# The Unemployment Benefit System: a Redistributive or an Insurance Institution?*

Daniel Cardona†
Universitat de les Illes Balears

Fernando Sánchez-Losada
CREB and Universitat de Barcelona

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**Abstract**

We analyze the effects of the unemployment benefit system on the economy. In particular, we focus on both the tax structure and the unemployment benefits composition. We show that if the unemployment benefit system is only paid by firms, then employment and production are maximized. Moreover, the way the government contemplates the unemployment benefit system, either as a redistributive or as an insurance institution, is crucial for the dynamics and the equilibria of the economy.

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†*Corresponding author:* Departament d'Economia Aplicada; Universitat de les Illes Balears; Ctra. Valldemossa km. 7,5; 07071 Palma de Mallorca; Spain; e-mail: d.cardona@uib.es; Tel.: (+ 34) 971172845; Fax: (+ 34) 971173089.

## 1. Introduction

In this paper we claim that the composition of the labor taxation does matter for both the wage formation and the employment. Moreover, the precise government program financed through these taxes is important for the wage formation. In an economy characterized by the presence of unions, we analyze the effects of both the tax structure and the unemployment benefits composition. We show that if the unemployment benefit system is only paid by firms, then employment and production are maximized. Moreover, the way the government contemplates the unemployment benefit system, either as a redistributive or as an insurance institution, is crucial for the dynamics and the equilibria of the economy.

We consider an unionized economy where the government sets an unemployment benefit system. This system is assumed to be two-tier: benefits are divided in both a fixed part and a variable part that depends on wages. In particular, the extreme cases where only the fixed part exists or only the variable part exists, known as the Beveridgean and the Bismarckian systems, respectively, are also analyzed. The government finances the system through both a wage tax levied on labor income and a payroll tax levied on firms.[1] When deciding the unemployment benefit system, the government has to choose between setting the benefit side or the tax side of the system. In this sense, we can say that the government chooses either an insurance institution or a redistributive one. Although ex-ante this selection could seem innocuous, it has important consequences on the economy.

A discussion of the unemployment benefit system and its effects on the economy have been widely analyzed in the last years.[2] The main and novel contribution, from our point of view, is Corneo and Marquardt (2000). They consider an economy with public pensions and a Beveridgean unemployment benefit system where the government concentrates on the redistributive institution. They find that the structure of the tax wedge has no influence on both the level and path of the unemployment rate. However, maximizing economic growth requires that firms alone finance the unemployment benefit system. This is due to the interaction between the unfunded social security system and the unemployment benefit system, and would not arise if only one of these institutions were present. Although we have different results for the unemployment rate, we show that the public pensions system is not needed for these results to arise and, as Blanchard and Summers (1986), a balanced-budget rule for the government can make expectations self-fulfilling and a hysteresis process can arise when the government takes the unemployment benefit system as an insurance institution. This is also a difference with Koskela and Schöb (1999), who analyze a revenue-neutral change in the tax structure.

We show that, when the government chooses the unemployment benefit system as a redistributive institution, the composition of the benefit side between the fixed part and the variable part does not affect the unemployment rate. Indeed, an increase in the payroll tax accompanied by a decrease in the wage tax such that the total wedge remains constant causes the unemployment rate to fall. Moreover, the net wage that workers receive increases. Therefore, the government can minimize unemployment at the same time that it maintains the total tax wedge unchanged by charging the total wedge on firms.

The government, by choosing the unemployment benefit system as an insurance institution, may induce the economy to a hysteresis status: if individuals expect that, in order to finance the unemployment

[1] For example, the taxes paid by the workers and the firms in France in 1998 were approximately 2.8% and 4%, respectively, and in Spain in 2003 they were approximately 1.6% and 6.7%, respectively.

[2] The institutional details of the unemployment benefit system for the different countries can be found in OECD (1999).

benefit system, the wage tax will be high, then their wage demand increases. Firms respond with a low labor demand and, then, unemployment rises. Thus, a wage demand spillover is created and the unemployment becomes high. Since the government financial necessities rise, the wage tax increases, which implies a reduction of savings and, thus, the economy converges to an equilibrium with low capital and high unemployment. In contrast, if individuals expect that the wage tax will not vary the net wage, then their wage demand is low. Since firms respond with a high labor demand, then the unemployment and the wage tax remain at a low rate. Therefore, the insurance institution implies the existence of two equilibria, one with a high level of employment (namely, optimistic equilibrium) and the other with a high level of unemployment (namely, pessimistic equilibrium). We show that the composition of the tax wedge does not affect the unemployment rate if, and only if, the unemployment benefit system is Beveridgean. Otherwise, an increase in the payroll tax accompanied by a decrease in the wage tax causes the unemployment rate to fall in the optimistic equilibrium and to rise in the pessimistic equilibrium. With respect to the benefit side, we show that an increase in either the variable part or the fixed part causes the unemployment rate to rise in the optimistic equilibrium and to fall in the pessimistic equilibrium. However, an increase in the variable part accompanied by a decrease in the fixed part such that the total benefit does not change, does not affect the unemployment rate. Therefore, a government may think that its economic policy is the correct one because an increase in the benefit side has implied a decrease in the unemployment rate, when this only implies that the economy is on the pessimistic equilibrium and that the unemployment rate could even be lower if the economy reaches the optimistic equilibrium.

In the insurance institution, the optimistic equilibrium is always locally stable whereas the pessimistic equilibrium may be either locally stable or unstable. If the pessimistic equilibrium is unstable, then the economy converges to the optimistic equilibrium. The problem to the government arises when both equilibria are locally stable, since then it does not know ex-ante the consequences of any economic policy.[3] In this case, we have global indeterminacy in the sense that agents may be initially either optimistic or pessimistic. However, once the economy reaches some equilibrium path, it remains on it if the expectations do not change. If the government changes the economic policy, it can influence on agents' expectations. Thus, when implementing any economic policy, the government must ensure that the agents' expectations are the optimistic ones and, therefore, the economy will end up in the "good" equilibrium path. Nonetheless, since a tax announcement can be non credible, the government has a mechanism to induce the economy to converge to the optimistic equilibrium. The government knows that, given the insurance institution, each of the two equilibria has associated a different tax path. Therefore, if the government fixes the tax path by establishing the redistributive institution, the economy will end up in the optimistic equilibrium and with the government's desired unemployment benefits (insurance institution). Thus, if the government objective is the insurance institution, it might be necessary to use the redistributive institution in order to achieve its objective.

In our paper, and in contrast with Corneo and Marquardt (2000), shifting the incidence of the unemployment contributions from the workers to the firms generates an adjustment in the optimal wage policy of the union. Moreover, we can have a non revenue-neutral change in the tax structure such that the tax wedge remains unchanged and the net wages increase. The existence of physical capital is crucial in our results, even when the wage elasticity of labor demand is constant, since it affects the capital demand and thus employment. Thus, the different results of Koskela and Vilmunen (1996), Goerke (2000), Beissinger

[3] Numerical simulations suggest that this is the case.

and Egger (2001), Egger (2002) or Goerke and Madsen (2003), among others, could be explained by their partial equilibrium analysis.

The tax system we consider is composed only by proportional taxes on labor levied on both workers and firms. We think that it has no sense to tax unemployed individuals in order to pay the unemployed benefits to themselves. However, we discuss the policy implications due to a change in the progressivity of the income tax system. While in the redistributive institution the results are independent of the precise tax system, this is not the case in the insurance institution. In this case, we observe that in a proportional income tax system where unemployed benefits are also taxed, the composition of the tax wedge does not affect the unemployment rate if, and only if, the unemployment benefit system is Bismarckian. Otherwise, the unemployment rate is minimized when the unemployment benefit system is financed exclusively by the workers. Indeed, in a more progressive income tax system where only the variable part of the unemployed benefits is taxed, the unemployment rate does not depend on how the unemployment benefit system is financed. In the more progressive system where unemployed benefits are not taxed (this paper), the unemployment rate is minimized when the unemployment benefit system is financed exclusively by the firms. Our conclusions do not coincide with previous papers (see Koskela, 2001, for a survey) that claim that when the income tax system becomes more progressive, the unemployment benefit system should be financed only by workers. Introducing capital accumulation changes drastically these conclusions. In fact, the effects of the tax composition on the unemployment rate depend crucially on the progressivity of the tax system, since taxes are associated to a precise government program. However, our results seem to indicate that the more progressive the tax system is, the lower the unemployment rate becomes if taxes are levied on firms.

The negotiation between unions and firms is a right-to-manage one, where unions focus exclusively on wages. We show that if unions focus and bargain on both labor and employment, then the qualitative results remain unchanged. Thus, we obtain the same result as Creedy and McDonald (1991), who show that the qualitative effects of taxes on employment do not depend on the type of negotiation.

Other studies have centered on other aspects of the unemployment benefit system. Among others, Fredriksson and Holmlund (2001) analyze a system with both unemployment insurance and unemployment assistance, Albrecht and Vroman (1999) analyze the experience rating, and Picard (2001) centers on both the job additionality and the unemployment trap in the sense that individuals loose their entitlement to unemployment and welfare when they choose to work. From an empirical point of view, the literature has centered on the effects of the labor taxes on the unemployment rate. Layard and Nickell (1986), Nickell and Layard (1999) and Daveri and Tabellini (2000) show that the rise in the labor tax wedge plays an important role in raising the wage pressure and hence the unemployment rate. However, Lockwood and Manning (1993) for the U.K. case and Holm, Honkapohja and Koskela (1994) for the Finnish case show that the tax wedge is not a good measure and, hence, the effects of either a wage tax or a payroll tax may be different, since the tax base of each tax may be different. Among these papers, only Holm et al. (1994) include in the analysis the spending counterpart that the government makes of the tax revenue (in this case the unemployment benefit system). None of them analyzes the case where the wage tax increases and the payroll tax decreases, or vice versa. From our point of view, a modification of the composition in the labor tax wedge such that it remains constant may vary the unemployment rate, even when the tax base is the same for both taxes. Moreover, the government use of the tax revenue, as the unemployment benefit system, might explain a hysteresis process that can be different for each country.

The paper is organized as follows. In the next section we present the framework economy. In section 3 we analyze both the redistributive and the insurance institutions of the unemployment benefit system. In section 4 we discuss the results. Finally, section 5 concludes.

## 2. The economy

We construct an overlapping generations economy with constant population, whose mass is normalized to one. Individuals live for two periods. Young generations are endowed with one unit of labor which they offer inelastically.

**Household**: The preferences of an individual $i$ are described by a linearly homogeneous utility function, $u\left(c_t^i, c_{t+1}^i\right)$, where $c_t^i$ and $c_{t+1}^i$ are consumption when young and old, respectively.[4] The maximum attainable utility is characterized by a multiplicatively separable indirect utility function $v\left[\cdot\right]$ which is linear in income $I_t^i$, i.e.,

$$\max\ u\left(c_t^i, c_{t+1}^i\right) = v\left[1/(1+r_{t+1})\right] I_t^i,$$

where $1+r_{t+1}$ is the return on savings between period $t$ and $t+1$, and $I_t^i$ is income. The income of an individual is either the wage net of taxes if she is employed or the unemployment benefit. Given these preferences, we can write individual savings $s_t^i$ as

$$s_t^i = s\left[r_{t+1}\right] I_t^i,$$

where, by Roy's identity, the propensity to save $s\left[\cdot\right]$ is

$$s\left[r_{t+1}\right] = v'\left[1/(1+r_{t+1})\right] / v\left[1/(1+r_{t+1})\right](1+r_{t+1}).$$

**Firms:** There is a continuum of firms, each producing according to a production function $F\left(K_t, L_t\right)$, which is assumed to have both constant returns to scale and constant elasticity of substitution between labor and capital, i.e.,

$$F\left(K_t, L_t\right) = \left(K_t^\sigma + L_t^\sigma\right)^{\frac{1}{\sigma}}, \quad \sigma \leq 1,$$

where $K_t$ is capital and $L_t$ is labor.

**Unemployment benefit system**: Unemployment benefits consist of a fixed part, $b_t \geq 0$, and a variable part which is assumed to be a function of the wage $w_t$,[5] i.e., $b_t + f\left(w_t\right)$. If $b_t = 0$ and $f\left(w_t\right) = \rho_t w_t$, where $\rho_t \in (0,1)$, then we have the Bismarckian unemployment system, and when $f\left(w_t\right) = 0$ we have the Beverigdean unemployment system. We consider an unemployment benefit system which is self-financed: workers and firms pay proportional taxes on wages (wage tax $\tau_t$ and payroll tax $\psi_t$, respectively) and the unemployed individuals receive the benefits. In this case, since unemployed individuals do not pay taxes, we consider that the variable part of the unemployment benefits is a proportion of the gross

[4] Note that, through a monotonic transformation, the homothetic utility functions are linearly homogeneous.

[5] In an extended model where individuals live for more than two periods, the variable part can be a function of the wage received by the worker when employed. Although the dynamics of the economy would change, the equilibria would remain unchanged.

wage of the economy, i.e., $f(w_t) = \rho_t w_t$, where $\rho_t$ is usually known as the benefit replacement ratio. Accordingly, the government budget constraint is given by

$$w_t L_t(\tau_t + \psi_t) = (1 - L_t)(\rho_t w_t + b_t). \tag{2.0}$$

Defining the unemployment rate by $u_t = (1 - L_t)$, the previous equation can be written as

$$(1 - u_t)w_t(\tau_t + \psi_t) = u_t(\rho_t w_t + b_t). \tag{2.1}$$

**Union bargaining**: We consider the right-to-manage bargaining. This bargaining takes place at a decentralized level, so that neither firms nor unions perceive the effects of their actions on the economy via the government budget constraint. The timing of the bargaining is as follows: once the firms have selected the level of capital, firms and unions bargain over wages**.** After, firms choose the employment level. Hence, given $w_t$ and $K_t$, the employment level chosen by any firm solves

$$\max_{\{L_t\}} \; [F(K_t, L_t) - w_t L_t(1 + \psi_t) - (1 + r_t)K_t],$$

from where the optimal level of employment is implicitly given by

$$(1 + \psi_t)w_t = F_{L_t}(K_t, L_t), \tag{2.2}$$

where $F_j$ is the marginal product with respect to $j$. The wage is selected through a bargaining process between the firm and the union. The objective function of the union is given by the net wage, while the firm's objective are profits. The disagreement point of the union is given by $\overline{w}_t$ while the firm's fall-back position is $-(1 + r_t)K_t$, since at this point its level of capital has been already selected. Thus, according to the Nash solution, and denoting the bargaining power of the union and the firm by $\beta$ and $(1 - \beta)$, respectively, with $\beta \in [0, 1]$, the wage solves

$$\max_{\{w_t\}} \; [(w_t(1 - \tau_t) - \overline{w}_t)]^{\beta} [F(K_t, L_t) - w_t L_t(1 + \psi_t)]^{1-\beta}$$

subject to the labor demand given by (2.2). The optimal wage is implicitly defined by

$$w_t L_t(1 + \psi_t) = \beta F(K_t, L_t) + (1 - \beta)\overline{w}_t L_t(1 + \psi_t)/(1 - \tau_t). \tag{2.3}$$

Since the firm anticipates both the level of employment and the wage, it chooses the level of capital that solves

$$\max_{K_t} \; [F(K_t, L_t) - w_t L_t(1 + \psi_t) - (1 + r_t)K_t]$$

subject to the labor demand (2.2) and the wage level (2.3). The optimal capital level is implicitly defined by

$$(1 + r_t) = \frac{(\beta F_{K_t} - L_t F_{K_t L_t}) L_t F_{L_t L_t}}{\left[-L_t F_{L_t L_t} - (1 - \beta) F_{L_t} + (1 - \beta)\overline{w}_t \frac{1+\psi}{1-\tau}\right]} + F_{K_t} - L_t F_{K_t L_t}. \tag{2.4}$$

Since all firms are symmetric, and following Layard, Nickell and Jackman (1991), in equilibrium the disagreement point is given by

$$\overline{w}_t = (1 - u_t)w_t(1 - \tau_t) + u_t(\rho_t w_t + b_t), \tag{2.5}$$

where the first part is the probability of finding a job elsewhere $(1-u_t)$ times the net wage and the second part is the probability of being unemployed $u_t$ times the unemployment benefits.

**Capital market clearing condition**: The amount saved by generation $t$ equals the stock of physical capital at $t+1$, i.e.,

$$K_{t+1} = \int_0^1 s_t^i di = s\left[r_{t+1}\right]\int_0^1 I_t^i di.$$

Noting that $L_t$ is the total number (measure) of workers and $(1-L_t)$ the number of unemployed individuals, the previous equation becomes[6]

$$K_{t+1} = s\left[r_{t+1}\right]\left[L_t w_t\left(1-\tau_t\right)+\left(1-L_t\right)\left(\rho_t w_t + b_t\right)\right]. \tag{2.6}$$

**Equilibrium**: Given equations (2.0) and (2.2), the market clearing condition can be expressed as

$$K_{t+1} = s\left[r_{t+1}\right]F_{L_t}\left(K_t, L_t\right)L_t. \tag{2.7}$$

Using the government's budget constraint (2.1) and the definition of the disagreement point (2.5) we get

$$\overline{w}_t = (1-u_t)w_t(1+\psi_t), \tag{2.8}$$

which combined with (2.2) and (2.3) yields

$$F_{L_t}(K_t, L_t)\left[1-\frac{\left(1-u_t\right)\left(1+\psi_t\right)\left(1-\beta\right)}{\left(1-\tau_t\right)}\right] = \frac{\beta F(K_t, L_t)}{L_t}. \tag{2.9}$$

Moreover, from (2.2) and (2.1) we have

$$\frac{F_{L_t}(K_t, L_t)}{(1+\psi_t)}(1-u_t)(\tau_t+\psi_t) = u_t\rho_t\frac{F_{L_t}(K_t, L_t)}{(1+\psi_t)} + u_t b_t. \tag{2.10}$$

Noting that one of the variables of the unemployment benefit system is endogenous, equations (2.4), (2.7), (2.9) and (2.10) yield the equilibrium of the economy.

Comparative static exercises are complicated since changes in the exogenous parameters will generally affect the interest rate and thus the propensity to save. We abstract from such considerations by concentrating on the benchmark case of Cobb-Douglas preferences, $u = (c_t^i)^{1-s}(c_{t+1}^i)^s$ and $0 < s < 1$, where the intertemporal elasticity of substitution is one and hence $s\left[r_{t+1}\right] = s$. We also assume a Cobb-Douglas production function, $F(K_t, L_t) = K_t^{1-\alpha}L_t^{\alpha}$, where $\alpha$ is the production elasticity with respect to labor, with $\alpha \in (0,1)$. We impose that $\alpha > \beta$ to have positive production. Therefore, from equation (2.7) we can isolate the unemployment level,

$$L_t = 1-u_t = \left(\frac{K_{t+1}}{s\alpha K_t^{1-\alpha}}\right)^{\frac{1}{\alpha}}. \tag{2.11}$$

Note that this equation informs us that in steady-state the capital-labor proportion $K/L$ is fixed with independence of the unemployment benefit system. But contrary, the capital per capita could be affected

[6] Note that, although profits would be for the old generation, they are zero, and thus shares do not exist.

by the unemployment benefit system. Combining equation (2.11) with (2.9) and (2.10), we recover the dynamics of the economy, represented by the following two equations:

$$(\alpha - \beta)(1 - \tau_t) = \alpha (1 - \beta)(1 + \psi_t) \left( \frac{K_{t+1}}{s\alpha K_t^{1-\alpha}} \right)^{\frac{1}{\alpha}}, \tag{2.12}$$

$$\frac{K_{t+1}(\tau_t + \psi_t)}{s(1 + \psi_t)} = \left[ 1 - \left( \frac{K_{t+1}}{s\alpha K_t^{1-\alpha}} \right)^{\frac{1}{\alpha}} \right] \left[ \frac{\rho_t \alpha \left( \frac{K_{t+1}}{s\alpha K_t^{1-\alpha}} \right)^{\frac{\alpha-1}{\alpha}} K_t^{1-\alpha}}{(1 + \psi_t)} + b_t \right], \tag{2.13}$$

from where the steady-state equilibrium solves

$$\frac{(1 - \tau)}{(1 + \psi)} = \frac{\alpha (1 - \beta)}{(\alpha - \beta)(s\alpha)^{\frac{1}{\alpha}}} K, \tag{2.14}$$

$$\frac{K(\tau + \psi)}{s(1 + \psi)} = \left[ 1 - \frac{K}{(s\alpha)^{\frac{1}{\alpha}}} \right] \left[ \frac{\rho\alpha}{(s\alpha)^{\frac{\alpha-1}{\alpha}}(1 + \psi)} + b \right]. \tag{2.15}$$

Next, we analyze the effects on the economy originated by the government decision about the variable of the unemployment benefit system that is endogenous.

## 3. Government objective

When deciding about the unemployment benefit system, the government has to choose between setting the benefit side or the tax side of the system. In this sense, we can say that the government chooses either an insurance institution or a redistributive one. Although ex-ante they could seem the same, next we show that they have a different impact on the dynamics and the equilibria of the economy and, consequently, the effects of any policy affecting the unemployment benefit system depend on the specific institution considered. In the analysis we do not impose a revenue-neutral tax policy, since the objective of the government, once fixed the type of unemployment institution and the dimension of the unemployment benefit system, is to minimize unemployment.

### 3.1. Redistributive institution

When the government fixes the tax side of the unemployment benefit system ($\tau_t$ and $\psi_t$) and let free one of the two variables of the benefits side ($\rho_t$ or $b_t$), it is redistributing income from the labor market insiders (both workers and firms) to the labor market outsiders (unemployed individuals). We fix $b_t$ and endogeneize $\rho_t$ in order to maintain only one discussion. Since $\alpha \in (0, 1)$, from (2.12) it is clear that the economy converges to a steady-state and, from (2.14), this equilibrium exists and is unique. Moreover, combining (2.11) and (2.12) we obtain

$$(\alpha - \beta)(1 - \tau_t) = \alpha (1 - \beta)(1 + \psi_t) L_t, \tag{3.1}$$

which implies that for constant values of both taxes there is no transition in employment, but it does in capital. An inspection of (3.1) directly gives the next result.

**Proposition 3.1.** *If the government chooses the unemployment benefit system as a redistributive institution, then an increase in the fixed part $b_t$ (accompanied by the corresponding decrease in the variable part $\rho_t$) does not affect the unemployment rate.*

Since the government does not change taxes, both the gross wage and the net wage do not vary. Therefore, aggregate income does not change and, correspondingly, unemployed individuals obtain the same benefits. Thus, in order to balance the benefits, an increase in the fixed part only implies a decrease in the variable part.

Clearly, an increase in either the wage tax $\tau_t$ or the payroll tax $\psi_t$ implies a lower employment rate, since the government is increasing the gross salary the firm has to pay per unit of labor. Moreover, a change in the composition of the tax mix without any change in the total tax wedge can have real effects on the economy, as the next result shows.

**Proposition 3.2.** *If the government chooses the unemployment benefit system as a redistributive institution, then an increase in the payroll tax $\psi_t$ accompanied by a decrease in the wage tax $\tau_t$ such that the total tax wedge does not change $d\psi_t = -d\tau_t$ causes the unemployment rate to fall. Moreover, the net wage that workers receive increases in steady-state.*

**Proof.** Differentiating (3.1) and using $d\psi_t = -d\tau_t$, we have that $sign(dL_t) = sign\left(d[(1-\tau_t)/(1+\psi_t)]\right) = sign\left[d\psi_t\left(\psi_t+\tau_t\right)/\left(1+\psi_t\right)^2\right]$, which is positive when $d\psi_t > 0$. Evaluating (2.11) in steady-state and using (2.2) we know that $(1+\psi)\,w$ is constant. Hence $dw = -d\psi\left[w/\left(1+\psi\right)\right]$. The net wage that workers receive is $(1-\tau)\,w$. Therefore, using the previous relation between $dw$ and $d\psi$ and $d\psi = -d\tau$, we have that $d\left[(1-\tau)\,w\right] = -wd\tau + (1-\tau)\,dw = -wd\tau - d\psi\,(1-\tau)\,w/\left(1+\psi\right) = -w\left[d\tau\,(1+\psi) + d\psi\,(1-\tau)\right]/\left(1+\psi\right) = -w\left[-d\psi\,(1+\psi) + d\psi\,(1-\tau)\right]/\left(1+\psi\right) = d\psi\left[w\left(\psi+\tau\right)/\left(1+\psi\right)\right]$, which is positive when $d\psi > 0$. ■

Although the gross wage for the firm does not vary, the wage decreases and the employment rises. This result highlights the importance of the physical capital in this economy: the unemployment reduction is only possible because there is an increase in the physical capital of the economy due to an increase in the net wage received by the workers and, thus, in savings. Otherwise, the right-to-manage assumption would imply a constant employment rate. Note that maintaining the total tax wedge unchanged does not imply that there is a revenue-neutral change, since the wage changes. Nonetheless, the objective of the government is the redistributive institution of the unemployment benefit system, with independence of the tax revenue. Also note that, since the tax base is the same, maintaining the total tax wedge unchanged is the same as maintaining the average tax unchanged.

**Corollary 3.3.** *If the government chooses the unemployment benefit system as a redistributive institution, then the government can minimize unemployment at the same time that it maintains the total tax wedge unchanged by charging the total tax wedge on firms, i.e. $\tau_t = 0$.*

The previous corollary follows if we assume that no subsidy can be given to the workers. Moreover, note that if a subsidy can be implemented,[7] then a policy such that $\psi_t + \tau_t = 0$ does not change the employment rate, since this policy means not having an unemployment benefit system. Further,

[7] Note that this possibility would imply a regressive tax system.

if $\psi_t + \tau_t > 0$ and subsidies are allowed, then the previous policy would not eliminate completely the unemployment.

### 3.2. Insurance institution

When the government fixes the benefit side of the unemployment benefit system ($\rho_t$ and $b_t$) and let free one of the two variables of the tax side ($\tau_t$ or $\psi_t$), it is concentrating in the insurance institution. We fix $\psi_t$ and endogeneize $\tau_t$ in order to maintain only one discussion. The government, by choosing an insurance institution, may induce the economy to have two self-fulfilling expectations equilibria. In the first, individuals expect that the wage tax will be high. Then their wage demand increases.[8] Firms respond with a low labor demand and, then, the unemployment rises. Thus, a wage demand spillover is created and the unemployment becomes high. Since the government financial necessities rise, the wage tax increases, which implies a reduction of savings and, thus, the economy converges to an equilibrium with low capital and high unemployment (namely, pessimistic equilibrium). In contrast, when individuals expect that the wage tax will not vary the net wage, then their wage demand is low. Since firms respond with a high labor demand, then the unemployment and the wage tax remain at a low rate. Therefore, the insurance institution implies the existence of two equilibria, one with a high level of employment and the other with a high level of unemployment. Next, we analyze the properties of these equilibria.

Substituting for $\tau_t$ from (2.12) into (2.13) we find the dynamics of the capital of this economy as

$$\frac{\alpha(1-\beta)}{(\alpha-\beta)}(s\alpha)^{-1/\alpha}K_{t+1}^{2/\alpha} - \left(1+\frac{\rho_t}{1+\psi_t}\right)K_{t+1}^{1/\alpha}K_t^{(1-\alpha)/\alpha} + \frac{\rho_t}{1+\psi_t}(s\alpha)^{1/\alpha}K_t^{2(1-\alpha)/\alpha} +$$
$$+ sb_tK_{t+1}^{(1-\alpha)/\alpha}K_t^{(1-\alpha)/\alpha} - b_ts(s\alpha)^{-1/\alpha}K_{t+1}^{(2-\alpha)/\alpha} = 0, \tag{3.2}$$

from where, defining $k_t = K_t(s\alpha)^{-1/\alpha}$ and fixing the government parameters, we can find the two steady-states by solving

$$\frac{\alpha(1-\beta)}{(\alpha-\beta)}k^2 - [1+A]k + A = 0, \tag{3.3}$$

where $A = bs(s\alpha)^{-1/\alpha} + \dfrac{\rho}{1+\psi}$. The solutions are given by

$$k = \frac{(\alpha-\beta)}{2\alpha(1-\beta)}\left[1+A \pm \sqrt{(1+A)^2 - 4A\frac{\alpha(1-\beta)}{(\alpha-\beta)}}\right]. \tag{3.4}$$

Since in steady-state the capital-labor proportion $K/L$ is fixed, a higher $k$ implies a higher employment rate. We denote the optimistic equilibrium by $k_1$ and the pessimistic equilibrium by $k_2$, with $k_1 \geq k_2$. The equilibria exist if and only if

$$A < \frac{\alpha(1-\beta) + \beta(1-\alpha) - 2\sqrt{\beta\alpha(1-\alpha)(1-\beta)}}{(\alpha-\beta)}, \tag{3.5}$$

which means that if the unemployment benefits are very high, then there is no production.

[8] If the payroll tax is endogenous instead of the wage tax, then firms could believe that the payroll tax will be high and hence their offered wage decreases.

In these steady-states the policy implications of a change in the unemployment benefit system are completely different. An inspection of (3.4) shows when it does not matter the fiscal source of the unemployment benefit.

**Proposition 3.4.** *If the government chooses the unemployment benefit system as an insurance institution, then an increase in the payroll tax $\psi_t$ (accompanied by a decrease in the wage tax $\tau_t$) does not affect the unemployment rate if, and only if, the unemployment benefit system is Beveridgean.*

The Beveridgean unemployment system implies that the unemployment benefits are completely exogenous. In this case, since the gross wage paid by the firms is constant, a decrease in the wage does not vary the unemployment benefits and, thus, the corresponding decrease in the wage tax adjusts in order to not modify the net wage. In contrast, the Bismarckian unemployment system partially endogeneizes the unemployment benefits, which implies that the net wage received by the workers does not necessarily remain constant and, then, savings might be affected when the tax mix is changed. In this case, capital accumulation would push the economy to a different equilibrium. Therefore, when the unemployment benefit system is not exclusively Beveridgean, we observe that the tax mix has important effects on the unemployment rate, as the next result shows.

**Proposition 3.5.** *If the government chooses the unemployment benefit system as an insurance institution and $\rho_t > 0$, then an increase in the payroll tax $\psi_t$ (accompanied by a decrease in the wage tax $\tau_t$) causes the unemployment rate to fall in the optimistic equilibrium and to rise in the pessimistic equilibrium.*

**Proof.** Differentiating $k$ with respect to $\psi$ in (3.4) gives $dk/d\psi = (dk/dA)(dA/d\psi)$, where $dA/d\psi < 0$ and $sign[dk/dA] = sign\left(\sqrt{(1+A)^2 - 4A\frac{\alpha(1-\beta)}{(\alpha-\beta)}} \pm \left[1 + A - \frac{2\alpha(1-\beta)}{(\alpha-\beta)}\right]\right)$, which depends on the considered equilibrium. Clearly, from (3.5) we have that the term in the squared brackets is negative, which implies that $dk/d\psi < 0$ for $k_2$. Straightforward calculations show that $dk/dA < 0$ for $k_1$, and hence $dk/d\psi > 0$. ■

Although the gross wage paid by the firm is constant, the variation in the net wage depends on the agents' expectations. If individuals expect that the wage tax will increase then their wage demand increases. These expectations are reinforced by the unemployment benefits, since the variable part partially endogeneizes the unemployment benefits and hence creates a higher wage demand spillover. If, instead, individuals expect that the wage tax will not vary the net wage, the variable part reinforces the agents' expectations by decreasing the wage tax. Since an increase in the variable part $\rho_t$ (or the fixed part $b_t$) has the opposite effect of an increase in the payroll tax $\psi_t$ (i.e. $dA/d\rho > 0$), we can state the following result.

**Proposition 3.6.** *If the government chooses the unemployment benefit system as an insurance institution, then an unilateral increase in the variable part $\rho_t$ (or the fixed part $b_t$) causes the unemployment rate to rise in the optimistic equilibrium and to fall in the pessimistic equilibrium.*

If the composition of the benefit side changes but the total unemployment benefits remain unchanged, then taxes do not change. Thus, the steady-state unemployment rates are not affected, but it does the dynamics, as we show next.

**Proposition 3.7.** *If the government chooses the unemployment benefit system as an insurance institution, then an increase in the variable part $\rho$ accompanied by a decrease in the fixed part $b$ such that the unemployment benefit does not change $d(\rho w + b) = 0$, does not affect the unemployment rates in the steady-state, but it changes the transition paths.*

**Proof.** Straightforward calculations show that the unemployment benefit in steady-state is $\rho w + b = As^{-1} (s\alpha)^{1/\alpha}$. Therefore, $d(\rho w + b) = 0$ implies that $dA = 0$ and, therefore, $dL = 0$. ■

Since the payroll tax is constant, an increase in the benefit side implies a change in the wage tax and, hence, agents' expectations are decisive. Therefore, a government may think that its economic policy is the correct one because an increase in the benefit side has implied a decrease in the unemployment rate. However, this also implies that the economy is on the pessimistic equilibrium and that the unemployment rate could be even lower if the economy was on the optimistic equilibrium.

The dynamic properties of the equilibria are analyzed in the Appendix. It is shown that the optimistic equilibrium is always locally stable, while the stability of the pessimistic equilibrium depends on the concrete value of the parameters. As a particular case, when the unemployment benefit system is Bismarckian then the pessimistic equilibrium is always locally stable, regardless of the unemployment benefit $\rho$. For the cases where the unemployment benefit system is not exclusively Bismarckian, numerical simulations indicate that it is always locally stable. Indeed, for our purpose, we only need to claim that there exist some parameter configurations implying that the pessimistic equilibrium is locally stable.

If the pessimistic equilibrium is unstable, then the economy converges to the optimistic equilibrium. If both equilibria are locally stable, then there is global indeterminacy in the sense that agents may be initially either optimistic or pessimistic. However, once the economy reaches some equilibrium path, it remains on it if the expectations do not change. If the government changes the economic policy, it can influence on agents' expectations. Thus, when implementing any economic policy, the government must ensure that the agents' expectations are the optimistic ones and, therefore, the economy will end up in the "good" equilibrium path. Nonetheless, since a tax announcement can be non credible, the government has a mechanism to induce the economy to converge to the optimistic equilibrium. The government knows that, given the insurance institution, each of the two equilibria has associated a different tax path. Therefore, if the government fixes the tax path by establishing the redistributive institution, the economy will end up in the optimistic equilibrium with the government's desired unemployment benefits (insurance institution). Thus, if the government objective is the insurance institution, it might be necessary to use the redistributive institution in order to achieve its objective.

## 4. Discussion

The tax system we consider in the paper is composed only by proportional taxes on labor paid by both workers and firms. In fact, the use of wage taxes can be interpreted as a particular case of a progressive income tax system where only employed individuals bear the tax burden. Although the scope of this paper is not the analysis of alternative tax systems, the conclusions derived in the previous sections change drastically when the tax system changes. We analyze two alternative tax systems: in the first, the unemployment benefit system is financed through both a payroll tax levied on firms and a proportional income tax levied on all the individuals. In the second tax system the government finances the unemployment benefit system through both a payroll tax levied on firms and a wage tax levied on both workers and unemployed. This second tax system is more progressive than the first one, but less progressive than the tax system analyzed in the previous sections. We concentrate on the insurance institution.

### 4.1. Proportional income taxes

When the unemployment benefit system is financed through a payroll tax levied on firms and a proportional income tax levied on all the individuals, then the government budget constraint becomes

$$(1-u_t)\, w_t\,(\tau_t+\psi_t) = u_t\,(\rho_t w_t + b_t)\,(1-\tau_t)\,. \tag{4.1}$$

The disagreement alternative is

$$\overline{w}_t = \left[(1-u_t)\, w_t + u_t\,(\rho_t w_t + b_t)\right](1-\tau_t)\,. \tag{4.2}$$

Using (2.2), (2.3) and (4.2), and evaluating in steady-state, we implicitly obtain the unemployment rate as

$$\alpha\,(1-\beta)\,u + \beta\,(1-\alpha) = (1-\beta)\left[\rho\alpha + \frac{b\,(1+\psi)}{(K/L)^{1-\alpha}}\right]u. \tag{4.3}$$

Note that there is a unique steady-state, since $K/L$ is constant in any steady-state. From the previous equation, we observe that the composition of the tax wedge does not affect the unemployment rate if, and only if, the unemployment benefit system is Bismarckian. Since the Bismarckian unemployment benefit system implies that the unemployment benefits are partially endogenous, a change in the tax wedge does not have any effect because the unemployment benefits vary in the same proportion that the net wage. Otherwise, when $b>0$, the unemployment rate is minimized when the unemployment benefit system is financed exclusively by the workers.

### 4.2. Wage taxes on both workers and unemployed

When the unemployment benefit system is financed through a payroll tax levied on firms and a wage tax levied on both workers and unemployed, the tax system becomes more progressive. The associated government restriction is

$$(1-u_t)\, w_t\,(\tau_t+\psi_t) = u_t\left[\rho_t w_t\,(1-\tau_t) + b_t\right], \tag{4.4}$$

and the disagreement payoff becomes

$$\overline{w}_t = (1-u_t)\, w_t\,(1-\tau_t) + u_t\left[\rho_t w_t\,(1-\tau_t) + b_t\right]. \tag{4.5}$$

Using (2.2), (2.3), (4.4) and (4.5), and evaluating in steady-state, we implicitly find the unemployment rate as

$$\frac{(\alpha-\beta)}{(1-\beta)\,\alpha} = (1-u)\,\frac{\left[(1-u)-u\rho\right]\alpha\,(K/L)^{1-\alpha}}{\left[(1-u)\,\alpha\,(K/L)^{1-\alpha} - ub\right]}. \tag{4.6}$$

Note that there exist two equilibria, since $K/L$ is constant in any steady-state. Nonetheless, the unemployment rates do not depend on the composition of the tax wedge.

The effects of the different taxes on the unemployment rate depend crucially on the progressivity of the tax system, since taxes are associated to a precise government program. Hence, our results seem to indicate that the more progressive the tax system is the lower the unemployment rate becomes if taxes are levied on firms.

### 4.3. Redistributive institution

When the government chooses the unemployment benefit system as a redistributive institution, one can easily observe that equation (3.1) is maintained regardless of considering either proportional income taxes or wage taxes levied on both workers and unemployed. Hence, all the results of section 3.1. remain unchanged under these alternative specifications of the tax structure.

### 4.4. Bargaining over wages and employment

The negotiation we consider in the paper is a right-to-manage one, where the unions focus exclusively on the wage. A different situation arises when the unions bargain on both the wage and the employment.[9] In this situation, after the level of capital has been selected by the firm, and according to the Nash solution, the wage and the employment level solve

$$\max_{\{w_t, L_t\}} \; \left[\left(w_t(1-\tau_t) - \overline{w}_t\right) L_t\right]^{\beta} \left[F(K_t, L_t) - w_t L_t(1+\psi_t)\right]^{1-\beta},$$

from where the following optimal conditions are satisfied:

$$\overline{w}_t\,(1+\psi_t) = (1-\tau_t)\,F_{L_t}(K_t, L_t), \tag{4.7}$$

$$w_t L_t(1+\psi_t) = \beta F(K_t, L_t) + (1-\beta)\overline{w}_t\,(1+\psi_t)\,L_t/\,(1-\tau_t)\,. \tag{4.8}$$

Since the firm anticipates this agreement, it chooses the level of capital that solves

$$\max_{K_t} \; F(K_t, L_t) - w_t\,(1+\psi_t)\,L_t - (1+r_t)K_t$$

subject to (4.7) and (4.8). The optimal capital level is implicitly defined by

$$(1+r_t) = (1-\beta)\,F_{K_t}(K_t, L_t). \tag{4.9}$$

Note that equation (4.7) is the unique equation that differs from the equations that determine the dynamics and the equilibria in the previous sections, where (4.7) is replaced by the right-to-manage condition. Having into account this difference, we obtain

$$L_t = \left(\frac{K_{t+1}}{s\gamma K_t^{1-\alpha}}\right)^{\frac{1}{\alpha}}, \tag{4.10}$$

[9] This model is usually called the efficient bargaining model. However, since in our model there is a previous decision on capital that is not considered in the bargaining, we do not use this term in order to avoid confusions about efficiency.

where the difference with the right-to-manage bargaining is that $\alpha$ is replaced by $\gamma = [\beta + \alpha(1-\beta)]$. After some calculations, we obtain the dynamics of the economy, represented by the following two equations:

$$\alpha(1-\tau_t) = \gamma(1+\psi_t)\left(\frac{K_{t+1}}{s\gamma K_t^{1-\alpha}}\right)^{\frac{1}{\alpha}}, \tag{4.11}$$

$$\frac{K_{t+1}(\tau_t+\psi_t)}{s(1+\psi_t)} = \left[1-\left(\frac{K_{t+1}}{s\gamma K_t^{1-\alpha}}\right)^{\frac{1}{\alpha}}\right]\left[\frac{\rho_t\gamma\left(\frac{K_{t+1}}{s\gamma K_t^{1-\alpha}}\right)^{\frac{\alpha-1}{\alpha}}K_t^{1-\alpha}}{(1+\psi_t)}+b_t\right], \tag{4.12}$$

from where the steady-state equilibrium solves

$$\frac{(1-\tau)}{(1+\psi)} = \frac{\gamma}{\alpha(s\gamma)^{\frac{1}{\alpha}}}K, \tag{4.13}$$

$$\frac{K(\tau+\psi)}{s(1+\psi)} = \left[1-\frac{K}{(s\gamma)^{\frac{1}{\alpha}}}\right]\left[\frac{\rho\gamma}{(s\gamma)^{\frac{\alpha-1}{\alpha}}(1+\psi)}+b\right]. \tag{4.14}$$

The previous equations are quite similar to (2.12)-(2.15). Moreover, in steady-state $K/L$ is also constant, regardless of the considered equilibrium. Thus, the conclusions derived in this case are qualitatively the same than those of the previous sections, where the unions were only concerned about wages. Therefore, we can conclude that, whereas the structure of the tax system seems to be crucial, the specific negotiation between workers and firms does not seem to have any impact on our results.

### 4.5. Corporatist institutions

The analysis of this paper assumes a decentralized negotiation. Thus, both unions and firms bargain at the firm level without having into account the indirect effects that their decisions have on the unemployment benefit system. In contrast, in a corporatist economy or an economy with a centralized negotiation, unions and firms would have into account this indirect effect and, as a result, unemployment would be lower. Moreover, the existence of hysteresis would disappear, since expectations would be coordinated among the agents.

## 5. Conclusions

The government, when deciding the unemployment benefit system, has to choose between setting the benefit side or the tax side of the system. In this sense, we can say that the government chooses either an insurance institution or a redistributive one. In the redistributive institution, an increase in the payroll tax levied on firms accompanied by a decrease in the wage tax levied on workers such that the total wedge remains constant causes the unemployment rate to fall. In the insurance institution, the existence of the unemployment benefit system implies the existence of two equilibria, one with a high level of employment (optimistic equilibrium) and the other with a high level of unemployment (pessimistic equilibrium). We show that the composition of the tax wedge does not affect the unemployment rate if, and only if, the unemployment benefit system is Beveridgean. Otherwise, an increase in the payroll tax accompanied by a decrease in the wage tax causes the unemployment rate to fall in the optimistic equilibrium and to rise in the pessimistic equilibrium. Therefore, a government may think that its economic policy is the correct one because **(a change in taxes?)** *an increase in the benefit side* has implied a decrease in the unemployment rate, when this only implies that the economy is on the pessimistic equilibrium and that the unemployment rate could even be lower if the economy reaches the optimistic equilibrium. Since the government knows that each of the two equilibria is associated to a different tax path, then, if it fixes the tax path by establishing the redistributive institution, the economy will end up in the optimistic equilibrium and with the government desired unemployment benefits (insurance institution). Thus, even if the government objective is the insurance institution, it might need to use the redistributive institution to achieve its objective.

In the analysis, we assume Cobb-Douglas preferences. This assumption is not innocuous. With this type of preferences, if the unemployment benefit system was financed exclusively through taxes on capital income, then the unemployment benefit system would be neutral for the unemployment. This informs us that a deeper insight should be made.

**Appendix**

**Equilibrium dynamics of the insurance institution economy**

Differentiating (3.2), evaluating the resulting expression in steady-state and using (3.3) we have

$$\left.\frac{dK_{t+1}}{dK_t}\right|_{K_{t+1}=K_t} = \frac{Q-\alpha Q}{Q-\alpha H},$$

where

$$Q = k\left(1+\frac{\rho}{1+\psi}\right) - A - \frac{\rho}{1+\psi}, \tag{A.1}$$

$$H = bs\,(s\alpha)^{-1/\alpha}\,(1-k)\,. \tag{A.2}$$

Note that, from (2.11), in steady-state $k = L$ and, thus, $H \geq 0$. Sufficient conditions for the equilibria to be stable without cycles are that either $Q \leq 0$ or $Q > 0$ and $Q > H$. A sufficient condition for the equilibria to be stable with cycles is that $Q > 0$ and $Q < H\alpha/(2-\alpha)$.

*Stability of the optimistic equilibrium*

Using (A.1) and (A.2) we have that

$$Q - H = (1+A)\,k_1 - 2A. \tag{A.3}$$

The optimistic equilibrium $k_1$ satisfies, from (3.3) and (3.4), respectively, that

$$\frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_1^2 - (1+A)\,k_1 + A = 0, \tag{A.4}$$

$$2\frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_1 - (1+A) > 0. \tag{A.5}$$

Therefore, from these two equations, we have

$$2\frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_1^2 - (1+A)\,k_1 = \frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_1^2 - A > 0. \tag{A.6}$$

Thus, from (A.3) and (A.6) we obtain

$$Q - H = \frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_1^2 - A > 0. \tag{A.7}$$

Hence, the optimistic equilibrium is always stable.

*Stability of the pessimistic equilibrium*

The pessimistic equilibrium $k_2$ satisfies, from (3.3) and (3.4), respectively, that

$$\frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_2^2 - (1+A)\,k_2 + A = 0, \tag{A.8}$$

$$2\frac{\alpha\,(1-\beta)}{(\alpha-\beta)}k_2 - (1+A) < 0, \tag{A.9}$$

which implies that

$$Q - H < 0. \tag{A.10}$$

Hence, a sufficient and necessary condition to have stability is

$$(2 - \alpha) Q - \alpha H < 0, \tag{A.11}$$

since this condition resumes that either $Q \leq 0$ or $Q > 0$ and $Q < H\alpha / (2 - \alpha)$. Note that if $b = 0$ then (A.11) is satisfied, since $H = 0$ and $Q < H$. We can define a subspace of the parameter space $\Theta \subset \Re^6$ such that if the vector $\theta = (\alpha, \beta, s, b, \rho, \psi)$ belongs to the subspace $\Theta$, then the pessimistic equilibrium is locally stable, and it is unstable otherwise. As an example, we show some numerical results obtained when $\alpha = 0.66$ and $\beta = 0.03$.[10]

| $s$ | $\psi(\%)$ | $\rho$ | $b$ | $L_2$ | $L_1$ | $w$ | $\rho w + b$ | $\tau_2(\%)$ | $\tau_1(\%)$ | $Q_1$ | $(2-\alpha) Q_2 - \alpha H_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 4 | 0.50 | 0.0475 | 0.852 | 0.921 | 0.1565 | 0.1257 | 9.92 | 2.87 | + | − |
| 0.1 | 4 | 0.55 | 0.0375 | 0.820 | 0.941 | 0.1565 | 0.1236 | 13.38 | 0.91 | − | − |
| 0.1 | 4 | 0.55 | 0.0400 | 0.861 | 0.914 | 0.1565 | 0.1261 | 8.99 | 3.56 | + | − |
| 0.1 | 5 | 0.5 | 0.0480 | 0.847 | 0.925 | 0.1550 | 0.1255 | 9.39 | 1.38 | + | − |
| 0.1 | 5 | 0.55 | 0.0400 | 0.843 | 0.928 | 0.1550 | 0.1252 | 10.08 | 1.27 | − | − |
| 0.1 | 5 | 0.55 | 0.0410 | 0.871 | 0.905 | 0.1550 | 0.1262 | 7.07 | 3.53 | + | + |
| 0.1 | 6 | 0.5 | 0.0485 | 0.843 | 0.928 | 0.1535 | 0.1253 | 9.18 | 0.35 | − | − |
| 0.1 | 6 | 0.55 | 0.0410 | 0.846 | 0.926 | 0.1535 | 0.1254 | 8.84 | 0.57 | − | − |
| 0.1 | 6 | 0.55 | 0.0415 | 0.857 | 0.917 | 0.1535 | 0.1259 | 7.65 | 1.39 | + | − |
| 0.1 | 7 | 0.55 | 0.0425 | 0.865 | 0.911 | 0.1521 | 0.1261 | 5.99 | 1.09 | + | + |
| 0.1 | 7 | 0.60 | 0.3450 | 0.853 | 0.921 | 0.1521 | 0.1257 | 7.29 | 0.10 | − | − |
| 0.2 | 4 | 0.60 | 0.0430 | 0.824 | 0.939 | 0.2236 | 0.1772 | 12.85 | 1.16 | − | − |
| 0.2 | 4 | 0.60 | 0.0460 | 0.862 | 0.914 | 0.2236 | 0.1802 | 8.96 | 3.59 | + | − |
| 0.2 | 4 | 0.65 | 0.0340 | 0.847 | 0.925 | 0.2236 | 0.1793 | 10.44 | 2.52 | − | − |
| 0.2 | 5 | 0.60 | 0.0460 | 0.842 | 0.929 | 0.2215 | 0.1789 | 10.19 | 1.20 | − | − |
| 0.2 | 5 | 0.60 | 0.0475 | 0.869 | 0.907 | 0.2215 | 0.1804 | 7.24 | 3.38 | + | + |
| 0.2 | 5 | 0.65 | 0.0345 | 0.837 | 0.932 | 0.2215 | 0.1785 | 10.69 | 0.91 | − | − |
| 0.2 | 6 | 0.60 | 0.0475 | 0.845 | 0.927 | 0.2194 | 0.1791 | 9.02 | 0.46 | − | − |
| 0.2 | 6 | 0.60 | 0.0485 | 0.861 | 0.914 | 0.2194 | 0.1801 | 7.29 | 1.67 | + | − |
| 0.2 | 6 | 0.65 | 0.0375 | 0.860 | 0.915 | 0.2194 | 0.1801 | 7.36 | 1.61 | − | − |
| 0.2 | 7 | 0.60 | 0.0500 | 0.870 | 0.906 | 0.2173 | 0.1804 | 5.35 | 1.65 | + | + |
| 0.2 | 7 | 0.65 | 0.0385 | 0.854 | 0.920 | 0.2173 | 0.1798 | 7.18 | 0.17 | − | − |

[10] In this numerical example we have included some cases where the pessimistic equilibrium is unstable (the case where $(2-\alpha)Q_2 - \alpha H_2 > 0$) in a larger proportion than the observed in other simulations, where these cases are unusual. Also, the cases where the pessimistic equilibrium is stable with cycles ($Q_2 > 0$) appear in other simulations in a smaller proportion than the suggested in this table.

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