Macroeconomic effects of the liquidity crisis in Spain: the increase in the risk premium

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Outline

- Main characteristics of the REMS model.
- Data (REMSDB), calibration and estimation.
- Simulations:
  1. Increase in risk premium:
     - Global risk premium in the Eurozone.
     - Specific Spanish risk premium.
  2. Sensitivity analysis.

Characteristics of the REMS model

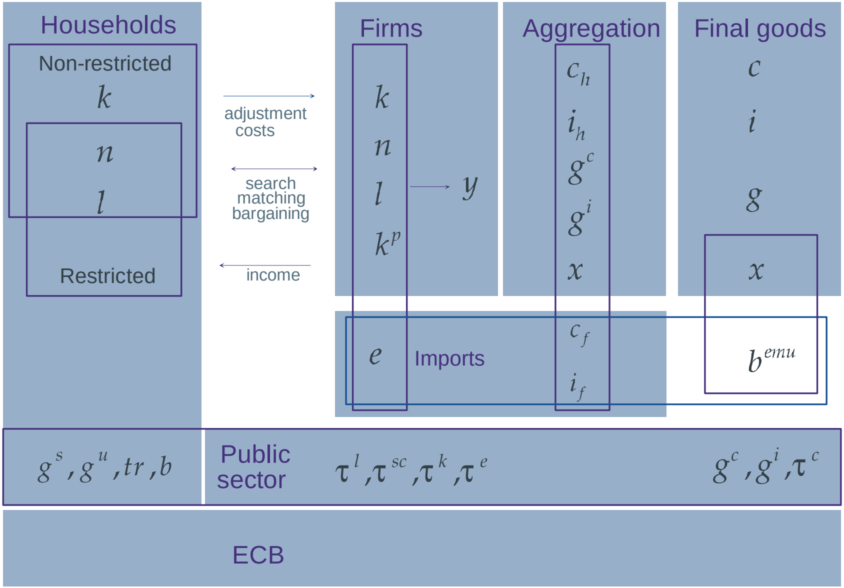
- A Rational Expectations Model for simulation and policy evaluation of the Spanish economy (REMS).
- REMS complements recent contributions such as a BEMOD (Andrés, Burriel and Estrada, 2006) and MEDEA (Burriel, Fernández-Villaverde and Rubio, 2007).
- REMS is not used for forecasting but to analyse the effects of policy shocks.
- Dynamic general equilibrium model with a strong microfounded system of equations.
- Model of a small open economy within a monetary union.

Characteristics of the REMS model

- Non-walrasian goods and labour markets. Agents face market power.
- Nominal rigidities (inflation), real rigidities (adjustment costs) and involuntary unemployment due to search inefficiencies.
- In the short run REMS is influenced by the New Keynesian modellization strategy.
- The demand side is represented by an expectational IS curve.
- Phillips curve is derived under the assumption of monopolistic competition.
- Public expenditures and revenues are carefully detailed.
- ECB monetary policy: interest rule.
- Supply-side and stabilization policies do play a role in affecting the economy in the long and short run, respectively.

The model

- Dynamic general equilibrium model.
- The behavioural equations result from intertemporal optimization by perfect foresight economic agents.
- Agents:
  1. Households: consumption, investment, labour supply.
  2. Firms: capital, employment (hours), energy, vacancies.
  3. Goverment: taxes, public expenditures, debt.
  4. Monetary authority: ECB.
  5. Rest of the world.


Households
Non-restricted
k
n
l
Restricted
adjustment costs
search matching bargaining
income
Firms
k
n
l
k^p
y
e
Imports
Aggregation
c_h
i_h
g^c
g^i
x
c_f
i_f
Final goods
c
i
g
x
b^emu
g^s, g^u, tr, b
Public sector
τ^l, τ^sc, τ^k, τ^e
g^c, g^i, τ^c
ECB

Model details: households

- Problem of optimizing households (with habits):

$$\max_{\substack{c_t, n_t, j_t, k_t, \\ b_t, b_t^{o,emu}, m_t}} E_t \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{c} \ln\left(c_t^o - hc_{t-1}^o\right) + n_{t-1}^o \phi_1 \frac{(T - l_{1t})^{1-\eta}}{1-\eta} \\ +(1 - n_{t-1}^o)\phi_2 \frac{(T - l_{2t})^{1-\eta}}{1-\eta} + \chi_m \ln\left(m_t^o\right) \end{array} \right]$$

subject to

$$\begin{array}{c} \left(r_t(1-\tau_t^k) + \tau_t^k \delta\right) k_{t-1}^o + w_t\left(1-\tau_t^l\right)\left(n_{t-1}^o l_{1t} + rr_t s\left(1 - n_{t-1}^o\right) l_{2t}\right) + \\ \left(\left(1-\tau_t^l\right) g_{st} - trh_t\right) + \frac{m_{t-1}^o}{1+\pi_t^c} + \left(1 + r_{t-1}^n\right) \frac{b_{t-1}^o}{1+\pi_t^c} + \left(1 + r_{t-1}^{emu}\right) \frac{b_{t-1}^{o,emu}}{1+\pi_t^c} \\ -(1+\tau_t^c) c_t^o \frac{P_t^c}{P_t} - \frac{P_t^i}{P_t} j_t^o \left(1 + \frac{\phi}{2}\left(\frac{j_t^o}{k_{t-1}^o}\right)\right) - \gamma_A \gamma_N \left(m_t^o + b_t^o + \frac{b_t^{o,emu}}{\phi_{bt}}\right) = 0 \end{array}$$

$$\gamma_A \gamma_N k_t^o = j_t^o + (1-\delta) k_{t-1}^o$$

$$\gamma_N n_t^o = (1-\sigma) n_{t-1}^o + \rho_t^w s (1 - n_{t-1}^o)$$

- Rule of Thumb households consume all their current labour income.

Model details: pricing behaviour and the new Phillips curve

- Intermediate good firms operate in a monopolistically competitive environment.
- Following Calvo (1983), each period a measure $1-\theta$ of firms set their prices, $\widetilde{P}_{it}$, to maximize the present value of future profits.
- The aggregate price index at t is

$$P_t = \left[\theta\left(\pi_{t-1}^{\varkappa} P_{t-1}\right)^{1-\varepsilon} + (1-\theta)\widetilde{P}_t^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

- As it is standard in the literature, we obtain an expression for aggregate inflation (the NPC):

$$\pi_t = \beta^f E_t \pi_{t+1} + \lambda \widehat{mc}_t + \beta^b \pi_{t-1}$$

- Technology

$$y_{it} = z_{it} k_{iet}^{1-\alpha} (n_{it-1} l_{i1t})^{\alpha} \left(k_{it-1}^{p}\right)^{\zeta}$$

where

$$k_{iet} = \left[a k_{it-1}^{-\rho} + (1-a) e_{it}^{-\rho}\right]^{-\frac{1}{\rho}}$$

Notice that energy is an intermediate input.

- Cost minimization problem

$$\min_{k_t, n_t, v_t, e_t} E_t \sum_{t=0}^{\infty} \beta^t \frac{\lambda_{1t+1}^{o}}{\lambda_{1t}^{o}} \left(\begin{array}{c} r_t k_{t-1} + w_t \left(1+\tau^{sc}\right) n_{t-1} l_{1t} \\ +\kappa_v v_t + \frac{P_t^e}{P_t} e_t \left(1+\tau^{e}\right) \end{array} \right)$$

subject to

$$y_t = z_{it} \left(\left[a k_{it-1}^{-\rho} + (1-a) e_{it}^{-\rho}\right]^{-\frac{1}{\rho}} \right)^{1-\alpha} (n_{it-1} l_{1it})^{\alpha} \left(k_{it-1}^{p}\right)^{\zeta} - \kappa$$

$$\gamma_N n_t = (1-\sigma) n_{t-1} + \rho_t^{f} v_t$$

Model details: wage and hours setting

- The search process in the labour market takes time and is resource consuming.
- Search models thus use a wage and hours determination scheme suitable for a bilateral monopoly framework.
- We assume a Nash bargaining scheme, which gives the solution for wage and working hours.

$$\max_{w_{t+1},\, l_{1t+1}} \left[\lambda^r \frac{\lambda^r_{3t}}{\lambda^r_{1t}} + (1-\lambda^r)\frac{\lambda^o_{3t}}{\lambda^o_{1t}}\right]^{\lambda^w} \left(\lambda^{nd}_t\right)^{(1-\lambda^w)}$$

- The bargaining scheme implicitly assumes a unique wage for all workers, irrespective of whether they are Ricardian or RoT consumers.

Model details: wage and hours setting

$$(1+\tau_t^{sc})w_t l_{1t} = \frac{\lambda^w}{\left[1-(1-\lambda^w)\, rr_t s\frac{l_{2t}}{l_{1t}}\right]}\left[\alpha mc_t \frac{y_t}{n_{t-1}} + (1-\sigma)\frac{\kappa_v}{\rho_t^f}\right] \quad (1)$$

$$+\frac{(1-\lambda^w)}{\left[1-(1-\lambda^w)\, rr_t s\frac{l_{2t}}{l_{1t}}\right]}\frac{(1+\tau_t^{sc})}{(1-\tau_t^l)}\left[\frac{\left(\widetilde{\frac{\lambda_{3t}}{\lambda_{1t-1}}}\right)}{\left(\widetilde{\frac{\lambda_{1t}}{\lambda_{1t-1}}}\right)}\left[\rho_t^w-(1-\sigma)\right]-\frac{\left(\widetilde{\frac{1}{\lambda_{1t-1}}}\right)}{\left(\widetilde{\frac{\lambda_{1t}}{\lambda_{1t-1}}}\right)}u_t\right]$$

$$\left(\widetilde{\frac{\lambda_{1t}}{\lambda_{1t-1}}}\right)\alpha mc_t \frac{y_t}{n_{t-1}l_{1,t}} = \left(\widetilde{\frac{1}{\lambda_{1t-1}}}\right)\frac{(1+\tau_t^{sc})}{(1-\tau_t^l)}\phi_1\left[1-l_{1t}\right]^{-\eta} \quad (2)$$

where:

$$u_t = \left[\phi_1\frac{(T-l_{1t+1})^{1-\eta}}{1-\eta}-\phi_2\frac{(T-l_{2t})^{1-\eta}}{1-\eta}\right] \quad (3)$$

Model details: government

- Government expenditure is financed through direct and indirect taxes:

$$
\begin{aligned}
t_t &= (\tau_t^l + \tau_t^{sc}) w_t (n_{t-1} l_{1t}) + \tau_t^k (r_t - \delta) k_{t-1} \\
&+ \tau_t^c \frac{P_t^c}{P_t} c_t + \tau_t^e \frac{P_t^e}{P_t} e_t + trh_t + \tau_t^l \overline{rr} w_t (1 - n_{t-1}) l_{2t} + \tau_t^l g_{st}
\end{aligned}
$$

- Total receipts and outlays are made consistent through the government's intertemporal budget constraint

$$
\gamma_A \gamma_N b_t = g_t^c + g_t^i + g_{ut}(1 - n_{t-1}) + g_{st} - t_t + \frac{(1 + r_t^n)}{1 + \pi_t} b_{t-1}
$$

- To enforce the government's intertemporal budget constraint, the following fiscal policy reaction function is imposed

$$
trh_t = trh_{t-1} + \psi_1 \left[\frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp} \right)} \right] + \psi_2 \left[\frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \right]
$$

Model details: monetary policy

- Monetary authorities -the European Central Bank- target short-term interest rates according to the following policy reaction function

$$\ln \frac{1+r_t^{emu}}{1+\overline{r^{emu}}} = \rho^r \ln \frac{1+r_{t-1}^{emu}}{1+\overline{r^{emu}}} + \rho^\pi (1-\rho^r) \ln \frac{1+\pi_t^{emu}}{1+\overline{\pi^{emu}}}$$

- The Spanish economy contributes to the monetary union CPI according to its relative size (we take the inflation for the rest of countries as given).

$$\pi_t^{emu} = 0.9\overline{\pi_t^{remu}} + 0.1\pi_t$$

- Domestic nominal interest rate r_t^n is linked with r_t^{emu} through the risk premium ϕ_{bt}, which is made a function of net foreign assets holdings:

$$1 + r_t^n = \phi_{bt}\left(1 + r_t^{emu}\right)$$

- The appreciation/depreciation of the real exchange rate is given by the inflation differential between EMU and Spain:

$$\frac{rer_{t+1}}{rer_t} = \frac{1+\pi_{t+1}^{emu}}{1+\pi_{t+1}}$$

Model details: the external sector

- SOE: all goods (both consumption and investment) are tradables.
- Aggregate consumption (and aggregate investment) is a composite basket (CES) of home and foreign produced goods:

$$c_t = \left((1-\omega_c)^{\frac{1}{\sigma_c}} c_{ht}^{\frac{\sigma_c - 1}{\sigma_c}} + \omega_c^{\frac{1}{\sigma_c}} (c_{ft})^{\frac{\sigma_c - 1}{\sigma_c}} \right)^{\frac{\sigma_c}{\sigma_c - 1}}$$

- Domestic demand of home and foreign consumption goods (demand for investment goods is similar):

$$c_{ht} = (1-\omega_c) \left(\frac{P_t}{P_t^c} \right)^{-\sigma_c} c_t$$

$$c_{ft} = \omega_c \left(\frac{P_t^m}{P_t^c} \right)^{-\sigma_c} c_t$$

Model details: the external sector

- The consumer price index is:

$$P_t^c = \left((1-\omega_c)P_t^{1-\sigma_c} + \omega_c P_t^{m1-\sigma_c}\right)^{\frac{1}{1-\sigma_c}}$$

- Price of imports:

$$P_t^m = \left(\widetilde{\alpha}_e P_t^e + (1-\widetilde{\alpha}_e)\overline{PFM}_t\right)$$

- Price of exports:

$$P_t^x = P_t^{(1-ptm)}\left(\overline{PFM}_t\right)^{ptm}$$

Model details: the external sector

- Aggregate imports in our model is the sum of consumption and investment of foreign goods:

$$im_t = c_{ft} + i_{ft} + \alpha_e e_t$$

- Exports are given by (some degree of pricing to market is assumed):

$$ex_t = s_t^x \left(\frac{\overline{PFM}_t}{P_t} \right)^{(1-ptm)\sigma_x} \overline{y}_t^w$$

- Net foreign assets accumulation is given by:

$$\frac{\gamma_A \gamma_N b_t^{oemu}}{\phi_{bt}} = \frac{(1 + r_t^{emu})}{1 + \pi_t^c} b_{t-1}^{oemu} + \frac{P_t^x}{P_t} ex_t - \frac{P_t^m}{P_t} im_t$$

Data base and baseline

- We have assembled a quartely data base for the Spanish economy (REMSDB).
- Main source: INE quarterly national accounts (QNA) and Stability Programme.
- SEC95 and seasonally adjusted variables 1980-2007 and 2007-10.
- Government accounts (all levels): quadratic interpolation of IGAE annual data.
- Public and private capital stocks: from BDMORES.
- Labour market: Employed workers (QNA and EPA), Vacancies (own construction) and Matchings (own construction).
- Energy: consumption of productive energy (intermediate input) and no final consumption of energy.

Estimation and calibration

- The parameters of the model are obtained using a hybrid method of estimation and calibration.
- The dynamic of the variables and their long run solution are well captured by the model.
- The model allows to analyse many different aspects of the Spanish economy: TFP, working hours, inflation, real wage dynamics, foreign sector issues.

The steady state

Table 1 – Steady State

$\frac{c_t}{gdp_t}$	0.5495	$\frac{k_t}{gdp_t}$	13.039	u_t	0.1001
$\frac{i_t}{gdp_t}$	0.2872	$\frac{k_t^p}{gdp_t}$	1.9096	v_t	0.0608
$\frac{g_t^c}{gdp_t}$	0.1553	$\frac{t_t}{gdp_t}$	0.3476	l_{1t}	0.4466
$\frac{g_t^i}{gdp_t}$	0.0297	r_t	0.0335	l_{2t}	0.2183
$\frac{ex_t}{gdp_t}$	0.2458	r_t^n	0.0142	$\frac{V_t}{U_t}$	0.1677
$\frac{im_t}{gdp_t}$	0.2685				

Simulation of Risk Premium Shocks

- Recall the policy reaction function of the ECB

$$\ln \frac{1+r_t^{emu}}{1+\overline{r^{emu}}} = \rho^r \ln \frac{1+r_{t-1}^{emu}}{1+\overline{r^{emu}}} + \rho^\pi (1-\rho^r) \ln \frac{1+\pi_t^{emu}}{1+\overline{\pi^{emu}}}$$

- It is easy to transform the expression as:

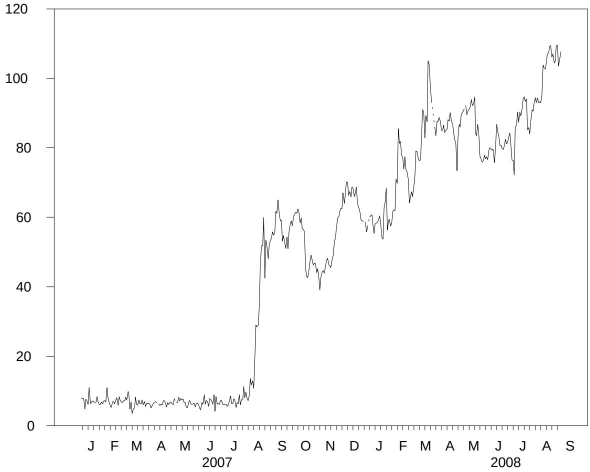
$$\begin{aligned}\ln(1+r_t^{emu}) &= (1-\rho^r)\ln(1+\overline{r^{emu}}+rpg_t) \\ &\quad +\rho^r \ln(1+r_{t-1}^{emu}) + \rho^\pi (1-\rho^r) \ln \frac{1+\pi_t^{emu}}{1+\overline{\pi^{emu}}}\end{aligned}$$

where we have added a global risk premium (rpg_t), that affects the Euribor interest rate (r_t^{emu}).

- Also, in the expression that links domestic and EMU interest rates we can add an idiosyncratic Spanish risk premium (rps_t):

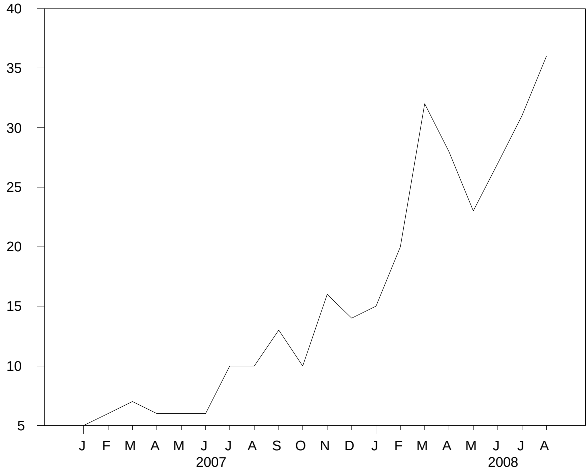
$$1+r_t^n = \phi_{bt}\,(1+r_t^{emu}) + rps_t$$

Diferential 12 months Euribor and Eonia Swap (bp)



The evolution of Spanish bond risk premium

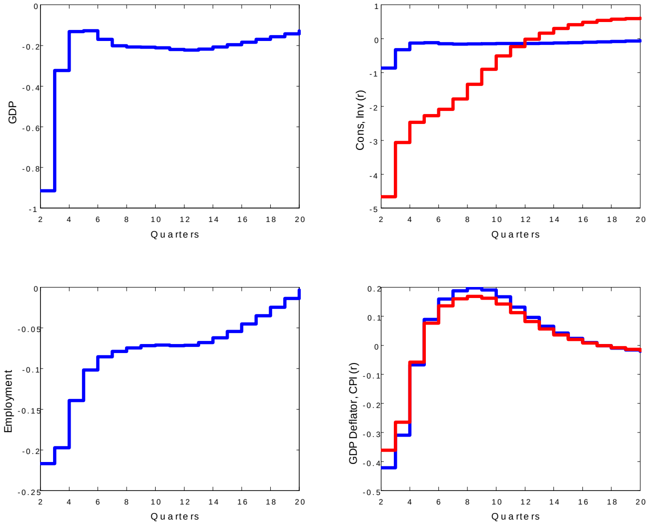
Diferential 10-years Spanish and German bond (bp)



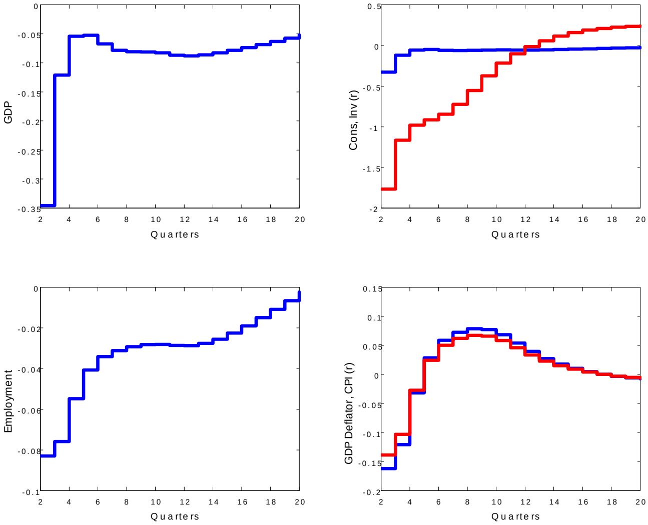
Simulations

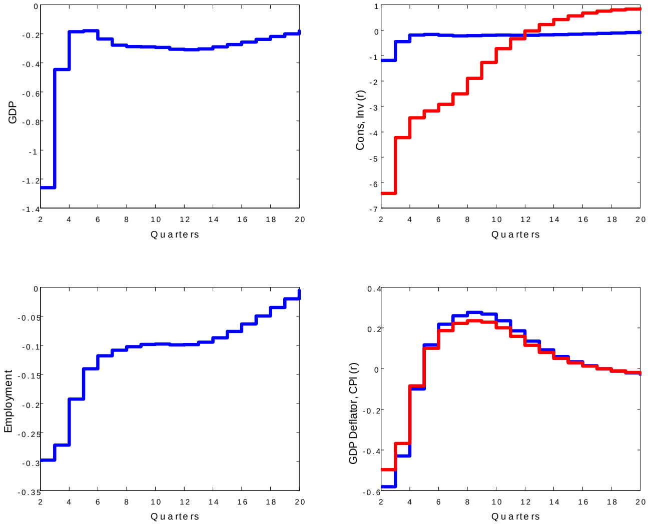
1. Global risk premium in the Eurozone:
   - First quarter: $\Delta 50$ bp
   - Second to third quarter: increases up to 70 bp
   - Fourth and fifth quarter: remains at 70 bp
   - Sixth to nineth quarter: disappears linearly
2. Specific Spanish risk premium:
   - First and second quarter: $\Delta 15$ bp
   - Third quarter: increases up to 30 bp
   - Fourth and fifth quarter: remains at 30 bp
   - Sixth to nineth quarter: disappears linearly

Global risk premium in the Eurozone



Specific Spanish risk premium




GDP
Quarters
Cons, Inv (r)
Quarters
Employment
Quarters
GDP Deflator, CPI (r)
Quarters

Effects of risk premia skocks

- The impact on GDP is around -1.25%. The effects are very persistent, after five years GDP is still 0.3% below its trend.
- Consumption worsens on impact 1.00%. The negative effects disappear after six years.
- Private investment falls on impact more than 6%. After three years the effects become slightly positive.
- On impact employment falls 0.3%. The negative effects are quite persistent.
- Inflation falls the first year, and increases thereafter.

Explaining the effects

- The increase in the interest rate reduces Tobin's q:

$$q_t = \frac{1+\pi^c_{t+1}}{1+r^n_t}\left[r_{t+1}(1-\tau^k_{t+1}) + \tau^k_{t+1}\delta + \frac{\phi}{2}\frac{j^2_{t+1}}{k^2_t} + q_{t+1}(1-\delta)\right]$$

- Reduction in Tobin's q pushes down investment:

$$q_t = \frac{P^i_t}{P_t}\left[1 + \phi\left(\frac{j^o_t}{k^o_{t-1}}\right)\right]$$

- The increase in the interest rate reduces present consumption for optimizing households:

$$\gamma_A \gamma_N E_t \lambda^o_{1t} = \beta E_t \frac{1+r^n_t}{1+\pi^c_{t+1}} \lambda^o_{1t+1}$$

- Reduction in wages and employment $w_t\left(1-\tau^l_t\right) n^o_{t-1} l_{1t}$ creates an additional negative effect on consumption for both optimizing households and, mainly, RoT consumers.

Sensitivity Analysis

1. Pesimistic scenario:
   - Sixth to thirteenth quarter: the shock disappears linearly during two years
2. Optimistic scenario:
   - Sixth quarter: the shock disappears suddenly

Sensitivity Analysis

Variable		2008	2009	2010
GDP	Optimistic	-0.385	-0.170	-0.198
	Baseline	-0.517	-0.272	-0.302
	Pesimistic	-0.583	-0.328	-0.362
Consumption	Optimistic	-0.356	-0.115	-0.126
	Baseline	-0.497	-0.209	-0.192
	Pesimistic	-0.570	-0.268	-0.233
Investment	Optimistic	-3.122	-1.061	0.026
	Baseline	-4.315	-2.143	-0,215
	Pesimistic	-4.913	-2.776	-0.524
Employment	Optimistic	-0.163	-0.067	-0.065
	Baseline	-0.225	-0.107	-0.098
	Pesimistic	-0.257	-0.130	-0.116