Structural reforms in DSGE models
a plead for sensitivity analysis

B. Campagne, A. Poissonnier

Insee/Crest/Ecole Polytechnique

Society for Economic Measurement Conference
22nd July 2015

This work reflect the opinions of the authors and not necessarily the views of Insee.
1 Motivation

2 A standard new-Keynesian DSGE model

3 Structural reforms: labour and goods markets deregulation

4 Structural reforms: a sensitivity analysis

5 Conclusion
Plan

1. Motivation
2. A standard new-Keynesian DSGE model
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5. Conclusion
Increasing use of DSGEs for policy purposes

DSGE models supplanted macroeconometric models, now widely used in governments, central banks and international institutions:

- Quest III (EC), NAWM or EAGLE (ECB), GIMF (IMF), SIGMA (FED)...

Vast literature using DSGE models for the evaluation of structural reforms (ie. deregulation of goods and labour markets):

- Quest III: Roeger et al. (2008), D’Auria et al. (2009), Annicchiarico et al. (2013), Varga et al. (2014)
- GEM: Bayoumi et al. (2004) or Everaert and Schule (2006, 2008) for European countries
- OECD: Cacciatore et al. (2012)
- Central Banks: Forni et al. (2010)
Motivation

In order to conduct policy evaluations in DSGE models:

- Do we understand how structural reforms affect the economy?
- Are DSGE models *qualitatively* stable enough?
- Are DSGE models *quantitatively* stable enough?
Our main results

- Structural reforms simulations in a Smets and Wouters’ type of model are in line with Blanchard and Giavazzi (2003).
- The consumption-leisure arbitrage plays a key role in the transmission of structural reforms to the economy.
- Therefore, the Frisch elasticity (as well as the risk aversion, and habits) are crucial for the quantitative assessment of reforms.
- Welfare analysis shows households might loose upon reform.
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A three-slide overview of the model

Core structure

New Keynesian model à la Smets and Wouters (2003):

- nominal rigidities on prices and wages, real rigidities on capital
- ... and all the "traditional" ingredients

Households' utility: non-separable (King et al., 2002), with consumption multiplicative habits (Abel, 1990 or Gali, 1994)

\[
U_t(\tau) = \frac{1}{1-\sigma_c} \left[ C_t(\tau) \left( \frac{C_{t-1}}{N} \right)^{-h_c} \right]^{1-\sigma_c} \left[ 1 - \kappa (1 - \sigma_c) l_t(\tau)^{1+\sigma_l} \right]^{\sigma_c}
\]

Alternative models:

- with no consumption habits
- with labour habits
- with non Ricardian agents à la Campbell and Mankiw
A three-slide overview of the model

Calibration

Detailed steady state calibration for the Eurozone taken as a closed economy (in line with Smets and Wouters, 2005)

<table>
<thead>
<tr>
<th></th>
<th>DATA EA (12)</th>
<th>MODEL EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output in 2000 (GDP)*</td>
<td>6943</td>
<td>6943</td>
</tr>
<tr>
<td>Output per capita growth rate**</td>
<td>1.2%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Working age population in 2000 ***</td>
<td>135.9</td>
<td>135.9</td>
</tr>
<tr>
<td>Hours worked per week and working age capita (since 2000)</td>
<td>34.3</td>
<td>34.3</td>
</tr>
<tr>
<td>Gross Op. Surplus to VA</td>
<td>46%</td>
<td>42%</td>
</tr>
<tr>
<td>Gross wages to VA</td>
<td>53%</td>
<td>58%</td>
</tr>
<tr>
<td>Nominal 3 month Euribor**</td>
<td>3.8%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Inflation**</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Private consumption to GDP ratio</td>
<td>56.3%</td>
<td>56.9%</td>
</tr>
<tr>
<td>Public consumption to GDP ratio</td>
<td>19.7%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Investment to GDP ratio</td>
<td>21.9%</td>
<td>23.5%</td>
</tr>
</tbody>
</table>

Sources: Eurostat with data averaged from 1995 to 2007.
* in billion € in current prices
** annualised
*** aged from 15 to 64 in millions
A three-slide overview of the model

Structural parameters

<table>
<thead>
<tr>
<th><strong>Technology</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology parameter</td>
<td>( \alpha )</td>
<td>0.3</td>
<td>Smets and Wouters (2005)</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>( \delta )</td>
<td>0.025</td>
<td>idem</td>
</tr>
<tr>
<td>Capital rigidity</td>
<td>( S )</td>
<td>6.17</td>
<td>idem</td>
</tr>
<tr>
<td>TFP growth rate</td>
<td>( g )</td>
<td>0.003</td>
<td>Eurostat</td>
</tr>
<tr>
<td>Population size</td>
<td>( N )</td>
<td>135 922 100</td>
<td>Eurostat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Monetary policy</strong></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>( \Pi^* )</td>
<td>1.005</td>
<td>Consensus, ECB</td>
</tr>
<tr>
<td>Smoothing parameter</td>
<td>( \rho )</td>
<td>0.85</td>
<td>Smets and Wouters (2005)</td>
</tr>
<tr>
<td>Weight on inflation</td>
<td>( r_\pi )</td>
<td>1.4</td>
<td>idem</td>
</tr>
<tr>
<td>Weight on output gap</td>
<td>( r_y )</td>
<td>0.11</td>
<td>idem</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Prices and Wages</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitutability between goods</td>
<td>( \theta )</td>
<td>6</td>
<td>QUEST III, GEM, NAWM, EAGLE ₢</td>
</tr>
<tr>
<td>Substitutability between workers</td>
<td>( \theta_w )</td>
<td>4</td>
<td>idem</td>
</tr>
<tr>
<td>Price rigidity</td>
<td>( \xi )</td>
<td>0.90</td>
<td>Smets and Wouters (2005)</td>
</tr>
<tr>
<td>Wage rigidity</td>
<td>( \xi_w )</td>
<td>0.92</td>
<td>idem</td>
</tr>
<tr>
<td>Price indexation</td>
<td>( \gamma_p )</td>
<td>0.29</td>
<td>idem</td>
</tr>
<tr>
<td>Wage indexation</td>
<td>( \gamma_w )</td>
<td>0.90</td>
<td>idem</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Preferences</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Households discount factor</td>
<td>( \beta )</td>
<td>0.9983</td>
<td>SS constraint</td>
</tr>
<tr>
<td>Risk aversion</td>
<td>( \sigma_c )</td>
<td>1.13</td>
<td>Smets and Wouters (2005)</td>
</tr>
<tr>
<td>Inverse Frisch elasticity</td>
<td>( \sigma_l )</td>
<td>2</td>
<td>idem</td>
</tr>
<tr>
<td>Consumption habits</td>
<td>( h_c )</td>
<td>0.61</td>
<td>idem</td>
</tr>
<tr>
<td>Labour habits</td>
<td>( h_l )</td>
<td>0</td>
<td>idem</td>
</tr>
<tr>
<td>Weight on labour disutility</td>
<td>( \kappa )</td>
<td>5812.38</td>
<td>SS constraint on hours worked</td>
</tr>
</tbody>
</table>
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5. Conclusion
Channels of transmission of structural reforms
What should we expect?

  - monopolistic competition, entry costs and wage Nash bargaining
  - production = employment

<table>
<thead>
<tr>
<th>Reform</th>
<th>short-run</th>
<th>transition</th>
<th>long-run</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ bargaining power of workers</td>
<td>profits ↑, and real wages ↓</td>
<td>more firms enter, labour and real wages ↑</td>
<td>labour ↑ and real wages stagnate</td>
</tr>
<tr>
<td>↑ substitutability between goods</td>
<td>real wages and labour ↑</td>
<td>profits ↓ so firms exit</td>
<td>neutral</td>
</tr>
<tr>
<td>↓ entry costs</td>
<td>neutral as fixed number of firms</td>
<td>firms start entering</td>
<td>real wages and labour ↑</td>
</tr>
</tbody>
</table>

- DSGE with labour search and matching (Cacciatore et al., 2012)
  - for labour market reforms, labour ↓ in the short-run
  - worsening trade-off between short-run pains and long-term gains
- no endogenous growth, so decreasing mark-ups to 0 is optimal
Channels of transmission of structural reforms
...in Smets and Wouters’ model

Capital demand curve

\[ \theta^{-1} \alpha \zeta^{1-\alpha} \left( \frac{\bar{K}}{\bar{L}} \right)^{\alpha-1} = \bar{r}^k \]

Capital supply curve

\[ \bar{r}^k = \frac{1 + \bar{r}}{\Pi} - 1 + \delta \]

Labour demand curve

\[ \theta^{-1} (1 - \alpha) \zeta^{1-\alpha} \left( \frac{\bar{K}}{\bar{L}} \right)^{\alpha} = \bar{RW} \]

Labour supply curve

\[ \bar{RW} = \frac{\theta_w}{\theta_w - 1} (1 + \sigma_l) \bar{c}f(\bar{l}) \]

**Figure:** Decomposition of revenues
Channels of transmission of structural reforms
...in Smets and Wouters’ model (graphically)

Capital market

Labour market

\[ \bar{K} \quad S \quad \bar{L} \quad S \]

\[ \bar{r}^k \quad D \quad \bar{R}W \quad D \]

Campagne, Poissonnier (INSEE) DSGE models’ sensitivity SEM 2015 14 / 29
Channels of transmission of structural reforms

Product market deregulation: ↑ substitutability between goods

- dividends ↓ and factors’ remuneration ↑ (D1 to D’)
- increased demand for factors translates into ↑ marginal productivity and further ↑ demand (D’ to D2)
- positive wealth effect, consumption ↑ and labour supply ↓ (S1 to S2)

At steady state

- capital ↑, labour ↑, production ↑
- consumption ↑, real wages ↑
Channels of transmission of structural reforms

Labour market deregulation: ↑ substitutability between workers

- lower marker power of workers implies an increased labour supply for a same wage (S1 to S’)
- increased labour supply translates into ↑ marginal productivity of capital and then labour (D1 to D2)
- consumption-leisure arbitrage adjusts (S’ to S2 - wealth effect) but unchanged real wages in the long-run

At steady state

- capital ↑, labour ↑, production ↑ in the same proportions
- consumption ↑, real wages stagnates
Channels of transmission of structural reforms

Quantitative simulations

Figure: Production

Figure: Real wage

Figure: Total utility

Steady state variations upon reforms in p.p.

- **Best practices** = standard exercise of convergence towards the three best EU performers (UK, SW, DK)

- Utility decreases (partly due to consumption habits)
Channels of transmission of structural reforms

Transition dynamics

Product market deregulation

- ↑ factors’ remuneration translates into ↑ in the real marginal cost
- \( r^k \) ↑ and then capital, real wages ↑ slowly so labour overshoots
- investment ↑ as \( r^k \) ↑, financed by labour and savings

Labour market deregulation

- immediate shift in the labour supply curve and labour overshoots to finance consumption and investment
- as marginal productivity ↑, capital overshoots
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Long term elasticities of output and utility

Elasticities when performing:

- a product market deregulation
  \[
  \frac{d\tilde{Y}}{\tilde{Y}} \equiv \left( \frac{\alpha}{1-\alpha} + \frac{1}{(1+\sigma_l)(1-h_l)(1+B)} \left(1 + \frac{iy}{cy}\right) \right) \frac{d\theta}{\theta-1} > 0
  \]
  \[
  \frac{d\tilde{U}}{\tilde{U}} = (1 - \sigma_c)(1 - h_c) \left[ \left( \frac{\alpha}{1-\alpha} - \frac{iy}{cy} \right) + \frac{1-\theta_{w-1}}{\theta-w} \left(1 - \frac{(1-\alpha)(1-h_l)}{(1-h_c)cy} \right) \left(1 + \frac{iy}{cy}\right) \right] \frac{d\theta}{\theta-1}
  \]

- a labour market deregulation
  \[
  \frac{d\tilde{Y}}{\tilde{Y}} = \frac{1}{(1+\sigma_l)(1-h_l)(1+B)} \frac{d\theta_w}{\theta_{w-1}} > 0
  \]
  \[
  \frac{d\tilde{U}}{\tilde{U}} = (1 - \sigma_c)(1 - h_c) \frac{1-\theta_{w-1}}{\theta-w} \frac{1}{(1+\sigma_l)(1-h_l)(1+B)} \frac{d\theta_w}{\theta_{w-1}} \]

→ Importance of the households’ utility and habits calibration
→ Output enhancing but ambiguous sign for utility
Calibration of the utility function
A strong dependency on the Frisch elasticity

**Figure**: Goods market reforms

**Figure**: Labour market reforms

A higher $\sigma_l$ implies a flatter labour supply curve, that is
- a smaller $\uparrow$ in labour when the demand curve shifts up for PMR
- a smaller shift in the labour supply curve for LMR
Calibration of the utility function

Habit formation

**Figure:** PMR - Standard

**Figure:** PMR - $h_c = 0$

**Figure:** PMR - $h_l = 0.5$

**Consumption habits**

- Negative externality
- No impact on real variables (steady state and transition)
- Strong impact on welfare

**Labour habits**

- Positive externality
- Scale effect on real variables (steady state and transition)
- Ambiguous impact on welfare

Identical conclusions for LMR
Introducing non-Ricardian households

Sensitivity

Impact of reforms in p.p. depending on the share of non-Ricardian agents

- Low sensitivity for labour market reforms, agents react similarly
- Strong impact for product market reforms, up to 1 p.p. of production
Introducing non-Ricardian households

Inequality implications of reforms

- For PMR, as dividends ↓ Ricardian households experience a negative wealth effect
- For LMR, profits are untouched. Undifferentiated behaviours.

Campagne, Poissonnier (INSEE)
Introducing non-Ricardian households

Utility decomposition

**Figure:** PMR - Representative

**Figure:** PMR - Ricardian

**Figure:** PMR - non-Ricardian

- For PMR, aggregate utility increases due to non-Ricardian agents
- Same decomposition for LMR, with a decrease in utility
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In short...

Our main results

- The effect of structural reforms in DSGE models strongly relies on the consumption/leisure arbitrage
- Changes in the definition and the calibration of the utility function have strong impact on the size of gains
- Economic-enhancement is not always in line with welfare improvement
  → need for sensitivity analyses when evaluating structural reforms

On the agenda

- Expand this analyses to a fully-fledged institutional-like model
- Investigate the relevance of reforms' transmission channels in DSGE models
Real rigidities and markups

Monopolistic competition between goods (resp. workers) : existence of market powers

Goods market

- differentiated goods
- market power : $\frac{\theta}{\theta - 1}$
- demand curve :

$$y_t = \left( \frac{p_t}{P_t} \right)^{-\theta} \frac{Y_t}{P}$$

Labour market (Erceg and al., 2000)

- differentiated workers
- market power : $\frac{\theta_w}{\theta_w - 1}$
- demand curve :

$$l_t = \left( \frac{w_t}{W_t} \right)^{-\theta_w} \frac{L_t}{N}$$

Competition level $\leftrightarrow$ degree of substitutability between goods/workers