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OPTIMAL FISCAL POLICY WHEN AGENTS FEAR GOVERNMENT DEFAULT

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Abstract

We derive the optimal fiscal policy for a government which is committed to honoring its debt but faces investors which fear a sovereign default. We assume that investors are able to learn form new evidence, as in Marcet and Sargent (1989), so that they can gradually correct their overly pessimistic view about government's creditworthiness. We show that in an economy with these features, contrary to the prescriptions of more standard models, a frontloaded fiscal consolidation after an adverse fiscal shock is optimal.

Keywords: Ramsey-optimal fiscal policy, non-contingent public debt, learning.
JEL Classification: D83, E62.

Contents

* Bank of Italy, Economic Research and International Relations.

"The only thing we have to fear is fear itself"
F. D. Roosevelt

1 Introduction[1]

To counter the severe global recession of 2009, governments in most advanced countries implemented expansionary fiscal policies. These interventions have led to a steep increase in debt levels. According to the IMF, in the advanced economies of the G20 the debt-to-GDP ratio is expected to rise from 78% in 2007 to 118% in 2014. While it is clear that ever-increasing debt-to-GDP ratios are inconsistent with government solvency and must be avoided, a critical policy choice confronting policy makers is whether to stabilize debt ratios at current levels, or bring them down to pre-crisis levels. On this issue, the counsel of international institutions and that of mainstream economic theory are at odds.

On the one hand, international institutions have called for a substantial and fast debt reduction. For example, the ECB (2009) calls for adjustment measures which "succeed in putting debt ratios on a declining trajectory", to be implemented in 2011 at the latest; the ECOFIN Council (October 2009) agrees that "beyond the withdrawal of the stimulus measures, substantial fiscal consolidation is required in order to halt and eventually reverse the increase in debt"; the European Commission (2009), while recognizing that "a one-off increase in the stock of government debt need not put sustainability at risk", stresses that "while, prior to the crisis, the three prongs of the Stockholm strategy [i.e.: deficit and debt reduction, increases in employment rates and reforms of social protection systems] were options from which countries could choose, each of these pillars is now indispensable for most EU countries"; the IMF (2010) argues that "stabilizing debt ratios at post-crisis level would be insufficient".

On the other hand, a surprisingly robust result in optimal fiscal policy theory is that public debt should on average be constant.[2] This has been demonstrated to be true both in a complete market framework (i.e. in a framework in which the government has access to a full array of bonds for each maturity and for each contingency[3]) and in a more realistic incomplete market framework. In this second setup, Aiyagari et al. (2002) rigorously confirm Barro's (1979) intuition that negative shocks should have a permanent effect on public debt.[4] These results are also robust to the introduction of capital (see, e.g., Chari et al. (1994) and Scott (1999)).

[1] The authors wish to thank Daniele Franco, Sandro Momigliano, Martino Tasso, seminar participants at Universitat Pompeu Fabra, University of Padua, the Bank of Spain, the Bank of Italy, the Annual Meeting of the European Economic Association and the Bank of France conference on "New Challenges for Public Debt in Advanced Countries". Any remaining errors are our own. The views in this paper are those of the authors alone, and should not be interpreted as reflecting the views of the Bank of Italy.

[2] See Barro (1979,1995,1997), Bohn (1990), Kydland and Prescott (1980), Lucas and Stokey (1983), Chari et al. (1994), Aiyagari et al. (2002), Zhu (1992) among others.

[3] Lucas and Stokey (1983).

[4] See also Marcet and Scott (2009).

In summarizing this wide body of literature, Scott (2009) concludes that economic theory suggests that "in the wake of large adverse shocks (...) the optimal response is to use debt as a buffer stock. Debt should show large and long term shifts and there is no presumption that governments need to reduce debt to pre-crisis levels". And that in any case "fluctuations in government debt after such adverse shocks are long lasting. (...) Debt stabilization occurs over decades, not within a decade".

Is it possible to make sense of the policy advice of international institutions and practitioners in a model which has most of the features of the neoclassical real business cycle model (which is the workhorse of standard optimal fiscal policy theory)? The aim of this paper is to answer this question.

We consider a highly stylized, closed, production economy, with no capital and infinitely lived agents. Public spending follows an exogenous stochastic process. The government is benevolent: it chooses the level of debt and distortionary taxes on labor income to maximize households' expected utility. Moreover, the government acts under full commitment, i.e. it always fulfills its promises. In particular, it always pays back its debts fully.

Nevertheless, we also assume that households believe: (a) that there is a positive probability the government will default on its own debt, and (b) that there is a positive relation between the probability of default and the amount of outstanding debt.

These assumptions about beliefs are quite realistic. For example, figure 1 points to a positive relation between the amount of government debt and the yield spread, a proxy for the sovereign risk premium required by investors, for ten euro area countries in the period 2000-2009. This link has been also confirmed by several econometric studies, for example, by Bayoumi et al. (1995), Codogno et al. (2003), Sgherri and Zoli (2009), and Attinasi et al. (2009).

On the contrary, we fully acknowledge that the assumption that the government will never default is quite unrealistic for most countries. However, our aim is to explore to what extent *even very small* departures from the rational expectation assumption, which is standard in the optimal fiscal policy theory, imply significant changes in the policy prescription of the theory itself, bringing these prescriptions closer to those often proposed by international institutions. This is why we prefer not to question the standard assumptions of no-default and full commitment.

Our main findings are the following. First, when agents fear government default, a fiscal consolidation after an adverse fiscal shock becomes optimal. The intuition is that the interest rate on government debt is too high due to distorted expectations about government default; therefore the marginal cost of higher distortionary taxes today is more than compensated by the expected future marginal benefits of lower distortionary taxes tomorrow. The incentive to reduce debt is stronger: ι) the more pessimistic agents are about government solvency and $\iota\iota$) for a given degree of pessimism, the higher the post-crisis debt level. Second, the state of agents' initial beliefs has an effect on the long-run mean value of the tax rate and debt. In particular, the more pessimistic agents' initial beliefs, the lower the long-run mean value of debt. The intuition is that the more pessimistic the agents are, the stronger the incentive to change their expectations.

This paper adds to a very small theoretical literature which argues, in a general equilibrium framework, that reducing debt can be advisable. In particular, Hiebert et al. (2009) study an economy with finitely lived individuals, which follow simple rules of thumb. The fiscal authority does not maximize social welfare (it only takes into account the welfare of currently living generations) and chooses among an exogenously fixed set of policy options (in particular, it is constrained by an exogenous deficit constraint). In this framework, Hiebert et al. (2009) show that current generations accept a fiscal consolidation because this increases the room for fiscal stabilization. Adam (2011) studies an economy which is analogous to ours, with two main differences. First, agents have rational expectations; second, there are exogenous technology shocks. These shocks are crucial, as their occurrence requires changes in the tax rate (in order to satisfy the inter-temporal government budget constraint), and these changes are larger the higher the initial debt level. This higher volatility of tax rates implies in turn higher welfare costs. This is why in his model a benevolent planner has a rationale to undertake fiscal consolidation. In our view, both papers highlight interesting mechanisms, which should be seen as complementary to the one discussed in the present study.

The paper proceeds as follows. Section 2 spells out the model and characterizes the optimal fiscal policy, both under rational expectations and under fear of government default. In section 3 we solve the model numerically. Section 4 concludes.

2 The Model

We consider an infinite horizon economy with an infinitely lived representative household and a benevolent fiscal authority. The government finances an exogenous stream of public consumption, levying a proportional tax on labor income and issuing a one-period non state-contingent bond, which is the only financial asset in the economy. The government has a full commitment technology and always repays its debt. There is only one source of aggregate uncertainty represented by a government expenditure shock, g_t, realized at the beginning of each period (g_0 is taken as given). We define the history of events up to time t as $g^t = (g_0, g_1, ..., g_t)$, the conditional probability of g^r given g^t as $\pi(g^r|g^t)$ and the set of all possible histories of length t as G^t. Time is discrete and indexed by $t = 0, 1, 2....$

There is only one non-storable good, produced by a representative price-taker firm with a linear production technology which uses labor (n_t) as the only input:

$$y_t = n_t.$$

Output (y_t) can be used either for private consumption (c_t) or public consumption (g_t). Equilibrium in the good market and in the labor market requires:

$$y_t = c_t + g_t \tag{1}$$

and that the wage rate (w_t) is always equal to 1.

The government finances the exogenous sequence of government expenditures levying taxes on labor income (τ_t) and issuing debt (b_t). Its policy $(\tau_t(g^t), b_t(g^t))_{t\geqslant 0}$ satisfies the period-by-period budget constraint:

$$b_{t-1} + g_t = \tau_t w_t n_t + p_t b_t.$$

where p_t is the price of the government bond. The initial level of debt b_{-1} is given. A representative household is endowed with one unit of time which can be used for leisure, l_t, or labor, n_t, so that:

$$n_t + l_t = 1. \tag{2}$$

In subsection 2.1 we briefly review optimal fiscal policy under the assumption that households are at any moment fully confident about government solvency, as in Aiyagari et al. (2002). In subsection 2.2 we modify this benchmark model assuming that households assign a positive probability to the event of government default.

2.1 The rational expectations benchmark

The household chooses contingent plans for consumption $c_t(g^t)$, leisure $l_t(g^t)$ and bond holdings $b_t(g^t)$ to maximize his lifetime discounted expected utility

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t) = \sum_{t=0}^{\infty} \sum_{g^t} \beta^t u(c_t(g^t), l_t(g^t)) \pi(g^t | g_0) \tag{3}$$

where β is the discount factor and the utility function satisfies the usual standard assumptions, i.e. $u_{c,t} > 0$, $u_{l,t} > 0$, $u_{cc,t} < 0$, $u_{ll,t} < 0$. The household is subject to the constraint (2) and to the period-by-period budget constraint

$$b_{t-1}(g^{t-1}) + (1 - \tau_t(g^t)) w_t(g^t)(1 - l_t(g^t)) = c_t(g^t) + p_t(g^t) b_t(g^t). \tag{4}$$

The household's optimality conditions are

$$\frac{u_{l,t}}{u_{c,t}} = w_t(1 - \tau_t) \tag{5}$$

$$p_t u_{c,t} = \beta E_t u_{c,t+1} \tag{6}$$

where $u_{l,t}$ and $u_{c,t}$ are the marginal utility of labor and consumption at the optimum. Aiyagari et al. (2002) show that, under rational expectations, the dynamic optimal taxation problem of the government is equivalent to the problem of maximizing:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t) \tag{7}$$

under the following constraints:

$$b_{t-1} = E_t \sum_{j=0}^{\infty} \beta^j \left(\frac{u_{c,t+j}}{u_{c,t}} c_{t+j} - \frac{u_{l,t+j}}{u_{c,t}} (1 - l_{t+j}) \right), \tag{8}$$

$$\underline{M} < E_t \sum_{j=0}^{\infty} \beta^j \left(\frac{u_{c,t+j}}{u_{c,t}} c_{t+j} - \frac{u_{l,t+j}}{u_{c,t}} (1 - l_{t+j}) \right) < \overline{M} \tag{9}$$

$$1 - l_t = c_t + g_t \tag{10}$$

$\forall t \geqslant 0$, $\forall g^t$. Constraints (8) require that for any period and any state the inherited level of debt is equal to the stream of expected future primary surpluses. That is, they correspond to the intertemporal budget constraint with both prices and taxes replaced using the household's optimality conditions (equations (5) and (6)). If financial markets were complete, constraints (8) would be satisfied by choosing the vector of state-contingent bonds appropriately, so they would not constrain the optimal choice of taxes. However, under incomplete markets, the government cannot make the start-of-the-period stock of debt a function of the current realization of the shock. Therefore, in any period the future path of taxes depends on the current state. Constraints (9) impose ad-hoc limits to debt[5]. Finally, equation (10) is the resource constraint of the economy.

Aiyagari et al. (2002) show that the optimal policy rules for the labor tax rate and debt are time-invariant functions of the current state g_t, the inherited debt b_{t-1} and an auxiliary state variable ψ_{t-1} which is equal to the sum from period 0 till $t-1$ of the Lagrange multipliers associated to the intertemporal budget constraints (8).[6]

Two observations are worth making. First, by including the costate variable ψ_{t-1} in the vector of state variables the problem becomes recursive and standard solution techniques can be applied. Second, the presence of ψ_{t-1} and b_{t-1} makes the allocation, and the cost of distortionary taxation, state- and history-dependent.

2.2 Introducing fear of government default

In the benchmark model of section 2.1 households fully understand the structure of the government problem and therefore attach zero probability to the event of a government default, whatever the observed evolution of government debt. In particular, as households understand the risk-free nature of government bonds, they do not require to be compensated for any default risk. In this section

[5] For a discussion of the implications of these constraints and for the solution of the problem we refer the interested reader to Aiyagari et al. (2002).

[6] This approach was pioneered by Marcet and Marimon (1998).

we study what happens if agents fear that the government might not fulfill the promise of always paying back its debt. In particular, they perceive in t a budget constraint for a generic future period $t+j>t$ given by

$$\begin{aligned} b_{t+j-1}+(1-\tau_{t+j})w_{t+j}(1-l_{t+j}) &= c_{t+j}+p_{t+j}b_{t+j} \quad \text{if} \quad \delta^{t+j}=[1,1,...,1] \\ (1-\tau_{t+j})w_{t+j}(1-l_{t+j}) &= c_{t+j} \qquad \text{otherwise} \end{aligned} \tag{11}$$

where $\delta_{t+j}\in\{0,1\}$ is equal to 1 if the government does not default on its outstanding debt in the period $t+j$ and equal to 0 otherwise, and $\delta^{t+j}\equiv(\delta_0;\delta_1;...;\delta_{t+j})$ is the vector containing the history of defaults from period 0 until $t+j$. For $j=1$, the previous equation differs from (4) forwarded one period as the agents assign a positive probability to histories at which default happens. They also believe (as in Arellano, 2008) that, contingent on sovereign default in the next period,[7] the government will run a balanced budget rule from that period onwards i.e. set taxes to satisfy $\tau_{t+j}(1-l_{t+j})=g_{t+j}$.

Distorted expectations also have an impact on households' objective function. Denoting by $\tilde{E}_t(.)$ agents' conditional expectations at time t, this is given by

$$\tilde{E}_0\sum_{t=0}^{\infty}\beta^t u(c_t,l_t)=\sum_{t=0}^{\infty}\sum_{g^t}\sum_{\delta^t}\beta^t u(c_t(g^t,\delta^t),l_t(g^t,\delta^t))\tilde{\pi}(g^t,\delta^t|g_0) \tag{12}$$

where $\tilde{\pi}(g^t,\delta^t|g_0)$ is a joint probability measure. In what follows we assume that agents believe that δ^t and g^h are independent $\forall t$ and h, and that δ^t is independent from g_0, so that:

$$\tilde{\pi}(g^t,\delta^t|g_0)=\pi(g^t|g_0)\times Prob_t(\delta^t).$$

The agents' perception about government default affects non only the perceived budget constraint but also the bond price as now expectations are taken with respect to the distribution of the government expenditure shock and of the event of default. Equation (6) becomes

$$\begin{aligned} p_t u_{c,t} =& \beta\tilde{E}_t(u_{c,t+1})= \\ =&\beta E_t(u_{c,t+1}|\delta_{t+1}=1)\times Prob_t(\delta_{t+1}=1)+ \\ &+\beta E_t(u_{c,t+1}|\delta_{t+1}=0)\times Prob_t(\delta_{t+1}=0)= \\ =&\beta E_t(u_{c,t+1}|\delta_{t+1}=1)\times Prob_t(\delta_{t+1}=1)+ \\ &+\beta E_t u^{bb}_{c,t+1}\times(1-Prob_t(\delta_{t+1}=1)) \end{aligned} \tag{13}$$

Where $E_t u^{bb}_{c,t+1}$ is expected marginal utility of consumption after a default, which agents can easily compute, given the balanced budget assumption and the exogeneity of g_t.

[7] Agents believe that default, if it happens, determines a loss equal to 100% of the investment.

We make two assumptions about how default expectations $Prob_t(\delta_{t+1} = 0)$ evolve. First, at any moment in time,

$$Prob_t(\delta_{t+1} = 0) = \frac{1}{1 + \alpha_{t-1}(max(b_{t-1} - \bar{b}; 0))} \equiv \hat{\pi}_t. \tag{14}$$

Equation (14) captures the idea that the higher the level of outstanding debt, the stronger the fear of government default, and in particular fear of default appears when debt goes above some psychological threshold $\bar{b}$.

Second, we assume that agents revise their beliefs about the probability of a public default as new evidence about government behavior becomes available. In the literature various proposals have been made for modeling agents' learning.[8] We adopt the approach pioneered by Marcet and Sargent, 1989. They study agents which are similar to an econometrician, i.e. in each period they estimate recursively those parameters which are relevant for their decision, and whose values they ignore. In our model the only parameter that has to be estimated is α. Let α_t be the agents' estimate of α at time t. If agents use a constant gain algorithm with gain parameter equal to k, a special case of the algorithm studied by Marcet and Sargent (1989)[9], it can be shown that α_t is given by the following expression:

$$\alpha_t = \alpha_{t-1}(1 - k(b_{t-1} - \bar{b})^2). \tag{15}$$

The initial value α_{-1} is exogenously given. Several observations are worth making. First, equation (14) nests the rational expectation case, discussed in section 2.1, in which households understand that default cannot happen. In fact, when $\alpha_t = 0$, $\hat{\pi}_t = 1$ and equation (13) becomes equation (6). Second, under the condition that $|(1 - kb_{t-1}^2)| < 1$ equation (15) is such that α_t converges to its true value, 0.

We are now ready to state the following definition.

Definition 1 *Given b_{-1} and a stochastic process for the government expenditure g_t, a competitive equilibrium is an allocation $\{c_t, l_t, g_t\}_{t=0}^{\infty}$, state-contingent beliefs about government default probabilities $\{\hat{\pi}\}_{t=0}^{\infty}$, a price system $\{p_t, w_t\}_{t=0}^{\infty}$ and a government policy $\{\tau_t, b_t\}_{t=0}^{\infty}$ such that: (a) given the price system, the beliefs and the government policy the households' optimality conditions are satisfied; (b) given the allocation and the price system the government policy satisfies the sequence of government budget constraint* (4)*; and (c) the goods and the bond markets clear.*

[8] For a comprehensive survey of learning models, see Evans and Honkapohja (2001). Several papers have already used these models to explain real world phenomena. For example, Adam et al. (2008), Carceles and Giannitsarou (2008) and Cogley and Sargent (2008) introduce boundedly rational agents in a standard consumption-based asset pricing model to fit some features of asset prices. Marcet and Nicolini (2003) and Adam et al. (2006) show how learning can be an explanation of hyperinflationary episodes. Kurz et al. (2005), Beaudry and Portier (2004, 2007) and Eusepi and Preston (2008) stress the importance of shifting expectations for business cycle fluctuations.

[9] In any case, the economic intuition behind the result is robust to alternative learning schemes.

Using households' optimality conditions to substitute out prices and taxes from the government budget constraint, Aiyagari et al. (2002) deduce the constraints that a competitive equilibrium imposes on allocations. Using a similar argument, we show that under incomplete markets and our assumptions about expectations formation, the following result holds:

Theorem 1 *Assume that for any competitive equilibrium* $\beta^t A_t u_{c,t} \to 0$ *a.s.. Given* b_{-1} *and* α_{-1}*, a feasible allocation* $\{c_t, l_t, g_t\}_{t=0}^{\infty}$ *is a competitive equilibrium if and only if it satisfies the following constraints*

$$b_{t-1} = E_t \sum_{j=0}^{\infty} \frac{\beta^j A_{t+j}}{A_t u_{c,t}} \left(u_{c,t+j} c_{t+j} - u_{l,t+j}(1 - l_{t+j})\right) \tag{16}$$

$$\underline{M} < E_t \sum_{j=0}^{\infty} \frac{\beta^j A_{t+j}}{A_t u_{c,t}} \left(u_{c,t+j} c_{t+j} - u_{l,t+j}(1 - l_{t+j})\right) < \overline{M}, \tag{17}$$

where

$$A_t \equiv \prod_{k=0}^{t} \frac{\hat{\pi}_k u_{c,k} + (1 - \hat{\pi}_k) E_k u_{c,k+1}^{bb}}{u_{c,k}}, \tag{18}$$

$A_{-1} = 1$*,* $\hat{\pi}_t$ *follows equations* (14) *and* (15)
and

$$1 - l_t = c_t + g_t \tag{19}$$

$\forall t \geqslant 0$, $\forall g^t$.

Proof. See Appendix. ■

It is easy to see that, if $\hat{\pi}_t = 1 \ \forall t$, A_t is constant and equal to 1, so that equations (16) and (17) coincide with their rational expectations counterparts (i.e. equations (8) and (9)).

Moreover, just like its rational expectations counterpart, equation (16) can be interpreted as the intertemporal budget constraint of the government. Indeed, the left-hand side is the expected present value of present and future primary surpluses, with the discount factor given by $\beta^j \frac{A_{t+j} u_{c,t+j}}{A_t u_{c,t}}$, and the right-hand side is outstanding debt.

2.3 The government's problem

Denoting by Ξ the set of tax rates and sovereign debt for which a competitive equilibrium exists, we can introduce the following definition.

Definition 2 *A Ramsey equilibrium is a government policy* $\xi \in \Xi$*, allocations of consumption and leisure* $c_t(\xi)$ *and* $l_t(\xi)$*, bond prices* $p_t(\xi)$ *and wages* $w_t(\xi)$*, beliefs* $\hat{\pi}_t(\xi)$ *such that: a) the policy* ξ *maximizes* $E_0 \sum_{t=0}^{\infty} \beta^t u(c_t(\xi), l_t(\xi))$ *subject to equation* (10)*; b) the allocation, the prices and the policy constitute a competitive equilibrium.*

Combining the definition of a Ramsey equilibrium and Theorem 1, the government problem can be written as follows:[10]

Theorem 2

$$\max_{\{c_t,l_t,\alpha_t,A_t,b_t,\hat{\pi}_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

subject to

$$b_{t-1} = E_t \sum_{j=0}^{\infty} \frac{\beta^j A_{t+j}}{A_t u_{c,t}} \left(u_{c,t+j} c_{t+j} - u_{l,t+j}(1 - l_{t+j})\right) \tag{20}$$

$$\underline{M} < E_t \sum_{j=0}^{\infty} \frac{\beta^j A_{t+j}}{A_t u_{c,t}} \left(u_{c,t+j} c_{t+j} - u_{l,t+j}(1 - l_{t+j})\right) < \overline{M} \tag{21}$$

$$A_t = A_{t-1} \frac{\hat{\pi}_t u_{c,t} + (1 - \hat{\pi}_t) E_t u^{bb}_{c,t+1}}{u_{c,t}} \tag{22}$$

$$\hat{\pi}_t = \frac{1}{1 + \alpha_{t-1} \max(0; b_{t-1} - \bar{b})} \tag{23}$$

$$\alpha_t = \alpha_{t-1}(1 - k(b_{t-1} - \bar{b})^2) \tag{24}$$

$$c_t + g_t = (1 - l_t) \tag{25}$$

for given b_{-1} and α_{-1}.

Equations (20) and (21) constrain the allocation to be chosen among competitive equilibria. Equations (22), (23) and (24) describe the law of motion for A_t and for beliefs. Equation (25) is the resource constraint.[11]

The Lagrangian for the Ramsey problem can be represented as:

$$\begin{aligned}
\mathcal{L} =& E_0 \sum_{t=0}^{\infty} \beta^t \{u(c_t, l_t) + \psi_t A_t (u_{c,t} c_t - u_{l,t}(1 - l_t)) \\
& - \lambda_t b_{t-1} A_{t-1} u_{c,t} + \gamma_t (A_t - A_{t-1} \frac{\hat{\pi}_t u_{c,t} + (1 - \hat{\pi}_t) E_t u^{bb}_{c,t+1}}{u_{c,t}}) \\
& + \rho_t (\alpha_t - \alpha_{t-1}(1 - k(b_{t-1} - \bar{b})^2)) + \nu_t (1 - l_t - c_t - g_t) \\
& + \mu_t (\hat{\pi}_t - \frac{1}{1 + \alpha_{t-1}(b_{t-1} - \bar{b})})\}
\end{aligned}$$

[10] At this point a clarification is needed. When the households and the benevolent government share the same information, they maximize the same objective function. But when the way in which they form their expectations differ, as in this setup, their objective functions differ as well. In what follows we assume that the fiscal authority maximizes the representative consumer's welfare *as if* the latter were rational. Said differently, the government understands how agents behave and form their beliefs, and it understands that these beliefs are distorted. We are now ready to state the following definition. The same assumption is made in Karantounias et al. (2009) and Caprioli (2010).

[11] As expectations of future control variables appear both in equations (20) and (21), we solve the model using the method described in Aiyagari et al. (2002).

where $\psi_t = \psi_{t-1} + \lambda_t - \epsilon_{1,t} + \epsilon_{2,t}$ and $\beta^t \epsilon_{1,t}$ and $\beta^t \epsilon_{2,t}$ are the Lagrange multipliers attached to the upper and lower debt constraints respectively. Since A_t and α_t have a recursive structure, the problem becomes recursive adding A_t and α_{t-1} as endogenous state variables to the ones in the Aiyagari et al. (2002) model, which are g_t, ψ_{t-1} and b_{t-1}.

First order necessary conditions $\forall t \geq 0$ are:[12]

- c_t:

$$u_{c,t} + \psi_t (A_t (u_{cc,t} c_t + u_{c,t}) - A_{t-1} \frac{(1-\hat{\pi}_t) E_t u^{bb}_{c,t+1}}{u^2_{c,t}}) - \lambda_{1,t} b_{t-1} u_{cc,t} A_{t-1} \hat{\pi}_t + \frac{\gamma_t A_{t-1} (1-\hat{\pi}_t) E_t u^{bb}_{c,t+1}}{u^2_{c,t}} = \nu_t \tag{26}$$

- l_t:

$$u_{l,t} + \psi_t A_t (u_{l,t} - u_{ll,t}(1-l_t)) = \nu_t \tag{27}$$

- b_t:

$$0.5 E_t \rho_{t+1} \alpha_t (b_t - \bar{b}) + E_t \mu_{t+1} \frac{\alpha_t}{1 + \alpha_t (b_t - \bar{b})} - E_t \lambda_{t+1} u_{c,t+1} A_{t+1} = 0 \tag{28}$$

- α_t:

$$\rho_t - \beta E_t \rho_{t+1} (1 - k(b_{t-1} - \bar{b})^2) + \beta E_t \mu_{t+1} \frac{b_t - \bar{b}}{(1 + \alpha_t (b_t - \bar{b}))^2} = 0$$

- A_t:

$$\psi_t (u_{c,t} c_t - u_{l,t}(1-l_t)) - \lambda t b_{t-1} u_{c,t} + \gamma_t - \beta E_t \gamma_{t+1} \frac{\hat{\pi}_{t+1} u_{c,t+1} + (1-\hat{\pi}_{t+1}) E_{t+1} u^{bb}_{c,t+2}}{u_{c,t+1}} = 0 \tag{29}$$

- $\hat{\pi}_t$:

$$\mu_t = \gamma_t A_{t-1} \frac{u_{c,t} - E_t u^{bb}_{c,t+1}}{u_{c,t}} \tag{30}$$

[12] As is often the case in the optimal fiscal policy literature, it is not easy to establish that the feasible set of the Ramsey problem is convex. To overcome this problem in our numerical calculations we check that the solution to the first-order necessary conditions of the Lagrangian is unique.

3 Solving the model numerically

Together, the first-order conditions and the constraints of the government program represent a system of stochastic non-linear difference equations in the variables $\{c_t, l_t, \tau_t, b_t, \psi_t, A_t, \alpha_t, \hat{\pi}_t\}$. We solve the system using first order linear approximation around the initial steady state both in the case in which there are no doubts about debt repayment (as in section 2.1) and in the case in which agents fear a government default (as in section 2.2).[13] In both cases we consider an AR(1) process for government expenditure:

$$g_t = (1 - \rho_g)\bar{g} + \rho_g g_{t-1} + \epsilon_t^g \tag{31}$$

where ϵ_t^g is assumed to be normally distributed with zero mean and σ^g standard deviation. We assume that consumers have the following CRRA period utility function:

$$u(c_t, l_t) = \frac{c_t^{1-\sigma_1}}{1-\sigma_1} a_h + \frac{l_t^{1-\sigma_2}}{1-\sigma_2} \tag{32}$$

The following table summarizes the numerical values assigned to the parameters.

Table 1: Parameters' values

σ_1	σ_2	a_h	β	$\bar{g}$	σ^g	ρ_g	$\bar{b}$	k	
2	2	1	0.98	.2	.001	0	0	0.05	

We use values which are quite standard in the literature. σ_1, the coefficient of relative risk aversion, and σ_2, the labor supply elasticity, are both set equal to 2, as as in Pouzo (2009). The weight of private consumption vs. leisure, a_h is normalized to one, as in Karantounias et al. (2009). The discount factor β is 0.98. The parameters in the government spending process, $\bar{g}$, σ_g and ρ_g, which represent respectively the steady-state level of government consumption, its standard deviation and its auto-correlation coefficient, are set at 0.2, 0.001 and 0 (as in Pouzo, 2009). The gain parameter k is equal to 0.05, in line with Ormeno (2009).

As a first step, we study the differences between the rational expectation benchmark and an economy in which agents fear government default keeping public expenditure constant at its unconditional mean $\bar{g} = 0.2$. Figure 2 shows the evolution of endogenous variables (consumption, leisure, government debt, primary surplus, labor tax rate and perceived probability of default) expressed

[13] This solution method, applied in a context in which there are transitional dynamics, can generate sizable approximation errors as we move away from the initial steady-state. Taking this problem into account , we also solved the model by using a global method whose solution is accurate over the entire domain of the state variables. In particular, we solved the system of first-order conditions and constraints of the government approximating the policy functions of the endogenous variables using Chebichev polynomials on the state variables, as explained in Judd (2005). In this case results are qualitatively similar to the ones shown in the paper.

as deviations from the initial steady-state when the initial value of α is equal to 0 (the rational expectation benchmark) and to 0.2. These values imply that, given the initial level of government debt-to-GDP ratio, which is set equal to 15%,[14] the perceived one-period-ahead default probability $(1 - \hat{\pi})$ is equal to 0 under the first scenario and equal to about 1% in the second. In the second scenario, as agents fear default, the optimal policy requires that the labor tax rate be increased above its steady state value to reduce public debt. Households will initially enjoy less consumption and more leisure, whereas the contrary will be true later on, when the tax rate can be lowered, thanks to the reduction attained in the burden of debt. To get an intuition of this result, it is important to understand the trade-off faced by the government. On the one hand, as in the rational expectations benchmark, changes in taxes increase distortions and therefore the government would like to keep them as constant as possible. On the other hand, the government is aware that the higher the debt level, the higher the perceived probability of default. These expectations translate into higher interest rates on government bonds and higher interest payments, which require higher taxes and therefore higher distortion. Since agents are learning, reducing debt is the only way to accelerate the correction of their distorted beliefs.

The impact of beliefs on the optimal policy is further clarified if we increase the initial debt-to-GDP ratio from 15% to 50% (figure 3).[15] Indeed, confronting figure 3 with figure 2, it appears that the higher the initial debt level the greater the fiscal consolidation, because the higher the debt the higher (for given α_{-1}) the perceived probability of default (see equation (14)), and therefore the higher the interest expenditure.

Moving from a single realization of $(g_t)_{t\geq 0}$ to a fully-fledged simulation, Table 2 shows the average values for consumption and leisure and for fiscal variables (tax rate, government debt and primary surplus) in our two economies: one populated by rational agents and the other by agents who fear government default (the initial level of government debt-to-GDP ratio is set again at 15%). The qualitative results previously obtained are confirmed. While in the first economy the average value of government debt over time is roughly equal to b_{-1}, in the second it is much lower, which means that a fiscal consolidation is indeed optimal. Debt-to-GDP ratio is on average equal to about 15% in the case of a fully credible government, while it is equal to about 6% in the alternative scenario. Debt reduction ensures that over time the perceived probability of government default progressively goes to zero, as shown in figure 4. The initial α has an effect on the long-run value of tax rate and debt: simulations confirm that the higher the former, the lower the latter, as shown in figure 5.

Up to now, we either assumed that expectations are always rational, or that the fear of default is already present at t=0. However, another interesting possibility is that households' expectations about government solvency are initially

[14] In our economy, the debt-to-GDP ratio is given by $\frac{b}{1-l}$.

[15] Actually, what matters for dynamics is not the debt level per-se, but rather the difference between it and the psychological threshold $\bar{b}$. Therefore, the sensitivity analysis concerning the initial debt level can be symmetrically read as sensitivity analysis concerning $\bar{b}$.

rational, but they start to be pessimistic after an adverse public finance shock in a certain period T. We model this possible scenario by assuming that g_t is constant in all periods apart from T, where it can assume two values, g_T^H and g_T^L with $g_T^H > g_T^L$. We also fix $\alpha_{-1} = 0$ and $b_{-1} = \bar{b} = 0$.

Figure 6 shows the optimal way to cope with the bad realization g_T^H. The government increases debt at T, even if this implies that the agents start to fear default. On the other hand, unlike what would happen in the rational expectations benchmark (figure 7) it also starts a process of debt reduction immediately after T, in order to quickly regain investors' trust. As we have argued above, this is the best way to deal with the trade-off between consumption smoothing and the need to anchor fiscal expectations. These results are confirmed when we consider an unexpected expenditure shock lasting for more than one period.

4 Conclusions

This paper uses the tools of optimal fiscal policy theory to provide a rationale for implementing a debt reduction policy after an adverse fiscal shock in a standard RBC model. Moreover, we derive the optimal size of consolidation as a function of the degree of government credibility and of the initial level of debt.

If agents fully trusted the commitment of governments to always honor their debt obligations, no fiscal consolidation would be required. But if agents fear government default, a frontloaded debt reduction helps to reduce such fears, thereby reducing risk premia on sovereign bonds and interest rates. In this case a rapid fiscal consolidation path, such as the one advocated by several international organizations and observers after the recent crisis, would be optimal.

The model can be extended in several possible directions. First, the assumption that default is not an equilibrium outcome should be relaxed. Another extension would be to analyze fiscal and monetary coordination. In particular, it would be interesting to understand whether optimality requires that fiscal consolidation precedes or follows monetary tightening in the aftermath of a crisis, and whether a certain amount of inflation tax is an optimal way to pay the fiscal costs of the crisis.

Finally, in the paper we assumed that government expenditure follows an exogenous stochastic process, as it is customary in the public finance literature. This assumption limits our analysis in two directions. First, we cannot address the issue of the optimal composition of the post-crisis fiscal adjustment. In particular, should the fiscal authority reduce debt by raising taxes or by lowering expenditure? Under standard assumptions on the utility and the production functions the optimal thing to do would probably be a mix of the two. Second, would results be robust if we include productive public expenditures and not only consumption spending?

We leave these extensions to future research.

5 References

Adam, K. (2011), "Government debt and optimal monetary and fiscal policy", *European Economic Review*, vol. 55, pp. 57-74.

Adam, K., and Evans, G.W. and Honkapohja, S. (2006), "Are Hyperinflations Paths Learnable?", *Journal of Economic Dynamics and Control*, vol. 12, pp. 2725-2748.

Adam, K., and Marcet, A. and Nicolini, J.P. (2008), "Learning and Stock Market Volatility", ECB working paper, no. 862.

Aiyagari, R. and Marcet, A. and Sargent, T. and Seppala, J. (2002), "Optimal Taxation without State-Contingent Debt", *Journal of Political Economy*, vol. 110, pp.1220-1254.

Arellano, C (2008), "Default Risk and Income Fluctuations in Emerging Economies", *American Economic Review*, vol. 98, pp. 690-712.

Attinasi, M.G., and Checherita, C. and Nickel, C. (2009), "What explains the surge in the euro area sovereign spreads during the financial crisis of 2007-09?", ECB working paper, no. 1131.

Barro, R.J. (1979), "On the determination of public debt", *Journal of Political Economy*, vol. 87, pp. 940-971.

Barro, R.J. (1995), "Optimal Debt Management", NBER working paper, no. 5327.

Barro, R.J. (1997), "Optimal Management of Indexed and Nominal Debt", NBER working paper, no. 6197.

Bayoumi, T, and Goldstein, M. and Woglom, G. (1995), "Do credit markets discipline sovereign borrowers? Evidence from the US States", *Journal of Money Credit and Banking*, vol. 4, pp.1046-59.

Beaudry, P. and Portier, F. (2004), "Stock Prices, News and Economic Fluctuations", NBER working paper, no. 10548.

Beaudry, P. and Portier, F. (2007), "When Can Changes in Expectations Cause Business-Cycle Fluctuations in Neo-Classical Settings?", *Journal of Economic Theory*, vol. 135, pp. 458-477.

Bohn, H. (1990), "Tax Smoothing with Financial Instruments", *American Economic Review*, vol. 80, pp. 1217-1230.

Caprioli, F. (2010), "Optimal Fiscal Policy When Agents Are Learning", Universitat Pompeu Fabra, mimeo.

Carceles, E. and Giannitsarou, C. (2008), "Asset Pricing with Adaptive Learning", *Review of Economic Dynamics*, vol. 11, pp. 629-651.

Chari, V.V. and Christiano, L.J. and Kehoe, P.J. (1994), "Optimal Fiscal Policy in a Business Cycle Model", *Journal of Political Economy*, vol. 102, pp. 617-652.

Codogno, L., and Favero, CA. and Missale, A. (2003), "Yield Spreads on EMU government bonds", *Economic Policy*, vol. 18, pp. 503-532.

Cogley, T. and Sargent, T. (2008), "The Market Price of Risk and the Equity Premium: A Legacy of the Great Depression?", *Journal of Monetary Economics*, vol. 55, pp. 454-476.

ECB (2009), *Monthly Bulletin, December*, Frankfurt.

European Commission (2009), *Long-term sustainability of public finances for a recovering economy*, Communication from the commission to the European parliament and the council, Brussels.

Eusepi, S., and Preston, B. (2008), "Expectations, Learning and Business Cycles Fluctuations", NBER working paper, no. 14181.

Evans, G, and Honkapohja, S. (2001), *Learning and Expectations in Macroeconomics*, Princeton University Press, Princeton, NJ.

Hiebert, P. and Perez, J.J. and Rostagno, M. (2009), "The trade-off between public debt reduction and automatic stabilization", *Economic Modeling*, vol. 26, pp. 464-472.

IMF (2010), *Strategies for fiscal consolidation in the post-crisis world*, Washington, DC.

Karantounias, A. and Hansen, L.P. and Sargent, T. (2009), "Managing Expectations and Fiscal Policy", Federal reserve Bank of Atlanta working paper, no. 29.

Kurz, M. and Jin, H. and Motoles, M. (2005), "The Role of Expectations in Economic Fluctuations and the Efficacy of Monetary Policy", *Journal of Economic Dynamics and Control*, vol. 29, pp. 2017-2065.

Kydland, F.E. and Prescott, E.C. (1980), "Dynamic Optimal taxation, Rational Expectations and Optimal Control", *Journal of Economic Dynamics and Control*, vol. 2, pp. 79-91.

Judd, K.L. (2005), *Numerical Methods in Economics*, MIT Press, Cambridge, Mass.

Lucas, R.E. and Stokey, N. (1983), "Optimal Fiscal and Monetary Policy in an Economy Without Capital", *Journal of Monetary Economics*, vol. 12, pp. 79-91.

Marcet, A. and Marimon, R. (1998), "Recursive Contracts", Economics Working Papers eco98/37, European University Institute.

Marcet, A. and Nicolini, J.P. (2003), "Recurrent Hyperinflations and Learning", *American Economic Review*, vol. 93, pp. 1476-1498.

Marcet, A. and Sargent, T. (1989), "Convergence of Least Squares Learning Mechanism in Self-Referential Linear Stochastic Models", *Journal of Economic Theory*, vol. 48, pp. 337-368.

Marcet, A. and Scott, A. (2009), "Debt and Deficit Fluctuations and the Structure of Bonds Markets", *Journal of Economic Theory*, vol. 144, pp. 473-501.

Ormeno, A. (2009), "Inflation Expectations, Learning and DSGE estimation", Universitat Pompeu Fabra, mimeo.

Pouzo, D. (2009), "Optimal Taxation with Endogenous Default Under Incomplete Markets", UC Berkeley, mimeo.

Scott, A. (1999), "Does Tax Smoothing Imply Smooth Taxes?", CEPR Discussion Paper, no. 2172.

Scott, A. (2009), "Government Debt After the Crisis", London Business School, mimeo.

Sgherri, S., and Zoli, E. (2009), "Euro area sovereign risk during the crisis", IMF working paper, no. 09/222.

Zhu, X. (1992), "Optimal Fiscal Policy in a Stochastic Growth Model", *Journal of Economic Theory*, vol. 58, pp. 250-289.

6 Appendix: proof of Theorem 1

First we show that constraints (4), (5) and (13) imply (**??**). The price of the government bond is equal to

$$p_t = \beta \frac{\hat{\pi}_t E_t u_{c,t+1} + (1-\hat{\pi}_t) E_t u^{bb}_{c,t+1}}{u_{c,t}} \tag{33}$$

The period-by-period budget constraint after substituting for the household optimality conditions becomes:

$$b_{t-1} = c_t - \frac{u_{l,t}}{u_{c,t}}(1-l_t) + \beta E_t \frac{\hat{\pi}_t u_{c,t+1} + (1-\hat{\pi}_t) u^{bb}_{c,t+1}}{u_{c,t}} b_t \tag{34}$$

Multiplying both sides of (34) by $u_{c,t}A_t$, where $A_t \equiv \prod_{k=0}^{t} \frac{\hat{\pi}_k u_{c,k} + (1-\hat{\pi}_k) E_k u^{bb}_{c,k+1}}{u_{c,k}}$ we get

$$b_{t-1} u_{c,t} A_t = A_t(u_{c,t} c_t - u_{l,t}(1-l_t)) + \beta A_t(\hat{\pi}_t E_t u_{c,t+1} + (1-\hat{\pi}_t) E_t u^{bb}_{c,t+1}) b_t \tag{35}$$

Forwarding equation (34) one period, substituting the expression for b_t into equation (35), and remembering the recursive formulation for A_t given by

$$A_t = A_{t-1} \frac{u_{c,t}\hat{\pi}_t + (1-\hat{\pi}_t) E_{t-1} u^{bb}_{c,t}}{u_{c,t}} \tag{36}$$

we get

$$b_{t-1} u_{c,t} A_t = A_t(u_{c,t} c_t - u_{l,t}(1-l_t)) + \beta E_t u_{c,t+1} A_{t+1} b_t \tag{37}$$

Keeping iterating forward equation (37) and imposing the transversality condition

$$lim_{t\to\infty} \beta^t A_t b_t u_{c,t} \to 0$$

we get

$$b_{t-1} u_{c,t} A_t = E_t \sum_{j=0}^{\infty} \beta^{t+j} A_{t+1}(u_{c,t+j} c_{t+j} - u_{l,t+j}(1-l_{t+j})) \tag{38}$$

To prove the reverse implication, take any feasible allocation $\{c_{t+j}, l_{t+j}\}_{j=0}^{\infty}$ that satisfies equation (**??**).

Define

$$b_{t-1} = E_t \sum_{j=0}^{\infty} \beta^j A_{t+j} u_{c,t+j} s_{t+j} \frac{1}{u_{c,t} A_t} \tag{39}$$

where $s_t \equiv c_t - \frac{u_{l,t}}{u_{c,t}}(1-l_t)$.

Since

$$b_t = E_{t+1} \sum_{j=0}^{\infty} \beta^j A_{t+1+j} u_{c,t+1+j} s_{t+1+j} \frac{1}{u_{c,t+1} A_{t+1}} \tag{40}$$

it follows that

$$
\begin{aligned}
b_{t-1} &= \frac{A_t u_{c,t} s_t}{u_{c,t} A_t} + E_t \sum_{j=1}^{\infty} \beta^j A_{t+j} u_{c,t+j} s_{t+j} \frac{1}{u_{c,t} A_t} = \\
&= \frac{A_t u_{c,t} s_t}{u_{c,t} A_t} + \beta E_t \sum_{j=0}^{\infty} \beta^j A_{t+1+j} u_{c,t+1+j} s_{t+1+j} \frac{1}{u_{c,t} A_t} = \\
&= \frac{A_t u_{c,t} s_t}{u_{c,t} A_t} + \frac{\beta}{u_{c,t} A_t} E_t \{u_{c,t+1} A_{t+1} [E_{t+1} \frac{\sum_{j=0}^{\infty} \beta^j A_{t+1+j} u_{c,t+1+j} s_{t+1+j}}{u_{c,t+1} A_{t+1}}]\} = \\
&= \frac{A_t u_{c,t} s_t}{u_{c,t} A_t} + \frac{\beta}{u_{c,t} A_t} E_t \{u_{c,t+1} A_{t+1} b_t\} =
\end{aligned}
\tag{41}
$$

Using equation (36) and the definition of s_t we get

$$
b_{t-1} = s_t + \frac{\beta \hat{\pi}_t E_t u_{c,t+1} + (1 - \hat{\pi}_t) E_t u_{c,t+1}^{bb}}{u_{c,t}} b_t \tag{42}
$$

Using the households' optimality conditions given by (5) and (13), equation (42) coincides with the period-by-period budget constraint.

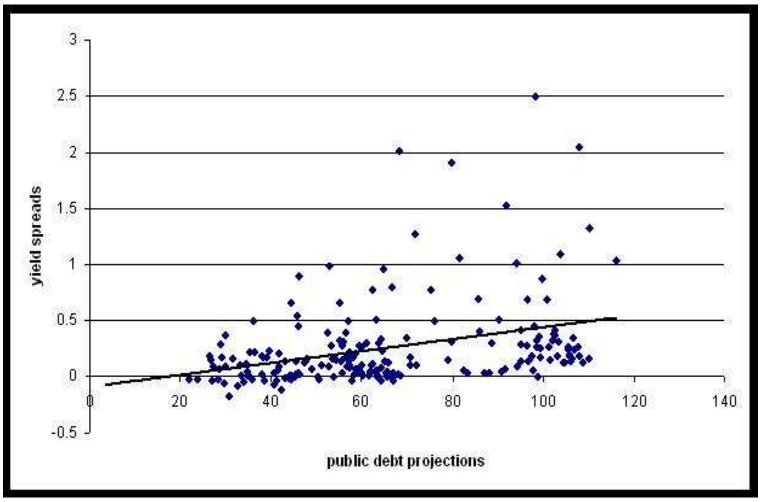

Figure 1: Debt levels and yield spreads. Official public debt projections by the European Commission; 10-year sovereign yield spreads with respect to Germany; biannual data for the Euro-Area countries, years 2000-2009.

Table 1: Equilibrium allocation and optimal fiscal policy.

	Rational expectations			Fear of government default		
	Mean	Standard deviation	Autocorrelation	Mean	Standard deviation	Autocorrelation
consumption	.299	.002	.049	.300	.002	.143
leisure	.500	.002	.049	.500	.002	.143
labor tax rate	.403	.007	.049	.389	.007	.143
government debt	.077	.034	.987	.028	.018	.995
primary surplus	0.001	.002	.073	.000	.003	.24

All statistics are averages over 1000 simulations of 500 periods each. Initial values: $b_{-1} = 0.06$ and $\alpha_{-1} = 0.2$.

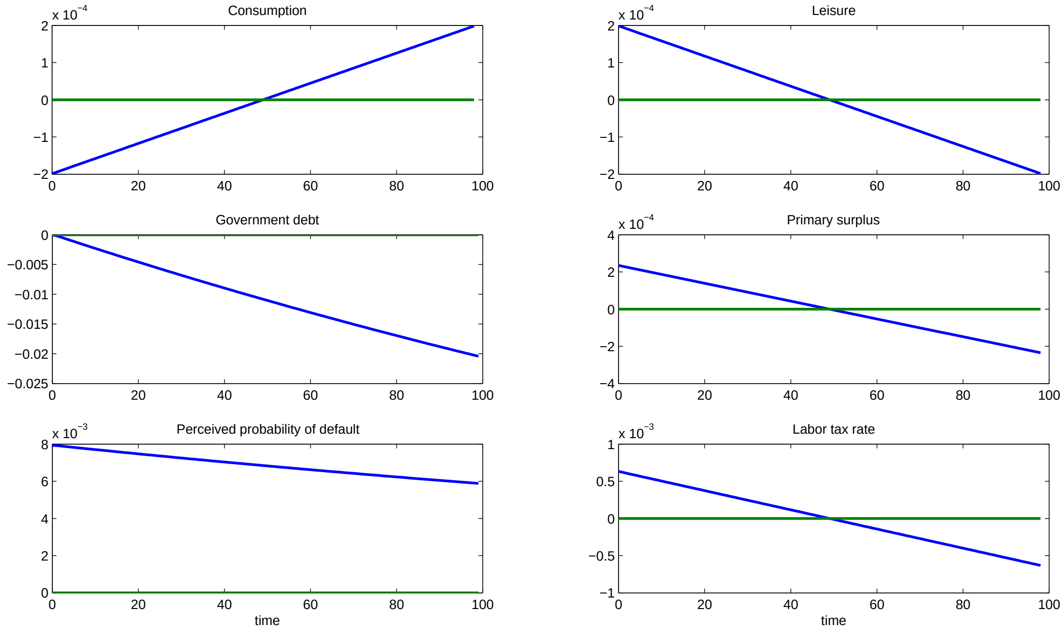

Figure 2: Effects of different initial beliefs: $\alpha_{-1} = 0$ (the rational expectations benchmark) and $\alpha_{-1} = 0.2$ (agents fear default), when the initial debt-to-GDP ratio is equal to 15%. All variables, except for the perceived probability of default, are expressed as log-deviation from the initial steady-state.

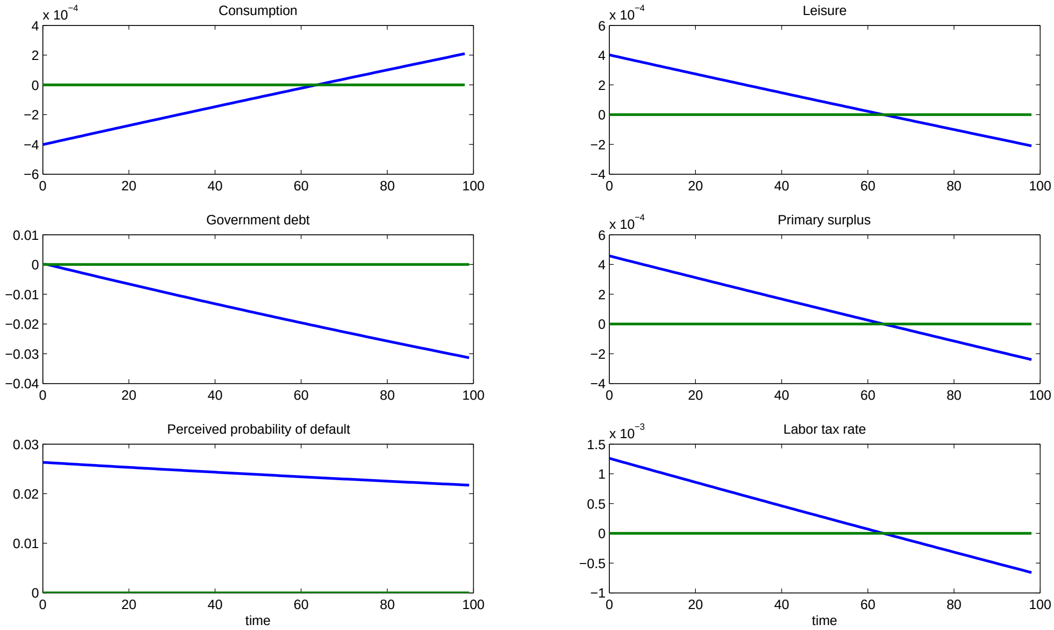

Figure 3: Effects of different initial beliefs: $\alpha_{-1} = 0$ (the rational expectations benchmark) and $\alpha_{-1} = 0.2$ (agents fear default), when the initial debt-to-GDP ratio is equal to 50%. All variables, except for the perceived probability of default, are expressed as log-deviation from the initial steady-state.

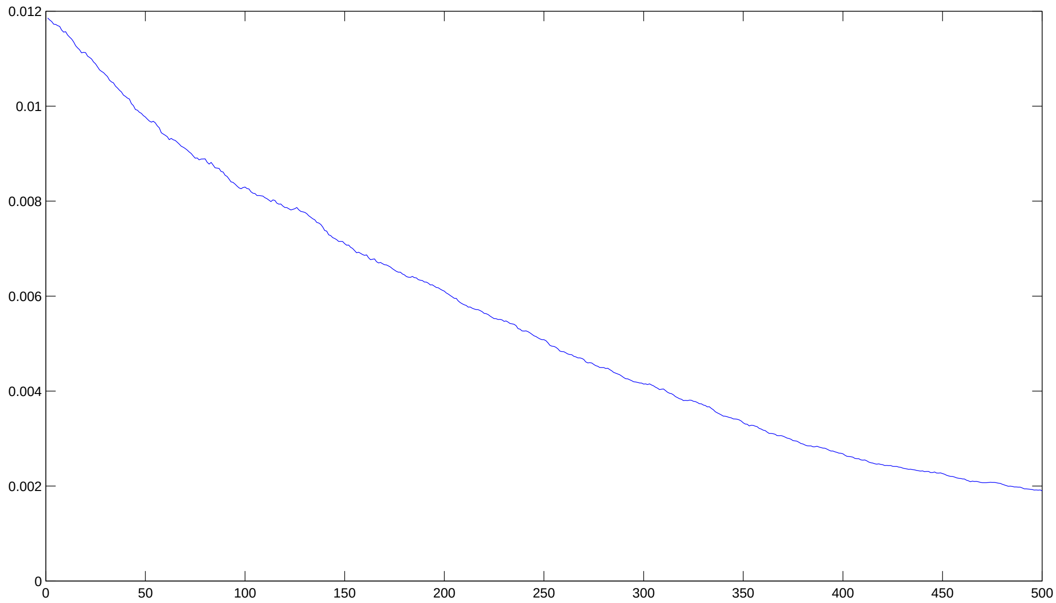

Figure 4: Perceived default probability. Values are averages over 1000 simulations, with $\alpha_{-1} = 0.2$ and $b_{-1} = 0.06$

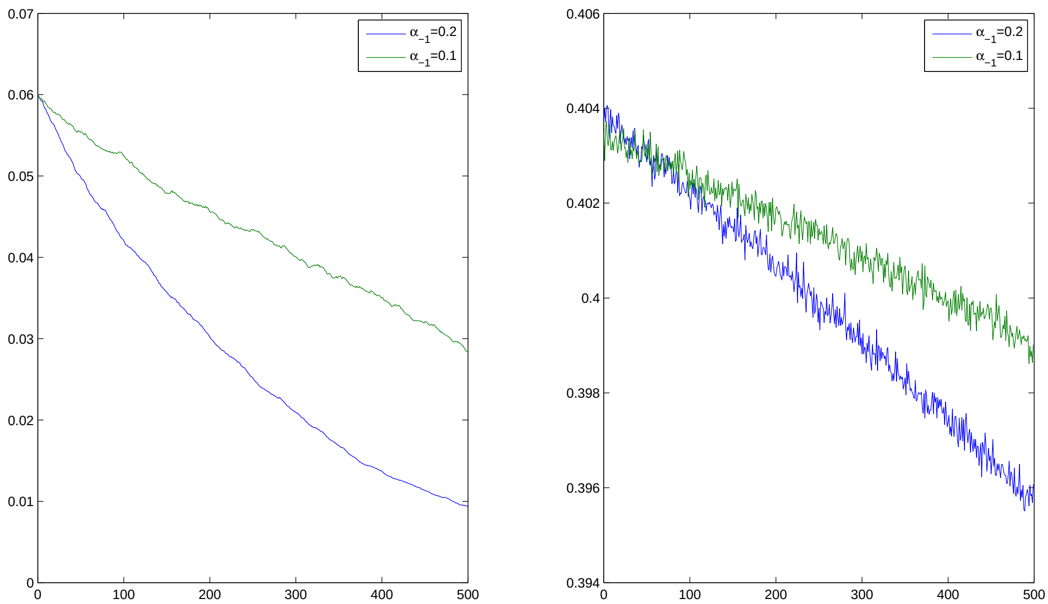

Figure 5: Government debt and tax rate for different initial beliefs. Values are averages over 1000 simulations, with $b_{-1} = 0.06$.

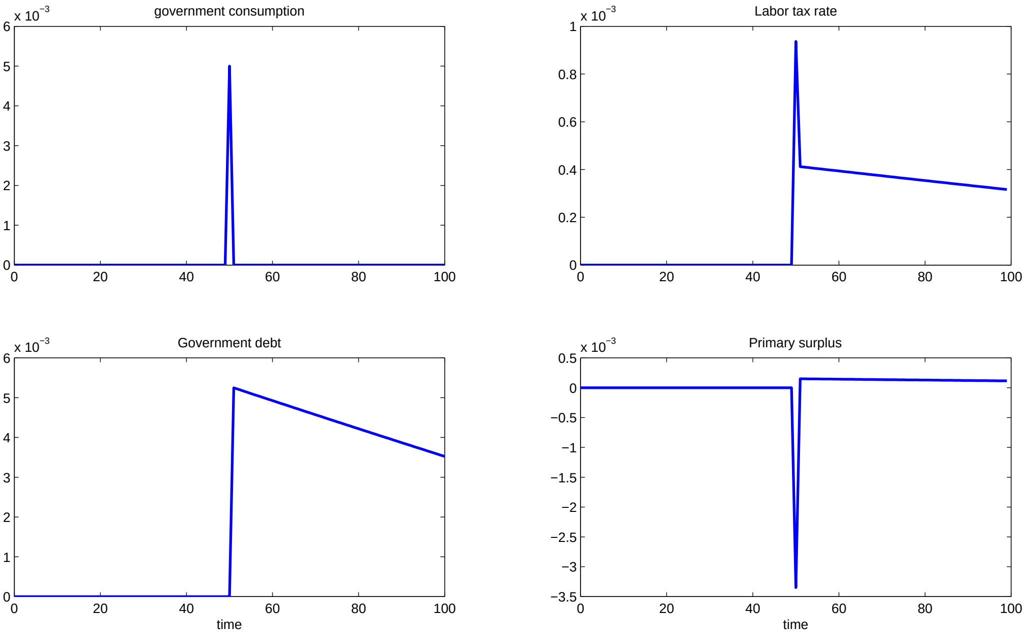

Figure 6: Optimal response to higher-than-expected government consumption. All variables, except for the perceived probability of default, are expressed as log-deviation from the steady-state.

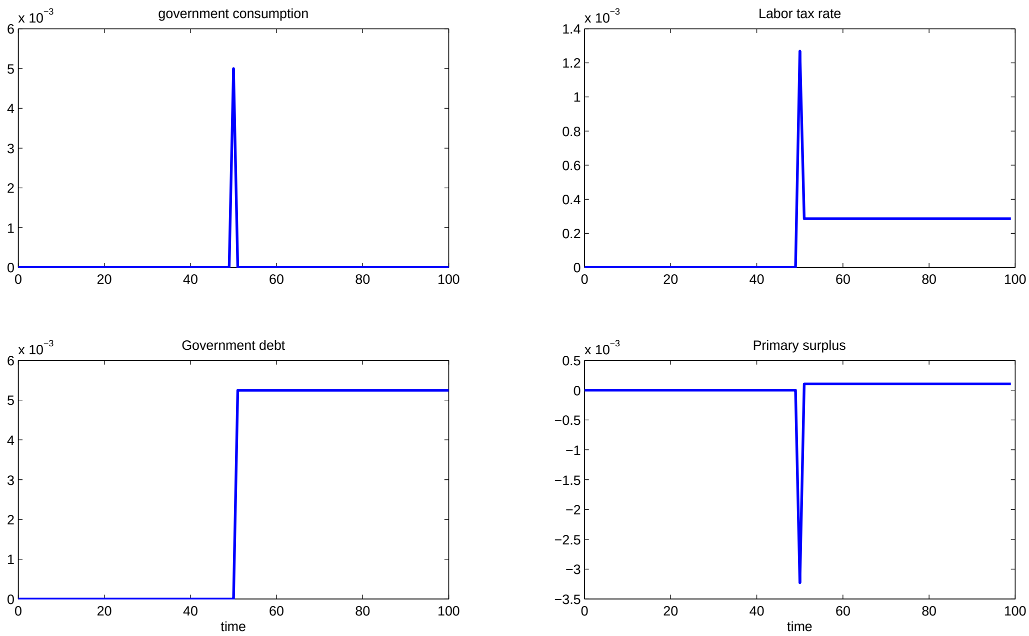

Figure 7: Optimal response to higher-than-expected government consumption under the rational expectations benchmark. All variables, except for the perceived probability of default, are expressed as log-deviation from the steady-state.

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S. MAGRI, *The financing of small innovative firms: the Italian case*, Economics of Innovation and New Technology, v. 18, 2, pp. 181-204, **TD No. 640 (September 2007).**

V. DI GIACINTO and G. MICUCCI, *The producer service sector in Italy: long-term growth and its local determinants*, Spatial Economic Analysis, Vol. 4, No. 4, pp. 391-425, **TD No. 643 (September 2007).**

F. LORENZO, L. MONTEFORTE and L. SESSA, *The general equilibrium effects of fiscal policy: estimates for the euro area*, Journal of Public Economics, v. 93, 3-4, pp. 559-585, **TD No. 652 (November 2007).**

Y. ALTUNBAS, L. GAMBACORTA and D. MARQUÉS, *Securitisation and the bank lending channel*, European Economic Review, v. 53, 8, pp. 996-1009, **TD No. 653 (November 2007).**

R. GOLINELLI and S. MOMIGLIANO, *The Cyclical Reaction of Fiscal Policies in the Euro Area. A Critical Survey of Empirical Research*, Fiscal Studies, v. 30, 1, pp. 39-72, **TD No. 654 (January 2008).**

P. DEL GIOVANE, S. FABIANI and R. SABBATINI, *What's behind "Inflation Perceptions"? A survey-based analysis of Italian consumers*, Giornale degli Economisti e Annali di Economia, v. 68, 1, pp. 25-52, **TD No. 655 (January 2008).**

F. MACCHERONI, M. MARINACCI, A. RUSTICHINI and M. TABOGA, *Portfolio selection with monotone mean-variance preferences,* Mathematical Finance, v. 19, 3, pp. 487-521, **TD No. 664 (April 2008).**

M. AFFINITO and M. PIAZZA, *What are borders made of? An analysis of barriers to European banking integration*, in P. Alessandrini, M. Fratianni and A. Zazzaro (eds.): The Changing Geography of Banking and Finance, Dordrecht Heidelberg London New York, Springer, **TD No. 666 (April 2008).**

A. BRANDOLINI, *On applying synthetic indices of multidimensional well-being: health and income inequalities in France, Germany, Italy, and the United Kingdom,* in R. Gotoh and P. Dumouchel (eds.), Against Injustice. The New Economics of Amartya Sen, Cambridge, Cambridge University Press, **TD No. 668 (April 2008).**

G. FERRERO and A. NOBILI, *Futures contract rates as monetary policy forecasts,* International Journal of Central Banking, v. 5, 2, pp. 109-145, **TD No. 681 (June 2008).**

P. CASADIO, M. LO CONTE and A. NERI, *Balancing work and family in Italy: the new mothers' employment decisions around childbearing*, in T. Addabbo and G. Solinas (eds.), Non-Standard Employment and Qualità of Work, Physica-Verlag. A Sprinter Company, **TD No. 684 (August 2008).**

L. ARCIERO, C. BIANCOTTI, L. D'AURIZIO and C. IMPENNA, *Exploring agent-based methods for the analysis of payment systems: A crisis model for StarLogo TNG*, Journal of Artificial Societies and Social Simulation, v. 12, 1, **TD No. 686 (August 2008).**

A. CALZA and A. ZAGHINI, *Nonlinearities in the dynamics of the euro area demand for M1*, Macroeconomic Dynamics, v. 13, 1, pp. 1-19, **TD No. 690 (September 2008).**

L. FRANCESCO and A. SECCHI, *Technological change and the households' demand for currency*, Journal of Monetary Economics, v. 56, 2, pp. 222-230, **TD No. 697 (December 2008).**

G. ASCARI and T. ROPELE, *Trend inflation, taylor principle, and indeterminacy*, Journal of Money, Credit and Banking, v. 41, 8, pp. 1557-1584, **TD No. 708 (May 2007).**

S. COLAROSSI and A. ZAGHINI, *Gradualism, transparency and the improved operational framework: a look at overnight volatility transmission*, International Finance, v. 12, 2, pp. 151-170, **TD No. 710 (May 2009).**

M. BUGAMELLI, F. SCHIVARDI and R. ZIZZA, *The euro and firm restructuring*, in A. Alesina e F. Giavazzi (eds): Europe and the Euro, Chicago, University of Chicago Press, **TD No. 716 (June 2009).**

B. HALL, F. LOTTI and J. MAIRESSE, *Innovation and productivity in SMEs: empirical evidence for Italy*, Small Business Economics, v. 33, 1, pp. 13-33, **TD No. 718 (June 2009).**

2010

A. PRATI and M. SBRACIA, *Uncertainty and currency crises: evidence from survey data*, Journal of Monetary Economics, v, 57, 6, pp. 668-681, **TD No. 446 (July 2002).**

L. MONTEFORTE and S. SIVIERO, *The Economic Consequences of Euro Area Modelling Shortcuts*, Applied Economics, v. 42, 19-21, pp. 2399-2415, **TD No. 458 (December 2002).**

S. MAGRI, *Debt maturity choice of nonpublic Italian firms* , Journal of Money, Credit, and Banking, v.42, 2-3, pp. 443-463, **TD No. 574 (January 2006).**

G. DE BLASIO and G. NUZZO, *Historical traditions of civicness and local economic development*, Journal of Regional Science, v. 50, 4, pp. 833-857, **TD No. 591 (May 2006).**

E. IOSSA and G. PALUMBO, *Over-optimism and lender liability in the consumer credit market*, Oxford Economic Papers, v. 62, 2, pp. 374-394, **TD No. 598 (September 2006).**

S. NERI and A. NOBILI, *The transmission of US monetary policy to the euro area,* International Finance, v. 13, 1, pp. 55-78, **TD No. 606 (December 2006).**

F. ALTISSIMO, R. CRISTADORO, M. FORNI, M. LIPPI and G. VERONESE, *New Eurocoin: Tracking Economic Growth in Real Time,* Review of Economics and Statistics, v. 92, 4, pp. 1024-1034, **TD No. 631 (June 2007).**

U. ALBERTAZZI and L. GAMBACORTA, *Bank profitability and taxation*, Journal of Banking and Finance, v. 34, 11, pp. 2801-2810, **TD No. 649 (November 2007).**

M. IACOVIELLO and S. NERI, *Housing market spillovers: evidence from an estimated DSGE model,* American Economic Journal: Macroeconomics, v. 2, 2, pp. 125-164, **TD No. 659 (January 2008).**

F. BALASSONE, F. MAURA and S. ZOTTERI, *Cyclical asymmetry in fiscal variables in the EU*, Empirica, **TD No. 671**, v. 37, 4, pp. 381-402 **(June 2008).**

F. D'AMURI, O. GIANMARCO I.P. and P. GIOVANNI, *The labor market impact of immigration on the western german labor market in the 1990s,* European Economic Review, v. 54, 4, pp. 550-570, **TD No. 687 (August 2008).**

A. ACCETTURO, *Agglomeration and growth: the effects of commuting costs,* Papers in Regional Science, v. 89, 1, pp. 173-190, **TD No. 688 (September 2008).**

S. NOBILI and G. PALAZZO, *Explaining and forecasting bond risk premiums,* Financial Analysts Journal, v. 66, 4, pp. 67-82, **TD No. 689 (September 2008).**

A. B. ATKINSON and A. BRANDOLINI, *On analysing the world distribution of income*, World Bank Economic Review , v. 24, 1 , pp. 1-37, **TD No. 701 (January 2009).**

R. CAPPARIELLO and R. ZIZZA, *Dropping the Books and Working Off the Books,* Labour, v. 24, 2, pp. 139-162 ,**TD No. 702 (January 2009).**

C. NICOLETTI and C. RONDINELLI, *The (mis)specification of discrete duration models with unobserved heterogeneity: a Monte Carlo study,* Journal of Econometrics, v. 159, 1, pp. 1-13, **TD No. 705 (March 2009).**

L. FORNI, A. GERALI and M. PISANI, *Macroeconomic effects of greater competition in the service sector: the case of Italy,* Macroeconomic Dynamics, v. 14, 5, pp. 677-708, **TD No. 706 (March 2009).**

V. DI GIACINTO, G. MICUCCI and P. MONTANARO, *Dynamic macroeconomic effects of public capital: evidence from regional Italian data,* Giornale degli economisti e annali di economia, v. 69, 1, pp. 29-66, **TD No. 733 (November 2009).**

F. COLUMBA, L. GAMBACORTA and P. E. MISTRULLI, *Mutual Guarantee institutions and small business finance,* Journal of Financial Stability, v. 6, 1, pp. 45-54, **TD No. 735 (November 2009).**

A. GERALI, S. NERI, L. SESSA and F. M. SIGNORETTI, *Credit and banking in a DSGE model of the Euro Area*, Journal of Money, Credit and Banking, v. 42, 6, pp. 107-141, **TD No. 740 (January 2010).**

M. AFFINITO and E. TAGLIAFERRI, *Why do (or did?) banks securitize their loans? Evidence from Italy*, Journal of Financial Stability, v. 6, 4, pp. 189-202, **TD No. 741 (January 2010).**

S. Federico, *Outsourcing versus integration at home or abroad and firm heterogeneity*, Empirica, v. 37, 1, pp. 47-63, **TD No. 742 (February 2010).**

V. Di Giacinto, *On vector autoregressive modeling in space and time*, Journal of Geographical Systems, v. 12, 2, pp. 125-154, **TD No. 746 (February 2010).**

L. Forni, A. Gerali and M. Pisani, *The macroeconomics of fiscal consolidations in euro area countries*, Journal of Economic Dynamics and Control, v. 34, 9, pp. 1791-1812, **TD No. 747 (March 2010).**

S. Mocetti and C. Porello, *How does immigration affect native internal mobility? new evidence from Italy*, Regional Science and Urban Economics, v. 40, 6, pp. 427-439, **TD No. 748 (March 2010).**

A. Di Cesare and G. Guazzarotti, *An analysis of the determinants of credit default swap spread changes before and during the subprime financial turmoil*, Journal of Current Issues in Finance, Business and Economics, v. 3, 4, pp., **TD No. 749 (March 2010).**

P. Cipollone, P. Montanaro and P. Sestito, *Value-added measures in Italian high schools: problems and findings*, Giornale degli economisti e annali di economia, v. 69, 2, pp. 81-114, **TD No. 754 (March 2010).**

A. Brandolini, S. Magri and T. M Smeeding, *Asset-based measurement of poverty*, Journal of Policy Analysis and Management, v. 29, 2 , pp. 267-284, **TD No. 755 (March 2010).**

G. Cappelletti, *A Note on rationalizability and restrictions on beliefs*, The B.E. Journal of Theoretical Economics, v. 10, 1, pp. 1-11,**TD No. 757 (April 2010).**

S. Di Addario and D. Vuri, *Entrepreneurship and market size. the case of young college graduates in Italy*, Labour Economics, v. 17, 5, pp. 848-858, **TD No. 775 (September 2010).**

A. Calza and A. Zaghini, *Sectoral money demand and the great disinflation in the US*, Journal of Money, Credit, and Banking, v. 42, 8, pp. 1663-1678, **TD No. 785 (January 2011).**

2011

S. Di Addario, *Job search in thick markets*, Journal of Urban Economics, v. 69, 3, pp. 303-318, **TD No. 605 (December 2006).**

F. Schivardi and E. Viviano, *Entry barriers in retail trade*, Economic Journal, v. 121, 551, pp. 145-170, **TD No. 616 (February 2007).**

G. Ferrero, A. Nobili and P. Passiglia, *Assessing excess liquidity in the Euro Area: the role of sectoral distribution of money*, Applied Economics, v. 43, 23, pp. 3213-3230, **TD No. 627 (April 2007).**

P. E. Mistrulli, *Assessing financial contagion in the interbank market: maximun entropy versus observed interbank lending patterns*, Journal of Banking & Finance, v. 35, 5, pp. 1114-1127, **TD No. 641 (September 2007).**

E. Ciapanna, *Directed matching with endogenous markov probability: clients or competitors?*, The RAND Journal of Economics, v. 42, 1, pp. 92-120, **TD No. 665 (April 2008).**

M. Bugamelli and F. Paternò, *Output growth volatility and remittances*, Economica, v. 78, 311, pp. 480-500, **TD No. 673 (June 2008).**

V. Di Giacinto e M. Pagnini, *Local and global agglomeration patterns: two econometrics-based indicators*, Regional Science and Urban Economics, v. 41, 3, pp. 266-280, **TD No. 674 (June 2008).**

G. Barone and F. Cingano, *Service regulation and growth: evidence from OECD countries*, Economic Journal, v. 121, 555, pp. 931-957, **TD No. 675 (June 2008).**

R. Giordano and P. Tommasino, *What determines debt intolerance? The role of political and monetary institutions*, European Journal of Political Economy, v. 27, 3, pp. 471-484, **TD No. 700 (January 2009).**

P. Angelini, A. Nobili e C. Picillo, *The interbank market after August 2007: What has changed, and why?*, Journal of Money, Credit and Banking, v. 43, 5, pp. 923-958, **TD No. 731 (October 2009).**

L. Forni, A. Gerali and M. Pisani, *The Macroeconomics of Fiscal Consolidation in a Monetary Union: the Case of Italy*, in Luigi Paganetto (ed.), Recovery after the crisis. Perspectives and policies, VDM Verlag Dr. Muller, **TD No. 747 (March 2010).**

A. Di Cesare and G. Guazzarotti, *An analysis of the determinants of credit default swap changes before and during the subprime financial turmoil*, in Barbara L. Campos and Janet P. Wilkins (eds.), The Financial Crisis: Issues in Business, Finance and Global Economics, New York, Nova Science Publishers, Inc., **TD No. 749 (March 2010).**

A. Levy and A. Zaghini, *The pricing of government guaranteed bank bonds*, Banks and Bank Systems, v. 6, 3, pp. 16-24, **TD No. 753 (March 2010).**

G. GRANDE and I. VISCO, *A public guarantee of a minimum return to defined contribution pension scheme members,* The Journal of Risk, v. 13, 3, pp. 3-43, **TD No. 762 (June 2010).**

P. DEL GIOVANE, G. ERAMO and A. NOBILI, *Disentangling demand and supply in credit developments: a survey-based analysis for Italy,* Journal of Banking and Finance, v. 35, 10, pp. 2719-2732, **TD No. 764 (June 2010).**

G. BARONE and S. MOCETTI, *With a little help from abroad: the effect of low-skilled immigration on the female labour supply,* Labour Economics, v. 18, 5, pp. 664-675, **TD No. 766 (July 2010).**

A. FELETTIGH and S. FEDERICO, *Measuring the price elasticity of import demand in the destination markets of italian exports*, Economia e Politica Industriale, v. 38, 1, pp. 127-162, **TD No. 776 (October 2010).**

S. MAGRI and R. PICO, *The rise of risk-based pricing of mortgage interest rates in Italy*, Journal of Banking and Finance, v. 35, 5, pp. 1277-1290, **TD No. 778 (October 2010).**

M. TABOGA, *Under/over-valuation of the stock market and cyclically adjusted earnings*, International Finance, v. 14, 1, pp. 135-164, **TD No. 780 (December 2010).**

S. NERI, *Housing, consumption and monetary policy: how different are the U.S. and the Euro area?*, Journal of Banking and Finance, v.35, 11, pp. 3019-3041, **TD No. 807 (April 2011).**

V. CUCINIELLO, *The welfare effect of foreign monetary conservatism with non-atomistic wage setters*, Journal of Money, Credit and Banking, v. 43, 8, pp. 1719-1734, **TD No. 810 (June 2011).**

A. CALZA and A. ZAGHINI, *welfare costs of inflation and the circulation of US currency abroad*, The B.E. Journal of Macroeconomics, v. 11, 1, Art. 12, **TD No. 812 (June 2011).**

I. FAIELLA, *La spesa energetica delle famiglie italiane*, Energia, v. 32, 4, pp. 40-46, **TD No. 822 (September 2011).**

R. DE BONIS and A. SILVESTRINI, *The effects of financial and real wealth on consumption: new evidence from OECD countries*, Applied Financial Economics, v. 21, 5, pp. 409–425, **TD No. 837 (November 2011).**

2012

A. ACCETTURO and G. DE BLASIO, *Policies for local development: an evaluation of Italy's "Patti Territoriali"*, Regional Science and Urban Economics, v. 42, 1-2, pp. 15-26, **TD No. 789 (January 2006).**

FORTHCOMING

M. BUGAMELLI and A. ROSOLIA, *Produttività e concorrenza estera*, Rivista di politica economica, **TD No. 578 (February 2006).**

F. CINGANO and A. ROSOLIA, *People I know: job search and social networks*, Journal of Labor Economics, **TD No. 600 (September 2006).**

S. MOCETTI, *Educational choices and the selection process before and after compulsory school*, Education Economics, **TD No. 691 (September 2008).**

P. SESTITO and E. VIVIANO, *Reservation wages: explaining some puzzling regional patterns*, Labour, **TD No. 696 (December 2008).**

P. PINOTTI, M. BIANCHI and P. BUONANNO, *Do immigrants cause crime?*, Journal of the European Economic Association, **TD No. 698 (December 2008).**

F. LIPPI and A. NOBILI, *Oil and the macroeconomy: a quantitative structural analysis,* Journal of European Economic Association, **TD No. 704 (March 2009).**

F. CINGANO and P. PINOTTI, *Politicians at work. The private returns and social costs of political connections*, Journal of the European Economic Association, **TD No. 709 (May 2009).**

Y. ALTUNBAS, L. GAMBACORTA, and D. MARQUÉS-IBÁÑEZ, *Bank risk and monetary policy,* Journal of Financial Stability, **TD No. 712 (May 2009).**

G. BARONE and S. MOCETTI, *Tax morale and public spending inefficiency,* International Tax and Public Finance, **TD No. 732 (November 2009).**

I. BUONO and G. LALANNE, *The effect of the Uruguay Round on the intensive and extensive margins of trade,* Journal of International Economics, **TD No. 835 (February 2011).**

G. BARONE, R. FELICI and M. PAGNINI, *Switching costs in local credit markets,* International Journal of Industrial Organization, **TD No. 760 (June 2010).**

E. COCOZZA and P. PISELLI, *Testing for east-west contagion in the European banking sector during the financial crisis,* in R. Matoušek; D. Stavárek (eds.), Financial Integration in the European Union, Taylor & Francis, **TD No. 790 (February 2011).**

S. NERI and T. ROPELE, *Imperfect information, real-time data and monetary policy in the Euro area*, The Economic Journal, **TD No. 802 (March 2011).**

M. AFFINITO, *Do interbank customer relationships exist? And how did they function in the crisis? Learning from Italy*, Journal of Banking and Finance, **TD No. 826 (October 2011).**

O. BLANCHARD and M. RIGGI, Why are the 2000s so different from the 1970s? A structural interpretation of changes in the macroeconomic effects of oil prices, Journal of the European Economic Association, **TD No. 835 (November 2011).**

R. CRISTADORO and D. MARCONI, *Households Savings in China,* Chinese Economic and Business Studies, **TD No. 838 (November 2011).**