

Balke, Neele; Ravn, Morten

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# Time Consistent Fiscal Policy in a Debt Crisis

Neele Balke<sup>1</sup> and Morten O. Ravn<sup>1,2,3</sup>

University College London<sup>1</sup>, Centre for Macroeconomics<sup>2</sup>,

and the Centre for Economic Policy Research<sup>3</sup>

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# 1 Extended Abstract

The financial crisis led to severe crises in much of Southern Europe that generated deep economic problems that still have not been resolved. Many of these economies (Greece, Italy, Spain and Portugal) witnessed not only large drops in aggregate activity but also rising levels of debt and falling debt prices which made financing of deficits very costly and triggered concerns about sovereign defaults. A large literature has considered environments in which large negative shocks can generate risk of default because sovereign governments lack commitment to debt. However, much of this literature either assumes that government has commitment to all other fiscal instruments or that these are exogenously determined. Therefore, it is unclear whether adjustments of other instruments - for example cuts in public spending or tax hikes - may not be preferable to default. Moreover, this literature typically does not allow for feedback from the fiscal instruments to the state of the economy beyond those triggered by punishment mechanisms in case of a sovereign default. Thus, these models are not useful for understanding richer questions regarding the adjustment of fiscal policy in crisis times.

This paper takes a first step in addressing these issues. We study a small open economy model in which a benevolent government aims at maximizing social welfare but lacks commitment to all its fiscal instruments. The economy consists of a government, households, firms and foreign lenders. Households derive utility from consumption of private goods, leisure and from government provided public goods. They differ in their labor market status because of matching frictions. Some households work and earn labor income. The government imposes a payroll tax on these households. Other households are unemployed but choose search effort. Households cannot purchase unemployment insurance contracts but receive government financed unemployment transfers. Firms post vacancies to hire workers and there is free entry. There is an aggregate productivity shock and wages are determined by a non-cooperative Nash bargaining game between firms and households. The government chooses payroll taxes, unemployment benefits, government spending and may be able to smooth the budget by international borrowing and lending. International lenders are risk neutral and charge an interest rate which takes into account that governments may choose to default. If a government defaults it is excluded from international financial markets for a stochastic number of periods and it may suffer a loss of productivity whilst excluded from international lending.

The government in this economy faces several trade-offs. It would like to insure households against unemployment risk and against wage risk which occurs due to productivity shocks. However, more generous unemployment insurance gives households less incentive to search for jobs and therefore pro-

duces higher unemployment and a smaller tax base. In order to smooth employed households against wage risk, the government would like to cut payroll taxes when productivity falls but this implies rising debt. The government also attempts to equalize the marginal utility of private and public consumption but cannot do so perfectly because of household heterogeneity. In this economy, falling productivity produces difficult choices since it puts a pressure on the government budget due to rising unemployment and a smaller tax base which produces an incentive for increasing government borrowing. However, rising debt levels may eventually impact on the price of debt because lenders perceive a risk of a sovereign default. For that reason, the government will eventually have to make a hard choice about whether to default on its debt which means it will have to balance its budget (and possibly suffer a drop in productivity), cut unemployment transfers which harms the unemployed, increase payroll taxes which harms the employed and produces higher unemployment, or cut government spending which lowers utility of households.

We derive optimal fiscal policies in this environment by studying Markov perfect equilibria. The model is calibrated to emulate the conditions of a typical Southern European economy. We show that the time-consistent policies involve countercyclical payroll taxes, constant unemployment benefits, and mildly procyclical government spending in ‘normal’ times when the risk of default is negligible. In crisis times, the government is willing to further distort the economy by providing less insurance against unemployment, increasing payroll taxes and cutting public goods provision to limit rising debt. However, once a default becomes inevitable, the government partially lifts such austerity measures since it ceases to be concerned about honouring its outstanding debt.

## 1.1 Environment

**Households.** The economy has a continuum of mass 1 of infinitely lived households indexed by  $i \in [0, 1]$ . Households have rational expectations and maximize their expected discounted lifetime utility. Households can neither save nor borrow but their consumption streams may be smoothed through government policies.

A household is either employed or unemployed. Employed households work one unit of time, earn a real wage  $w$  and pay a proportional income tax  $\tau w$ . Households cannot purchase unemployment insurance contracts but unemployed households receive government provided unemployment benefits  $\mu \leq (1 - \tau)w$ . The labor market status is determined at the beginning of the period. Households exert  $e$  units of search effort and find jobs with probability  $pe \in [0, 1]$  where  $p \in [0, 1]$  is the job finding rate per unit of search intensity. Households take  $p$  for given. Employment contracts last one period. This assumption, together with the lack of household savings implies that households each period are ex-ante identical but ex-post heterogeneous due to unemployment risk.

Households derive utility from consuming goods,  $c$ , from government provision of public goods,  $G$ , and disutility from labor market search and from working. Households maximize their expected present discounted utility stream:

$$\mathcal{U}_{i,t} = \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} [\mathbf{u}(c_{i,t}, e_{i,t}, G_t) - \kappa \mathbf{n}_i] \quad (1)$$

$\mathbb{E}$  is the mathematical expectations operator,  $\beta \in (0, 1)$  is the subjective discount factor,  $\kappa \in \mathbb{R}_{++}$  denotes a fixed cost of working.  $\mathbf{u}$  is the instantaneous felicity function which is assumed strictly increasing and concave in  $c$ , non-decreasing in  $G$ , and strictly decreasing and convex in  $e$ .  $\mathbf{n}_i$  is an indicator function which summarizes the household's labor market status:

$$\mathbf{n}_i = \begin{cases} 0 & \text{if the household is unemployed} \\ 1 & \text{if the household is employed} \end{cases} \quad (2)$$

We will from now drop the date notation unless necessary.

Households cannot save nor borrow and choose consumption and search effort subject to a sequence of budget constraints:

$$c_i = (1 - \tau)w\mathbf{n}_i + (1 - \mathbf{n}_i)\mu + \pi \quad (3)$$

where  $\pi$  denotes the household's receipts of dividends from the firms.

The first-order necessary condition for search effort is:

$$p[\mathbf{u}(c_i^w, e_i, G) - \mathbf{u}(c_i^u, e_i, G) - \kappa] = pe_i \mathbf{u}_e(c_i^w, e_i, G) + (1 - pe_i) \mathbf{u}_e(c_i^u, e_i, G) \quad (4)$$

where  $c_i^w = (1 - \tau)w + \pi$  denotes consumption of an employed household and  $c_i^u = \mu + \pi$  is consumption of an unemployed household. Condition (4) equalizes the expected marginal utility gain from searching (the left hand side) to the expected marginal utility cost of searching (the right hand side). Since households are ex-ante identical, they all choose the same search effort,  $e^*$ . It follows that aggregate employment,  $n = \int_i \mathbf{n}_i di = pe^*$ .

**Firms.** Output is produced by a continuum of identical competitive firms indexed by  $j$  each of which employ one worker. There is free entry into the industry. The profits of an existing firm are given as:

$$\pi_j = \mathbf{x}(z, h') - w - av_j \quad (5)$$

$\mathbf{x}(z, h')$  is the (common) productivity of the firm which depends on an exogenous aggregate productivity shock,  $z$ , and on the country's end of period credit history  $h'$ :

$$h' = \begin{cases} 0 & \text{if the country has access to financial markets} \\ 1 & \text{if the country is in autarky} \end{cases}$$

We assume that  $\mathbf{x}(z, 0) \geq \mathbf{x}(z, 1)$  so that firms in countries that are excluded from international financial markets experience lower productivity ceteris paribus. The aggregate productivity shock follows a discrete first-order homogeneous Markov process,  $z \in \Omega_z \subset \mathbb{R}_{++}^N$  with transition probabilities  $\psi(z'|z) \in [0, 1]$ .  $v_j$  denotes vacancies and  $a \in \mathbb{R}_{++}$  is a constant proportional vacancy posting cost.

Vacancies are filled with probability  $q \in [0, 1]$ . The value of a filled job,  $\mathcal{R}^f$ , and the value of a vacancy,  $\mathcal{R}^v$ , are given as, respectively:

$$\mathcal{R}^f = \mathbf{x}(z, h') - w \quad (6)$$

$$\mathcal{R}^v = q\mathcal{R}^f - a \quad (7)$$

Free entry drives the value of vacancies to zero and the equilibrium value of a filled job therefore equals the expected cost of hiring a worker:

$$\mathbf{x}(z, h') - w = \frac{a}{q} \quad (8)$$

**Labor Market.** The measure of new matches between workers and firms, which in our setting also equals aggregate employment, is determined by a standard Cobb-Douglas matching function:

$$n = \psi e^\phi v^{1-\phi} \quad (9)$$

where  $v = \int v_j dj$  is the aggregate measure of vacancies,  $e = \int e_i di$  is the measure of search effort and  $\phi, \psi \in \mathbb{R}_{++}$  are constant parameters.

Wages are determined according to a non-cooperative Nash bargaining game between workers and firms. Since matches last one period, the surplus of a matched household is given by the instantaneous utility gain from being employed:

$$\mathcal{S}^w = \mathbf{u}(c^w, e^*, G) - \mathbf{u}(c^u, e^*, G) - \kappa \quad (10)$$

where  $e^*$  denotes the optimal search intensity determined by condition (4) above. Due to free entry, the surplus to firms from having filled job is the within-period return  $\mathcal{R}^f$ . The wage is then determined in a Nash bargaining game:

$$w = \arg \max (\mathcal{S}^w)^\lambda (\mathcal{R}^f)^{1-\lambda} \quad (11)$$

where  $\lambda \in \mathbb{R}_{++}$  denotes the households' bargaining power. Using (10) and (6) the first-order necessary condition can be expressed as:

$$w = \mathbf{x}(z, h') - \frac{1 - \lambda}{\lambda} \frac{\mathbf{u}(c^w, e^*, G) - \mathbf{u}(c^u, e^*, G) - \kappa}{(1 - \tau) \mathbf{u}_c(c^w, e^*, G)} \quad (12)$$

**Government.** The government chooses policies aimed at maximizing social welfare. The policy variables at its disposal are income taxes, transfers to unemployed households, public goods provision, and government debt.

The government enters the period with  $B$  units of outstanding debt, productivity level  $z$ , and credit history  $h$ . At the beginning of the period, a country with a bad credit record,  $h = 1$ , is readmitted to international financial markets with probability  $(1 - \alpha) \in (0, 1)$ . The government then chooses its policies. A country with a good credit score can choose whether or not to default on its outstanding debt. If it does not default,  $d = 0$ , the government can issue new debt  $B'$  at the price  $R(B', z)$  and it will have a good end of period credit score,  $h' = 0$ . If the country defaults, it cannot issue new debt, it may experience a drop in productivity, and its end of period credit score is bad,  $h' = 1$ . A country with a bad beginning of period credit score,  $h = 1$ , that is not readmitted to international financial markets is in autarky, has low productivity and must run a balanced budget. A country with a bad credit history that *is* readmitted to international financial markets faces the same problem as a government with a good beginning of period credit score (but never defaults since it has no debt).

The government maximizes a utilitarian social welfare function:

$$\mathcal{U}_t^s = \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \mathbf{u}^s(c_t^w, c_t^u, e_t, n_t, G_t) \quad (13)$$

where  $\mathbf{u}^s$  is assumed to be given by a population weighted average of the flow utility of employed and unemployed households:

$$\mathbf{u}^s(c^w, c^u, e, n, G) \stackrel{def}{=} n[\mathbf{u}(c^w, e, G) - \kappa] + (1 - n)\mathbf{u}(c^u, e, G) \quad (14)$$

Define the aggregate state vector as  $S = (z, B, h)$ . The government's policy vector is  $\Theta(S) = [\tau, \mu, G, d, B']$  which it chooses optimally taking into account the behavior of the private sector and the price of debt. We express the social welfare function as  $\mathcal{U}^s(Y, \Theta, S)$  where  $Y(S, \Theta) = (e, c^w, v)$  and we express other endogenous variables as implicit functions of  $(Y, \Theta, S)$ .<sup>1</sup> The government must respect the government budget constraint and the economy-wide resource constraint which are given, respectively, as:

$$G + (1 - \mathbf{n}(Y, \Omega, S))\mu = \tau \mathbf{w}(Y, \Omega, S) \mathbf{n}(Y, \Omega, S) + R(B', z)B' - B \quad (15a)$$

$$x(z, h')\mathbf{n}(Y, \Omega, S) - av + R(B', z)B' = \mathbf{n}(Y, \Omega, S)c^w + (1 - \mathbf{n}(Y, \Omega, S))\mathbf{c}^u(Y, \Omega, S) + G + B \quad (16a)$$

It must also observe implementability constraints:

$$\begin{aligned} & \mathbf{u}(c^w, e, G) - \mathbf{u}(\mathbf{c}^u(Y, \Omega, S), e, G) - \kappa \\ &= e\mathbf{u}_e(c^w, e, G) + \frac{(1 - \mathbf{p}(Y, \Omega, S)e)}{\mathbf{p}(Y, \Omega, S)}\mathbf{u}_e(\mathbf{c}^u(Y, \Omega, S), e, G) \end{aligned} \quad (17)$$

$$\mathbf{w}(Y, \Omega, S) = \mathbf{x}(z, h') - \frac{1 - \lambda}{\lambda} \frac{\mathbf{u}(c^w, e, G) - \mathbf{u}(\mathbf{c}^u(Y, \Omega, S), e, G) - \kappa}{(1 - \tau)\mathbf{u}_c(c^w, e, G)} \quad (18)$$

$$\mathbf{w}(Y, \Omega, S) = \mathbf{x}(z, h') - \frac{a}{\mathbf{q}(Y, \Omega, S)} \quad (19)$$

where (17) is the first-order condition for optimal search effort, (18) is the Nash bargaining solution for the real wage, and (19) is the free entry condition.

Let  $\mathcal{Q}^{aut}(z)$  denote the value of a government which is excluded from international financial markets and  $\mathcal{Q}^i(B, z)$  the value of a government that has access to international financial markets. Note that the autarky value is independent of  $B$  since the country is in default and therefore has no debt. The value of autarky,  $\mathcal{Q}^{aut}(z)$ , is given as:

$$\mathcal{Q}^{aut}(z) = \max_{Y, \Omega_0} \mathcal{U}^s(Y, \Omega_0, S_0(z)) + \beta \mathbb{E} [\alpha \mathcal{Q}^{aut}(z') + (1 - \alpha) \mathcal{Q}^i(0, z')] \quad (20)$$

where  $S_0(z)$  is the state vector  $S$  setting  $B = 0$  and  $h = 1$  and  $\Omega_0$  indicates that the country cannot issue any debt,  $B' = 0$ . The value is maximized subject to the government budget constraint and the aggregate resource constraint and the implementability conditions (17) – (19) setting  $S = S_0(z)$  thus imposing budget balance on the government and that domestic absorption equals domestic output.<sup>2</sup>

<sup>1</sup>See Appendix 1 for a definition of these implicit functions.

<sup>2</sup>The government budget constraint is  $G + (1 - \mathbf{n}(Y, \Omega, S))\mu = \tau \mathbf{w}(Y, \Omega, S) \mathbf{n}(Y, \Omega, S)$ .



Thus, a government with a bad credit history cannot smooth the deficit through foreign borrowing and may have low productivity. Next period it remains in autarky with probability  $\alpha$  and gains access to international financial markets with probability  $1 - \alpha$ .

A government with a good credit history  $h = 0$  has first to decide whether to honor its debt or not:

$$\mathcal{Q}^i(B, z) = \max \left[ \mathcal{Q}^{i,nd}(B, z), \mathcal{Q}^{i,d}(B, z) \right] \quad (21)$$

where  $\mathcal{Q}^{i,nd}(B, z)$  is the value of the government's objective when choosing not to default and  $\mathcal{Q}^{i,d}(B, z)$  is the value when it chooses to default. The value of not defaulting is:

$$\mathcal{Q}^{i,nd}(B, z) = \max_{Y, \Omega} U^s(Y, \Omega, S_1(z, B)) + \beta \mathbb{E} \mathcal{Q}^i(B', z') \quad (22)$$

where  $S_1(z, B) = S(z, B, h = 0)$ , subject to the budget and resource constraints (15a)-(16a) and to the implementability constraints (17)-(19) setting  $S = S_1(z, B)$  and  $h = 0$ . Hence, when the government does not default it can issue new debt, it retains high productivity (relative to the autarky states), and it also keeps open the option of borrowing next period.

The value of default  $\mathcal{Q}^{i,d}(B, z)$  is given as:

$$\mathcal{Q}^{i,d}(B, z) = \max_{Y, \Omega} U^s(Y, \Omega, S_1(z, B)) + \beta \mathbb{E} \left[ \alpha \mathcal{Q}^{aut}(z') + (1 - \alpha) \mathcal{Q}^i(B' = 0, z') \right] \quad (23)$$

subject to the government budget constraint and the aggregate resource constraint and the implementability conditions (17) – (19) for  $h = 1$  and  $B = B' = 0$ . Thus, while the government does not pay its current creditors, it cannot issue new debt, it may experience a drop in productivity, and remains in autarky next period with probability  $\alpha$ .

**Lenders.** There is a large amount of identical risk neutral international lenders and we assume free entry. A lender purchases  $b'$  bonds at the price  $q(B', z)$  and receives  $b'$  in the subsequent period unless the sovereign defaults. We assume that lenders can alternatively invest in a risk free asset which delivers a real return  $1 + r$ . For an individual lender, the expected present value of the revenue from lending  $b'$  to the sovereign is therefore:

$$\Lambda = -R(B', z) b' + \mathbb{E} \frac{1 - d'}{1 + r} b'$$

Thus, given free entry the expected payoff from lending to the government must equal the risk free rate:

$$R(B', z) = \frac{1 - \mathbb{E}d'}{1 + r} \quad (24)$$

It follows that the bond price compensates the lender for the default risk. When default is inevitable,  $\mathbb{E}d' = 1$ , the bond price falls to zero and the country is de facto excluded from international debt markets.

**Equilibrium.** We assume that the government lacks commitment and we focus upon Markov perfect equilibria. The lack of commitment refers not only to its debt policy but also to its other instruments. It will therefore have to set policies that are self-reinforcing in a game between its current self, the future government and foreign lenders. In choosing its policies it will maximize the weighted average welfare of households taking into account its actions impact future welfare and choices.

Formally, we focus upon:

**Definition 1** *A Markov Perfect equilibrium is a set of policies  $\Omega(S)$ , an allocation  $Y(S, \Omega)$  and a set of future policies  $\Omega'(S)$  such that:*

- (i) The policies and the allocations solve (20) and (21);
- (ii) The bond price is given by (24); and
- (iii)  $\Omega(S) = \Omega'(S)$ ;

Given the solutions for  $\Omega(S)$  and  $Y(S, \Omega)$ , we can use conditions (??)-(??) to solve for  $(p, q, n, c^u, w)$ .