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Distortionary Taxation, Rule of Thumb Consumers and the Effect of Fiscal Reforms

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Abstract

We consider a standard growth model augmented with a share of rule of thumb consumers. A Government finances a preset level of public expenditure through flat tax rates on labor and capital income and also makes lump sum transfers to non ricardian consumers. It has been shown in representative agents models with perfect competition that balanced budget rules with endogenous tax rates are likely to generate indeterminacy of the perfect foresight equilibrium. We show that the presence of rule of thumb consumers reduces this possibility. Further, we show that a fiscal reform which features a reduction in the capital income tax rate and leads to the steady state where the welfare of non ricardian agents is maximized could be Pareto improving. This is obtained via a direct redistribution of resources to rule of thumb consumers along the transition path.

1   Introduction

In the last twenty years research in the field of fiscal policy has, mainly, been carried out within the framework of the neoclassical growth model with a representative agent. Early examples are Chamley (1986) and Lucas (1990), while more recent treatments can be found in Chari *et al* (1994) and Woodford and Benigno (2004). There is, however, a fast growing scepticism about the plausibility of such a framework for fiscal policy analysis. The neoclassical growth model assumes that agents use financial markets to smooth consumption over time. On the contrary, empirical evidence suggests that the relationship between consumption and disposable income seems stronger than that postulated by forward looking theories of consumer behavior. Further, the wealth distribution in the Unites States is highly concentrated. Wolff (1998) finds that a 18.5 percent of households have zero or negative net worth, with the percentage increasing to 28.7 percent if home equity is not taken into account. He also accounts that a mere 5 percent of population holds about 60 percent of total wealth. This supports the view that a large fraction of households does not have the means to smooth consumption over time, and states of nature, as required by standard macro-models.

For these reasons Mankiw (2000) suggest the adoption of a new model for the analysis of fiscal policy. His model features next to, standard, forward looking consumers a fraction of "Rule of Thumb" agents who do not hold capital and cannot smooth consumption over time. These agents set their level of consumption according to a simple rule of thumb: they consume their available income in each period. The simple heterogeneity between households, breaks the Ricardian Equivalence an has relevant consequences for the conduct of fiscal policy. For this reason rule of thumb consumers are also defined as non ricardian consumers and it what follows we will use the two definitions interchangeably.[1]

In this paper we introduce an exogenous fraction of rule of thumb consumers in a neo-classical model augmented with a government sector. The government balances its budget in each period and raises revenues through distortionary taxation of labor and capital income. Tax revenues are used to finance a constant level of public expenditure and to provide lump sum transfers to rule of thumb consumers. Our model departs from Mankiw (2000) since it features endogenous labor supply of both ricardian and non ricardian agents.

We derive analytically a series of results concerning the steady state of the economy. First we show that given tax rates on labor and capital income the steady state is unique. Second, assuming a non separable CRRA period utility function, we show that the presence of rule of thumb consumers does not affect the value of aggregate variables. In particular, although non ricardian consumers cannot accumulate capital, the aggregate steady state stock capital is not affected by their numerical importance in the economy. This leads to the third of our result concerning the steady state, namely that a larger share of rule of thumb consumers leads to a higher individual capital holding for ricardian agents and throughout this channel positively affects their steady state welfare.

Having described the steady state we focus on its dynamic properties. Smitt-Grohè and Uribe (1997) show, in a deterministic standard growth model, that a balanced budget rule where tax rates vary endogenously is likely the generate indeterminacy of the perfect foresight equilibrium. We find that indeterminacy regions in the relevant space shrinks as the share of non ricardian consumers increases. We interpreter this result as suggesting that when a fraction of agents is strongly financially constrained a balanced budget rule is less likely to deliver indeterminacy.

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[1] This terminology is due to Galì *et al* (2004). Simmetrically standard forward looking households are defined as ricardian households.

Next we consider the design of fiscal policy in the long run. We restrict our attention to steady state welfare maximizing or golden rule fiscal policies. We characterize numerically golden rule policies under alternative specification of social preferences. Under all the specifications we consider, we find that a government concerned with steady state welfare maximization should rely more heavily on taxation of labor income rather that on taxation of capital income. In particular, no matter the specification of social preferences, the golden rule tax rate on capital income is lower that the actual tax rate on capital income in most of industrialized countries.

Finally we evaluate the welfare effect of some fiscal reforms. Starting from an initial steady state, where tax rates are calibrated to the average values for the United States, we assume that tax rates are set to the golden rule level and kept constant throughout the transition to the golden rule steady state. Lump sum transfers (taxes) to non ricardian consumers are used to balance the government budget in each period. When tax rates are set to the levels which maximize steady state welfare on non ricardian consumers we find that the policy is Pareto improving, even considering the whole transition path to the golden rule steady state. Although the reform implies a substantial reduction in the capital income tax rate compensated by an increase in the tax rate on labor income, we find that rule of thumb consumers experience a welfare gain. This result differs from those reported in other studies which consider fiscal reforms in heterogeneous agents models. For example Garcia-Milà et al (2001) and Heathcote and Domeij (2003) find that a reduction in capital income tax rate harms wealth-poor agents. The different result is due to the presence of lump sum transfers to rule of thumb consumers. In other words a reduction in capital income taxation may be favoured by all agents in the economy when it is accompanied by an effective redistributive policy.

The paper is laid as follows. Section 2 outlines the model. Section 3 provides an analysis of the steady state. Section 4 verifies the dynamic properties of the steady state. Section 5 provides the golden rule fiscal policy. Section 6 studies the welfare effects of alternative fiscal reforms. Section 7 concludes.

2　The Model

2.1　Households

We assume a continuum of households indexed by $i \in [0,1]$. As in Galì *et al* (2004), households in the interval $[0, \lambda]$ cannot access financial markets and do not have an initial capital endowment. The behavior of these agents is characterized by a simple rule of thumb: they consume their available labor income in each period. The rest of the households on the interval $(\lambda, 1]$, instead, is composed by standard ricardian households who have access to the market for physical capital. We assume that Ricardian households hold a common initial capital endowment. Factors' markets are frictionless. The period utility function is common across households and it has the following form

$$U_t = \frac{1}{1-\sigma} \left[C_t\left(i\right) \left(L_t\left(i\right)\right)^{\theta} \right]^{1-\sigma} \tag{1}$$

where $C_t(i)$ is agent *i's* consumption and $L_t(i)$ is leisure. Available time is normalized to unity so that $L_t\left(i\right) + N_t\left(i\right) = 1$, where N_t denotes hours worked. In what follows we restrict our analysis to a deterministic setting.

2.1.1 Ricardian households

Variables relative to ricardian agents are denoted with the superscript o. Period t flow budget constraint of a typical ricardian household is in real terms:[2]

$$C_t^o + I_t^o = \left(1 - \tau_t^l\right) W_t N_t^o + \left(1 - \tau_t^k\right) R_t^k K_{t-1}^o \tag{2}$$

$\left(1 - \tau_t^l\right) W_t N_t^o$ is period t after tax labor income, while $\left(1 - \tau_t^k\right) R_t^k K_{t-1}^o$ is after tax capital income obtained from renting the capital stock to firms at the real rate R_t^k. Notice that there is no depreciation allowance in the tax structure. The stock of physical capital evolves according to:

$$K_t^o = I_t^o + (1 - \delta) K_{t-1}^o \tag{3}$$

where I_t^o denotes investment. Ricardian households face the, usual, problem of maximizing the discounted sum of istantaneous utility subject to constraints (2), (3) and the time resource constraint, taking taxes as given. Households supply labor until the marginal rate of substitution between leisure and consumption is equal to the net real wage

$$\frac{\theta C_t^o}{1 - N_t^o} = \left(1 - \tau_t^l\right) W_t \tag{4}$$

Consumption/savings decisions are governed by the following Euler condition

$$\frac{1}{\beta} = \left(\frac{C_t^o}{C_{t+1}^o}\right)^\sigma \left(\frac{L_{t+1}^o}{L_t^o}\right)^{\theta(1-\sigma)} \widetilde{R}_{t+1}^k \tag{5}$$

where $\beta = \frac{1}{1+\rho}$ is the discount factor while ρ is the time preference rate. For convenience, we defined $\widetilde{R}_{t+1}^k = \left[(1 - \delta) + \left(1 - \tau_{t+1}^k\right) R_{t+1}^k\right]$.

2.1.2 Non Ricardian households

Variables relative to non ricardian agents are denoted with the superscript rt. Non Ricardian households flow budget constraint is[3]

$$C_t^{rt} = \left(1 - \tau_t^l\right) W_t N_t^{rt} + tr_t^{rt} \tag{6}$$

where tr_t^{rt} denotes individual lump sum transfers. We assume that only agents belonging to this class receive lump sum transfers form the government. Given non ricardian agents cannot save for the future, they simply maximize period utility subject to (6), taking tax rates and transfers as given. The first order necessary condition for labor supply parallels that of ricardian consumers

$$\frac{\theta C_t^{rt}}{1 - N_t^{rt}} = \left(1 - \tau_t^l\right) W_t \tag{7}$$

Substituting (6) into the latter we get

$$N^{rt} = \frac{1}{1 + \theta} - \frac{\theta}{(1 + \theta)} \frac{tr_t^{rt}}{\left(1 - \tau_t^l\right) w_t} \tag{8}$$

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[2]Ricardian agents have simmetric preferences and a common initial capital endowment, further factors' markets are competitive. It follows that they choose the same level of consumption, leisure and investment in each period. For this reasons we treat ricardian households symmetrically.

[3]Notice that we have already abandoned index i for simmetry between ricardian agents.

Notice that transfers exert a positive income effect on non ricardian agents and, thus, affect negatively their labor supply. Absent lump sum transfers, non-ricardian agents would supply a constant amount of hours equal to $\frac{1}{1+\theta}$.[4] Finally substituting (8) into (6) we get

$$C_t^{rt} = \frac{\left(1 - \tau_t^l\right)}{1 + \theta} W_t + \frac{1}{(1 + \theta)} tr_t^{rt}$$

2.2 Firms

The final good is produced by a representative firm with the following CRS production function

$$Y_t = K_{t-1}^\alpha N_t^{1-\alpha} \tag{9}$$

FOCs for profit maximization are given by

$$W_t = (1 - \alpha) A_t K_{t-1}^\alpha N_t^{-\alpha} = (1 - \alpha) \left(\frac{K_{t-1}}{N_t}\right)^\alpha \tag{10}$$

$$R_t^k = \alpha A_t K_{t-1}^{\alpha-1} N_t^{1-\alpha} = \alpha \left(\frac{K_{t-1}}{N_t}\right)^{\alpha-1} \tag{11}$$

2.3 Government

Fiscal policy at time t is denoted by $\left(\tau_t^k, \tau_t^l, tr_t^{rt}\right)$. We assume that the level of public expenditure, G, is constant and exogenous. The government period budget in real terms is

$$TR_t = \tau_t^k R_t^k K_{t-1} + \tau_t^l W_t N_t - G \tag{12}$$

The term $TR_t = \lambda tr_t^{rt}$ represents aggregate transfers to rule of thumb consumers.

2.4 Equilibrium

An equilibrium is defined as a process for allocations and prices together with a government policy $\left\{\tau_t^k, \tau_t^l, tr_t^{rt}\right\}_{t=o}^\infty$ and an exogenous constant level of government expenditure, G, such that:

i) consumer maximize their utility: equations (4), (5) and (7) hold;

ii) rule of thumb agents consume their disposable income: equation (6) holds.

iii) firms maximize profits: equations (10) and (11) are satisfied;

iv) the government budget is balanced is each period: (12) holds;

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[4]The selected period utility implies offsetting income and substitution effect of (permanent) wage changes on labor supply. Non ricardian agents' labor supply would be constant even if the real wage was to increase temporarely because of a positive shock to factor productivity. The higher labor income would be entirely consumed, and the equality of real wage and marginal rate of substitution between leisure and consumption would be ensured through this way. A ricardian agent would, instead, modify his labor supply in the face of a temporary productivty shock. This is because when he faces an unusually high opportunity cost of taking leisure he finds convenient to increase his labor supply and save the higher labor income. It is, thus, the binding budget constraint that makes non-ricardian household supplying a constant amount of labor in the absence of transfers.

v) markets clear. The clearing of factors' markets is given by

$$(1 - \lambda) K_t^o = K_t; \lambda N_t^{rt} + (1 - \lambda) N_t^o = N_t \tag{13}$$

while the clearing of the final good market reads as

$$Y_t = \lambda C_t^{rt} + (1 - \lambda) C_t^o + K_t - (1 - \delta) K_{t-1} + G_t \tag{14}$$

Equations (6), (12), (14) and (13) imply the budget constraint of ricardian agents. For this reason we did not include it between equilibrium conditions.

3 Steady State Analysis

In this section we show that given tax rates on labor and capital income the steady state of the economy is unique. Then, we study how the presence of rule of thumb consumers affects the steady state.

3.1 Existence of the steady state.

In what follows variables without time subscript denote steady state values. Evaluating equations (10) and (11) at the steady state we obtain the steady state real wage and the steady state marginal product of capital, which are respectively

$$W = (1 - \alpha) \left(\frac{K}{N} \right)^\alpha \tag{15}$$

$$R^k = \alpha \left(\frac{K}{N} \right)^{\alpha - 1} \tag{16}$$

Combining the latter with the steady state version of equation (5) uniquely determines the steady state effective capital

$$\frac{K}{N} = \left[\frac{\alpha \left(1 - \tau^k \right)}{[\rho + \delta]} \right]^{\frac{1}{1 - \alpha}} \tag{17}$$

Individual labor supply of non ricardian consumers is

$$N^{rt} = \frac{1}{1 + \theta} - \frac{\theta}{(1 + \theta)} \frac{tr^{rt}}{(1 - \tau^l) W} \tag{18}$$

while that of Ricardian agent reads as

$$N^o = \frac{1}{(1 + \theta)} - \frac{1}{(1 - \lambda)} \frac{\theta \rho}{(1 + \theta) (1 - \tau^l) W} K \tag{19}$$

Steady state consumption levels are instead

$$C^{rt} = \left(1 - \tau^l \right) W N^{rt} + tr^{rt} \tag{20}$$

and

$$C^o = \left(1 - \tau^l \right) W N^o + \frac{\rho}{(1 - \lambda)} K \tag{21}$$

Notice that individual transfers are given by

$$tr^{rt} = \frac{1}{\lambda} \left[\left(\frac{K}{N} \right)^{\alpha} N \left(\alpha \tau^{k} + (1 - \alpha) \tau^{l} \right) - G \right] \tag{22}$$

where $N = \lambda N_{t}^{rt} + (1 - \lambda) N_{t}^{o}$. In the appendix we show that N is uniquely determined by tax rates and model parameters. In this case the steady state is unique.

3.2   Properties of the steady state

Absent non ricardian agents, the model above collapses to a standard Ramsey model augmented with a government sector. In this case, deviations from the efficient, or first best, steady state are due solely to distortionary taxes. We ask whether the presence of a share of financially constrained agents implies an additional efficiency loss beside that induced by taxation of labor and capital income. We denote variables relative to a Ramsey economy with the subscript $\lambda = 0$, thus $X_{\lambda=0}$ is the steady state value of X in a Ramsey economy. In what follows we will refer to an economy where the share of non ricardian agents, λ, is equal to zero as to a Ramsey or standard economy.

Proposition 1 (Efficiency) *The presence of a share of financially constrained consumers does not affect the efficiency of the steady state.*

Proof.   Equation (17) shows that steady state units of effective capital are not affected by the share of non ricardian consumers, λ. For a given government policy, it follows that $\frac{K}{N} = \frac{K}{N}_{\lambda=0}$. This also implies that the steady state wage and the steady state return on capital are equal to those we would get in Ramsey economy: $W = W_{\lambda=0}$ and $R^{k} = R^{k}_{\lambda=0}$. Proving that $N = N_{\lambda=0}$ would suffice to establish the result in the proposition, since it would also imply $K = K_{\lambda=0}$, $Y = Y_{\lambda=0}$ and $C = C_{\lambda=0}$. In the Appendix we show that aggregate labor supply in the model with non ricardian consumers is given by

$$N = \frac{\left(1 - \tau^{l} \right) (1 - \alpha) + \theta G \left(\frac{K}{N} \right)^{-\alpha}}{\left(1 - \tau^{l} \right) (1 - \alpha) (1 + \theta) + \theta \left(\alpha \tau^{k} + (1 - \alpha) \tau^{l} + \rho \left(\frac{K}{N} \right)^{1-\alpha} \right)} \tag{23}$$

Consider a standard economy. The first order conditions for labor supply reads as $\frac{\theta C_{\lambda=0}}{1 - N_{\lambda=0}} = \left(1 - \tau^{l} \right) W$ while the household's budget constraint is given by $C_{\lambda=0} = \left(1 - \tau^{l} \right) W N_{\lambda=0} + \rho K_{\lambda=0} + T R_{\lambda=0}$. Balance budget requires $T R_{\lambda=0} = \left[\left(\frac{K}{N} \right)^{\alpha} N_{\lambda=0} \left(\alpha \tau^{k} + (1 - \alpha) \tau^{l} \right) - G \right]$. Combining the last three equations it can be shown that $N_{\lambda=0} = N$. ■

Intuitively, the selected momentary utility function implies that both consumption and labor supply depend linearly on wealth. In this case wealth distribution does not matter for the determination of aggregate variables. Notice that the presence of lump sum transfers is not necessary for proposition 1 to hold. The next propositions provide some welfare properties of the steady state. In particular, we analyze the welfare implications of the presence of non ricardian consumers.

Proposition 2 (Welfare) *As long as transfers satisfy the participation constraint $\rho \frac{K}{1-\lambda} > \frac{TR}{\lambda}$, ricardian consumers are strictly better off that non ricardian at the steady state. Further, ricardian consumers are strictly better off than the representative agent of a Ramsey Economy.*

Proof. The functional form adopted for momentary utility implies wealth effects on labor supply: agents who enjoy higher consumption also enjoy higher leisure. Comparing equations (18) and (19), we see that if $\rho\frac{K}{1-\lambda} > tr^{rt}$ it follows that $N^{rt} > N^o$, which implies $C^o > C^{rt}$. Given the claim in proposition 1 and since aggregate variables in the economy with non ricardian consumers are weighted averages of individual variables it has to be the case that $C^o > C_{\lambda=0}$ and that $N_{\lambda=0} > N^o$. ∎

Proposition 3 (Welfare Inequality) *Steady state welfare inequality increases as the importance of non ricardian consumers in the economy increases.*

Proof. Equation (22) together with equations (20) and (18) imply $\frac{\partial C^{rt}}{\partial \lambda} < 0$ and $\frac{\partial N^{rt}}{\partial \lambda} > 0$. For what concerns ricardian consumers it easy to see from equations (19) and (21) that $\frac{\partial C^o}{\partial \lambda} > 0$ and $\frac{\partial N^o}{\partial \lambda} < 0$. ∎

Steady state aggregate transfers and the steady state stock of capital are not affected by the value of the share of non ricardian consumers. This implies that individual transfer diminishes as the importance of Rule of thumb consumers in the economy increases. For the same reason a larger share of non ricardian consumers implies a larger individual capital holding for ricardian agents.[5]

4   Analysis of Dynamics.

In this section we verify which combinations of steady state tax rates lead to a unique and stable perfect foresight equilibrium. Smitt-Grohè and Uribe (1997) show, in Ramsey economy, that a balanced budget rule is prone to generate indeterminacy of the perfect foresight equilibrium. Local indeterminacy of the perfect foresight equilibrium implies the existence of stationary sunspot equilibria. In this case the economy may be subject to fluctuations even in the absence of shocks to fundamental variables. We consider a log-linear approximation of the equilibrium conditions around the steady state and study which combinations of steady state tax rates lead to a unique and stable perfect foresight equilibrium. We analyze two alternative fiscal policies within the class of balanced budget rules: (1) No transfers, while capital and labor income tax rates vary proportionally to balance the budget. In this case the government budget is $G = \tau_t^k R_t^k K_{t-1} + \tau_t^l W_t N_t$; (2) fixed tax rates, while transfers to rule of thumb consumers change endogenously to balance the budget in each period. In the latter case the government budget reads as $G + TR_t = \tau^k R_t^k K_{t-1} + \tau^l W_t N_t$.[6]

Calibration is conducted on a quarterly basis. We set $\sigma = 1$ and $\theta = 2$, thus period utility takes a log-log form as in the studies of Prescott (1986) and Plosser (1989). The long run capital income share, α, is set to one-third, which is a standard value for the United States. The depreciation rate, δ, is 0.025, while the discount factor, β, is 0.984. The baseline value assigned to the share of non ricardian consumers, λ, is one half. This is consistent with the estimates in Campbell and Mankiw (1989) and Muscatelli *et al* (2004). It is also the baseline value chosen by Galì *et al* (2004).

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[5]For large values of λ, say larger than a given $\widetilde{\lambda}$, ricardian consumers would cease to supply labor. In this case they would be pure capitalists. In the remainder of the paper we focus on steady state where the labor supply of ricardian agents is stricktly positive. In the appendix we provide the treshold value, $\widetilde{\lambda}$, as a function of governemnt fiscal policy.

[6]Under both policies the level of government expenditure is that which balances the Government budget at the steady state. Under policy 2 steady state government purchases represent 80% of total government expenditure, while the the remaining fraction of steady state expenditure is represented by transfers.

Figure 1 depicts indeterminacy and instability areas in the space $\left(\tau^l, \tau^k\right)$ under policy 1. In panel a reports the case $\lambda = 0$, panel b consider the baseline parameterization, while in panel c we set $\lambda = 0.8$. A first result of our analysis is visually evident:

Result 1. The indeterminacy region shrinks as the share of non ricardian agents increases. Thus in the presence of non ricardian agents a balanced budget rule with endogenous tax rates is less likely to generate indeterminacy of the perfect foresight equilibrium.

As the share of non ricardian consumers increases, the minimum value of the labor income tax rate, τ^l, which could generate indeterminacy gets larger. The latter goes from 55 percent in the case in which the share of rule of thumb consumers is zero (panel a) to 70 percent when non ricardian consumers represent 80 percent of the population (panel c). According to the estimates of average tax rates on labor and capital income provided by Mendoza *et al* (1994), the tax codes of most industrialized countries fall within the determinate regions, no matter the share of non ricardian consumers. In particular, the estimates for the United States suggest an average labor income tax rate, τ^l, equal to 26 percent and a capital income tax rate, τ^k, equal to 39 percent.[7] To understand the economic mechanism behind Result 1 let me consider the thought experiment provided by Smitt-Grohè and Uribe (1997). Assume, initially, that all agents are ricardian and that government expenditure is financed solely through labor income taxation. Suppose that labor income taxes are expected to increase without a fundamental reason. For any given level of the capital stock, future hours worked are lower. This will lead to a reduction in the return on capital. Intertemporal substitution calls for lower current investment and throughout this way there is a decrease in current labor supply and in the tax base. The balance budget requirement forces the government to increase the current labor income tax rate. Expectations of future higher tax rates can be selfulfilled. if the balance budget requirement leads to an increase in the tax rate which is larger that the expected one. We are ready to consider the role of rule of thumb consumers. Policy 1 rules out lump sum transfers to non ricardian agents. In this case their labor supply is constant. Clearly the reduction in current aggregate labor supply due to the expectation of future higher taxes will be lower the higher the share of non ricardian agents. In this case the absence of intertemporal substitution on the side of non ricardian agents confines the likelihood of self-fulfilling expectation to extreme cases.

Turning to policy 2, we find that the perfect foresight equilibrium is stable and unique independently of steady state tax rates. When tax rates are constant, expectation cannot be self-fulfilling. This result is due to Guo and Harrison (2004). Our analysis extends it to an economy where transfers have a redistributive role and part of the agents cannot plan for the future.

In sum, we find that the presence of non ricardian consumers reduce the likelihood of sunspot equilibria under a balanced budget rule where tax rates vary endogenously to balance the budget. However, the tax codes of most industrialized countries fall within the determinate regions independently of the share of non ricardian agents. In accordance to Guo and Harrison (2004) when tax rates are constant and transfers are endogenous there is no room for indeterminacy.

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[7]The estimates in Mendoza *et al* (1994) suggest that France is the European country which relies more heavily on taxation of labor income, with an average tax rate equal to 45.3%. However this tax rate does not fall within the range of labor tax rates which could generate indeterminacy.

5 Constrained optimal policy

When looking at the optimal fiscal policy in the long run there exists a distinction between the constrained and unconstrained policy. The former is constituted by the fiscal policy which maximizes istantaneous utility under the constraint that the steady state conditions are imposed ex-ante. As in Monacelli and Faia (2004) we define this policy as the *golden rule* fiscal policy. In general the golden rule policy does not coincide with the unconstrained long run optimal policy. The latter is the policy that would be chosen in the long run by a planner which cares about agents' lifetime utility and takes as constraints the resources of the economy and the optimality conditions of other economic players. This policy is generally referred to as the long run *Ramsey policy*. Chamley (1986) shows that in the case of a fully credible commitment technology the long run Ramsey policy is characterized by a zero tax rate on capital income. Judd (1988) extends Chamley's famous result to an economy characterized by the simple heterogeneity between households considered in this paper.[8] In what follows we restrict our analysis to golden rule policies.

5.1 Numerical Results

We assume that the government faces an exogenous constant level of public expenditure and chooses fiscal policy in order to maximize the following social welfare function, which is weighted average of non ricardian and ricardian agents steady state utilities

$$\frac{1}{1-\sigma}\left\{\phi\left[C^{rt}\left(1-N^{rt}\right)^{\theta}\right]^{1-\sigma} + (1-\phi)\left[C^{o}\left(1-N^{o}\right)^{\theta}\right]^{1-\sigma}\right\} \tag{24}$$

Constraints to this problem are the steady state versions of equilibrium conditions provided in section 2.6. In particular notice that combining (4) and (7) it follows that each steady state of the model has to be characterized by the relationship $\frac{C^{o}}{C^{rt}} = \frac{1-N^{o}}{1-N^{rt}}$, which says that consumers characterized by a higher level of consumption should also enjoy higher leisure. The steady state counterpart of equation (5) pins down, instead, the steady state after tax return on capital i.e. $\left(1-\tau^{k}\right)R^{k} = \left(\frac{1}{\beta} - 1 + \delta\right)$.

The selected specification of the social welfare function (24) nests alternative social preferences. In what follows we will consider three possible characterization. In the first one we set $\phi = 0$ and feature a government which values uniquely steady state welfare of non ricardian agents. In the second of our specifications we set $\phi = 1$ and characterize a Government which cares solely about welfare of ricardian agents. Finally, in the third scenario, the Government weights welfare levels of the alternative groups according to their importance in the economy, this is accomplished by setting $\phi = \lambda$.

We identify golden rule policies numerically.[9] To evaluate the dependence of our result from the exogenous level of government expenditure, we consider two alternative parameterization of G, which are chosen on the basis of the following empirical observations. Klein *et al* (2003), argue that the United States rely for their government revenues more on the

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[8] Lansig (1999) shows a kinife-edge case where the Ramsey capital income tax could differ from zero. Lansing considers an economy populated by workers and pure capitalists with logarithmic utility, where the government follows a balanced budget rule. He shows that the long run capital income tax could be either positive, negative or zero depending on model's parameters.

[9] In our grid search we allow for subsidies to labor and capital income, i.e. we consider negative tax rates. We let both, τ^{k} and τ^{l}, range from -0.99 to 0.99, with a step equal to 0.01. We also impose a non negativity constraint on transfers to rule of thumb consumers.

taxation of capital relative to the taxation of labor than continental European countries do.[10] There are also significant differences between the United States and continental Europe for what concerns the size of the government. While in the main countries of continental Europe the size of the government is between 40 and 45 percent of GDP, in the U.S. government spending is in the order of 30-35 percent.[11] These facts suggest to consider two alternative parameterizations of government expenditure. The first one, which we define $G^{USA.}$, is that which balances the steady state budget of the model economy when labor and capital income tax rates are set at the level estimated by Mendoza *et al* (1994) for the U.S., that is 39 percent for what concerns capital income taxation and 26 percent for what concerns labor income taxation. The resulting level of government expenditure is 30 percent of steady state output. We regard the latter parameterization to be representative of the fiscal stance and the government size of the U.S.

The second parameterization of government expenditure, G^{EURO}, is meant to be representative of the fiscal stance and government size of a typical continental European country. For this reason we set G^{EURO} at the level which balances the government budget when tax rates on capital and labor income are 29 and 45 percent respectively. This tax code, roughly, represent the estimates of Mendoza et al. (1994) for a typical continental European country. In this case the resulting level of government expenditure is 39 percent of steady state GDP. In what follows the values of σ and θ are kept at their baseline parameterizations. Table 1 reports steady state values of aggregate variables under the alternative parameterization we have just discussed. Recall that this are not affected by the value assigned to the share of non ricardian consumers.

5.1.1 Ramsey Economy

We report the golden rule fiscal policy for a Ramsey economy in Table 1. In this case the social welfare function coincides with steady state utility of the representative agent of a Ramsey economy.[12] Notice that this will represent a useful benchmark when we will evaluate golden rule policies in the presence of non ricardian agents.

Result 2 The golden rule policy in a Ramsey economy features a capital income subsidy when the size of government is relatively small, while it features a capital income tax in the case of a relatively large government sector.

Inspection of Table 2 suggests the following observations. The golden rule tax rate on capital income is lower than the capital income tax rate estimated for both the United States and Europe. On the contrary the golden rule tax rate on labor income is higher than empirical estimates of the actual labor income tax rate.

Independently of its size, a government concerned with the maximization of steady state welfare of agents should rely more heavily on taxation of labor income rather that on taxation of capital income. With respect to this aspect, the tax code of the continental European countries resembles that prescribed by the golden rule optimal policy.

We find, as in Garcia-Milà *et al* (2001), that low capital income taxes stimulate economic activity in the long run. This can be appreciated by observing that while G^{USA} initially

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[10]Considerations relative to the United States also apply to the United Kingdom.

[11]This measurement of government spending includes purchase of goods and social security. Since our scope is that of broadly characterizing the difference in government size between the United States and the continental european countries we simply include everything into G.

[12]This is obtained by setting $\phi = 0$ into (24) and considering consumption and labor supply of the representative agent in a Ramsey economy.

represented 30 percent of total output, it represents 25 percent of output at the golden rule steady state.

Whether the best steady state is characterized by a subsidy or by a tax on capital income depends on the size of the government. When the government has a relatively small size, the best steady state in terms of welfare is characterized by a subsidy to capital income, which is entirely financed through a tax on labor income. Countries characterized by a large government sector should, instead, impose a tax on capital income. Intuitively, when government spending is large providing a capital income subsidy is too costly in terms of the tax rate to be imposed on labor income.

5.1.2   The role of Rule of Thumb consumers.

In what follows we asses whether the presence of rule of thumb consumers affects the golden rule fiscal policy. Table 2 depicts the golden rule fiscal policy in the case $\phi = 0$, that is when the social planner computes golden rule policy from the standpoint of ricardian agents.

Result 3 As the share of non ricardian consumers gets larger, the golden rule fiscal policy from the standpoint of ricardian features a larger capital income subsidy.

A capital income subsidy leads to larger steady state stock of capital. Notice that a one unit increase in the aggregate stock of capital leads to an increases of $\frac{1}{1-\lambda}$ units in individual capital holdings. Thus, the benefit which ricardian agents obtain from a capital income subsidy is a positive function of the importance of non ricardian agents in the economy. Combinations of high values of λ and high capital income subsidies would lead to steady states where ricardian consumers are pure capitalists. Since, as mentioned earlier, we focus on outcomes where ricardian agents have a positive labor supply, the capital income subsidy starts decreasing for values of λ equal to 0.7 or larger. When the government sector is relatively large, low values of the share of non ricardian consumers are coupled with a positive tax on capital income. However the tendency to provide a subsidy to capital income as the share of non ricardian consumers gets larger is maintained.

Table 4 depicts the golden rule fiscal policy in the case in which the government computes golden rule fiscal policy from the standpoint on non ricardian agents, that is when we set $\phi = 1$ in (24).

Result 4 Steady state capital income taxation from the standpoint of non ricardian consumers favors a positive tax on capital income.

Non ricardian agents would provide a subsidy to capital income just in the case $\lambda = 0.1$. Result 4 is in sharp contrast with that provided by Mankiw (2000), who finds that golden rule fiscal policy from the standpoint of non ricardian agents features a zero tax on capital income. This discrepancy is easily reconciled considering that Mankiw's model features exogenous labor supply. In that case labor income taxation amounts to lump sum taxation and does not affect the supply of labor. When labor supply is endogenous non ricardian agents' golden rule policy shifts part of the tax burden on ricardian consumers by imposing a tax on capital income. It can be shown that this does not depend on the presence of lump sum transfers.

Finally, Table 5 depicts the case $\phi = \lambda$. The best steady state in terms of welfare is reached with a subsidy to capital income in the case of a low government expenditure. When the government sector is relatively large optimal tax policy calls for a positive tax on capital income.

6 Fiscal Reforms

What would be the welfare consequences of implementing golden rule fiscal policies?

In this section we evaluate the welfare outcomes of some simple fiscal reforms. Starting from a steady state where tax rates are set to the level estimated for the United States and government expenditure is set at G^{USA}, we characterize the transition to the steady states implied by the following three alternative policies:[13]

1. the government set tax rates to the golden rule level from the standpoint of **ricardian agents**;

2. the government set tax rates to the golden rule level from the standpoint of **non ricardian** agents;

3. the government set tax rates to the level which maximizes **average** steady state welfare;

During the transition to the golden rule steady state, government expenditure is held fixed at G^{USA}, while tax rates on capital and labor income are held fixed at the golden rule levels. Lump sum transfers (taxes) to non ricardian consumers adjust endogenously to balance the budget in each period. Remaining parameters are set to the baseline values, thus our simulations feature a share of non ricardian consumers equal to $\frac{1}{2}$. Since there are no random shocks the transition path can be computed exactly.[14]

The initial steady state is taken as a the benchmark for welfare evaluation. Welfare changes due the reforms are measured as the percentage variation in consumption that a consumer should experience to be as well off as under the initial steady leaving leisure unchanged (as in Lucas (1990), Cooley and Hansen (1992) and Garcia-Milà *et al* (2001)). We start analyzing the steady state welfare change, next we take into account the transition path and compute the overall welfare variation. Agent i's steady state welfare change associated to the golden rule fiscal policy $\tau^{gr} = \left\{ \tau^{l,gr}, \tau^{k,gr}, tr^{rt,gr} \right\}$ is the solution for $\Delta C^i(ss)$ to the following equation

$$u\left(C^i\left(1 + \Delta C^i(ss)/100\right), L^i\right) = u\left(C^i(\tau^{gr}), L^i(\tau^{gr})\right)$$

for $i=rt,o$ where $C^i(\tau^{gr})$ and $L^i(\tau^{gr})$ are the levels of consumption and leisure of consumer i at the steady *state* implied by the golden rule policy, and C^i and L^i are consumption and leisure of agent i at the initial steady state. The welfare change considering the transition path is the solution for ΔC^i to the following equation

$$\sum_{t=1}^{2000} \beta^t u\left(C^i\left(1 + \Delta C^i/100\right), L^i\right) = \sum_{t=1}^{2000} \beta^t u\left(C_t^i(\tau^{gr}), L_t^i(\tau^{gr})\right)$$

As in Cooley and Hansen (1991) we compute the transition path for 2000 periods. Next to welfare change measures we also provide a measure of welfare inequality. We measure welfare inequality with the percentage consumption change required to make a non ricardian agent as well off as a ricardian. Thus, steady state inequality under policy τ^{gr} is the solution for $\Delta C_{gr}^{ineq}(ss)$ to the following equation

$$u\left(C^{rt}(\tau^{gr})\left(1 + \Delta C_{gr}^{ineq}(ss)/100\right), L^{rt}(\tau^{gr})\right) = u\left(C^o(\tau^{gr}), L^o(\tau^{gr})\right)$$

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[13]Recall that G^{USA} is set at the level which balances the budget given $\tau^k = 0.39$ and $\tau^l = 0.26$, there are no lump sum transfers to rule of thumb consumers at the initial steady state.

[14]We compute the exact transition path with DYNARE v3.04.

Steady state welfare inequality is lower under policy τ^{gr} than under the benchmark policy if

$$\Delta C_{gr}^{ineq}(ss) < \Delta C^{ineq}(ss)$$

where $\Delta C^{ineq}(ss)$ is welfare inequality at the initial steady state. Welfare inequality considering the transition path is, instead, the value of ΔC_{gr}^{ineq} which solves

$$\sum_{t=1}^{2000} \beta^t u\left(C_t^{rt}(\tau^{gr})\left(1 + \Delta C_{gr}^{ineq}/100\right), L_t^{rt}(\tau^{gr})\right) = \sum_{t=1}^{2000} \beta^t\left(C_t^o(\tau^{gr}), L_t^o(\tau^{gr})\right)$$

6.1 Steady state effect

Under all the policy scenarios we consider, the golden rule tax rate on capital income is lower than that at the initial steady state. As mentioned above, reducing the capital income tax rate favours economic activity in the long run. Table 6 shows that output, capital and the units of effective capital undertake a substantial positive change with respect to the initial steady state in all the cases we consider. Notice that the increase in the units of effective capital also implies that the wage will be higher in the golden rule steady state. Aggregate labor supply is, instead, lower with respect to the pre-reform level. Under policy 1 and policy 3, steady state lump sum transfers are zero, thus non ricardian consumers labor supply is unchanged with respect to that at the initial equilibrium. Non ricardian consumers contribute to the reduction in aggregate steady state hours just under policy 2, whence their receive a positive lump sum transfer. Table 7 reports steady welfare and distributional effects of the reforms. In the new steady state, ricardian consumers are better off than under the initial one for all the policies considered. Non ricardian consumers' welfare is instead reduced with respect to that in the initial steady state just under policy 1, which features a large steady state capital income subsidy. Notice that welfare gains are very high if compared with those relative to models with homogenous agents. Our measure of welfare inequality takes the value 32.25 at the initial steady state: given leisure, consumption of non ricardian agents should increase by 32.25% for them to be as well off as ricardian agents. The last row of table 7 shows that under all policies steady state welfare inequality increases. This suggest that capital holders take the most from the reforms in the long run.

6.2 Effect over the Transition path

Figure 2 and Figure 3 depict the transitional dynamics of the main variables from the initial steady state to the golden rule steady state under the three policies we have described. The transition of the capital stock to its higher level in the golden rule steady state requires an increase in investment. This justifies the sizeable contraction in consumption of ricardian consumers in the aftermath of the reform. Consumption of non ricardian agents diminishes because of higher labor income taxation.

Lump sum transfers, depicted in figure 4, are negative over the transition path under policy 1 and 3, for this reason leisure of non ricardian consumers is lower than at the initial steady state. Under policy 2, instead, lump sum transfers are positive from the outset of the reform, hence non ricardian consumers enjoy higher leisure. The level of leisure in the golden rule steady state is at least as large as that in the initial steady state under all the policies. Table 8 reports welfare changes once the transition path is taken into account. All policies lead to a welfare improvement of ricardian consumers thanks to the reduction in capital income taxation. As mentioned above, policies 1 and 3 feature, mildly, negative transfers to

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non ricardian consumers during the transition path. For this reason non ricardian agents are worse off under policies 1 and 3. On the contrary policy 2, i.e. the policy which maximizes steady state welfare of non ricardian consumers, leads to a Pareto improvement. Although this policy features a reduction in capital income taxation coupled with an increase in the tax rate on labor income, agents who do not hold capital at all enjoy a substantial welfare gain. This result is in contrast with that in Marcet and Garcia-Milà (2001) and Heathcote and Domeij (2004) who find that a reduction in capital income tax rate compensated by an increases in the labor income tax rate worsen welfare of wealth-poor agents. Notice however that the afore mentioned authors do not consider direct redistribution in favor of wealth-poor agents. Our results suggest that a reduction in capital income taxation accompanied by the use off an effective redistributive tool such as lump sum transfers to agents who do not hold capital may constitute a welfare improving policy.

7   Conclusions

We have assessed the consequences of introducing rule of thumb consumers in an otherwise standard Ramsey economy augmented with a government sector. We have obtained two main results. The first one is that balanced budget rules with endogenous tax rates are less likely to generate indeterminacy of the perfect foresight equilibrium when a fraction of the agents in the economy is constrained to consume out of current disposable income. The second one is that a fiscal reform featuring a reduction in capital income taxation, beside generating the standard increase in long-run economic activity, may also be beneficial for agents who do not hold capital at all when it is accompanied by an effective redistributive policy.

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Appendix

This appendix shows in detail the derivation involved to obtain equations (17)-(21). Dropping time indexes from (5) leads to $\frac{1}{\beta} - (1 - \delta) = (1 - \tau^k) r^k$. Combining the latter with (16) uniquely determines the steady state ratio $\frac{K}{N}$ as a function of parameters and tax rates as follows

$$\frac{K}{N} = \left[\frac{\alpha (1 - \tau^k)}{[\rho + \delta]} \right]^{\frac{1}{1-\alpha}}$$

Substituting (15) into the first order condition for constrained consumers labor supply, i.e. equation (18), we obtain

$$N^{rt} = \frac{1}{1 + \theta} - \frac{\theta}{(1 + \theta)} \frac{tr}{(1 - \tau^l)(1 - \alpha)\left(\frac{K}{N}\right)^{\alpha}} \tag{25}$$

The government runs a balanced budget policy, thus steady state aggregate transfers are given by $TR = \left(\tau^k R^k K + \tau^l W N - G \right)$. Since $R^k K = \alpha \left(\frac{K}{N}\right)^{\alpha - 1} K$ and $WN = (1 - \alpha)\left(\frac{K}{N}\right)^{\alpha} N$, it follows that

$$TR = \left[\left(\frac{K}{N} \right)^{\alpha} N \left(\alpha \tau^k + (1 - \alpha) \tau^l \right) - G \right] \tag{26}$$

Dividing aggregate transfer by λ and substituting into equation (25) leads to individual hours of non ricardian consumers, which reads as

$$N^{rt} = \frac{1}{1 + \theta} \left[1 + \frac{1}{\lambda} \frac{\theta G}{(1 - \tau^l)(1 - \alpha)\left(\frac{K}{N}\right)^{\alpha}} \right] - \frac{\theta}{\lambda(1 + \theta)} \frac{\alpha \tau^k + (1 - \alpha) \tau^l}{(1 - \tau^l)(1 - \alpha)} N \tag{27}$$

The latter is a function of aggregate hours, exogenous public expenditure and the tax rates. We now turn to the determination of variables relative to ricardian consumers. Ricardian agents' steady state budget is

$$C^o + \delta K^o = \left(1 - \tau^l \right) W N^o + \left(1 - \tau^k \right) R^k K^o$$

Using equation (16), it reduces to

$$C^o = \left(1 - \tau^l \right) W N^o + \frac{\rho}{1 - \lambda} K$$

where we also used the identity $K^o = \frac{1}{1-\lambda} K$. Notice that a larger share of liquidity constrained agents leads to a higher steady state capital income for ricardian agents. The steady state version of the first order condition for labor supply is $N^o = 1 - \frac{\theta C^o}{(1 - \tau^l) W}$. Substituting equation (21) into the previous and rearranging yields

$$N^o = \frac{1}{(1 + \theta)} - \frac{\theta \rho}{(1 + \theta)(1 - \lambda)(1 - \tau^l)(1 - \alpha)} \left(\frac{K}{N} \right)^{1-\alpha} N \tag{28}$$

which, as well as hours of non ricardian agents, is a function of aggregate hours, model parameters and tax rates. Aggregate employment is given by

$$N = \lambda N^{rt} + (1 - \lambda) N^o \tag{29}$$

Given tax rates, parameters and public expenditure, equations (27), (28) and (29) constitute a system of three linear equations in the variables N^{rt}, N^o and N. Substituting equations (28) and (27) into equation (29) we recover aggregate hours as a function of parameters, exogenous public expenditure and the fiscal policy chosen by the government:

$$N = \frac{\left(1 - \tau^l\right)(1 - \alpha)(\rho + \delta) + (\rho + \delta)\theta G \left(\frac{K}{N}\right)^{-\alpha}}{\Omega} \tag{30}$$

where

$$\Omega = (1 - \alpha)(\rho + \delta)\left[1 + \theta - \tau^l\right] + \alpha\theta\delta\tau^k + \alpha\theta\rho$$

Finally, substituting equation (30) into equation (28) we recover the value $\widetilde{\lambda}$ after which ricardian consumers ceases to supply labor:

$$\widetilde{\lambda} = 1 - \frac{\theta\rho}{\left(1 - \tau^l\right)(1 - \alpha)}\left(\frac{K}{N}\right)^{1 - \alpha} \frac{\left(1 - \tau^l\right)(1 - \alpha)(\rho + \delta) + (\rho + \delta)\theta G \left(\frac{K}{N}\right)^{-\alpha}}{\Omega}$$

			Steady State Levels					
	τ^k	τ^l	G	$\frac{K}{N}$	Y	K	N	C	$\frac{G}{Y}$
USA	0.39	0.26	0.20	10.94	0.66	3.29	0.30	0.38	0.30
EURO	0.29	0.45	0.27	13.74	0.68	3.91	0.28	0.31	0.39

Table 1: Steady state levels under alternative parameterizations of fiscal variables. USA and EURO denote the parameterizations which mimic fiscal stance and government size in the United States and continental Europe respectively

Golden rule fiscal policy and allocation: Ramsey Economy								
	$\tau^{k,gr}$	$\tau^{l,gr}$	$\frac{K}{N}^{gr}$	Y^{gr}	K^{gr}	N^{gr}	C^{gr}	$\frac{G}{Y^{gr}}$
G^{USA}	-0.12	0.44	27.1	0.79	7.16	0.263	0.41	0.25
G^{EURO}	0.04	0.54	21.7	0.73	5.68	0.262	0.32	0.37

Table 2: Golden rule fiscal policy and allocation in a Ramsey economy under alternative parameterization of government spending

	Golden Rule Fiscal Policy: $\phi = 0$								
	λ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
	$\tau^{k,gr}$	-0.14	-0.17	-0.25	-0.29	-0.36	-0.42	-0.37	-0.08
G^{USA}	$\tau^{l,gr}$	0.45	0.47	0.51	0.53	0.57	0.61	0.57	0.43
	$\frac{tr^{rt,gr}}{C^{rt,gr}}$	0	0	0	0	0	0	0	0
	$\tau^{k,gr}$	0.04	0.02	-0.05	-0.05	-0.11	-0.16	-0.15	0.08
G^{EURO}	$\tau^{l,gr}$	0.54	0.55	0.58	0.58	0.61	0.65	0.64	0.52
	$\frac{tr^{rt,gr}}{C^{rt,gr}}$	0	0	0	0	0	0	0	0

Table 3: Golden rule fiscal policies when planner values welfare of ricardian agents

Golden Rule Fiscal Policy: $\phi = 1$								
λ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
$\tau^{k,gr}$	-0.06	0.00	0.09	0.19	0.15	0.12	0.12	0.12
G^{USA} $\quad\tau^{l,gr}$	0.45	0.47	0.48	0.49	0.41	0.34	0.34	0.34
$\frac{tr^{rt,gr}}{C^{rt,gr}}$	0.29	0.31	0.32	0.34	0.13	0	0	0
$\tau^{k,gr}$	0.11	0.19	0.26	0.21	0.19	0.19	0.19	0.19
G^{EURO} $\quad\tau^{l,gr}$	0.45	0.47	0.48	0.49	0.41	0.34	0.34	0.34
$\frac{tr^{rt,gr}}{C^{rt,gr}}$	0.30	0.31	0.28	0.04	0.001	0	0	0

Table 4: Golden rule fiscal policies when planner values welfare of non ricardian agents

Golden Rule Fiscal Policy: $\phi = \lambda$							
λ	0.1	0.2	0.3	0.4	0.5	0.6	0.7
$\tau^{k,gr}$	-0.1	-0.1	-0.1	-0.1	-0.1	-0.07	-0.07
G^{USA} $\quad\tau^{l,gr}$	0.43	0.43	0.43	0.43	0.43	0.42	0.42
$\frac{tr^{rt,gr}}{C^{rt,gr}}$	0.012	0	0	0	0	0	0
$\tau^{k,gr}$	0.03	0.03	0.03	0.05	0.05	0.05	0.07
G^{EURO} $\quad\tau^{l,gr}$	0.54	0.54	0.54	0.53	0.53	0.53	0.52
$\frac{tr^{rt,gr}}{C^{rt,gr}}$	0	0	0	0	0	0	0

Table 5: Golden rule fiscal policies when planner values average welfare

Golden Rule Steady State							
$\frac{K}{N}$	N	K	Y	C^{rt}	C^o	N^{rt}	N^o
Policy 1							
233.58	-21.73	161.1	16.94	-13.18	2.32	0	-48.723
Policy 2							
64.48	-11.13	46.17	4.89	-1.51	-1.25	-9.29	-13.43
Policy3							
142.34	-11.72	113.95	18.58	2.74	12.63	0	-26.28

Table 6: Percentage change of main variables with respect to initial steady state

Steady state welfare change and welfare inequality			
	Policy 1	*Policy 2*	*Policy 3*
$\Delta C^{rt}(ss)$	-13.17	7.85	2.74
$\Delta C^o(ss)$	42.138	8.70	35.37
$\Delta C^{ineq}(ss)$	116.49	33.3	74.25

Table 7: Steady state welfare change and welfare inequality

Total welfare change and welfare inequality			
	Policy 1	*Policy 2*	*Policy 3*
ΔC^{rt}	-19.49	6.04	-3.42
ΔC^o	13.74	2.07	15.45
ΔC^{ineq}	88.74	27.8	59.28

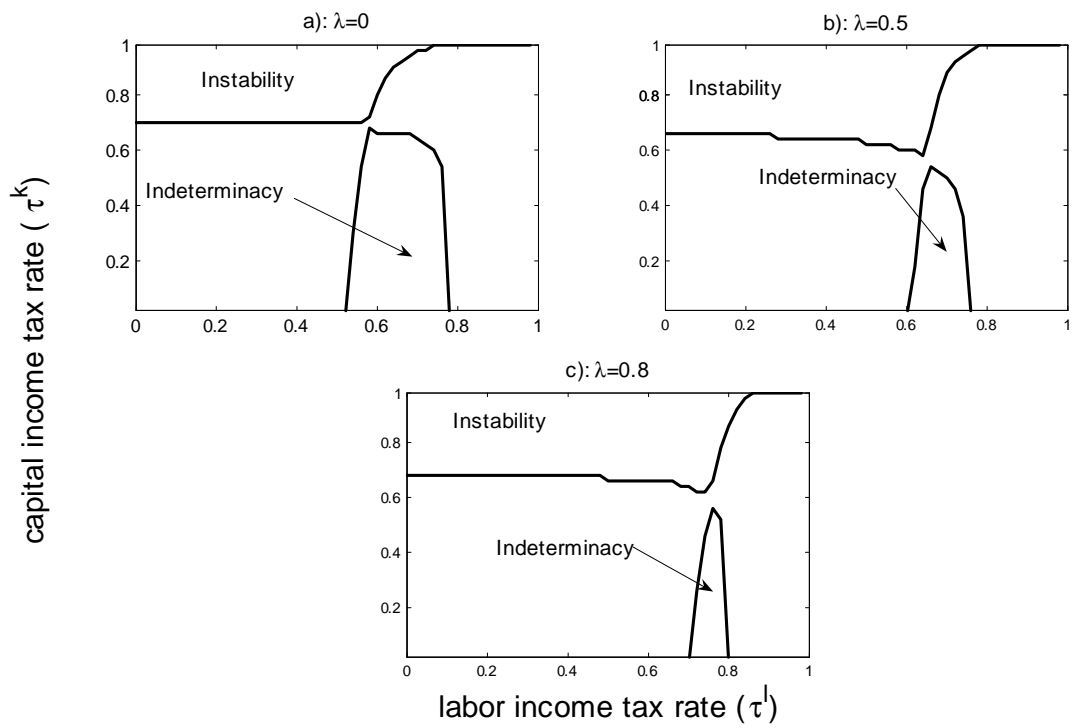Table 8: Total welfare change and welfare inequality (steady state and transition)

Figure 1: Indeterminacy and Instability regions. Panel a) $\lambda = 0$; Panel b) $\lambda = 0.5$; Panel c) $\lambda = 0.8$;
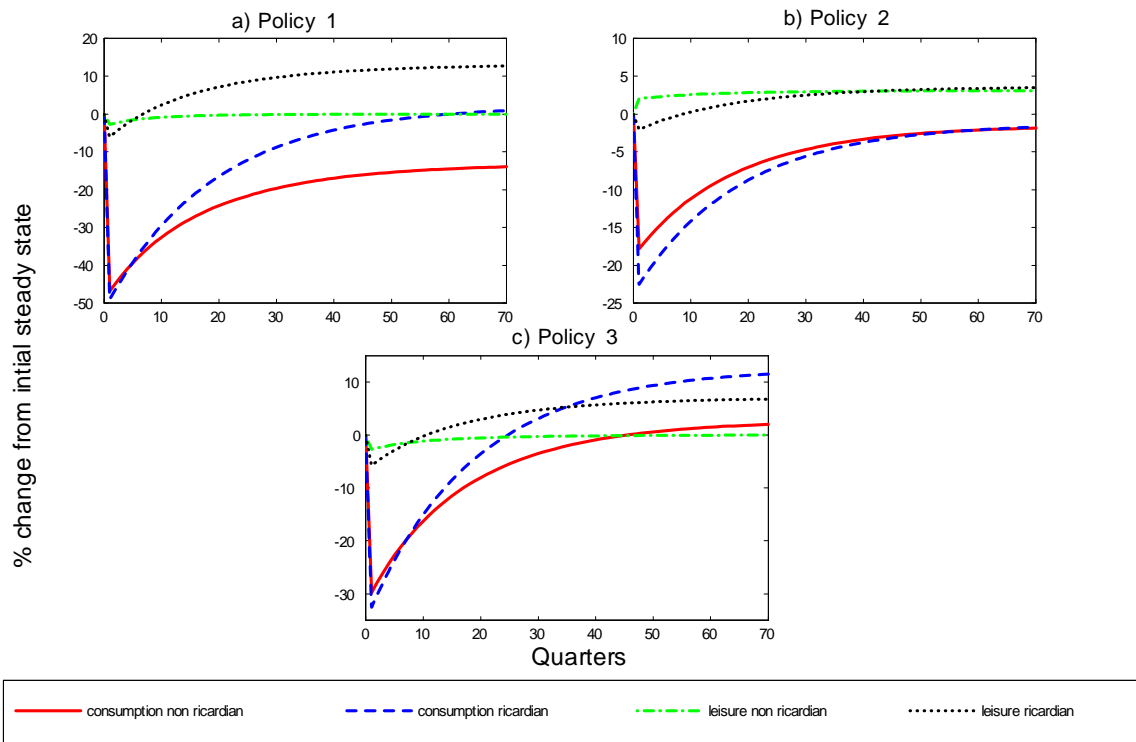
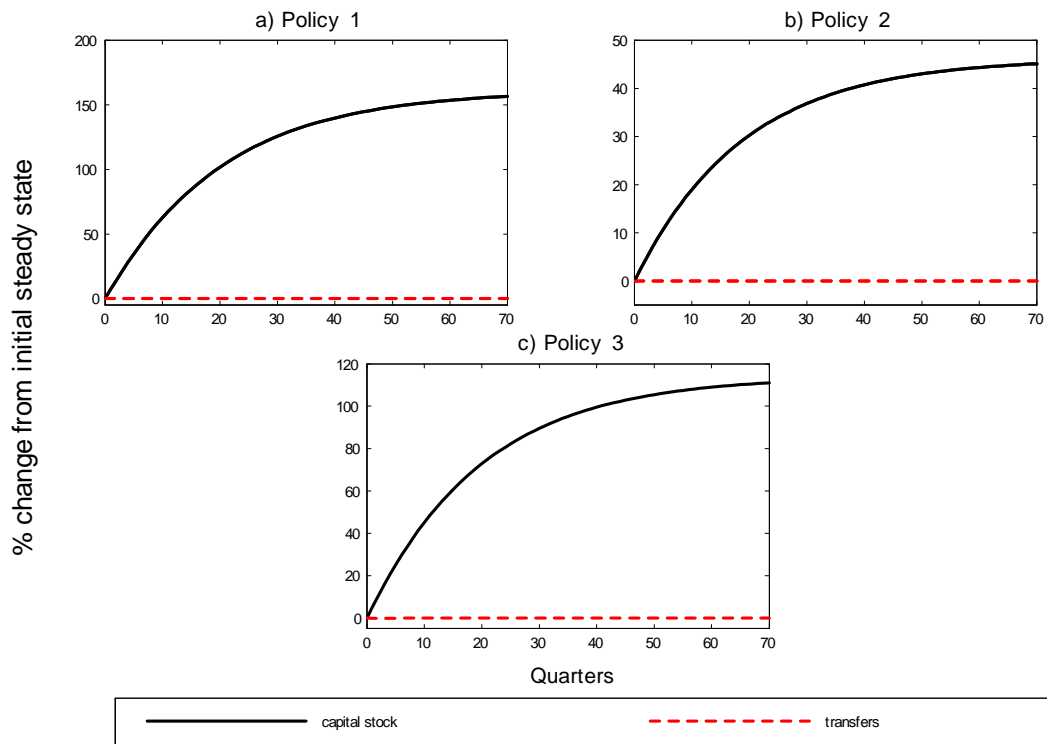Figure 2: Dynamics of consumption and leisure during the transition to the golden rule steady state.

Figure 3: Dynamics of capital and lump sum transfers to rule of thumb consumers during the transition to the golden rule steady state.