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Optimal Public Debt Consolidation with Distributional Conflicts*

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Abstract

In this paper, we adopt a Ramsey-optimal approach to the identification of debt reduction strategies, that is, the optimal policy mix for labor and capital income taxes, public expenditures and inflation designed to achieve an exogenous debt reduction path. Our model accounts for monopoly profits, limited asset market participation and asset holders' infrequent optimization of their portfolio composition between money holdings and other financial assets. The optimal policy envisages persistent reductions in public consumption and increases in taxes and inflation. Distributional conflicts arise between asset owners and the rest of the population. When asset holders interests are relatively less important in the planner's objective function, labor income taxes are drastically reduced whereas capital income taxes and inflation are increased. Just in this case the consolidation has short term expansionary effects.

JEL codes: E32, E62, E63

Keywords: Fiscal Consolidation, Limited Asset Market Participation, Ramsey Fiscal Policy

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1 Introduction

Following the large increases in public-debt-to-GDP ratios observed in the aftermath of the 2007-2008 financial crisis, fiscal consolidation, i.e. a reduction in the debt-to-GDP ratio, has come to the forefront of political debate and macroeconomic analyses (Blanchard et al., OECD 2012).

Consolidation plans can be designed using a relatively wide range of possible fiscal instruments which have different short- and log-run implications in terms of both efficiency and social costs, including distributional conflicts. Empirical research suggests that fiscal adjustments based upon spending cuts are much less costly, in terms of output losses, than tax-based ones (Nickel, Rother and Zimmermann, 2010; Alesina, Favero and Giavazzi, 2015). However, fiscal consolidations seem to be associated to an increase in inequality, and spending-based consolidations tend to worsen inequality more significantly than tax-based consolidations (Ball et al. 2013, Woo et al. 2013; Agnello and Sousa, 2014). Another related issue concerns the sustainability of consolidations. According to a popular view adjustment programmes relying mainly on expenditure cuts rather than on tax revenue increases are less likely to be reversed (Alesina and Ardagna, 2010, 2013; Molnar, 2012), and a more equitable distribution of fiscal adjustment costs is found to raise the chance of consolidation success, thus providing the "double dividend" of sustainable consolidation and enhanced social cohesion (Kaplanoglou et al., 2015).

Theoretical contributions on fiscal consolidations typically describe the effects of simple feedback rules for tax and expenditure variables, as in Coenen, Mohr and Straub, 2008; Erceg and Lindè, 2013; Cogan et al., 2013; Ferrara and Tirelli, 2014. However, a normative analysis of debt consolidation should identify the optimal fiscal policy mix - the combination of taxes and public expenditures - both in the long run and during the transition, when monetary policy could also play a role. To this purpose, we adopt a Ramsey-optimal approach to the identification of debt reduction strategies, i.e. we identify the optimal policy mix for income taxes, public expenditures and inflation designed to achieve an exogenous debt reduction path as typically envisaged in debt consolidation plans (OECD, 2011). Our study is meant to address a number of issues. First, what is the optimal combination of public expenditure reductions and increases (if any) in distortionary taxes based on purely efficiency grounds? Second, how do redistributive concerns affect the optimal combination of capital and labor income taxes? Third, how should monetary policy be implemented during the transition?

A large literature on optimal dynamic taxation under perfectly competitive goods markets argues that in the long run public expenditures should not be financed by capital taxes, which in fact should be zero even if some households have no wealth and the policymaker cares about them (Judd, 1985; Chamley, 1986; Atkeson, Chari, and Kehoe, 1999). Guo and Lansing (1999) use a representative agent model with monopolistic competition to show that concern for efficiency may justify a positive capital income tax when the fiscal policymaker cannot levy a specific tax on profits. Distributional conflicts about the optimal long-run combination of tax policies are therefore likely to emerge in economies characterized by monopoly profits in the firms sector and unequal wealth distribution. Similarly, disagreements about the optimal transition path may arise if households differ in their ability to smooth consumption.

To capture these effects, we carry out our analysis in a DSGE model characterized by potential distributional conflicts, that is, we assume that ownership of interest bearing assets is concentrated in the hands of few *unconstrained* households and the rest of the population - *constrained* households - can only exploit their money holdings to partly smooth consumption, as in Coenen, Mohr and Straub (2008). This assumption of Limited Asset Market Participation (LAMP) is broadly in line with empirical evidence provided in the Luxembourg Wealth Study (Bonesmo Fredriksen, 2012), which shows that in a number of OECD countries only a very small fraction of wealth is owned by the lowest 50% of households in the wealth distribution, while a large part of wealth is concentrated in the hands of the top 10%.

To avoid trivial results, we assume that public consumption is not a mere dissipation of resources but generates utility to households, as in Stahler and Thomas (2012), so that a natural trade-off emerges between public expenditure reductions and increases in distortionary taxation. Further, the set of policy tools is incomplete by assumption. Thus we posit that monopoly profits cannot be confiscated by specific direct taxation, i.e. all capital incomes are subject to a uniform tax. Further, redistributive concerns cannot be addressed by using transfer schemes. In this regard our work is closely related to the literature on optimal capital and labor tax policies in models of heterogeneous agents. Floden (2009), Garcia-Milà et al. (2010) and Laczo et al. (2015) study how distributional concerns affect the dynamic path of such tax instruments, but their contributions are based on models where optimal long-run capital income taxation is zero because the firm sector is perfectly competitive. Further, we incorporate nominal rigidities, so that interactions between fiscal and monetary policies may play an important role during the transition.

One innovative feature of our model is that we allow for the asset holders' infrequent optimization of their portfolio composition between money holdings and other financial assets. This is consistent with a relatively large body of empirical evidence which suggests that financial investors infrequently adjust their portfolios (Lusardi, 1999, 2003; Vissing-Jørgensen, 2002; Ameriks and Zeldes, 2004; Mitchell et al., 2006; Brunnermeier and Nagel, 2008; Bilias et al., 2009). Infrequent trading has been used to replicate the empirical distribution of money holdings in the hands of rich asset holders (Ragot, 2014) and the effects of monetary shocks (Alvarez et al., 2002, 2009). For our purposes, one important implication of infrequent asset trading is that it may reduce consumption smoothing for agents who own interest bearing assets. This, in turn, could affect the optimal policy mix during the consolidation period.

Our results in a nutshell. We find that consolidations entail a persistent tax (public expenditure) increase (reduction). Output remains below the pre-consolidation level throughout the transition to the new debt-to-GDP ratios, and the benefits from the consolidation begin to materialize with considerable delay with respect to the end of the consolidation. The consolidation is associated to a sharp reduction in investment. Infrequent trading considerably worsen the asset holders' ability to smooth consumption during the transition. We also uncover important redistributive effects so that distributional conflicts may imply quite different consolidation paths. Even a limited prevalence of unconstrained households in the planner's objective function is sufficient to tilt the policy plan towards lower (higher) labor (capital) income taxes and higher inflation.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 defines the competitive equilibrium and the Ramsey optimal policy, while section 4 describes results. Finally, section 5 concludes.

2 The model

We consider a standard DSGE model characterized by monopolistic competition and nominal rigidities both in the goods and labor markets. A mass $\theta \in [0, 1]$ of constrained agents (henceforth, c) hold money balances but do not participate in the market for interest bearing assets. The remaining $1-\theta$ unconstrained agents (henceforth, u) benefit from full participation to financial markets and own firms. We allow for the possibility that portfolio rebalancing between money and interest-bearing asset occurs infrequently.

Following Schmitt-Grohé and Uribe (2004), monetary transaction costs are introduced in order to motivate a demand for money:

$$s_{t,i} = Av_{t,i} + \frac{B}{v_{t,i}} - 2\sqrt{AB} \tag{1}$$

that depends on money velocity, $v_{t,i} = \frac{c_{t,i}}{m_{t,i}}$, household's i real consumption, $c_{t,i}$, real money balances, $m_{t,i} = \frac{M_{t,i}}{P_{t,i}}$.Note that

$$s'(v_{t,i}) > 0 \text{ for } v_{t,i} \geq v^*; \quad s(v^*) = 0; \quad v^* > 0 \tag{2}$$

where $v^* > 0$ defines a satiation level for money velocity which is associated to a zero nominal interest rate.

Households utility function is

$$U = E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t^i, l_t^i, g_t\right);\; u\left(c_t^i, l_t^i, g_t\right) = \ln c_t^i + \eta^i \ln\left(1 - l_t^i\right) + \xi \ln g_t \tag{3}$$

where l_t^i denotes supply of a differentiated labor type and g_t defines public consumption.

The government finances expenditures by levying distortionary taxes and by printing money. Optimal policy is set according to a Ramsey plan. Right from the outset, we emphasize that some restrictions are imposed upon the set of available fiscal tools, in line with the literature on Ramsey optimal fiscal policies. Here, we rule out production subsidies as well as lump-sum and consumption taxes. In our relatively simple framework, use of these instruments allows to obtain outcomes that would be difficult to reach in more complex and more realistic settings. For instance, in this class of models subsidies allow to offset monopolistic distortions, and negative lump-sum taxes in combination with consumption taxation allow to achieve the optimal allocation addressing distributional issues (Correia, 2010).[1] In this regard, our setting is akin to Laczo et al. (2015), who focus on optimal capital and labor taxes. Further, previous contributions have shown that the government would levy a 100% tax rate on profits in order to reduce distortionary taxation on factor inputs. This possibility is artificially restricted here. As a matter of fact, such policy may be unfeasible in practice, partly because the policymaker may find it difficult to distinguish between profits and other income from capital, and partly because profits may simply be hidden. Following Lansing (1998), we allow for alternative tax schemes on profits which may be untaxed, taxed at the same rate as other return from capital, subject to double taxation as in most developed countries.

2.1 Labor Packers

Firms use a labor bundle, l_t^d, as a production factor. Such bundle is produced by labor packers who buy the differentiated labor services from households. Under perfect competition, labor packers solve the following problem:

$$\max \; w_t l_t^d - \int_0^1 w_t^i l_t^i \quad di$$

[1] Motta and Rossi (2013) provide arguments for the Ramsey planner to replace a labor income tax with a consumption tax, Krusell et al.(1996) depict a political equilibrium where income taxes might be preferred to consumption taxes.

subject to

$$l_t^d = \left[\int_0^1 \left(l_t^i\right)^{\rho_w} di\right]^{\frac{1}{\rho_w}} \tag{4}$$

The downward sloping demand function for labor type i takes the form

$$l_t^i = l_t^d \left(\frac{w_t^i}{w_t}\right)^{\frac{1}{\rho_w - 1}} \tag{5}$$

where w_t indicates the wage index described by

$$w_t = \left[\int_0^1 \left(w_t^i\right)^{\frac{\rho_w}{\rho_w - 1}} di\right]^{\frac{\rho_w - 1}{\rho_w}} \tag{6}$$

2.2 Constrained households

In every period the representative constrained household maximizes (3) subject to

$$c_t^c + s(v_t^c) + m_t^c = \left(1 - \tau_t^l\right) w_t^c l_t^c + \frac{m_{t-1}^c}{\pi_t} - \frac{\xi_w}{2} l_t^c \left(\frac{w_t^c \pi_t}{w_{t-1}^c} - 1\right)^2 \tag{7}$$

where τ_t^l is the labor income tax rate; $\pi_t = \frac{P_t}{P_{t-1}}$ is the gross inflation rate, parameter ξ_w defines standard nominal wage adjustment costs à la Rotemberg. The first-order conditions are:

$$\lambda_t^c = \frac{u_c\left(c_t^c, l_t^c\right)}{1 + s(v_t^c) + \frac{c_t^c}{m_t^c} s'(v_t^c)} \tag{8}$$

$$\frac{\left(w_t^c \rho_w + \frac{u_l\left(c_t^c, l_t^c\right)}{\left(1-\tau_t^l\right)\lambda_t^c}\right)\left(\frac{w_t^c}{w_t}\right)^{\frac{1}{\rho_w - 1}}}{1 - \rho_w} + \xi_w \frac{w_t^c \pi_t}{w_{t-1}^c}\left(\frac{w_t^c \pi_t}{w_{t-1}^c} - 1\right) = \beta E_t \left\{\frac{l_{t+1}^c \lambda_{t+1}^c}{l_t^c \lambda_t^c} \xi_w \left[\frac{w_{t+1}^c \pi_{t+1}}{w_t^c}\left(\frac{w_{t+1}^c \pi_{t+1}}{w_t^c} - 1\right)\right]\right\} \tag{9}$$

$$1 - E_t\left[\frac{\beta}{\pi_{t+1}} \frac{\lambda_{t+1}^c}{\lambda_t^c}\right] = s'(v_t^c)\left(v_t^c\right)^2 \tag{10}$$

Similarly to Schmitt-Grohé and Uribe (2004), in (8) the transaction costs introduce a wedge between the marginal utility of consumption, $u_c\left(c_t^c, l_t^c\right)$, and the marginal utility of wealth, λ_t^c, that vanishes only if $\frac{c_t^c}{m_t^c} = v_t^c = v^*$. Condition (9) is a standard wage-setting equation. Equation (10) shows that constrained households' money demand is a negative function of expected inflation and a positive function of the expected increase in the marginal utility of wealth. Note that the money demand equation can also be interpreted as an Euler equation where expected inflation drives consumption decisions for constrained households:

$$c_t^c = E_t \left\{\frac{\pi_{t+1}\left[1 - s'(v_t^c)\left(v_t^c\right)^2\right]\left[1 + s(v_{t+1,i}^c) + v_{t+1}^c s'(v_{t+1}^c)\right]}{\beta\left[1 + s(v_t^c) + v_{t,i}^c s'(v_t^c)\right]} c_{t+1}^c\right\} \tag{11}$$

2.3 Unconstrained households

Following Alvarez et al. (2009), unconstrained households are assumed to possess a bank and a brokerage account. In the bank account they hold money balances and receive monetary payment for their wage bill. In the brokerage account they hold all other types of wealth. Consumption decisions involving monetary transactions can only occur by withdrawing money balances from the bank account. Transfers of funds between the two accounts occur every N periods, so that in each period only a share $1/N$ of unconstrained agents can transfer funds. Indexing each unconstrained agent by $p_t \in [0, N-1]$, i.e. the number of periods left at time t before a transfer can be made, for type p_t the bank account evolves as follows:[2]

$$c_t^u(p_t) + S_t^u(p_t) + m_t^u(p_t) = \tag{12}$$
$$\left(1-\tau_t^l\right)\left[w_t^u(p_t) l_t^u(p_t)\right] + \frac{m_{t-1}^u(p_t)}{\pi_t} - \frac{\xi_w}{2} l_t^u \left(\frac{w_t^u \pi_t}{w_{t-1}^u} - 1\right)^2 + x_t(p_t)$$

where $x_t(p_t)$ is the transfer between the brokerage account and the bank account. Note that, due to infrequent trading, $x_t(p_t)$ is constrained to zero for all $p_t \neq 0$.

Similarly, the brokerage account evolves as follows:

$$k_t(p_t) + b_t(p_t) = r_t^k k_{t-1}(p_t) + (1-\delta) k_{t-1}(p_t) + \Pi_t^u + \tag{13}$$
$$+ \frac{R_{t-1} b_{t-1}(p_t)}{\pi_t} - x_t(p_t) - T_t^k$$

where Π_t^u indicates real firms profits; R_t is the gross nominal interest rate, b_t^u is the real amount of a nominally riskless bond that pays one unit of currency in period $t+1$. k_t^u denotes the capital stock, r_t^k is the real rental rate of capital and δ is the depreciation rate. T_t^u defines the tax burden:[3]

$$T_t^k = \tau_t^k \left(r_t^k - \delta\right) k_{t-1}^u + \left[1 - (1-\tau_t^k)^{\vartheta}\right] \Pi_t^u$$

where ϑ allows to consider different degrees of profit taxation. We characterize ϑ as in Lansing (1998). When $\vartheta = 0$ firms monopoly profits escape taxation. When $\vartheta = 1$ all capital incomes are taxed at a uniform rate. The case $\vartheta = 2$ incorporates the double taxation of firms profits, but also allows to take into account that firms may "hide" some profits (see Guo and Lansing (1999) or that it may be desirable to leave some profits untaxed in order to provide incentives for managerial activities (Mirlees, 1971).

To facilitate aggregation, we follow Alvarez et al. (2009), in assuming that the initial financial wealth distribution among unconstrained agent types is such that the marginal value of wealth delivered in the brokerage account in the initial period is identical across households. Another simplifying assumption in Alvarez et al. (2009) is that households labor (income) endowments are exogenous. In our model we allow for individual labor supply responses to business cycle condition unless $N = 1$, unconstrained households' wage-setting decisions must differ because consumption decisions of p_t-type agents are also different. To limit computational problems and to facilitate comparison with the frequent trading case, we assume that individual wage setting decisions of unconstrained households are delegated to a labor union that maximizes $\frac{1}{N}\sum_{p=0}^{N-1} U(p_t)$, where for

[2] Notice that agents of type p at time t (p_t) were of type $p+1$ at time t-1, which implies that p_t and $(p+1)_{t-1}$ index the same agent. This is true for all agents apart from type N-1 agents, for whom the type was 0 at time t-1.

[3] We assume that the government grants depreciation tax allowances.

each p_t-type agent the utility function U is defined by (3). As a result the wage rate is unique and unconstrained households supply the same number of hours. The wage setting equation takes the following form

$$\frac{\left(w_t^u \rho_w + \frac{u_l^u}{(1-\tau_t^l)\lambda_t^u}\right)\left(\frac{w_t^i}{w_t}\right)^{\frac{1}{\rho_w - 1}}}{1-\rho_w} + \xi_w \frac{w_t^u \pi_t}{w_{t-1}^u}\left(\frac{w_t^u \pi_t}{w_{t-1}^u} - 1\right) = \beta E_t \left\{ \frac{l_{t+1}^u \lambda_{t+1}^u}{l_t^u \lambda_t^u} \xi_w \left[\frac{w_{t+1}^u \pi_{t+1}}{w_t^u} \left(\frac{w_{t+1}^u \pi_{t+1}}{w_t^u} - 1 \right) \right] \right\} \tag{14}$$

where $u_l^u = \frac{1}{N}\sum_{p=0}^{N-1} u_l(p_t)$, $\lambda_t^u = \frac{1}{N}\sum_{p=0}^{N-1} \lambda_t(p_t)$.

Each household maximizes (3) subject to the consumption transaction technology (1) and to the bank- (eq. 12) and brokerage-account constraints (eq. 13). In particular, infrequent trading implies that the traditional Lagrange multiplier λ_t^u is replaced by two multipliers on the bank and brokerage accounts, $\lambda_t^u(p_t)$ and ζ_t^u respectively. It can be easily shown that the multiplier ζ_t^u is the same for all types, and the following Euler equations with respect to bonds and to physical capital must hold for each unconstrained agent, irrespective of the time left before he can access his brokerage account:

$$\zeta_t^u = \beta \left(\frac{\zeta_{t+1}^u R_t}{\pi_{t+1}} \right) \tag{15}$$

$$\zeta_t^u = \beta \left\{ \zeta_{t+1}^u \left[(1-\tau_{t+1}) \left(r_{t+1}^k - \delta \right) + 1 \right] \right\} \tag{16}$$

N first order conditions, one for each type p_t, identify the Lagrange multipliers on the bank accounts

$$\lambda_t^u(p_t) = \frac{u_c\left(c_t^u(p_t), l_t^u(p_t)\right)}{1 + s\left(\frac{c_t^u(p_t)}{m_t^u(p_t)}\right) + \frac{c_t^u(p_t)}{m_t^u(p_t)} s'\left(\frac{c_t^u(p_t)}{m_t^u(p_t)}\right)} \tag{17}$$

where $\lambda_t^u(p_t = 0) = \zeta_t^u$ for $p_t = 0$. Similarly, N money demand condition are driven by:

$$1 - \left[\frac{\beta}{\pi_{t+1}} \frac{\lambda_{t+1}^u(p_t)}{\lambda_t^u(p_t)} \right] = s'\left(\frac{c_t^u(p_t)}{m_t^u(p_t)}\right)\left(\frac{c_t^u(p_t)}{m_t^u(p_t)}\right)^2 \tag{18}$$

Average values for consumption, money holdings and marginal utility of unconstrained households are, respectively, as follows:

$$c_t^u = \sum_{p=0}^{N-1} \frac{1}{N} c_t^u(p) \tag{19}$$

$$m_t^u = \sum_{p=0}^{N-1} \frac{1}{N} m_t^u(p) \tag{20}$$

$$\lambda_t^u = \sum_{p=0}^{N-1} \frac{1}{N} \lambda_t^u(p) \tag{21}$$

2.4 Firms

Perfectly competitive final good firms buy differentiated goods $z \in (0,1)$ from intermediate firms and assemble them into a final good bundle, $y_t^d = \left[\int_0^1 y_t(z)^\rho \, dz\right]^{\frac{1}{\rho}}$, which can be used both for consumption and for investment. The optimality condition reads as follows:

$$y_t(z) = y_t^d \left[\frac{P_t(z)}{P_t}\right]^{\frac{1}{\rho-1}} \tag{22}$$

where $P_t = \left[\int_0^1 P_t(z)^{\frac{\rho}{\rho-1}} \, dz\right]^{\frac{\rho-1}{\rho}}$ is the price index.

The representative intermediate firm produces a differentiated good under a standard Cobb-Douglas technology:

$$y_t(z) = a_t l_t(z)^\alpha k_{t-1}(z)^{1-\alpha} \tag{23}$$

where a_t is stochastic total factor productivity. Pricing decisions for intermediate goods are subject to a quadratic costs of nominal price adjustment (Rotemberg (1982)):

$$\frac{\xi_p}{2} y_t^d \left[\frac{P_t(z)}{P_{t-1}(z)} - 1\right]^2 \tag{24}$$

As a result the standard Phillips curve reads as:

$$\frac{(\rho - mc_t)}{1-\rho} + \xi_p \pi_t (\pi_t - 1) = \beta E_t \left\{ \frac{y_{t+1}^u \zeta_{t+1}^u}{y_t \zeta_t^u} \xi_p \left[\pi_{t+1}(\pi_{t+1} - 1)\right] \right\} \tag{25}$$

where mc_t are the real marginal costs.

Cost minimization implies the following factor demands:

$$w_t = a_t \alpha mc_t \left(\frac{l_t}{k_{t-1}}\right)^{\alpha-1} \tag{26}$$

$$r_t^k = a_t (1-\alpha) mc_t \left(\frac{l_t}{k_{t-1}}\right)^{\alpha} \tag{27}$$

Finally, firm profits are

$$\frac{\Pi_t}{P_t} = a_t l_t^\alpha k_{t-1}^{1-\alpha} - w_t l_t^d - r_t^k k_{t-1} - \frac{\xi_p}{2} a_t l_t^\alpha k_{t-1}^{1-\alpha} (\pi_t - 1)^2 \tag{28}$$

2.5 Aggregation

Equations (29)-(34) define aggregate consumption, aggregate hours, aggregate real money balances, bonds, profits, aggregate capital and total output:

$$c_t = (1-\theta) c_t^u + \theta c_t^c \tag{29}$$

$$m_t = (1-\theta) m_t^u + \theta m_t^c \tag{30}$$

$$B_t^u = \frac{B_t}{1-\theta} \tag{31}$$

$$\Pi_t^u = \frac{\Pi_t}{1-\theta} \tag{32}$$

$$k_t^u = \frac{k_t}{1-\theta} \tag{33}$$

$$y_t^d = (1-\theta)\, c_t^u \left(1 + s(\frac{c_t^u}{m_t^u})\right) + \theta c_t^c \left(1 + s(\frac{c_t^c}{m_t^c})\right) + k_t - (1-\delta)\, k_{t-1} + \tag{34}$$
$$+ g_t + \frac{\xi_p}{2} y_t \left(\pi_t - 1\right)^2 + (1-\theta)\, \frac{\xi_w}{2} l_t^u \left(\frac{w_t^u \pi_t}{w_{t-1}^u} - 1\right)^2 + \theta \frac{\xi_w}{2} l_t^c \left(\frac{w_t^c \pi_t}{w_{t-1}^c} - 1\right)^2$$

2.6 Government

Government expenditures, g_t, are financed by labor and capital income taxes, by money creation and by issuance of one-period, nominally risk free bonds. The government flow budget constraint is then given by

$$R_{t-1} \frac{B_{t-1}}{P_t} + g_t + t_t = \tau_t^l w_t l_t^d + \tau_t^k \left(r_t^k - \delta\right) k_{t-1} + \left[1 - (1 - \tau_t^k)^{\vartheta}\right] \frac{\Pi_t^u}{P_t} + \frac{M_t - M_{t-1}}{P_t} + \frac{B_t}{P_t} \tag{35}$$

The debt consolidation experiment is defined as a sequence of public consumption, tax and inflation rates that allow to achieve in each period a reduction in the debt-to-GDP ratio, $\frac{B_t}{P_t y_t}$, such that a 20% reduction is obtained over a 10-year horizon. This implies that dynamics for real debt, b_t, is defined as follows

$$\frac{b_t}{y_t} = \frac{b_{t-1}}{y_{t-1}} - \rho^b;\ 0 < t \leq T \tag{36}$$

where b_0 is set equal to 80% of pre-consolidation steady state GDP and b_T is the post-consolidation amount of debt, equal to 60% of post-consolidation GDP. We set T equal to 10 years, and set ρ^b equal to 0.02, such that the government achieves an equal reduction in the debt to GDP ratio each year during the consolidation period.[4]

3 Equilibrium and Ramsey policy

In this section we define the competitive equilibrium conditions and the optimal Ramsey policy.

[4] Notice that, as usual in Ramsey problems where the government issues non-state contingent nominally riskless debt, the Ramsey steady state is indeterminate, unless public debt is exogenously set. In fact, if the path of public debt is obtained endogenously, its final steady state level depends on its initial value, which implies that there are as many steady states as possible initial inherited debt levels. Furthermore, it is not guaranteed that a public debt reduction is optimal. Our objective in this paper is not to assess the optimality of the decision to reduce public debt, but to identify the best combination of fiscal and monetary instruments that policy-makers can use once the choice to reduce public debt has been taken.

3.1 Competitive Equilibrium

Definition 1 *A competitive equilibrium is a set of plans*

$$\left\{c_t^u, c_t^c, c_t, l_t^u, l_t^c, l_t, \lambda_t^u, \lambda_t^c, mc_t, \pi_t, w_t, w_t^u, w_t^c, m_t^u\left(p_t\right), m_t^c, m_t, y_t, b_t, R_t, k_t, r_t^k, \tau_t^k, \tau_t^l, g_t\right\}_{t=0}^{\infty},$$

that, given initial values $\left\{m_{-1}^u\left(p_{t-1}\right), m_{-1}^c, m_{-1}, b_{-1}, k_{-1}\right\}$ *satisfies the no-Ponzi game condition, the non-negativity constraint* $R_t \geq 1$*, and the competitive equilibrium conditions associated with each case we study as reported in section (2).*

3.2 Ramsey Optimal Policy

Definition 2 *A Ramsey optimal policy is a competitive equilibrium that attains the maximum of the following additive social welfare function*

$$W = E_0 \sum_{t=0}^{\infty} \beta^t \left[\left(1 - X^R\right) \sum_{p=0}^{N-1} \frac{1}{N} u\left(c_t^u(p), l_t^u(p), g_t\right) + X^R u\left(c_t^c, l_t^c, g_t\right)\right] \tag{37}$$

where X^R *is the weight given to constrained households utility.*[5]

The time unit is a year[6] and we set the subjective discount rate β to 0.96 to be consistent with a steady-state real rate of return of 4% per year. We set α and δ at 64% and 8% respectively. The weight of leisure in equation (3), η^i, is set to always obtain that households work about 20% of their time in the pre-consolidation steady state. Parameters concerning monopolistic competition in the goods and labor market, nominal rigidities, the transaction technology and the share of public consumption over GDP in steady state are as in Schmitt-Grohé and Uribe (2004). It follows that the annualized Rotemberg price and wage adjustment costs (ξ_p and ξ_w) are 4.375, monetary transaction cost parameters A and B are set at 0.011 and 0.075 respectively, steady state public consumption is 19% of GDP, parameter ρ is such that in the goods market monopolistic competition implies a gross markup of 1.2 under flexible prices.[7] We also set $\rho_w = \rho$, implying the same degree of monopolistic competition in the goods and labor markets. As for profit taxation, we parameterize ϑ as in Lansing (1998), i.e. $\vartheta = 0, 1, 2$, allowing for no taxation, uniform taxation of all capital incomes, partial double taxation. We found that the choice of ϑ mainly affect the steady state value of τ^k. For sake of expositional simplicity we present results obtained under $\vartheta = 2$.

To characterize infrequent trading, we set $N = 3$, implying that portfolio reoptimization under infrequent trading occurs every three years, in line with the frequency chosen in Alvarez et al.

[5] The Ramsey program is non-stationary because in the first period an incentive exists for the planner to generate inflation or tax "surprises". Following the literature we assume the planner does not engage in such policies (Schmitt-Grohé and Uribe, 2004a). Since the analytical derivation of the first order conditions of the Ramsey plan is cumbersome, we compute them using symbolic Matlab routines. The steady state of the Ramsey program is obtained using the OLS approach suggested in Schmitt-Grohé and Uribe (2011). Dynamics of the Ramsey plan during the transition are computed using Dynare.

[6] In setting the time unit to be a year, we follow the literature. See, e.g., Schmitt-Grohé and Uribe (2004). Tax rate adjustments require a political process that may take time. As a consequence, it may be difficult to change them at quarterly frequency. We feel one year is a much more realistic time lenght. No fundamental result of the paper depends on this assumption.

[7] Calibration of price markups is crucial to define the amount of profits. Jaimovich and Floetotto (2008) report that estimates of gross markups in value added data range between 1.2 and 1.4.

(2009). Finally, the baseline value for the fraction of constrained households, θ, is set at 0.5. This is in line with the proportion of individuals who do not hold retirement accounts in the US.[8]

Table 1 we reports parameter values:

Parameters		Description
β	0.96	Discount Factor
α	0.64	Capital Share
δ	0.08	Depreciation Rate
A	0.011	Trans. Cost Parameter
B	0.075	Trans. Cost Parameter
N	3	Frequency of portfolio optimization
ϑ	$0-1-2$	Degree of profit taxation
ρ	$1/1.2$	Inverse Price Mark-up
ρ_w	$1/1.2$	Inverse Wage Mark-up
ξ_p	4.375	Rotemberg Par. on Prices
ξ_w	4.375	Rotemberg Par. on Wages
θ	0.5	Share of constrained households
g	$0.19y$	Pre-consolidation Public Consumption over GDP
b_0	$0.8y$	Pre-consolidation Public Debt/GDP
b_T	$0.6y$	Post-consolidation Public Debt/GDP
θ	$0, 0.5$	Fraction of constrained households
X^R	$0.4, \theta, 0.6$	Weight of constrained households in planer objective function

Table 1: Calibration

4 Results

We begin our discussion by summarizing results obtained for a number of distinct cases described in Table 2, depending on whether the model incorporates LAMP, $\theta = 0.5 - 0$, and infrequent trading, $N = 3 - 1$. This allows to pinpoint some results concerning steady state effects and transition dynamics for output and policy instruments that seem to hold irrespective of whether or not agents can participate to financial markets. Then, in section 4.1 we focus on the model that incorporates financial frictions, to highlight the different effects of the consolidation for the two households groups and to explain the implications of Infrequent trading.

In Table 3 we report a qualitative description of long run outcomes. In consequence of the reduction in public debt service payments, public consumption increases and both labor and capital income taxes fall. This is associated to positive variations of output, consumption and labor supply. Lower capital income taxes induce an increase in the capital labor ratio, in labor productivity and in the before-tax real wage rate.

[8] Source: Federal Reserve Bullettin, June 2012, Vol 98, No 2. 2010 Survey.

Case description	N	θ	ϑ
1) LAMP, Freq. Trad.	1	0.5	2
2) NoLAMP, Freq. Trad.	1	0	2
3) LAMP, Inf.Trad.	3	0.5	2
4) NoLAMP Inf.Trad.	3	0	2

Table 2: Description of policy experiments

variable response	Case description			
	1	2	3	4
y	+	+	+	+
c	+	+	+	+
l	+	+	+	+
w	+	+	+	+
g	+	+	+	+
τ^k	−	−	−	−
τ^l	−	−	−	−

Table 3: Long-run outcomes

Figure (1) shows transition dynamics for output. It is easy to see that the consolidation always entails a persistent output contraction. The long-run output increase is achieved with a substantial delay relative to the conclusion of the consolidation period.[9] Private consumption also falls during the transition, and only for the frequent trading model we observe a temporary and relatively short-lived increase in private consumption (Figure 2). We also obtain a generalized and persistent increase in inflation (Figure 3); in fact consolidation is associated to stagflation during the first 5 years.

Our results are better understood by looking at policy tool dynamics (Figure 4). In fact we find that concern for the supply of public goods induces the government to raise income taxes, thus bearing the cost of a consumption fall during the transition. Note that higher labor income taxation raises product wages and marginal costs, and the optimal monetary policy accommodates by lowering real interest rates. This entails a substantial and persistent difference between the optimal policy and the one generated by standard Taylor rules based on pure inflation targeting, where the real interest rate should increase following a surge in inflation.

[9] The output contraction is mitigated in the infrequent trading cum LAMP model. We will discuss this latter result in section 4.1 below.

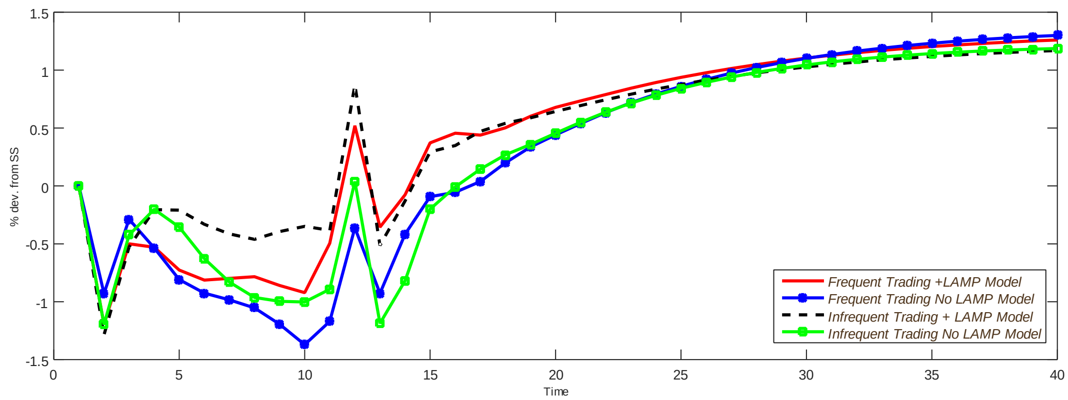

Figure 1: Output dynamics relative to initial steady state

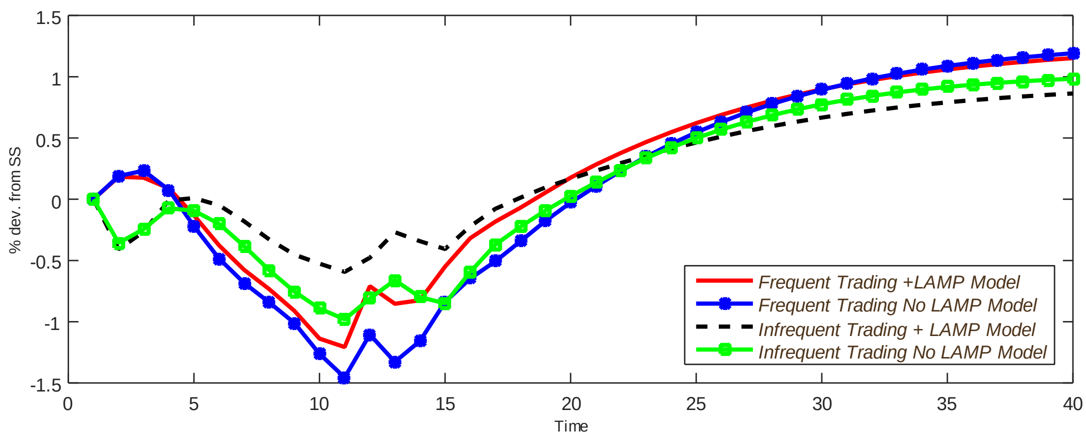

Figure 2: Consumption dynamics relative to initial steady state

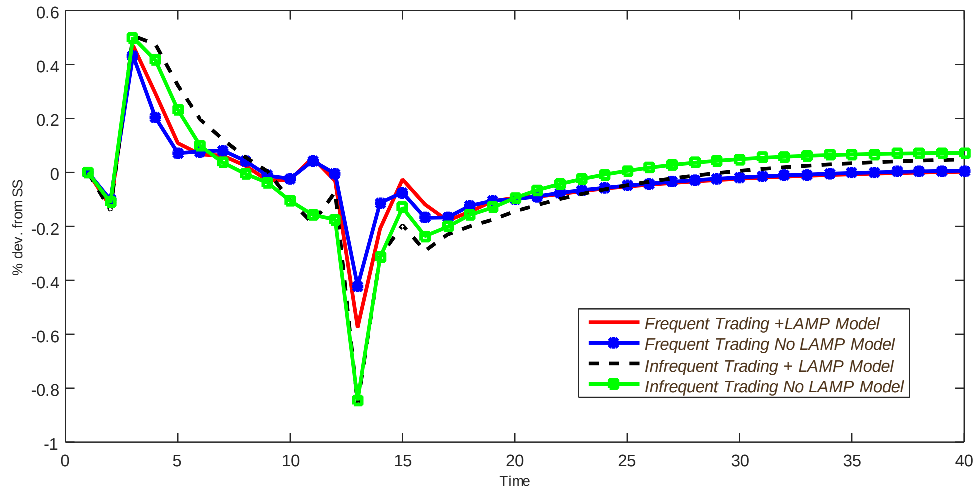

Figure 3: Inflation dynamics relative to initial steady state

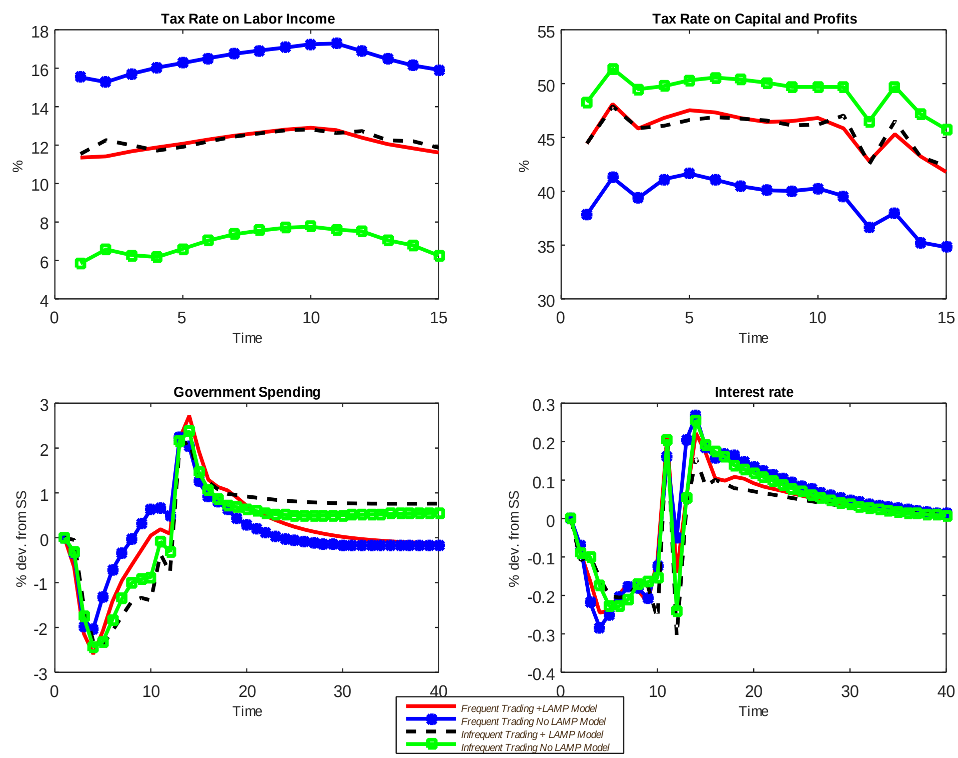

Figure 4: Policy tools during the transition.

4.1 Focus on Frequent and Infrequent trading in presence of LAMP under double taxation

Table 4 reports the pre- and post-consolidation steady state values for the policy variables and for individual consumption and leisure levels. Note that both households groups benefit from a wage increase and raise their consumption. We observe a generalized reduction in taxes and an increase in consumption and labor effort. Unconstrained households react to the income loss by raising their labor effort. Finally, the labor supply of unconstrained households increases, whereas it remains stable for constrained households. This difference is due to the wealth effects determined by lower interest payments accruing to unconstrained households in consequence of the consolidation.

	Frequent Trading			Infrequent Trading		
	Pre-Cons	Post-Cons.	Variation	Pre-Cons	Post-Cons.	Variation
y	0.295	0.299	1.36%	0.297	0.301	1.35%
c	0.189	0.191	1.06%	0.190	0.192	1.05%
c^u	0.237	0.239	0.84%	0.239	0.240	0.42%
c^c	0.140	0.143	2.14%	0.141	0.143	1.42%
l	0.204	0.206	0.98%	0.205	0.207	0.98%
l^u	0.203	0.207	1.97%	0.204	0.210	2.94%
l^c	0.204	0.204	-	0.204	0.204	-
w	0.773	0.775	0.26%	0.772	0.774	0.26%
w^u	0.773	0.774	0.13%	0.772	0.772	-
w^c	0.772	0.776	0.52%	0.773	0.776	0.39%
g	0.060	0.061	1.67%	0.060	0.061	1.67%
τ^k	44.43%	43.88%	-1.24%	44.44%	44.01%	-0.97%
τ^l	11.35%	10.13%	-10.75%	11.54%	10.53%	-8.75%

Table 4: Pre- and Post-consolidation outcomes

Figures (5) and (6) report dynamics during the transition. The main policy differences are that under infrequent trading the planner achieves the budget target through a combination of labor taxes and public consumption which during the transition to the new debt ratio are on average lower than under frequent trading. Note that, due to infrequent trading, consumption decisions of unconstrained households are more dependent from current disposable income, and this induces the planner to limit the labor tax increase. Unlike the case of frequent trading, constrained households cannot escape a consumption fall during the early phase of the consolidation. Labor supply dynamics are now remarkably similar for the two groups, whereas under frequent trading the labor tax increase causes a stronger contraction in the unconstrained households' labor supply.

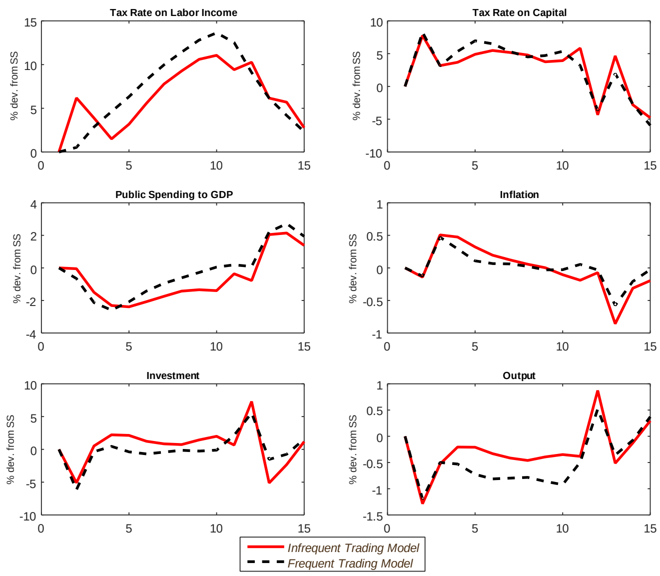

Figure 5: Policy tools dynamics under Frequent and Infrequent trading

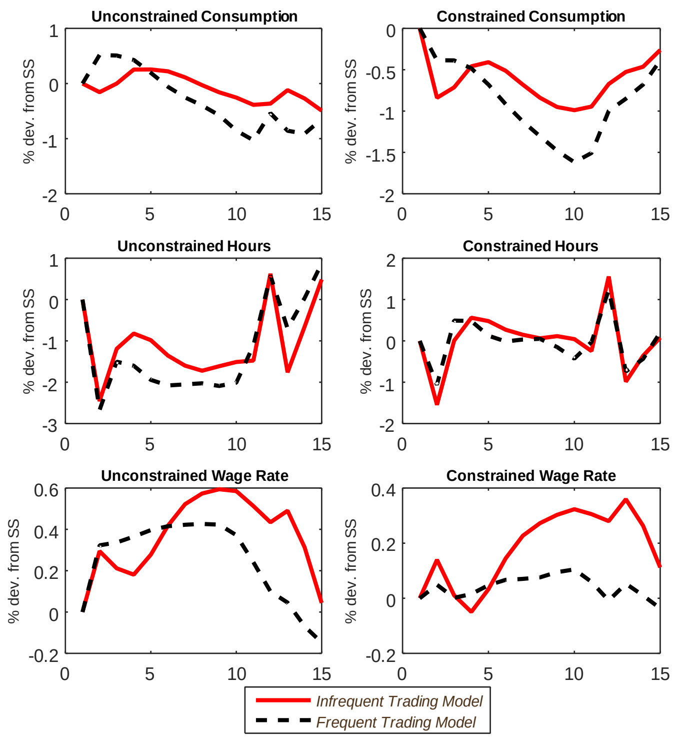

Figure 6: Macro variables' dynamics under Frequent and Infrequent trading

In analogy to Ascari and Ropele (2012), to quantify welfare effects of the consolidation we use the consumption equivalent measure, CE, i.e. the fraction of steady state consumption equivalent to the welfare gain (loss) generated by the consolidation.[10]

Note that in the post-consolidation steady state there is a reduction of interest payments on public debt, which are received only by unconstrained households. By contrast, the lower factor income taxes benefit both groups.[11] As a result, unconstrained households obtain a relatively small gain. During the transition this result is reversed: constrained households are able to smooth consumption and labor efforts, whereas unconstrained households suffer larger losses.

	Frequent Trading	Infrequent Trading
	Post consolidation steady state	
Unconstrained HH	0.20%	0.38%
Constrained HH	1.77%	1.99%
Entire economy	0.98%	1.18%
	Transition	
Unconstrained HH	-0.16%	-0.22%
Constrained HH	-1.37%	-1.48%
Entire Economy	-0.76%	-0.85%
	Total	
Unconstrained HH	0.04%	0.15%
Constrained HH	0.40%	0.50%
Entire Economy	0.22	0.33%

Table 5: Consumption equivalent welfare gains from consolidation

4.1.1 Distributional conflicts

To assess the importance of distributional conflicts, we highlight how transitional dynamics change if the weight of unconstrained households utility in the planners objective function takes values 0.4 and 0.6. Results are striking: an increase (fall) in the weight attached to constrained households induces the planner to drastically reduce (raise) labor taxes, and to raise (reduce) capital income taxes and inflation. Constrained households also prefer a stronger reduction in public expenditure, whereas public consumption increases when the weight of unconstrained households falls. Similar results obtain under infrequent trading.[12]

When $\theta = 0.6$ in the planner's objective function, the combination of higher inflation and lower labor taxes has a powerful positive effect on constrained households' consumption. Similarly, the larger real interest rate fall and the stronger increase in capital income taxation reduce investment relative to the baseline scenario inducing a persistent increase in unconstrained households' consumption. Given the very large fall in labor taxes, a stronger fall in public consumption is

[10] The consumption equivalent measure is calculated as $1 - \exp\left[(1-\beta)\, V^i_{new} - V^i_{old}\right]$, where V^i_{new} is the expected utility value for agent i once consolidation takes place, whereas V^i_{old} is the expected utility valute for the agent before the consolidation experiment.

[11] Capital income taxes raise the capital-labor ratio and consequently increase the wage rate. This, in turn, indirectly benefits constrained households.

[12] It is interesting to note that when we drasticaly reduce steady stat profits by setting $\rho = 0.99$ such conflicting views on the optimal consolidation plans persist albeit on a more limited scale. Results available upon request.

necessary to secure debt consolidation. In this case we do observe an expansionary consolidation: output initially overshoots its long-run increase.

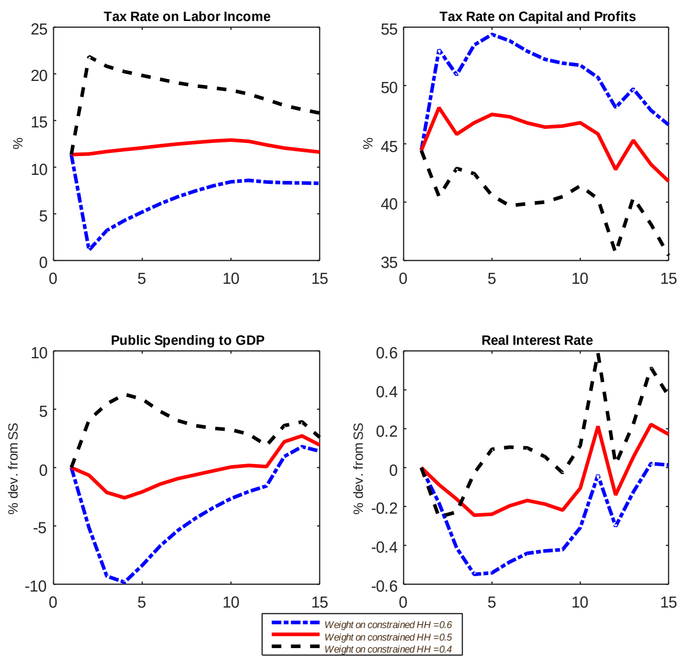

Figure 7: Policy tools under different weight on Non-optimizing households in Frequent Trading Model

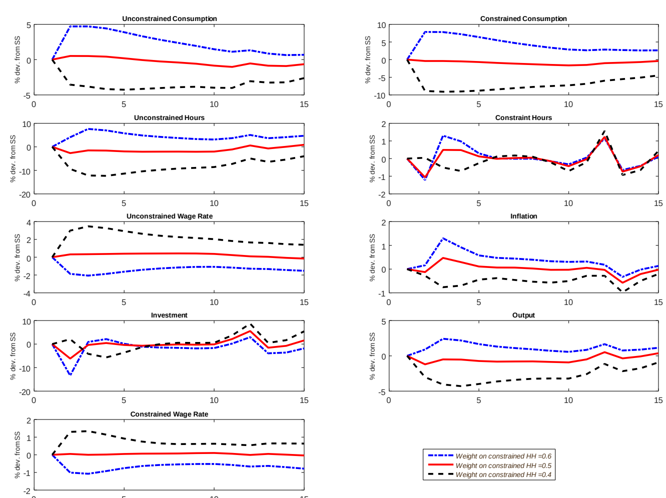

Figure 8: Frequent Trading Model. Macro-variables under different weight on constrained households

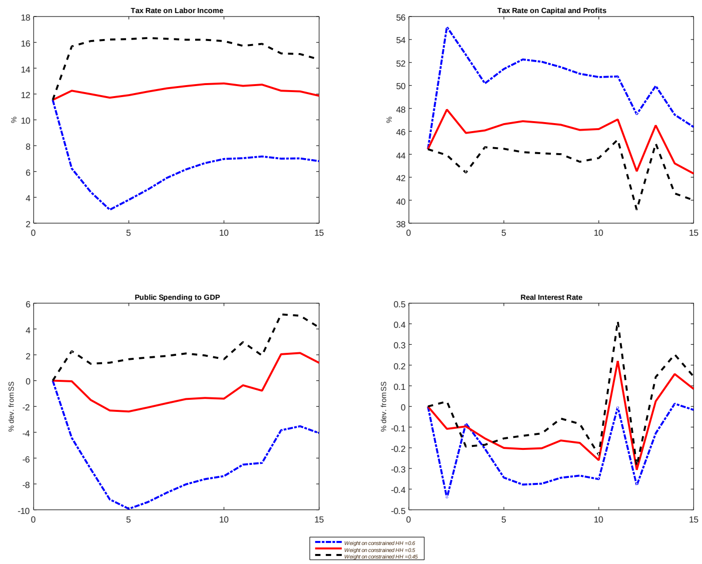

Figure 9: Infrequent Trading Model. Policy tools under different weight on constrained households.

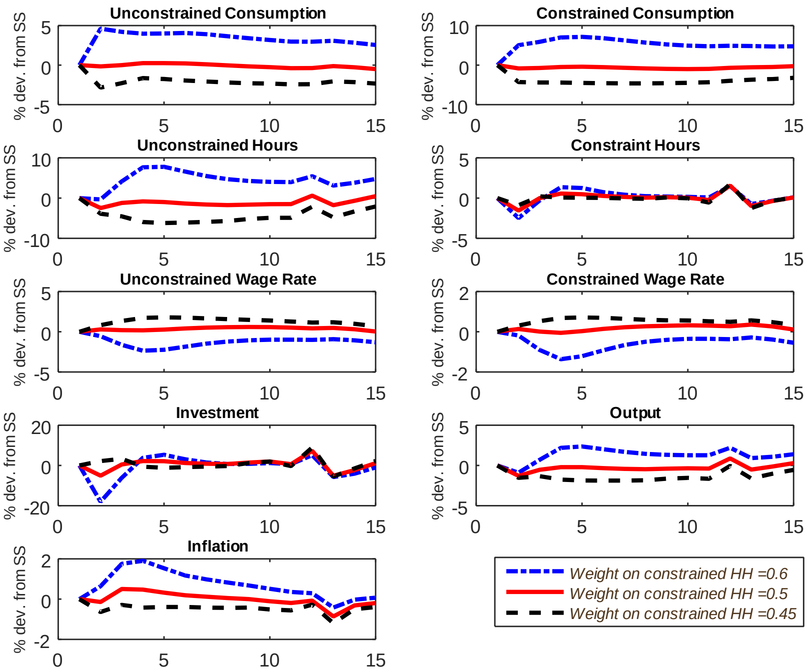

Figure 10: Infrequent Trading Model. Macro variables under different weight on constrained households.

5 Conclusions

We adopt a Ramsey-optimal approach to the identification of debt reduction strategies, that is, we identify the optimal policy mix for labor and capital income taxes, public expenditures and inflation designed to achieve an exogenous debt reduction path. Our model accounts for monopoly profits, limited asset market participation and asset holders' infrequent optimization of their portfolio composition between money holdings and other financial assets.

Irrespective of the relative importance of financial frictions, the optimal policy envisages persistent reductions in public consumption and increases in taxes and inflation. A persistent fall in consumption and investment cannot be avoided.

Distributional conflicts arise between asset owners and the rest of the population, implying that the optimal policy plan is crucially affected by the relative weight attached to the two households groups. When asset holders interests are relatively less important in the planner's objective function, labor income taxes and public expenditures are drastically reduced whereas capital income taxes and inflation are increased. It is just in this case the optimal consolidation has short term expansionary effects.

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