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Equilibrium taxation with inconsistent preferences

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# Equilibrium taxation with inconsistent preferences\*

Pietro Senesi<sup>†</sup>

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## Abstract

Inconsistent preferences are a cause of time-inconsistency in policy design. This type of inconsistency entails welfare costs for allocations associated with Pareto-inefficient competitive equilibria. This paper builds a general equilibrium model for the characterization of allocations induced by Nash-equilibrium taxation policies with competitive markets.

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# 1 Introduction

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This paper builds a general equilibrium model for the characterization of allocations induced by Nash-equilibrium taxation policies with competitive markets.

The paper is organized as follows. Section 2 puts forth the model of optimal factors income taxation with commitment technology. Section 3 extends the infinitely lived agent framework by adding the constraints implied by the original SGP first, and its revised version subsequently. Section 4 shows that implementing the reformed SGP entails an inefficiently extended duration of capital income taxation. Section 5 illustrates simulated equilibrium paths. Section 6 ends the paper with a brief summary.

## 2 Definitions and assumptions

In this Section we set out the framework of analysis that closely follows [6]. Hyperbolic preferences at time  $t$ , over the same consumption good at different time periods are

$$U(x_t, x_{t+1}, \dots) = u(x_t) + \delta \sum_{i=1}^{\infty} \beta^i u(x_{t+i}), \quad (1)$$

where the vector  $x_t = (c_t, l_t, g_t)$  is a vector of private consumption, labor supply and government consumption levels. The discount factor of future utilities is  $0 < \beta < 1$ .

**Assumption 1.** The function  $U(x_1, x_2, \dots)$  is weakly separable across consumption at different times and homothetic in consumption at different times.

The representative consumer aims at maximizing (1) under the constraint

$$c_t + k_t + b_t \leq (1 - \tau_t)w_t l_t + R_t^k k_t + R_t^b b_t, \quad t = 1, \dots, \infty \quad (2)$$

where  $\tau_t$  denotes the tax rate set on wage, and

$$R_t^k = 1 + (1 - \theta_t)(r_t - \delta_t) \quad (3)$$

is the gross return on capital after taxes  $\theta$  and depreciation  $\delta$  are deducted from the before-tax return  $r$ . Notice that the government is allowed to set a return from bonds  $R_t^b$  different from the gross return on capital.

The government policy thus consists of setting tax rates on returns from capital and labor, and a gross return on bonds, such that the exogenous sequence of government consumption be financed under the budget constraint

$$b_t = R_t^b b_{t-1} + b_{t-1} - \tau_t w_t l_t - \theta_t (r_t - \delta) k_t \quad (4)$$

Under the budget constraint, the gross return on bonds is implied by tax rates on labor and capital, so that time  $t$  government policy  $\pi_t$  is given by  $(\tau_t, \theta_t)$ .

We assume existence of a *commitment technology*, i.e. the government can commit itself to  $\tau_1$  and a sequences of couples  $\{\tau_t, \theta_t\}_{t=2, \dots, \infty}$  announced at time  $t = 1$ .

**Definition 1.** (*Policy*) A policy  $\{\pi_t\}_{t=1, \dots, \infty}$  is a sequences of couples

$$\{\tau_t, \theta_t\}_{t=1, \dots, \infty}.$$

A competitive allocation is defined as follows

**Definition 2.** (*Competitive Allocation, CA.*) A CA is such that both the resource constraint

$$c_t + g_t + k_t = F(k_t, l_t) + (1 - \delta)k_{t-1}, \quad t = 1, \dots, \infty \quad (5)$$

and the first-order maximization condition

$$U'(c_t) + U'(l_t) = 0, \quad t = 1, \dots, \infty \quad (6)$$

hold.

**Definition 3.** (*Allocation rules, ARs.*) Allocation rules are sequences of functions  $\{x_t(\pi)\}_{t=1, \dots, \infty}$  that map policies into CAs.

A price system is defined as follows

**Definition 4.** (*Price System, PS.*) A PS is a triple

$$(w_t, r_t, R_t^b) \quad (7)$$

A competitive price system is defined as follows

**Definition 5.** (*Competitive Price System, CPS.*) A CPS is a triple

$$(w_t, r_t, R_t^b), w_t = F_l, r_t = F_k \quad (8)$$

**Definition 6.** (*Price Rules, PRs.*) Price rules are sequences of functions  $\{w_t(\pi)\}_{t=1,\dots,\infty}$ ,  $\{r_t(\pi)\}_{t=1,\dots,\infty}$ , and  $\{R_t^b(\pi)\}_{t=1,\dots,\infty}$  that map policies into PSs.

In the present setting individual and aggregate allocations coincide, i.e. *representativeness* holds (see [5].) Hence, a competitive equilibrium is defined as follows

**Definition 7.** (*Competitive Equilibrium, CE.*) A CE is a policy, a CPS and an allocation such that (1) is maximized under the consumer's budget constraint (2), and the government budget constraint (4) holds.

A Ramsey equilibrium is defined as follows

**Definition 8.** (*Ramsey Equilibrium, RE.*) A RE is a policy, a price and an allocation rules such that both the government budget constraint (4) is satisfied and the policy, the PS and the allocation constitute a CE.

### 3 Equilibrium taxation of goods

### 4 Equilibrium factor taxation

### 5 Welfare analysis

### 6 Incorporating fiscal discipline

In this Section *commitment technologies* representative of the arrangements agreed upon by EMU member states in the original and reformed SGP are added to the model in order to evaluate effects on social welfare of re-designing the SGP. We assume these arrangements are able to commit society

to future policies. As such, the analysis abstracts from *time inconsistency* issues related to the possibility of non-compliance of SGP rules on the part of any EMU member state, and focuses on RE (for more on this point, see [5]).

The addition of commitment technologies in the form of either deficit/GDP or debt/GDP ratios is shown to imply an upper bound on the tax rate set on capital income at early stages. This is sufficient to rule out lump-sum taxation of the inelastically supplied capital (at time  $t = 1$ ).

The commitment technology we model is fairly simple: *we associate with a given commitment an upper bound on time  $t=1$  tax rate on capital income.* More exactly, optimal upper bounds are defined as follows

**Definition 9.** (*Optimal Upper Bounds, OUBs.*) OUBs are functions

$$\bar{\theta}(\tau_1, \{\pi_t\}_{t=2,\dots,\infty})$$

from commitments to time  $t = 1$  tax rates on capital income such that (given the commitment) the government budget constraint (4) holds.

OUBs are implicit in EMU fiscal discipline rules, among others. By simply requiring EMU member states to comply with a tendency towards budget balance coupled with a net debt position not exceeding 60% of GDP, SGP arrangements impose an upper bound on the initial capital income tax rate that rules out financing of total repayment of public debt through lump-sum taxation of private assets.

We assume in the sequel that commitments are part of optimal tax sequences, i.e. governments do their best by committing to solutions of welfare-loss minimization problems as stated in the next two Subsections.

## 6.1 The original SGP

Let commitment to the SGP consist of  $(\tau_1^1 \cup \{\pi_t^1\}_{t=2,\dots,\infty})$ . Then the Lagrangian is

$$\sum_{t=1}^{\infty} \beta^t u(x_t) + \lambda(\theta - \bar{\theta}(\tau_1^1 \cup \{\pi_t^1\}_{t=2,\dots,\infty})) \quad (9)$$

and the maximizing sequence of tax rates  $\{\tau_t^*, \theta_t^*\}_{t=1,\dots,\infty}^1$  is

$$((\tau_1^1, \bar{\theta}(\tau_1^1 \cup \{\pi_t^1\}_{t=2,\dots,\infty})) \cup \{\pi_t^1\}_{t=2,\dots,\infty})$$

## 6.2 The reformed SGP

Let commitment to the RSGP consist of  $(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty})$ . Then the Lagrangian is

$$\sum_{t=1}^{\infty} \beta^t u(x_t) + \lambda(\theta - \bar{\theta}(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty})) \quad (10)$$

and the maximizing sequence of tax rates  $\{\tau_t^*, \theta_t^*\}_{t=1,\dots,\infty}^2$  is

$$((\tau_1^2, \bar{\theta}(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty})) \cup \{\pi_t^2\}_{t=2,\dots,\infty}).$$

It is immediate to verify that, as the RSGP allows for an extended time horizon to implement a given correction of public finances, the following inequality holds

$$\bar{\theta}(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty}) < \bar{\theta}(\tau_1^1 \cup \{\pi_t^1\}_{t=2,\dots,\infty}). \quad (11)$$

## 7 Welfare losses from the SGP

In this Section we show that both the original and the latest version of the SGP entail upper bounds on the initial tax rate on return from capital. As in the presence of upper bounds it is optimal to front load taxes on capital at the maximal rate until the constraint is fulfilled, and set zero tax rate on capital thereafter, it turns out that the reformed SGP is worse fiscal discipline than the original SGP, as the former entails a lower upper bound on the tax rate, and an associated prolonged phase of capital income taxation causing an extended welfare loss.

This point can be made more explicit by focusing, e.g., on the deficit/GDP ratio. Given the deviation of the actual ratio from its target value at time  $t = 1$ , by allowing compliance within an extended time horizon the RSGP entails a lower upper bound on the initial capital income tax rate. As a consequence, *efficient taxes on capital income that exceed the upper bound must be postponed, thus entailing a distortion in relative prices that is exponentially increasing with time.* The resulting saving distortion is biased towards present consumption, thus reducing investment and growth. The inefficiency of the RSGP (when compared to the original SGP) lies in the fact that taxes that were efficiently front-loaded according to the SGP are forced to postponing under the more lax regime of the RSGP.

Given the way we model commitment technologies and define policies, the set of maximal time  $t = 1$  implementable tax rates on capital income is given

by  $\bar{\theta}(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty}) \cup \bar{\theta}(\{\pi_t^1\})$ . The basic result of this paper immediately follows

**Proposition 1** *REs associated with the SGP entail a lower welfare loss than REs associated with the RSGP.*

**Proof.** This consists of showing that the sequence

$$((\tau_1^2, \bar{\theta}(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty})) \cup \{\pi_t^2\}_{t=2,\dots,\infty})$$

cannot be optimal. Assume it is. According to principles of optimal factor taxation, capital income must be taxed at the maximum possible rate when it is inelastically supplied at time  $t = 1$ . Hence, from (11) the best initial tax rate on capital income  $\theta_1^*$  must equal

$$\max(\bar{\theta}(\tau_1^2 \cup \{\pi_t^2\}_{t=2,\dots,\infty}), \bar{\theta}(\tau_1^1 \cup \{\pi_t^1\}_{t=2,\dots,\infty})),$$

i.e.  $\theta_1^* = \bar{\theta}(\tau_1^1 \cup \{\pi_t^1\}_{t=2,\dots,\infty})$ , which contradicts the assumption. ■

## 8 Conclusions

The preceding analysis showed that beyond allowing for smoothing the excess burden from additional taxation out, implementing the SGP in its revised form also entails an inefficiently extended phase of taxation of income from capital. When compared to the effects of the original correction procedure, the net result on social welfare will in general be negative, as extending capital income taxation in time *tantamounts* to exponentially increasing the price of households' future consumption.

Our model predicts that, as long as future consumption is a normal good, countries compliant with the revised SGP will display increased current consumption at the expense of long-run growth and welfare, compared to what would occur had they complied with the original SGP. We illustrate this by simulating EMU countries consumption and capital accumulation paths in both cases.

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