from a recession scenario
Response of employment

DEMAND STIMULUS

HIRING SUBSIDY

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Fiscal Calculus in a New Keynesian Model with Matching Frictions
### Demand stimulus

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### Increase in hiring subsidies

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<td>2.6204</td>
<td>-0.2292</td>
<td>3.4805</td>
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SRM = \( \frac{dy_0}{d\text{cost}_0} \), LRM = \( \sum_{t=0}^{\infty} \beta^t \frac{dy_t}{d\text{cost}_t} \)

⇒ Demand stimulus: Larger multipliers also with search frictions

⇒ Hiring subsidies: policy only successful when accompanied by a fall in the nominal interest rate

Reason: real interest rate jumps up \( \rightarrow \) discounted future values of new vacancies decrease
Non-Walrasian labor markets are a crucial dimension in evaluating fiscal multipliers.

Frictions in the labor market dampens effects of demand stimuli:
- Contrast the common wisdom that sees fiscal stimuli helpful exactly when unemployment is high.
- Literature may overestimate the actual demand stimulus.

Policies targeted towards the labor demand schedule are effective in boosting employment and output.
Future work

- Add frictions along the labor supply schedule (endogenous labor market participation)
- Simplicity of our model allows to explain the key mechanism and to compare fiscal multipliers under different labor market regimes
- To come out with some real quantitative statements about fiscal stimuli we have to bring the model to the data