Optimal Fiscal Policy with Consumption Taxation*

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Abstract

We characterise optimal fiscal policies in a tractable Dynamic General Equilibrium model with monopolistic competition and endogenous public spending. The government has access to consumption taxation, in addition or as alternative to labour income taxation. First we find that the optimal share of government spending is higher with consumption taxes than with labour income taxation. Then we show that using consumption taxation is welfare superior as this tax component acts as indirect taxation of profits (*intratemporal gains of taxing consumption*) and enables the policy-maker to manage the burden of public debt more efficiently (*intertemporal gains of taxing consumption*). We quantify each of these welfare gains by calibrating the model on the US economy.

JEL classification: E62, H21.
Keywords: fiscal policy, consumption taxation, endogenous government spending.

1 Introduction

What are the benefits from taxing consumption? We answer this question by studying Ramsey fiscal policies in a tractable and deterministic dynamic general equilibrium model that abstracts from capital accumulation, where firms have monopolistic power, public spending directly increases households' utility and the government balances its budget by levying distortionary linear labour income and consumption taxes (but no lump-sum taxes) and by issuing risk-less bonds.

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Compared to a scenario where only labour income taxes are available, we identify and quantify two benefits of taxing consumption. First, consumption taxation serves as indirect taxation of inefficient profits. We call this the *intratemporal gains of taxing consumption.* These intratemporal gains increase with the monopolistic power of firms and disappear under perfect competition. Second, consumption taxation helps to manage more efficiently the price of public debt, via direct manipulations of the households' Euler equation. We call this the *intertemporal gains of taxing consumption.* These intertemporal gains grow with the initial level of public debt and vanish when the initial level of debt is zero. In a numerical exercise aimed to replicate some salient features of the US economy, we find that both gains are quantitatively important. These gains hold under some important extensions of the baseline model, such as non-separability between leisure and consumption and complementarity-substitutability between private and public spending.

Furthermore we show that compared to a scenario where only labour income taxes are available, these two characteristics of consumption taxation allow the policy-maker to set a higher government spending-to-income ratio. For the special case of separable preferences, we are able to present a set of analytical conditions on the optimal provisions of public goods. In particular, if households hold logarithmic preferences in private and public consumption, the optimal share of public-to-private consumption is at the efficient level under consumption taxes, while the same ratio is lower under labour income taxation, and it gets smaller the higher the monopolistic power of firms.

From this, the main contributions and novelties of this paper lay in quantifying and disentangling the different gains from taxing consumption and from presenting a set of analytical conditions on the optimal provision of public spending. Our model sacrifices complexity so that our results may be conveyed transparently, and so that we may obtain analytical results.

This paper links to the existing literature in several ways. First, we contribute to the literature that studies the welfare gains of taxing consumption. The closest contribution can be found in Coleman (2000), who finds, in a deterministic model with capital accumulation and perfect competition, that replacing income taxes with consumption taxes would lead to large welfare gains in the United States. Correia (2010) extends this result to a heterogeneous-agents framework. Two recent contributions highlight the role of consumption taxation as a tool to relax a constraint of the monetary authority on the nominal interest rate, either as a result of the zero lower bound (Correia, Farhi, Nicolini, and Teles, 2013) or in a monetary union (Farhi, Gopinath, and Itskhoki, 2014). However none of these contributions highlights and quantifies the interactions of consumption taxation with monopolistic power, public debt and government spending.

Second, we contribute to the literature on the optimal provision of public goods. Adam (2011) analyses optimal government spending in a New Keynesian model with labour income taxation and finds that, as here, public spending-to-income ratio fall short of its first best level. Klein, Krusell, and Ríos-Rull (2008) study the provision of public spending in a Real Business Cycle model with labour income taxation when the policy-maker may or may not be able to commit to future policies. They find that the optimal share of public spending-to-income is higher under commitment. However this literature does not consider the role of consumption taxation in shaping the optimal provision of public good.

The paper is organized as follows. Section 2 sets up the model. Section 3 presents the policy analysis. Finally, Section 4 concludes.

2 Model

We present a flexible price economy with linear technology in labour, without uncertainty nor capital accumulation, where firms have monopolistic power. The benevolent government finances an endogenously determined level of government spending (g_t) through a proportional labour income tax ($\tau_t^h \in (-\infty, 1)$), a linear consumption tax ($\tau_t^c \in (-1, \infty)$) and by issuing a one-period discount bond (b_{t+1}). Its budget constraint is

$$g_t + b_t = \tau_t^c c_t + \tau_t^h w_t h_t + p_t^b b_{t+1}, \tag{1}$$

where c_t is private consumption, w_t are real wages, h_t represents labour supply and p_t^b is the ex-ante real bond price.

The representative household takes prices and policies as given, chooses consumption, savings via public bond holding (b_{t+1}), and leisure (ℓ_t), with the standard time constraint, $1 = h_t + \ell_t$, in order to maximise the expected discounted value of her lifetime utility, i.e.

$$\max_{c_t,\ell_t,b_{t+1}} \sum_{t=0}^{\infty} \beta^t u\left(c_t, \ell_t, g_t\right), \tag{2}$$

where $\beta \in (0,1)$ is the discount factor. The utility function in (2) is separable across time, twice continuously differentiable, with a constant Frisch elasticity of labour supply. Furthermore we assume that utility is increasing in its three arguments, that is $u_{c,t} > 0$, $u_{\ell,t} > 0$ and $u_{g,t} > 0$, concave, i.e. $u_{cc,t} < 0$, $u_{\ell\ell,t} < 0$ and $u_{gg,t} < 0$, and that allows for non-separability between leisure and consumption and complementarity/substitutability between private and public spending. We indicate respectively with $u_{x,t}$ and $u_{xx,t}$ the first and the second partial derivatives of u_t with respect to the generic variable x at time t.

Both private and public consumption baskets consist of constant-elasticity of substitution aggregators of individual goods i, i.e. $c_t = \left(\int_0^1 c_{it}^{\frac{\epsilon-1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}$ and $g_t = \left(\int_0^1 g_{it}^{\frac{\epsilon-1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}$, where $\epsilon > 1$ is the elasticity of substitution. The household's budget constraint can be written as

$$\left(1+\tau_t^c\right) c_t + p_t^b b_{t+1} = w_t \left(1-\ell_t\right)\left(1-\tau_t^h\right) + b_t + d_t, \quad \forall t, \tag{3}$$

where d_t are the aggregate profits rebated from the monopolistic competitive producers. The household's optimal behaviour is characterised by the following first order conditions

$$\frac{u_{\ell,t}}{u_{c,t}} = w_t \frac{\left(1-\tau_t^h\right)}{\left(1+\tau_t^c\right)}, \quad \forall t, \tag{4}$$

and

$$p_t^b = \beta \frac{u_{c,t+1}\left(1+\tau_t^c\right)}{u_{c,t}\left(1+\tau_{t+1}^c\right)}, \quad \forall t, \tag{5}$$

Examining the household's first-order conditions, the different distortions caused by the two tax instruments become apparent. The labour income tax distorts the (intratemporal) consumption-leisure margin, (4). The current consumption tax distorts the same margin. In addition, both the current and next period's consumption tax enters into the current (forward-looking) Euler equation, (5).

We now present the supply side of the economy. Each of the differentiated goods $i \in [0, 1]$ is produced by one monopolistic firm who employs labour using a linear production technology $y_{i,t} = h_{i,t}$, where $y_{i,t}$ is the output of the generic firm i. Via standard optimality conditions, one can show that the marginal costs for firm i are simply equal to the real wages w_t. Monopolistic competition implies that firms can charge a price higher than their marginal costs. Normalising prices to 1, this implies $\mu_i w_t = 1$, where $\mu_i = \frac{\epsilon}{\epsilon - 1} \geq 1$ represents the (time-invariant) mark-up of firms i over their marginal costs. Finally, firm's i profits are equal to $d_{i,t} = (1 - w_t)\, y_{i,t} = \frac{1}{\epsilon} y_{i,t}$. Note that under perfect competition ($\epsilon \to \infty$) profits will be zero. We concentrate on symmetric equilibrium. Thus the following aggregations hold for any i, 1) $h_{i,t} = h_t$; 2) $y_{i,t} = y_t$; 3) $\mu_{i,t} = \mu_t$; and 4) $d_{i,t} = d_t$. We are now ready to provide a formal definition of the decentralised equilibrium.

Definition 1 (Decentralised Equilibrium)**.** *A decentralised equilibrium consists of government policies,* $\left\{\tau_t^h, \tau_t^c, g_t, b_{t+1}\right\}_{t=1}^{\infty}$, *prices,* $\left\{w_t, p_t^b\right\}_{t=1}^{\infty}$, *and private sector allocations,* $\{c_t, \ell_t, h_t, y_t, d_t\}_{t=1}^{\infty}$, *satisfying, the government's budget constraint, (1); the private sector optimisation taking government policies and prices as given, that is, the household's time constraint,* $\ell_t + h_t = 1$, *budget constraint, (3), and optimality conditions, (4), (5); the market clearing conditions,* $c_t + g_t = y_t$; *the transversality condition* $\lim_{T\to\infty} \beta^T \frac{u_{c,T}}{1+\tau_T^c} b_T = 0$ *and the no-Ponzi game condition* $\lim_{T\to\infty}\left[\left(\prod_{i=0}^{T-1} p_i^b\right) b_T\right] = 0$, *taking the initial level of debt* b_0 *as given.*

3 Ramsey Policy

Our policy exercise starts by defining the efficient allocation of the model.

Definition 2 (First Best). *The Social Planner's Program defines the first-best allocation. This consists of allocations* $\{g_t, c_t, \ell_t, h_t, y_t\}_{t=0}^{\infty}$ *that maximise* (2) *subject to household's time constraint,* $1 = h_t + \ell_t$, *the production function,* $y_t = h_t$, *and the market clearing condition,* $c_t + g_t = y_t$.

Proposition 1 (Social Planner's Problem). *The Social Planner's allocation is*

$$u_{c,t}^{sp} = u_{\ell,t}^{sp} = u_{g,t}^{sp}, \quad \forall t. \tag{6}$$

Proof. The proof is straightforward. First let us substitute the production function into the market clearing condition to eliminate y_t and have a single constraint to the maximisation problem. Then by taking the first order conditions and combining them through the Lagrangian multiplier, we obtain (6). □

Where a variable with the superfix ^{sp} indicates its level in the Social Planner (or first best) allocation. In the first best equilibrium the marginal utilities of private and public consumption must equate the marginal utility of leisure. This simple allocation rule is optimal because it is equally costly to produce public and private consumption goods.

Definition 3 (Ramsey Problem). *The Ramsey policy-maker maximises (2) over the decentralised equilibria. A Ramsey outcome is a decentralised allocation that attains the maximum of (2).*

The first natural question arising in our policy exercise is whether or not the set of fiscal instruments $\left\{\tau_t^h, \tau_t^c, g_t, b_{t+1}\right\}_{t=1}^{\infty}$ suffice the Ramsey policy-maker to decentralise the first-best allocation in (6), for any exogenous level of b_0. The answer is no. As shown more formally in Motta and Rossi (2013), the decentralisation of the efficient allocation requires i) at least one tax instrument between τ_t^h and τ_t^c to be a subsidy, i.e. to be negative; and ii) large government asset positions, i.e. negative b_0. Put it differently, the Ramsey Planner cannot obtain the first best allocation with a generic initial level of public debt b_0, as this would imply either $\tau_t^c < -1$ or $\tau_t^h > 1$. Condition i) is necessary to guarantee that the marginal rate of substitution between leisure and consumption equals 1, while condition ii) is necessary to satisfy the government budget constraint. The reason for this result is the following. Consider, for sake of simplicity, a simplified model with no public spending, no public debt and perfect competition ($\epsilon \to \infty$, so that $w_t = 1 \, \forall t$). This model is static, the market clearing condition is $h_t = c_t$ and consumption and labour income taxes have the same equilibrium tax base. Then, the decentralization of the first best implies $\tau_t^c = -\tau_t^h \, \forall t$. This tax policy would raise zero revenues in equilibrium, i.e. $|\tau_t^c c_t| = | - \tau_t^h h_t|$. However, in the presence of monopolistic competition, i.e. $\epsilon < \infty$, full efficiency implies $-\tau_t^h = \frac{1}{\epsilon-1} + \tau_t^c \frac{\epsilon}{\epsilon-1}$ as the policy-maker needs to compensate households for the fact that the real wage falls short of equating the marginal rate of substitution between consumption and leisure. Given that $\left(\frac{1}{\epsilon-1} + \tau_t^c \frac{\epsilon}{\epsilon-1}\right) h > \tau_t^c c_t$, this policy implies negative revenues in equilibrium.

Moreover, using numerical solutions which we describe in detail below, we find that for any given level of b_0, the policy-maker always finds a marginal welfare advantage in increasing consumption taxation and subsiding labour. This means that a potentially revenue-neutral combination of an increase in the consumption tax and a decrease in the labour income tax, always increases efficiency. However, while this policy will never replicate the first best allocation, it would create extreme tax and subsidy positions. Hence, this policy would be extremely difficult to implement due, for example, to the high costs associated in verifying hours worked. Similarly, a very high consumption tax rate would perhaps lead to a significant amount of unreported barter. Therefore, we study and compare the cases where the Ramsey Planner is constrained in using only one tax instrument, i.e. either $\tau_t^c = 0$ or $\tau_t^h = 0$. This is common practice in the literature when optimal policy implies extreme tax positions, e.g. Coleman (2000), Correia (2010) and Martin (2010). In what follows we are going to express the Ramsey problem with a *primal approach*, i.e. we write the policy problem solely in terms of allocations rather than tax rates.

Proposition 2 (Ramsey Problem with Labour Income Taxes)**.** *For any initial level of debt b_0, the Ramsey policy-maker chooses allocations $\{c_t, \ell_t, g_t\}_{t=1}^{\infty}$ and policies $\{b_{t+1}\}_{t=1}^{\infty}$ in order to maximise (2) subject to* *the feasability constraint* $1-\ell_t = c_t + g_t$ *and the implementability constraint*

$$u_{c,t}c_t + \beta u_{c,t+1}b_{t+1} = u_{\ell,t}\left(1-\ell_t\right) + u_{c,t}b_t + u_{c,t}\frac{1}{\epsilon}\left(1-\ell_t\right), \forall t = 0,1,2,.... \tag{7}$$

Proof. The implementability constraint (7) is obtained by substituting into (3) taxes and real wages via (4) and bond prices via (5) and then imposing $\tau_t^c = 0$. □

Taking derivatives to the associated Lagrangian problem, the optimality conditions are

$$u_{\ell,t}\left(1+\gamma_t\right) - \gamma_t\left[u_{\ell\ell,t}\left(1-\ell_t\right) - \frac{1}{\epsilon}u_{c,t}\right] + u_{c\ell,t}\left\{\gamma_t\left[c_t - \frac{1}{\epsilon}\left(1-\ell_t\right)\right] - \left(\gamma_t - \gamma_{t-1}\right)b_t\right\} = \lambda_t, \tag{8}$$

$$u_{c,t}\left(1+\gamma_t\right) + \gamma_t u_{cc,t}\left[c_t - \frac{1}{\epsilon}\left(1-\ell_t\right)\right] - \left(\gamma_t - \gamma_{t-1}\right)u_{cc,t}b_t - \gamma_t u_{\ell c,t}\left(1-\ell_t\right) = \lambda_t, \tag{9}$$

$$u_{g,t} + \gamma_t\left[u_{cg,t}c_t - u_{\ell g,t}\left(1-\ell_t\right) - u_{cg,t}b_t - u_{cg,t}\left(1-\ell_t\right)\frac{1}{\epsilon}\right] + \gamma_{t-1}u_{cg,t}b_t = \lambda_t, \tag{10}$$

$$\gamma_{t+1} = \gamma_t, \qquad \gamma_{-1} = 0, \tag{11}$$

where $u_{xy,t}$ indicate the cross derivatives of the generic variables x and y at time t and $\lambda_t \geq 0$ and $\gamma_t \geq 0$ denote the Lagrange multipliers attached to the feasibility and the implementability constraints, respectively. Importantly, (11) implies that γ_t must be constant $\forall t > 0$. As presented in Lucas and Stokey (1983), in this class of models the steady-state level of debt is not determined. Given that in the equilibrium γ_t must be constant, all the remaining conditions are identical $\forall t \geq 1$, and so do the values of c, g, ℓ, and b. Thus, the steady-state allocations depend on γ. Equation (9) evaluated at time 0 shows that γ depends on the initial level of debt, b_0. Hence the steady-state of the Ramsey Problem depends on initial conditions.

Next we set out the Ramsey problem for the case of consumption taxation.

Proposition 3 (Ramsey Problem with Consumption Taxes)**.** *For any initial level of debt* b_0*, the Ramsey policy-maker chooses allocations* $\{c_t, \ell_t, g_t\}_{t=1}^{\infty}$ *and policies* $\{b_{t+1}\}_{t=1}^{\infty}$ *in order to maximise (2) subject to the feasability constraint* $1-\ell_t = c_t + g_t$ *and the implementability constraint*

$$u_{c,t}\frac{\epsilon-1}{\epsilon}c_t + \beta u_{\ell,t+1}b_{t+1} = \frac{\epsilon-1}{\epsilon}u_{\ell,t}\left(1-\ell_t\right) + u_{\ell,t}b_t + u_{\ell,t}\frac{1}{\epsilon}\left(1-\ell_t\right) \tag{12}$$

Proof. See Proof to Proposition 2. □

In this case, the first order conditions of the Ramsey problem with consumption taxation can be written as

$$u_{g,t} + \gamma_t u_{cg,t} \frac{\epsilon - 1}{\epsilon} c_t - (\gamma_t - \gamma_{t-1}) u_{\ell g,t} b_t - \gamma_t u_{\ell g,t} (1 - \ell_t) = \lambda_t \tag{13}$$

$$u_{\ell,t} + \gamma_t u_{cg,t} \frac{\epsilon - 1}{\epsilon} c_t - (\gamma_t - \gamma_{t-1}) u_{\ell\ell,t} b_t - \gamma_t (1 - \ell_t) u_{\ell\ell,t} + \gamma_t u_{\ell,t} = \lambda_t \tag{14}$$

$$u_{c,t} + \gamma_t \frac{\epsilon - 1}{\epsilon} (u_{cc,t} c_t + u_{c,t}) - (\gamma_t - \gamma_{t-1}) u_{\ell c,t} b_t - \gamma_t u_{\ell c,t} (1 - \ell_t) = \lambda_t \tag{15}$$

$$\gamma_{t+1} - \gamma_t = 0 \qquad \gamma_{-1} = 0 \tag{16}$$

As in the case of labour income taxes, the steady-state of the Ramsey Problem depends crucially on the initial level of debt b_0. Similarly, the transition from the initial conditions to this steady-state lasts one period. However, under the two different tax instruments, the Ramsey Planner faces different implementability constraints, i.e. (7) versus (12). This implies that, given the same initial level of public debt b_0, and the structural parameters of the economy, the allocations along the transition and in turn the welfare properties of the two policy scenarios will be in general different. The aim of this policy exercise is to explore these differences.

3.1 Analytical Results

We first impose some special conditions to the model that allow us to present a set of analytical results. These results will be instructive to develop transparent economic intuitions. Let us assume that the Utility Function in (2) is separable in its three arguments, i.e. $u_{cg,t} = u_{\ell g,t} = u_{\ell c,t} = 0$ and that displays *log* preferences in private and public consumption, i.e. $-u_{cc,t} c_t = u_{c,t}$ and $-u_{gg,t} g_t = u_{g,t}$.

Proposition 4 (Optimal Government Spending with Labour Income Taxation)**.** *Under labour income taxation, given a generic level of initial outstanding debt b_0, the Ramsey Planner sets*

$$u_{g,t} \geq u_{\ell,t} \;\; and \;\; u_{g,t} \geq u_{c,t}, \;\; \forall t \geq 1, \tag{17}$$

Where the function $\mathcal{G}_t \equiv u_{g,t} - u_{c,t}$*, is monotonically decreasing in* ϵ*, the parameter governing monopolistic power. Under perfect competition,* $\epsilon \to \infty$*,* $\mathcal{G}_t = 0$*, so that the share of government spending to total income is at the efficient level.*

Proof. See Appendix. □

This proposition shows that it is optimal in the presence of monolistic competition to set public consumption below its efficient level . This is because there exists a wedge between the marginal utility of leisure and the marginal utility of consumption, which is composed of two components. First, the monopolistic power that firms hold. Second, the distortive nature of fiscal policy used to finance public spending and public debt. By reducing government spending, the Ramsey Planner can lower the tax rate thus shrinking the wedge between consumption and leisure. Consider, for instance, any increase in inefficiency, due, for example, to more market power. This would dampen economic activity. The Ramsey Planner by adjusting the government size relative to GDP and therefore the level of taxation, can affect households labour supply and private consumption and potentially reduce inefficiency.

Interestingly, under perfect competition, i.e. $\epsilon \to \infty$, the optimal steady-state ratio of public to private consumption would be equal to the one chosen in the efficient allocation, even though labour supply is distorted by the income taxes and indirectly by public debt. It should be noted that this result does not hold in general and depends, in particular, on the utility function that implies under perfect competition that income and substitution effects of taxation on labour supply cancel each other out. In turn, when $\epsilon < \infty$, the extra inefficiency represented by untaxed profits makes the substitution effect of labour supply stronger, thus inducing the Ramsey Planner, other things equal, to reduce the public spending-to-income ratio. For this reason, the logarithmic utility function in private consumption we have chosen is particularly instructive, as it allows to isolate in a transparent way how the interaction between of monopolistic competition and labour income tax affects the optimal provision of public consumption. We now turn our attention to the case when the Ramsey Planner can access consumption taxation.

Proposition 5 (Optimal Government Spending with Consumption Taxes)**.** *Under consumption taxation, given a generic level of initial outstanding debt b_0, the Ramsey Planner sets*

$$u_{g,t} = u_{c,t}, \ \ \forall t \geq 1, \tag{18}$$

and the share of government spending to total income is as in the Social Planner equilibrium.

Proof. See Appendix. □

Under consumption taxation, the Ramsey planner chooses to fix the share of government spending to private consumption as in the efficient allocation independently of the level of long-run public debt or monopolistic power in the economy. This result is driven by the specific shape of the utility function and by the nature of consumption taxation. The log specification of the utility function guarantees that for any change in consumption tax rate, triggered for instance by higher long-run public debt, the substitution and income effect of labour supply are of the same magnitude. At the same time, any change in monopolistic power is absorbed by consumption taxation, which acts as indirect taxation of profits. This latter mechanism is crucial in order to understand the optimal provision provision of public spending and the efficiency gains from taxing consumption. Furthermore, by inspecting Propositions 4 and 5, it results apparent that for any level of long-run level of public debt and monopolistic power, the optimal share of government spending to total output is higher under consumption taxation than under labour income tax.

3.2 Quantitative Analysis

We now turn to numerical methods to find the optimal fiscal policy mix quantitatively with and without consumption taxation. We will also quantify the welfare gains from taxing consumption. In order to see how the allocations and tax rates behave, we solve a calibrated version of our economy. In what follows we specify the benchmark calibration of the model as well as some alternative parametrisations. To this end, we need to make some further assumptions up front. We specify the utility function as,

$$u\left(c_t,\ell_t,g_t\right)=\frac{\left(c_t+\alpha g_t\right)^{1-\sigma}\left(1-\kappa\left(1-\sigma\right)\left(1-\ell_t\right)^{1+1/\varphi}\right)^{\sigma}-1}{1-\sigma}+\omega_g\frac{g_t^{1-\sigma_g}}{1-\sigma_g},\text{for } \sigma\neq 1,\sigma_g\neq 1, \tag{19}$$

and

$$u\left(c_t,\ell_t,g_t\right)=log\left(c_t+\alpha g_t\right)-\kappa\left(1-\ell_t\right)^{1+1/\varphi}+\omega_g log\left(g_t\right),\text{ for } \sigma=1,\sigma_g=1. \tag{20}$$

where φ is the (constant) Frisch elasticity of labour supply and κ is the utility weight of leisure. The parameter α indicates the degree to which government and private consumption are substitute in the *Edgeworth* sense. That is, the marginal utility of private consumption increases (decreases) with public spending if α is negative (positive). The term $\omega_g\frac{g_t^{1-\sigma_g}}{1-\sigma_g}$ allows complementarity (i.e., $\alpha<0$) and avoids that the representative household receives a negative utility stream from government consumption, where ω_g is the utility weight on public goods and σ_g is the curvature of the utility in g. The parameter $\sigma\geq 0$ is the inverse of the constant elasticity of intertemporal substitution (EIS) in the case of $\alpha=0$, while for the general case of $\alpha\neq 0$ the elasticity of intertemporal substitution is also function of private and public consumption. On the same note, when $\alpha=0$, our utility function features a constant income effect of labour supply that is independent from the EIS and it is equal to 1. The model is calibrated at annual frequency on US data over the period 1996-2010. Data are collected from Trabandt and Uhlig (2011). We set the discount factor β to 0.979. This value implies an average annual bond prices of 2.2%. For the benchmark case, we set σ and σ_g equal to 1, so that our benchmark utility specification specialises to (20). We then allow σ parameters to vary in the range $[0.5,2]$, which covers most macro and micro literature on the estimation of the EIS. Given an intertemporal elasticity of substitution equal to 1, we set the Frisch elasticity of labour supply equal to 1 in our benchmark case, a value consistent with Kimball and Shapiro (2008). The micro and macro literature tend to differ on the estimates of the Frisch elasticity. For this reason we also control the robustness of our results with a wide range of values of φ. We calibrate κ such that, given the other parameters, the optimal supply of labour in the efficient equilibrium is the 30% of the time endowment, i.e. $\ell=0.7$. We choose ω_g such that in the efficient equilibrium the ratio of government spending to GDP in $t = 0$ is 20%. In the benchmark case we set $\alpha = 0$, then we allow to vary it in the range of $(-0.5, 0.5)$, consistently with the estimations of Ni (1995) and the parametrisation of Natvik (2009). We calibrate the elasticity of substitution among good varieties ϵ to 6 which implies a price mark-up of around 20%, a value consistent with the data, see for example Rotemberg and Woodford (1998). Given how crucial this parameter is in shaping the optimal government spending under the two tax scenarios, we allow this elasticity to vary between 5 and ∞, that correspond to the high mark-up ($\epsilon = 5$) and to perfect competition ($\epsilon = \infty$) cases. Finally, in our benchmark case we fix the initial level of public debt, b_0 so that the share of debt-to-GDP, γ_b in $t = 0$ equals 0.64. We then solve for the optimal allocation for different values of debt-to-GDP ratios. The complete description of the parametrisation adopted is reported in Table (1).

As explained in Section 3, the Ramsey problem can be recast as a two-period problem, at $t = 0$ and at $t \geq 1$, imposing the extra condition that $\gamma_{-1} = 0$. By doing so, one can find the solution to the Ramsey allocation solving a system of non-linear equations and time 0 and for any $t \geq 1$, given the initial level of debt, b_0.[1]

Table 1: Calibrated Parameters

Parameter	Benchmark	Alternative	Description	Restriction
φ	1	0.2-5	Frisch Elasticity	Literature
σ	1	0.8-2	IES	Literature
σ_g	1	-	Curvature Public Spending	Literature
β	0.979	-	Discount Factor	Data
κ	6.944	Various	Weight of Leisure	Data
ω_g	0.25	Various	Weight of Public Goods	Data
α	0	-0.5-0.5	Edgworth Parameter	Literature
ϵ	6	5-∞	Elasticity of Substitution	Data
γ_b	0.64	0-1.2	Debt-to-GDP Ratio	Data

Table (2) reports the allocations and welfare under the benchmark calibration for the cases of labour income tax and consumption tax, as well as the efficient allocation. A standard result in the optimal taxation literature shows that a Ramsey government has the temptation to influence favourably the bond prices p_t^b given by the Euler equation (5), see Lucas and Stokey (1983) among others. This is the time

[1] We try several solution algorithms (non-linear solvers) and all deliver the same results.

inconsistency problem that affects the Ramsey policy. In a generic period $t \geq 1$ current consumption influences both p_t^b and p_{t-1}^b. As a consequence, if the government uses taxes and public expenditure to increase the price of the bond p_t^b, other things equal, p_{t-1}^b decreases. Instead at $t = 0$ consumers' savings and previous prices (p_{-1}^b) are given. Therefore, if the government inherits a positive level of debt, it can benefit from an increase in the price of the bond (p_0^b) without incurring any additional cost.

Under labour income taxes, this incentive to manipulate bonds prices translates into an increase in initial private consumption c_0, thus fostering the demand for saving, and allowing the government to sell its bonds at a more convenient price. This policy is implemented by reducing τ_0^h below its long run level thus increasing debt and debt-to-income ratio at $t \geq 1$. All in all, the resulting lower interest rate allows the government to sell its bond at a higher price. At the same time, lower taxes in the initial period push households to postpone leisure. As a result, income in the initial period is above its long run level. Finally and consistently with Proposition 4, the public spending income ratio is below the efficient level along the entire transition path.

Under consumption taxation the incentive to manipulate the initial bond prices is lower, as the Ramsey planner can directly boost the initial level of savings via an increase of the tax rate in the initial period. In turn the time inconsistency problem under consumption taxation is less severe than under labour income taxation. This policy allows to reduce debt and debt-to-income ratio for any $t \geq 1$, thus reducing the need of fiscal revenues in the long run. Higher taxes in the initial period create an incentive to postpone labour supply and consumption. As a result, income is lower in $t = 0$ than in the subsequent periods. As shown analytically in Proposition 5, under consumption taxation the government spending to income ratio is at the efficient level for the entire transition path.

The dramatic policy differences between the two tax schemes (labour income vs consumption) imply a substantial welfare gain from taxing consumption. It is interesting to note that the gains from taxing consumption come both from the role that this taxation has in indirectly taxing profits, thus reducing inefficiency, (*intratemporal gains from taxing consumption*) and from the dynamic properties of consumption taxation which allows to reduce debt in the long run (*intertemporal gains from taxing consumption*). In our benchmark calibration, despite the fact that the consumption tax base is smaller than the labour income tax base, taxing consumption rather than labour income can reduce our measure of welfare loss by 22.3%.[2]

Table 2: Tax Rates and Allocations, Benchmark Case

Variable	First Best	$\tau^c = 0$, $t = 0$	$\tau^c = 0$, $t \geq 1$	$\tau^h = 0$, $t = 0$	$\tau^h = 0$, $t \geq 1$
Consumption tax rate	-	0	0	0.400	0.263
Labour income tax rate	-	0.074	0.247	0	0
Hours worked, Income	0.300	0.257	0.236	0.231	0.244
Leisure	0.700	0.743	0.764	0.768	0.756
Consumption	0.240	0.216	0.191	0.185	0.195
Public spending	0.060	0.042	0.045	0.046	0.049
Public debt	-	0.165	0.172	0.148	0.117
Public Debt Price	-	1.104	0.979	1.031	0.979
Consumption-income ratio	0.800	0.838	0.810	0.800	0.800
Public spending-income ratio	0.200	0.162	0.190	0.200	0.200
Public debt-income ratio	-	0.640	0.730	0.640	0.479
Welfare-eq. consumption loss	0	0.063		0.049	

In Table (3) we solve the model with different degrees of monopolistic competition.[3] In order to do so we vary the parameter ϵ. For the high monopolistic case we set $\epsilon = 5$, a value that implies a mark-up of 25%. Then we solve the model under perfect competition, i.e. $\epsilon \to \infty$.[4] This exercise is particularly instructive as it allows to gather a better insight about the welfare gains of taxing consumption, i.e. intratemporal vs. intertemporal gains. This is because the role of consumption taxes as indirect taxation of profits disappears under perfect competition. Hence the resulting welfare gains of taxing consumption

[2]Welfare is calculated in the following way. Let $\{c_t^{sp}, \ell_t^{sp}, g_t^{sp}\}_{t=0}^{\infty}$ be the allocation in the efficient equilibrium and $\{c_t^i, \ell_t^i, g_t^i\}_{t=0}^{\infty}$ the allocation under the generic policy i. The last row in Table 2 reports the percentage increase in consumption υ making the utility in the first best allocation equivalent to the alternative utility under policy i, i.e.

$$\sum_{t=0}^{\infty} \beta^t u\left(c_t^i * (1+\upsilon^i), \ell_t^i, g_t^i\right) = \sum_{t=0}^{\infty} \beta^t u\left(c_t^{sp}, \ell_t^{sp}, g_t^{sp}\right),$$

while the welfare gains of taxing consumption is given by $\left(1 - \frac{\upsilon^{ct}}{\upsilon^{it}}\right)$, where υ^{it} and υ^{ct} are the consumption equivalent welfare losses under labour income and consumption taxation, respectively.

[3]Along the robustness analysis, for brevity reasons, we use the *log* specification of the utility function. In an Online Appendix available at this link, we solve the model with several other combinations of parameters.

[4]In order to mimic the perfectly competitive case, we set $\epsilon = 10^4$.

are generated only by the intertemporal dimension.[5] In our parametrisation, the intertemporal gains of taxing consumption amount to 3.70%. Differently when monopolistic power is high, i.e. $\epsilon = 5$, the role of consumption taxation as an indirect profits tax magnifies (intratemporal gains from taxing consumption). Hence the welfare gains from taxing consumption increases with respect to the benchmark calibration and amount to 24.38%. Moreover it is interesting to see that under labour income tax the share of government spending to total output decreases respect to the benchmark case. As explained in Proposition 4, this is due to the negative substitution effect on labour supply generated by the increase in monopolistic competition which pushes the Ramsey planner to reduce public spending.

Table 3: Tax Rates and Allocations, Monopolistic Power

Variable	First Best	$\tau^c = 0$, $t = 0$	$\tau^c = 0$, $t \geq 1$	$\tau^h = 0$, $t = 0$	$\tau^h = 0$, $t \geq 1$
$\epsilon \to \infty$, $\kappa = 6.944$, $\omega_g = 0.25$					
Consumption tax rate	-	0	0	0.349	0.264
Labour income tax rate	-	0.130	0.215	0	0
Hours worked, Income	0.300	0.277	0.266	0.258	0.267
Leisure	0.700	0.723	0.734	0.742	0.733
Consumption	0.240	0.226	0.213	0.206	0.213
Government Spending	0.060	0.051	0.053	0.052	0.053
Public debt	-	0.177	0.185	0.165	0.143
Public debt price	-	1.041	0.979	1.011	0.979
Consumption-income ratio	0.800	0.816	0.800	0.800	0.800
Public spending-income ratio	0.200	0.184	0.200	0.200	0.200
Public debt-income ratio	-	0.640	0.695	0.640	0.537
Welfare-eq. consumption loss	0	0.017		0.016	
$\epsilon = 5$, $\kappa = 6.944$, $\omega_g = 0.25$					
Consumption tax rate	-	0	0	0.410	0.262
Labour income tax rate	-	0.060	0.253	0	0
Hours worked, Income	0.300	0.253	0.230	0.226	0.239
Leisure	0.700	0.747	0.770	0.774	0.761
Consumption	0.240	0.214	0.187	0.181	0.191
Government Spending	0.060	0.040	0.043	0.045	0.048
Public debt	-	0.162	0.169	0.145	0.112
Public debt price	-	1.119	0.979	1.035	0.979
Consumption-income ratio	0.800	0.844	0.813	0.800	0.800
Public spending-income ratio	0.200	0.156	0.187	0.200	0.200
Public debt-income ratio	-	0.640	0.736	0.640	0.468
Welfare-eq. consumption loss	0	0.077		0.058	

Table (4) presents the results from solving the model for different initial level of debt. This exercise is important, because by varying b_0 and keeping the monopolistic competition at its benchmark value,

[5] With perfect competition $\epsilon \to \infty$, and no public debt $\gamma_b = 0$, the welfare gain from taxing consumption is zero.

we can control and in turn shut down the intertemporal gain of taxing consumption. In the limiting case with no initial debt, the Ramsey problem reduces to a static maximisation problem. This case is presented in the top quadrant of Table (4). Here the gains from taxing consumption are solely given by its role in indirectly taxing profits, i.e. intratemporal gains from taxing consumption, and amount to 19.88%. While both the intertemporal and the intratemporal gains from taxing consumption are sizeable, the intratemporal gains are quantitatively more important.

In the second part of Table (4) we increase the initial debt equal to 120% of GDP, a value that is almost twice as big as in the benchmark calibration. The results follow consistently as expected. Compared to the benchmark, under both tax scenarios, the Ramsey Planner suffers a greater welfare loss and has a stronger incentive to manipulate the initial bond price p_t^b. Moreover, under labour income taxation, the higher need for fiscal revenues reinforce the substitution effect of labour supply. This pushes the Ramsey planner to lower the government spending to income ratio compared to the benchmark case. In this case, the gains from taxing consumption amount to 25.01%.

Table (5) presents the allocation and welfare under the alternative parametrisation where $\sigma \neq 1$. In order to be consistent with the benchmark case, we re-calibrate κ and ω_g so that in the efficient allocation $\ell_{sp} = 0.7$ and $\frac{g^{sp}}{h^{sp}} = 0.2$. We keep all the remaining parameters at their benchmark values. The literature has not reached a unanimous consensus on the EIS. To this end, we solve the model with $\sigma = 2$, which is consistent with low values of EIS as typically found by the micro literature, see among others Blundell, Browning, and Meghir (1994). We also solve the model with $\sigma = 0.5$, a value consistent with some macro-finance literature that finds high values of the EIS, see among others Bansal and Yaron (2004). Given this parametrisation, the utility function is not longer separable in consumption and leisure. This means among other things, that labour supply decisions directly affect the marginal utility of consumption, and in turn, consumption decisions directly affect the marginal utility of leisure.

Despite this, the main message from this experiment does not change qualitatively from the benchmark

Table 4: Tax Rates and Allocations, Public Debt

Variable	First Best	$\gamma_b = 1.2$ $t=0$	$\gamma_b = 1.2$ $t \geq 1$	$\tau^h = 0$ $t=0$	$\tau^h = 0$ $t \geq 1$
$\gamma_b = 0$, $\kappa = 6.944$, $\omega_g = 0.25$					
Consumption tax rate	-	0	0	0.250	0.250
Labour income tax rate	-	0.229	0.229	0	0
Hours worked, Income	0.300	0.239	0.239	0.245	0.249
Leisure	0.700	0.761	0.761	0.755	0.755
Consumption	0.240	0.193	0.193	0.196	0.196
Government Spending	0.060	0.046	0.046	0.049	0.049
Public debt	-	0	0	0	0
Public debt price	-	0.979	0.979	0.979	0.979
Consumption-income ratio	0.800	0.809	0.809	0.800	0.800
Public spending-income ratio	0.200	0.191	0.191	0.200	0.200
Public debt-income ratio	-	0	0	0	0
Welfare-eq. consumption loss	0	0.058		0.046	
$\gamma_b = 1.2$, $\kappa = 6.944$, $\omega_g = 0.25$					
Consumption tax rate	-	0	0	0.535	0.272
Labour income tax rate	-	-0.065	0.262	0	0
Hours worked, Income	0.300	0.273	0.234	0.222	0.243
Leisure	0.700	0.727	0.766	0.779	0.757
Consumption	0.240	0.234	0.189	0.177	0.194
Government Spending	0.060	0.039	0.044	0.044	0.049
Public debt	-	0.327	0.315	0.265	0.200
Public debt price	-	1.210	0.979	1.075	0.979
Consumption-income ratio	0.800	0.858	0.820	0.800	0.800
Public spending-income ratio	0.200	0.142	0.190	0.200	0.200
Public debt-income ratio	-	1.200	1.345	1.200	0.823
Welfare-eq. consumption loss	0	0.068		0.051	

case. However There are some important quantitative differences. With a low EIS, i.e. $\sigma = 2$, the optimal long run level of public spending is higher than the benchmark case and government spending-to-income ratio is higher under consumption taxation than under labour income taxes. Sustaining a bigger government size requires higher taxes in the long run. In turn, higher taxes depress labour supply and consumption, thus decreasing the overall welfare. Interestingly, under labour income taxation, the need for higher taxes in long-run generates a stronger incentive to manipulate the initial bond prices, i.e. p_0^b is bigger when $\sigma = 2$ than in the benchmark case. This is due to the fact that with this tax component and a low EIS, it is more difficult to affect initial private consumption through the Euler equation. Differently, under consumption taxation the Ramsey planner has a weaker incentive to manipulate the initial bond prices compared with the benchmark case. This is because contrary to the labour income tax case, the Ramsey planner can now influence directly the Euler equation via a dynamic pattern of consumption taxes in period zero and in subsequent periods.

Consistently, all these results are reversed when the model is solved with a high EIS. Compared to the benchmark case, the government size is now smaller, taxes are lower and the welfare loss is greatly reduced under both tax scenarios. Remarkably the welfare gains from taxing consumption are very similar across the different EIS experiments and amount to 22.44% when $\sigma = 2$ and to 22.82% with $\sigma = 0.5$.

Table 5: Tax Rates and Allocations, Non-Separable Preferences

Variable	First Best	$\tau^c = 0$, $t = 0$	$\tau^c = 0$, $t \geq 1$	$\tau^h = 0$, $t = 0$	$\tau^h = 0$, $t \geq 1$
$\sigma = 2$, $\kappa = 5.050$, $\omega_g = 2.204$					
Consumption tax rate	-	0	0	0.292	0.2767
Labour income tax rate	-	-0.026	0.247	0	0
Hours worked, Income	0.300	0.256	0.218	0.221	0.226
Leisure	0.700	0.744	0.782	0.778	0.773
Consumption	0.240	0.220	0.177	0.180	0.181
Government Spending	0.060	0.035	0.042	0.042	0.046
Public debt	-	0.164	0.154	0.142	0.130
Public debt price	-	1.325	0.979	1.004	0.979
Consumption-income ratio	0.800	0.862	0.809	0.812	0.799
Public spending-income ratio	0.200	0.138	0.191	0.188	0.201
Public debt-income ratio	-	0.640	0.707	0.640	0.575
Welfare-eq. consumption loss	0	0.087		0.067	
$\sigma = 0.5$, $\kappa = 8.547$, $\omega_g = 0.096$					
Consumption tax rate	-	0	0	0.461	0.261
Labour income tax rate	-	0.152	0.248	0	0
Hours worked, Income	0.300	0.265	0.256	0.249	0.261
Leisure	0.700	0.734	0.744	0.751	0.738
Consumption	0.240	0.218	0.207	0.197	0.209
Government Spending	0.060	0.048	0.049	0.052	0.052
Public debt	-	0.170	0.180	0.159	0.111
Public debt price	-	1.021	0.979	1.018	0.979
Consumption-income ratio	0.800	0.820	0.808	0.792	0.800
Public spending-income ratio	0.200	0.180	0.192	0.208	0.200
Public debt-income ratio	-	0.640	0.705	0.640	0.425
Welfare-eq. consumption loss	0	0.042		0.032	

Table (6) presents the results from varying the Frisch elasticity of labour supply. This exercise is particularly important as the micro and macro literature tend to differ on the estimates of this structural parameter. For this reason we solve the model with two values that are somehow at the extremes of the available estimates of the elasticity of labour supply. In particular, we consider (i) $\varphi = 0.5$, which is in line with recent micro estimates such as Domeij and Floden (2006) (see also Guner, Kaygusuz, and Ventura, 2012), and (ii) $\varphi = 5$ as a high value, which is sometimes chosen to better match the intertemporal variation of aggregate hours (e.g. Galí, López-Salido, and Vallés, 2007). We adjust κ appropriately in each case as described for the benchmark parametrisation. When the Frisch elasticity is low, i.e. $\varphi = 0.5$, the substitution effect of labour supply is reduced. Thus the policy-maker can sustain the same level of public expenditure and debt at a lower welfare cost. Under labour income tax this implies that the Ramsey Planner can afford to push the public spending-income ratio closer to the first best level without distorting excessively the economy. Of course this result is reversed when the Frisch elasticity of high i.e. $\varphi = 5$ as the substitution effect of labour supply gets bigger. Differently, under consumption taxation, the policy-maker finds it optimal to keep the government spending to income ratio at the first best regardless of the labour supply elasticity, see Proposition 5. Therefore the economy is facing a higher welfare loss when the Frisch elasticity is high compared to when the Frisch elasticity is low. The gains from taxing consumption are roughly the same under the two different parametrisations and amount to around 22.4%.

Table 6: Tax Rates and Allocations, Frisch Elasticity

Variable	First Best	$\tau^c = 0$, $t = 0$	$\tau^c = 0$, $t \geq 1$	$\tau^h = 0$, $t = 0$	$\tau^h = 0$, $t \geq 1$
$\varphi = 0.5$, $\kappa = 15.432$, $\omega_g = 0.25$					
Consumption tax rate	-	0	0	0.444	0.261
Labour income tax rate	-	0.133	0.250	0	0
Hours worked, Income	0.300	0.266	0.256	0.250	0.261
Leisure	0.700	0.734	0.744	0.750	0.739
Consumption	0.240	0.220	0.206	0.200	0.209
Government Spending	0.060	0.046	0.049	0.050	0.052
Public debt	-	0.170	0.179	0.160	0.113
Public debt price	-	1.045	0.979	1.071	0.979
Consumption-income ratio	0.800	0.827	0.806	0.800	0.800
Public spending-income ratio	0.200	0.172	0.193	0.200	0.200
Public debt-income ratio	-	0.640	0.699	0.640	0.433
Welfare-eq. consumption loss	0	0.041		0.032	
$\varphi = 5$, $\kappa = 4.418$, $\omega_g = 0.25$					
Consumption tax rate	-	0	0	0.311	0.265
Labour income tax rate	-	-0.039	0.241	0	0
Hours worked, Income	0.300	0.252	0.201	0.206	0.212
Leisure	0.700	0.748	0.798	0.794	0.789
Consumption	0.240	0.215	0.164	0.164	0.169
Government Spending	0.060	0.036	0.037	0.041	0.042
Public debt	-	0.161	0.160	0.132	0.123
Public debt price	-	1.283	0.979	0.985	0.979
Consumption-income ratio	0.800	0.856	0.815	0.800	0.800
Public spending-income ratio	0.200	0.144	0.185	0.200	0.200
Public debt-income ratio	-	0.640	0.795	0.640	0.582
Welfare-eq. consumption loss	0	0.107		0.083	

Finally, in Table (7) we explore the possibility that public and private consumption are complements or substitutes in the Edgeworth sense. This is achieved by varying $\alpha \in [-0.5, 0.5]$, whereas a positive value implies substitutability and a negative one complementarity. In the former case, an increase in government spending decreases the marginal utility of consumption. This weakens the income effect of labour supply and the increases the EIS. Ceteris paribus, a lower income effect means that the substitution effect becomes relatively stronger. Compared to the benchmark case, this implies a stronger distortionary effect of taxation that in turn pushes the Ramsey Planner to reduce government spending-to-income ratio. Under labour income tax, the incentive to reduce public consumption is more pronounced than under consumption taxation, although under both fiscal scenarios the government spending-to-income ratio fall short of its first best. Furthermore, given the substitutability between private and public consumption, the reduction of public spending is compensated by the increase in private consumption and this leads to a lower welfare loss. The gains from taxing consumption reduces to 17.81%.

Conversely, with $\alpha = -0.5$, an increase in government spending increases the marginal utility of consumption. This weakens the income effect of labour supply and the increases the EIS. A higher income effect decreases the distortionary effects of taxation thus pushing the Ramsey Planner to increase government spending-to-income ratio. This ratio is only marginally higher under consumption taxation, and under both fiscal scenarios the government spending-to-income ratio is higher than their first best counterparts. In turn the lower allocation of resources to private consumption implies, compared to the benchmark a higher welfare loss and a higher welfare gain from taxing consumption (24.22%).

4 Concluding Remarks

Consumption taxation has been widely used by governments around the globe as a source of fiscal revenues. For example, as of August 2016, the value-added tax on standard items ranges from 17 (Luxembourg) to 27 (Hungary) percent in European Union countries. We consider a simple economy characterised by

Table 7: Tax Rates and Allocations, Complementarity

Variable	First Best	$\tau^c = 0$ $t = 0$	$\tau^c = 0$ $t \geq 1$	$\tau^h = 0$ $t = 0$	$\tau^h = 0$ $t \geq 1$
$\alpha = 0.5$, $\kappa = 6.173$, $\omega_g = 0.111$					
Consumption tax rate	-	0	0	0.350	0.199
Labour income tax rate	-	0.059	0.202	0	0
Hours worked, Income	0.300	0.261	0.241	0.233	0.247
Leisure	0.700	0.739	0.758	0.767	0.753
Consumption	0.240	0.226	0.205	0.196	0.208
Government Spending	0.060	0.035	0.037	0.037	0.039
Public debt	-	0.167	0.177	0.149	0.113
Public debt price	-	1.068	0.979	1.039	0.979
Consumption-income ratio	0.800	0.864	0.847	0.842	0.842
Public spending-income ratio	0.200	0.136	0.153	0.158	0.158
Public debt-income ratio	-	0.640	0.735	0.640	0.456
Welfare-eq. consumption loss	0	0.055		0.045	
$\alpha = -0.5$, $\kappa = 7.936$, $\omega_g = 0.429$					
Consumption tax rate	-	0	0	0.391	0.281
Labour income tax rate	-	0.070	0.271	0	0
Hours worked, Income	0.300	0.257	0.237	0.235	0.245
Leisure	0.700	0.742	0.763	0.765	0.755
Consumption	0.240	0.212	0.188	0.185	0.193
Government Spending	0.060	0.045	0.050	0.050	0.052
Public debt	-	0.165	0.170	0.150	0.125
Public debt price	-	1.148	0.979	1.020	0.979
Consumption-income ratio	0.800	0.824	0.789	0.789	0.789
Public spending-income ratio	0.200	0.176	0.210	0.211	0.211
Public debt-income ratio	-	0.640	0.719	0.640	0.510
Welfare-eq. consumption loss	0	0.062		0.047	

infinitely lived representative households with love for public goods, a perfect competitive labour market and a monopolistic competitive goods market. In this general environment, our analysis shows that taxing consumption, compared to taxing labour income, allows the policy-maker to sustain both higher public spending and higher aggregate welfare. We are able to disentangle two effects through which consumption taxation overtake income taxes. First, consumption taxation serves as an indirect taxation of the inefficient profits produced by the non competitive markets. This beneficial effect increases with the assumed firms' market power and disappears under perfect competition. Second, given the intertemporal structure of consumption behaviour, taxing consumption allows the policy-maker to directly manipulate households' Euler equation in order to favourably influence the price of public debt. This effect increases with the size of public debt. We we find that both effects are quantitatively important in an economy calibrated to replicate some salient features of the US economy.

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A Proof of Proposition 4

For the case of *log* utility, the FOCs for $t \geq 1$ of the Ramsey specialise to

$$u_{\ell,t}\left(1+\gamma_t\right) - \gamma_t \left[u_{\ell\ell,t}\left(1-\ell_t\right) - \frac{1}{\epsilon}u_{c,t}\right] = u_{g,t}, \tag{21}$$

$$u_{c,t}\left(1+\gamma_t\right) + \gamma_t u_{cc,t}c_t - \gamma_t u_{cc,t}\frac{1}{\epsilon}\left(1-\ell_t\right) = u_{g,t}. \tag{22}$$

Then using the fact in the *log* case $-u_{cc,t}c_t = u_{c,t}$, equation (22) can be written as

$$u_{c,t} - \gamma_t u_{cc,t}\frac{1}{\epsilon}\left(1-\ell_t\right) = u_{g,t}. \tag{23}$$

Given that $\gamma_t > 0$ and $u_{cc,t} < 0$, equation (23) implies that $u_{g,t} \geq u_{c,t}$. Then we can write (4) as $u_{\ell,t} = w_t\left(1-\tau_t^h\right)u_{c,t}$. Using that $w_t\left(1-\tau_t^h\right) \leq 1$, it follows that $u_{c,t} \geq u_{\ell,t}$, which implies $u_{g,t} \geq u_{\ell,t}$. Clearly, if $\epsilon \to \infty$, equation (23) implies $u_{g,t} = u_{c,t}$. In this case, given the log preferences in government spending, $g_t/y_t = g_t^{sp}/y_t^{sp}$. QED

B Proof of Proposition 5

Similarly, under consumption taxation, the Ramsey planner for $t \geq 1$ collapses to

$$u_{\ell,t}\left(1+\gamma_t\right) - \gamma_t\left(1-\ell_t\right)u_{\ell\ell,t} = u_{g,t}, \tag{24}$$

$$u_{c,t} + \gamma_t\frac{\epsilon-1}{\epsilon}\left[u_{cc,t}c_t + u_{c,t}\right] = u_{g,t}. \tag{25}$$

Then using again that $-u_{cc,t}c_t = u_{c,t}$, it follows from (25) that $u_{c,t} = u_{g,t}$. Then, the *log* preferences in government spending imply that $g_t/y_t = g_t^{sp}/y_t^{sp}$. QED