Introducing an Austrian Backpack in Spain*

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Abstract

In an overlapping generations economy with incomplete insurance markets, the introduction of an employment fund – akin to the one introduced in Austria in 2003, also known as 'Austrian backpack'– can enhance production efficiency and social welfare. It complements the two classical systems of public insurance: pay-as-you-go pensions and unemployment insurance (UI). We show this in a calibrated dynamic general equilibrium model with heterogeneous agents of the Spanish economy (2014). A 'backpack' (BP) employment fund is an individual (across jobs) transferable fund, which earns the economy interest rate as a return and is financed with a payroll tax (a BP tax). The worker can use the fund if he or she becomes unemployed or retires. To complement the existing Spanish pension and UI systems with a welfare maximising 19% BP tax would raise welfare by 1.3% of average consumption at the new steady state, and would be preferred to the *status quo* by most economic and demographic groups. Our model also provides a framework where other reforms – e.g. a partial, or complete, substitution of current unsustainable pension systems – can be quantitatively assessed.

Keywords: Computable general equilibrium, welfare state, social security reform, retirement.

JEL classification: C68, H55, J26

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1 Introduction

The reform of existing public insurance systems is an ongoing issue which the last euro crisis and recession has only exacerbated, and which has been the focus of extensive research in economics and other social sciences. Most of this research has focused on the possible reform of separate specific systems: either the pay-as-you-go pension system or the unemployment insurance system (UI), but not on their interaction. However, there is an interesting reform that, in our opinion, deserves further analysis: this is the introduction of an *employment fund*, akin to the one introduced in Austria in 2003 – also known as the 'Austrian backpack'. This is the enquiry that we start in this paper: the effect of introducing such a fund to complement and partially, or even completely, substitute existing public insurance systems.

The basic features of a 'backpack' (BP) employment fund are: it is a fund own by the employee which accumulates, with a basic payroll (BP) tax, while working; it is transferable across jobs and can be finally used as a pension fund; usually it earns a market interest rate (i.e. it can be privately managed), but there may be restrictions in its use (e.g. additional individual contributions may be restricted and the worker may only be able to use it if he or she is unemployed, inactive or retired). While different forms of private employment funds are not a novelty in some countries – Austria being the leading example and it is has been proposed in Spain – such funds are not common as part of the public insurance policy. One example of a private funding scheme is the TIAA-CREF (Teachers Insurance and Annuity Association-College Retirement Equities Fund), which is a non-profit employment fund founded by Andrew Carnegie in 1918 and nowadays serving over 5 million active and retired employees; it has played, and plays, an important role in enhancing mobility among university professors across US universities. However, it is a retirement fund not designed to provide unemployment insurance, while the 'backpack' provides both forms of insurance. Obviously, privately saved assets can also play this double role. However, there are two features that distinguish the 'backpack': first, and foremost, its character of 'forced savings', and, second, possibly a favourable tax treatment (both are common features of fully-funded pension systems). Our benchmark 'backpack' does not allow additional private contributions, the worker can only draw from it if not employed, and its returns are taxed (as any capital gains) but backpack assets are not taxed as part of the income.

The 'Austrian backpack' was introduced in 2003 as part of a broader labour reform. In particular, it was the socially agreed exchange for the elimination of the existing system of severance payments and, in fact, the 'backpack tax' of 1.5% was set according to this tradeoff. Kettemann *et al.* (2017) have shown (with a structurally estimated search-and-matching model) that this reform spiked job-creation and lowered unemployment. Nevertheless, the main effect of the reform came from the elimination of severance payments. We are interested in analysing the effect of just introducing the 'backpack', therefore we do not pair its introduction to another labour reform. To our best knowledge, this analysis is missing and it is the focus of this paper.

As mentioned, there is a wide related literature on the reform of public insurance systems; nevertheless our work builds directly on, and integrates, two models: the model of Díaz-Giménez and Díaz-Saavedra (2009) and Díaz-Gimnez and Díaz-Saavedra (2017), developed to study pension system reforms in Spain using overlapping generations general equilibrium models, and the model with job creation and destruction with search frictions and three employment states (employed, unemployed and inactive) of Krusell et al. (2011), further developed in Ábrahám et al. (2018) to study unemployment insurance reforms in Europe. The latter shows that there is ample room to improve existing European UI systems even within the limits of their current design in which unemployment benefits (UB) are determined by their duration and the replacement rate. In particular, unlimited UB duration emerges as a welfare-improving feature when agents have limited insurance possibilities. In sum, in our model economy agents – which we refer to as households – can differ by their age, education, and productivity, and they decide how much to save and consume, as well as their employment status, which also depends on the rates of job creation and destruction – i.e. agents can also differ by their assets and employment status and are subject to idiosyncratic risks.

In our benchmark economy, households can insure against their idiosyncratic risks privately, through their savings, but there is also public unemployment insurance and a pay-as-you go pension system, both financed with payroll taxes. An aggregate production function and a government that must balance the budget close the model. The model is calibrated to the Spanish economy (in 2014) with the distinct – welfare improving – feature of having unlimited unemployment benefits[1].

We find a welfare maximizing 'backpack tax' at 19%, substantially higher than the one introduced in Austria. We compute the new steady state under the backpack system, and compare it with the status quo economy. The effects within the economy are relatively large in terms of macroeconomic aggregates (higher capital and output) and prices (lower interest rates and higher wages), as well as in terms of households' decisions underlying the macroeconomic effects (substitution of private for backpack savings) and as a result of these effects (high productivity agents work more). Overall the economy is more productive and agents benefit from higher consumption. The final result is that there are substantial welfare gains, in terms of consumption-equivalent values and, importantly, of support for the change when agents are asked whether they would prefer to be in an economy with the 'backpack'. The fact that, at this stage, we only 'add the backpack' makes the comparison of steady states more meaningful since we do not violate any existing claims that retirees or unemployed may have on the current public insurance system. That said, an important dimension still missing in our analysis is the accounting of the transition period between the status quo and the backpack economy, during which a substantial accumulation of capital would take place.

[1]This distinct feature also helps to reduce the number of states since our detailed heterogenous agents structure already results in 6,804,000 agent types!

The next section presents our model economy, Section 3 its calibration and Section 4 the results.

2 The Model Economy

In this section we introduce the baseline model economy. We study an overlapping generations model economy with heterogeneous households, a representative firm, and a government. The model economy is an enhancement of framework in Díaz-Giménez and Díaz-Saavedra (2009), with job creation and destruction and dynamic work and search decisions as in Ábrahám et al. (2018).

2.1 The Households

Households in our baseline economy are heterogeneous and differ in their age, $j \in J$; in their education, $h \in H$; in their temporary productivity level $z \in \mathcal{Z}$; in their employment status, $l \in \mathcal{L}$, and in their assets, $a \in A$; Sets J, H, $\mathcal{Z}$, $\mathcal{L}$, and A, are all finite sets and we use $\mu_{j,h,z,l,a}$ to denote the measure of households of type (j, h, z, l, a). They also differ in their claims to different social insurance systems: unemployment benefits $ub \in UB$ and retirement pensions $p \in P$. In Section 4, we introduce an employment fund (the Austrian backpack) as yet another social insurance policy. In this section we describe the model that will be matched with the Spanish economy in 2014 and we do not make reference to the backpack system. We think of a household in our model as a single individual, even though we use the two terms interchangeably. To calibrate the model, we use individual data of persons older than 20 in the Spanish economy.

Age. Individuals enter the economy at age 20, the duration of their lifetimes is random, and they exit the economy at age 100 at the latest. Therefore $J = \{20, 21, ..., 100\}$. The parameter ψ_j denotes the conditional probability of survival from age j to age $j+1$. The notation makes explicit that the probabilities depend on age j, but not on education or other factors.

Fertility and immigration. In our model there is no demographic change and, therefore, economy fertility rates and immigration flows are not accounted for.

Education. Households can either be high school dropouts with $h = 1$, high school graduates who have not completed college $h = 2$, or college graduates denoted $h = 3$. Therefore $H = \{1, 2, 3\}$. A household's education level is exogenous and determined forever at the age of 20.

Labor market productivity. Individuals receive an endowment of efficiency labor units every period. This endowment has two components: a deterministic component, denoted $\epsilon_{h,j}$ and a stochastic component, denoted by z. The deterministic component depends on the household's age and education, and we use it to characterize the life-cycle profiles of earnings. The stochastic component is independently and identically distributed across the households, and we use it to generate earnings and wealth inequality within the age cohorts. This component does not depend on the age or the education of the households, and we assume that it follows a first order, finite state, Markov chain with conditional transition probabilities given by Γ:

$$\Gamma\left[z'|z\right] = \Pr\left\{z_{t+1} = z'|z_t = z\right\}, \text{ with } z, z' \in Z. \tag{1}$$

Every period, agents who have not retired yet receive a new realization of z. Accordingly, the labor productivity is given by $\epsilon_{h,j}z$. An individual may or may not have a job opportunity in any given period. If he does and decides to work, he works for a given number of hours denoted e_j, that depend on age.[2] His gross labor earnings during that period, y, are given by $\epsilon_{h,j}z$ times the economy-wide wage rate w:

$$y = \omega\epsilon_{h,j}ze_j. \tag{2}$$

Labor market status. In the model economy, an agent is either employed, unemployed, non-active or retired. Every individual enters the economy with a job opportunity. An individual with a job at hand in the beginning of the period, who decides to work, is employed in that period and his labor market status is denoted by $l = e$. An agent without a job or who decides not to work, can search for a new job for the next period - becoming unemployed -, or choose not to search and remain non-active in that period. An unemployed household who is eligible for unemployment benefits is labeled u^e, and if he is not eligible labeled $l = u^n$. An agent not working and also not actively searching for a job, who has not retired yet, is non-active and denoted with $l = n$. The eligibility criteria is defined below. Every worker faces a positive probability of becoming jobless next period, and every jobless agent (who has not retired) receives a job offer with some probability. The probability of receiving a job offer is higher for job-searchers than for non-active agents. Once a household has reached the early retirement age, it decides whether to retire. The retirement decision is irreversible and there is no mandatory retirement age.

Workers. A worker provides labor services and receives a compensation that depends on his efficiency labor units. Workers face a probability of loosing their job at the end of the period, denoted σ_j. This probability is age dependent, and we use it to generate the observed labor market flows between employment and non-employment states within age cohorts. With probability $1-\sigma_j$, the worker keeps his job, draws a productivity according to Γ, and decides whether to continue working or to quit.

Unemployed. Unemployed agents who lost a job at the end of the previous period and exercise a search effort are entitled to collect unemployment benefits determined by the function b, specified below. At the end of each unemployment period, an unemployed receives a job offer with probability λ_j^u. This probability is again age dependent, and we use it to generate the observed labor market flows between unemployment and employment.

[2]All the details on the calibration of the process $\epsilon_{h,j}$ and e_j are provided in Section 3

Non-Active. Agents that are without a job and do not actively search for a new one are labeled non-active. Those agents are not eligible for unemployment benefits, and receive a job offer for next period with a lower probability than an unemployed agent, $\lambda_j^n < \lambda_j^u$. This probability is also age dependent, and we use it to generate the observed labor market flows between non-activity and employment.

Retirees. Households who are R_0 years old or older and have a job decide whether to to retire and collect the retirement pension. They take this decision after observing their current labor productivity. If they decide to retire, they loose the endowment of labor efficiency units for ever and exit the labor market.

Insurance Markets. An important feature of the model is that there are no insurance markets for the stochastic component of the endowment shock nor for unemployment risk. We model different public insurance systems that help agents in the economy to smooth consumption in face of these shocks.

Assets. Households in our model economy differ in their asset holdings, which are constrained to being non-negative. The absence of insurance markets give the households a precautionary motive to save. They do so by accumulating real assets which take the form of productive capital, denoted $a \in A$. For computational reasons below we restrict A to be a discrete set $A = \{a_1, a_2, ..., a_n\}$.

Unemployment Benefits. Eligibility for unemployment benefits is conditional on having lost a job at some point in the past and not having started a new job yet, and on continuously searching for a job. Eligibility does not expire as long as this condition is met, and non-eligibility is an absorbing state. Eligible agents receive unemployment benefits given $ub = b_0 \bar{y}$, where b_0 is a replacement rate and $\bar{y}$ is the average labor earnings in the economy. Unemployment benefits are financed with payroll taxes, described below.

Pensions. Pension payments differ for each educational group,

$$p_h = p_b \bar{y}_h, \tag{3}$$

where $\bar{y}_h$ is the average earnings of households in educational group h during the last N_b years before the first retirement age, R_0, and p_b is a replacement rate. Specifically, $\bar{y}_h$ is computed as:

$$\bar{y}_h = \frac{1}{N_b} \sum_{j=R_0-N_b}^{R_0-1} \bar{y}_{jh} \tag{4}$$

where $\bar{y}_{jh}$ is the average gross labor earnings of workers aged j and with education h. Finally, in this model we assume that there are no early retirement penalties, nor minimum or maximum pensions. Pension payments are financed with payroll taxes.

Other transfers. In addition to the social insurance systems described before, households receive a small transfer from the government, denoted t_r.

Preferences. Households derive utility from consumption and leisure, and disutility from search effort. Given our assumption of a discrete choice of work and search, the period utility is described by a utility flow from consumption and the utility cost of time allocated to market work and to job search. Non-active and retired agents dedicate all the time endowment to leisure consumption. Accordingly, lifetime utility is given by

$$\mathbb{E}\sum_{j=20}^{100}\beta^{j-20}\psi_{j-1}\Big[\frac{c^{1-\theta}}{1-\theta}-\alpha w-\gamma s\Big], \tag{5}$$

where β is a time discount factor, c is consumption and θ the curvature parameter, α and γ are respectively the work and job search utility costs. ψ_j is the survival probability, and $\psi_{19}=1$. w equals 1 in periods of work and is zero otherwise, and similarly for the search decision s.

2.2 The Firm

In our model economy there is a representative firm. Aggregate output depends on aggregate capital, K, and on the aggregate labor input, L, through a constant returns to scale, Cobb-Douglas, aggregate production function of the form

$$Y=K^{\theta}(AL)^{1-\theta} \tag{6}$$

where A denotes an exogenous labor-augmenting productivity factor. Factor and product markets are perfectly competitive and the capital stock depreciates geometrically at a constant rate, δ.

2.3 The Government

The government taxes capital income, household income and consumption, and it confiscates unintentional bequests. It uses its revenues to finance an exogenous flow of public consumption, and to make transfers to households other than pensions. In addition, the government runs a pay-as-you-go pension system and provides unemployment benefits. The consolidated government and pension system budget constraint is then:

$$G+P+U+T_r=T_k+T_p+T_y+T_c+E \tag{7}$$

where G denotes government consumption, P denotes total pension payments, U denotes unemployment benefits, T_r denotes government transfers other than pensions, T_k, T_p, T_y, and T_c, denote the revenues collected by the capital income tax, the payroll tax, the household income tax, and the consumption tax, and E denotes unintentional bequests.

Capital income taxes. Capital income taxes are given by $\tau_k y_k$, where τ_k is the tax rate on gross capital income y_k.

Payroll taxes. Payroll taxes are proportional to before-tax labor earnings: $\tau_p y$.

Consumption taxes. Similarly, consumption taxes are simply $\tau_c c$, where τ_c is the consumption tax rate and c is consumption.

Household income taxes. In this model, we assume a simplified income tax formula according to which the income tax is proportional to the income level: $\tau_y y_b$, where τ_y is a tax rate parameter and y_b is the tax base. The income tax base depends on the employment status. If a household is employed,

$$y_b = (1 - \tau_p)y + r(1 - \tau_k)a + t_r. \tag{8}$$

For the unemployed and non-active agents,

$$y_b = r(1 - \tau_k)a + t_r, \tag{9}$$

and for a retired household:

$$y_b = r(1 - \tau_k)a + t_r + p. \tag{10}$$

In these expressions, p is the retirement pension, that depends on h as explained before.

2.4 The Backpack System

Our baseline model, calibrated to the Spanish economy in 2014, does not feature the employment fund that we denote by Backpack system. Hence, even though to simplify the model description we omit the backpack system in the next section, we explain it here to fix ideas. It is at the center of our analysis in the policy experiments discussed in Section 4. The backpack system is a fully-funded social security program, similar to the system introduced in Austria in 2003. Every individual starts without backpack claims. For every period of employment, a worker sees a fraction τ_b of his gross labor income deducted and invested into a personal employment-linked savings account, which is remunerated at the market rate of return, r. If b_t is the level of backpack assets at the beginning of an employment period, then next period's backpack evolves according to:

$$b_{t+1} = \tau_b y_t + (1 + r(1 - \tau_k))b_t, \tag{11}$$

When a worker looses his job, his backpack assets are added to his private savings that he can use to finance consumption (present or future, as he can choose to save the backpack assets). In contrast, if a worker chooses to quit his job while still in the labor force, he keeps the backpack but cannot withdraw. In that period, the backpack evolves according to

$$b_{t+1} = (1 + r(1 - \tau_k))b_t. \tag{12}$$

Upon retirement, backpack assets are added to private savings and households can use them as they please. The aggregate amount of backpack assets is invested in the capital market and adds to the supply of productive capital in the economy.

2.5 The Households' Decision Problem

The households' problem is described recursively. To simplify the exposition, we describe first the consumption and savings decision facing each household after his labor market decision has been taken. Given the value of having a job opportunity or being jobless, the optimal consumption and savings decisions determine the value of working, searching, inactivity, and retirement. With those values, we in turn describe the optimal labor market decisions.

We start with individuals that are younger than the minimum retirement age, specifically $j < R_0$. In this way we can abstract, for now, from the retirement decision. An individual of age j and education level h, private savings a, stochastic productivity z, and is currently employed (w), faces the following optimization problem:

$$W_{h,j}(a,z) = \max_{(c,a')\in B_h^e(a,z)} \left\{ \frac{c^{1-\theta}}{1-\theta} - \alpha + \beta\psi_j \sum_{z'\in Z} \Gamma(z'|z) \Big[(1-\sigma_j) J_{h,j+1}(a',z') + \sigma_j L_{h,j+1}(a',z',1) \Big] \right\}, \tag{13}$$

subject to the budget constraint B_h^e given by

$$B_h^e(a,z) = \Big\{ (c,a') : c, a' \geq 0, \text{ and } (1+\tau_c)c + a' + \tau_y y_b + \tau_p y \leq (1 + r(1-\tau_k))a + y + t_r \Big\}. \tag{14}$$

with $y = \omega\epsilon_{h,j} z e_j$ and $y_b = (1-\tau_p)y + r(1-\tau_k)a + t_r$.

Equation (13) above reads in the following way: the first two terms inside the curly brackets reflect the flow utility from consumption and the utility cost of work, α. The continuation value, discounted by β times the probability of survival until age $j+1$, given by ψ_j, reflects all the possible continuation histories of the realization of the stochastic component $z' \in \mathcal{Z}$, and two distinct labor market outcomes. With probability $1-\sigma_j$, the worker keeps the job in the next period, which has a value $J_{h,j+1}$ that also depends on next period's assets a' and the new realization of idiosyncratic productivity z'. With probability σ_j, the worker looses his job and starts next period jobless, with value $L_{h,j+1}$. This value depends on whether the household is eligible for unemployment compensation. After a period of work and a separation shock, the agent is eligible and hence the last argument of L equals 1, denoting eligibility for unemployment benefits (0 denotes not eligible, below). Savings a' are optimally chosen today and z' follows the Markov chain described in (1). A household currently unemployed and eligible for unemployment benefits solves the following problem:

$$U_{h,j}(a,z,1) = \max_{(c,a')\in B_h^{u^e}(a,z)} \left\{ \frac{c^{1-\theta}}{1-\theta} - \gamma + \beta\psi_j \sum_{z'\in Z} \Gamma(z'|z) \Big[\lambda_j^u J_{h,j+1}(a',z') + (1-\lambda_j^u) L_{h,j+1}(a',z',1) \Big] \right\}, \tag{15}$$

subject to

$$B_h^u(a,z,1) = \Big\{(c,a') : c, a' \geq 0, \text{ and } (1+\tau_c)c + a' + \tau_y y_b + \leq (1+r(1-\tau_k))a + ub + t_r\Big\}, \tag{16}$$

where $y_b = r(1-\tau_k)a + t_r$ (also in (18), (20) and (25) below). Similarly, an unemployed household who is not eligible for benefits solves

$$U_{h,j}(a,z,0) = \max_{(c,a') \in B_h^{u^n}(a,z)} \Bigg\{ \frac{c^{1-\theta}}{1-\theta} - \gamma + \beta\psi_j \sum_{z' \in Z} \Gamma(z'|z) \Big[\lambda_j^u J_{h,j+1}(a',z') + (1-\lambda_j^u) L_{h,j+1}(a',z',0)\Big] \Bigg\}, \tag{17}$$

with the important difference that in this case there are no unemployment benefits:

$$B_h^u(a,z,0) = \Big\{(c,a') : c, a' \geq 0, \text{ and } (1+\tau_c)c + a' + \tau_y y_b \leq (1+r(1-\tau_k))a + t_r\Big\}. \tag{18}$$

Note that eligibility for unemployment benefits is represented by the last argument in the value functions U and L, and the expression for the budget constraint of the unemployed: 1 means the agent is eligible for benefits, a 0 means he is not. An agent who is currently unemployed, eligible for benefits, and does not find a job for next period will continue to be eligible (and will collect unemployment benefits if he decides to continue searching for a job). In contrast, an agent who is currently non-eligible (because he quit the job or because we was not eligible last period) will continue to be non-eligible next period. Finally, households may decide to stay out of the labor market, by not working and not actively searching for a job. The problem is:

$$N_{h,j}(a,z) = \max_{(c,a') \in B_h^n(a)} \Bigg\{ \frac{c^{1-\theta}}{1-\theta} + \beta\psi_j \sum_{z' \in S} \Gamma(z'|z) \Big[\lambda_j^n J_{h,j+1}(a',z') + (1-\lambda_j^n) L_{h,j+1}(a',z',0)\Big] \Bigg\}, \tag{19}$$

For non-active households, the flow utility comes only from consumption, and the job arrival rates are lower than for the unemployed and given by λ_j^n. As in the previous case, consumption and investment are supported solely by past savings and government transfers:

$$B_h^n(a) = \Big\{(c,a') : c, a' \geq 0, \text{ and } (1+\tau_c)c + a' + \tau_y y_b \leq (1+r(1-\tau_k))a + t_r\Big\}. \tag{20}$$

To close the description of the household's problem when $j < R_0$, the values of having a job or being jobless at the beginning of a period pin down the work and search decicions:

$$J_{h,j}(a,z) = \max_{w \in \{0,1\}} \Big\{ w W_{h,j}(a,z) + (1-w) L_{h,j}(a,z) \Big\}, \tag{21}$$

$$L_{h,j}(a,z,1) = \max_{s \in \{0,1\}} \Big\{ s\, U_{h,j}(a,z,1) + (1-s) N_{h,j}(a,z) \Big\}, \tag{22}$$

$$L_{h,j}(a,z,0) = \max_{s \in \{0,1\}} \Big\{ s\, U_{h,j}(a,z,0) + (1-s) N_{h,j}(a,z) \Big\}. \tag{23}$$

We consider now the the problem of the retiree and the retirement decision. Retired individuals are not in the labor market and have no endowment of efficiency units of labor. They finance consumption with past private savings, pension payments (and with backpack savings if there is a backpack system). The problem is a standard consumption-savings decision, with survival risk and a certain maximum attainable age, assumed to be $j = 100$. At age $j = 99$, the continuation value is zero because the agent exist the economy next period with probability one. Before that, the retired household solves:

$$Vr_{h,j}(a) = \max_{(c,a')\in B_h^r(a)} \left\{ \frac{c^{1-\theta}}{1-\theta} + \beta\psi_j \, Vr_{h,j+1}(a') \right\}, \tag{24}$$

subject to

$$B_h^r(a) = \Big\{(c,a') : c, a' \geq 0, \text{ and } (1+\tau_c)c + a' + \tau_y y_b \leq (1 + r(1-\tau_k))a + p_h + t_r \Big\}. \tag{25}$$

The problem depends on state a and on h, the education level, because the pension payments depend on h: p_h. From the first retirement age R_0 on, an employed household compares the value of retirement $Vr_{h,j}$ with the value of working one additional period, depending on his current labor market productivity. In addition to his current endowment of efficiency units, the decision depends on his savings and on his education level that, as we have assumed, determines is pension payments. The retirement decision is given by:

$$r(j,h,a,z) = \underset{\rho\in\{0,1\}}{\operatorname{argmax}} \Big\{(1-\rho)J_{h,j}(a,z) + \rho \, Vr_{h,j}(a)\Big\}. \tag{26}$$

2.6 Steady-state dynamics

The steady-state dynamics of the economies under study have the following characterisation. Given a distribution of households entering the economy ($j = 20$ and $a = 0$; say, at T) they all receive a job opportunity and make their consumption, asset and employment decisions. These households' decisions together with their survival probabilities define the distribution of this cohort the following year ($T + 1$) at $j = 21$, but it also the distribution of households of $j = 21$ at T. Similarly, for $j = 22, ..., 100$; that is, the different cohorts coexisting at T mirror the evolution of the distribution of households entering the economy at T up to the end of their potential survival $j = 100$. In other words, the decisions that agents of generation T make through their live are already made in the year they enter the labour market by older agents if they have the same state. By construction, this is a steady-state distribution, which is our benchmark distribution. Different economies simply expose the T cohort distribution to different public insurance systems and, therefore, all the cohorts coexisting at T behave as if the given system was in place when they entered the economy.

2.7 Definition of Stationary Equilibrium

Let $j \in J$, $h \in H$, $z \in \mathcal{Z}$, $l \in \mathcal{L}$, and $a \in A$, and let $\mu_{j,h,z,l,a}$ be a probability measure defined on $\Re = J \times H \times \mathcal{Z} \times \mathcal{L} \times A$.[3] Then, a stationary competitive equilibrium for this economy is a government policy, $\{G, P, T_r, U, T_k, T_s, T_y, T_c, E\}$, a household policy, $\{c(j,h,z,l,a)$, $w(j,h,z,l,a)$, $s(j,h,z,l,a)$, $r(j,h,a,z)$, $a^{'}(j,h,z,l,a)\}$, a measure, μ, factor prices, $\{r, w\}$, macroeconomic aggregates, $\{C, Y, K, L\}$, and a function, Q, such that:

(i) The government policy satisfy the consolidated government described in Expression (7).

(ii) Firms behave as competitive maximizers. That is, their decisions imply that factor prices are factor marginal productivities $r = f_1(K, AL) - \delta$ and $\omega = f_2(K, AL)$.

(iii) Given the government policy, and factor prices, the household policy solves the households' decision problem defined in Expressions (13), through (26).

(iv) The stock of capital, consumption, the aggregate labor input, pension payments, unemployment benefit payments, lump-sum transfers, tax revenues, and accidental bequests are obtained aggregating over the model economy households as follows:

$$
\begin{aligned}
K &= \int a \, d\mu \\
C &= \int c \, d\mu \\
L &= \int \epsilon_{jh} z e_j \, d\mu \\
P &= \int p_h \, d\mu \\
U &= \int ub \, d\mu \\
T_r &= \int t_r \, d\mu \\
T_c &= \int \tau_c c \, d\mu \\
T_k &= \int \tau_k y_k \, d\mu \\
T_p &= \int \tau_p y \, d\mu \\
T_y &= \int \tau_y y_b \, d\mu \\
E &= \int (1 - \psi_j) a^{'} \, d\mu
\end{aligned}
$$

where all the integrals are defined over the state space $\Re$.

[3] For convenience, whenever we integrate the measure of households over some dimension, we drop the corresponding subscript.

(vi) The goods market clears:

$$C + \int (a^{'} - (1-\delta)a)d\mu + G = F(K, AL). \tag{27}$$

(vii) The law of motion for μ_j is:

$$\mu_{j+1} = \int_{\Re} Q d\mu_j. \tag{28}$$

Describing function Q formally is complicated because it specifies the transitions of the measure of households along its five dimensions: age, education level, productivity, employment status, and assets holdings. An informal description of this function is the following: We assume that new-entrants, who are 20 years old, enter the economy with a job opportunity, that they draw the stochastic component of their endowment of efficiency labor units from its invariant distribution, and that they own zero assets. Their educational shares are exogenous. The evolution of μ_{jh} is exogenous, it replicates the the distribution by age and education of the Spanish population in our calibration target year, 2014. The evolution of μ_z is governed by the conditional transition probability matrix of its stochastic component. The evolution of μ_l, is governed by the exogenous probabilities of find/loss a job, by the endogenous employment and search decisions, and by the optimal decision to retire. The evolution of μ_a is determined by the optimal savings decision and by the changes in the population.

3 Calibration

To calibrate our model economy we do the following: First, we choose a calibration target country — Spain in this article— and a calibration target year —2014 in this article. Then we choose the initial conditions and the parameter values that allow our model economy to replicate as closely as possible selected macroeconomic aggregates and ratios, distributional statistics, and the institutional details of our chosen country in our target year. We describe these steps in the subsections below.

3.1 Initialising the steady-state

In order to determine the steady-state, first we choose as an initial distribution of households $\mu_0 = \mu_{2014}$; that is, we take μ_{jh} at year 2014 directly from the Spanish Institute of Statistics (INE). The initial distribution of households implies an initial value for the capital stock. This value is $K_{2014} = 8.8025$. The initial distribution of households and the initial survival probabilities determine the initial value of unintentional bequests, E_{2014}. Finally, we must also specify the initial values for the productivity process, A_{2014}. Since A_{2014} determines the units which we use to measure output and does nothing else, we choose $A_{2014} = 1.0$.

3.2 Parameters

Once the initial conditions are specified, to characterize our model economy fully, we must choose the values of a total of 40 parameters. Of these 40 parameters, 4 describe the household preferences, 3 describe the age profile of hours worked, 21 the process on the endowment of efficiency labor units, 2 the production technology, 4 the pension system rules, and 6 the remaining components of the government policy. To choose the values of these 40 parameters we need 40 equations or calibration targets which we describe below.

3.3 Equations

To determine the values of the 40 parameters that identify our model economy, we do the following. First, we determine the values of a group of 21 parameters directly using equations that involve either one parameter only, or one parameter and our guesses for (K, L). To determine the values of the remaining 19 parameters we construct a system of 19 non-linear equations. Most of these equations require that various statistics in our model economy replicate the values of the corresponding Spanish statistics in 2014. We describe the determination of both sets of parameters in the subsections below.

3.3.1 Parameters determined solving single equations

The life-cycle profile of earnings. We measure the deterministic component of the process on the endowment of efficiency labor units independently of the rest of the model. We estimate the values of the parameters of the three quadratic functions that we describe in Expression (29), using the age and educational distributions of hourly wages reported by the *Instituto Nacional de Estadística* (INE) in the *Encuesta de Estructura Salarial* (2010) for Spain.[4] This procedure allows us to identify the values of 9 parameters directly.

$$\epsilon_{jh} = \xi_{1h} + \xi_{2h} j - \xi_{3h} j^2 \tag{29}$$

Age profile of hours worked. To characterize the age profile of full-time hours, we use data from the Encuesta de Empleo del Tiempo 2010 provided by the Spanish National Institute of Statistics (INE). We impute hours supplied to the market as a fraction of the total time endowment and we assume that the time endowment is 14 hours a day, 7 days a week. We then parameterize the average allocated time to market activities per age with the help of quadratic curves. That is, we estimate e_j as:

$$e_j = a_1 + a_2 j - a_3 j^2 \tag{30}$$

[4] Since we only have data until age 64, we estimate the quadratic functions for workers in the 20–64 age cohort and we project the resulting functions from age 65 onwards.

Table 1: Parameters determined solving single equations

	Parameter	Value
Parameters determined directly		
Earnings Life-Cycle		
	$\xi_{1,1}$	0.9189
	$\xi_{1,2}$	0.8826
	$\xi_{1,3}$	0.5064
	$\xi_{2,1}$	0.0419
	$\xi_{2,2}$	0.0674
	$\xi_{2,3}$	0.1648
	$\xi_{3,1}$	0.0006
	$\xi_{3,2}$	0.0008
	$\xi_{3,3}$	0.0021
Age Profile of Hours Worked		
	a_1	0.3649
	a_2	0.0025
	a_3	0.00005
Preferences		
Curvature	σ	2.0000
Technology		
Capital share	θ	0.4702
Public Pension System		
Number of years of contributions	N_b	17
First retirement age	R_0	61
Parameters determined by guesses for (K, L)		
Public Pension System		
Payroll Tax Rate	τ_p	0.2954
Government Policy		
Government consumption	G	0.5181
Capital income tax rate	τ_k	0.1116
Consumption tax rate	τ_c	0.2330
Income tax Rate	τ_y	0.1214

Full hours worked rise initially and then they level off. Starting in the 50s, hours decline slightly. This procedure allows us to identify the values of 3 parameters directly.

The pension system. In 2014 in Spain, the payroll tax rate paid by households was 28.3 percent and it was levied only on the first 50,358 euros of annual gross labor income. Since we omit the tax cap, we impose that all gross earnings pay pension contributions. We also impose that payroll tax collections are used to finance both pension payments and unemployment benefits. This implies that the payroll tax rate in our model economy is 0.2954.

Our choice for the number of years used to compute the retirement pensions in our benchmark model economy is $N_b = 17$. This is because in 2014 the Spanish *Régimen General de la Seguridad Social* took into account the last 17 years of contributions prior to retirement to compute the pension. Finally, our choice for the first retirement age is $R_0 = 61$.

Government policy. To specify the government policy, we must choose the values of government consumption, G_t, of the tax rate on capital income, τ_k, of the tax rate on income, τ_y, and of the tax rate on consumption, τ_c.

Preferences. Of the three parameters in the utility function, we choose the value of only σ directly. Specifically, we choose $\sigma = 2.0$.

Technology. According to the Spanish National Institute of Statistics data (INE), the capital income share in Spanish GDP was 0.4702 in 2014. Consequently, we choose $\theta = 0.4702$.

Adding up. So far we have determined the values of 21 parameters either directly or as functions of our guesses for (K, L) only. We report their values in Table 1.

3.3.2 Parameters determined solving a system of equations

We still have to determine the values of 19 parameters. To find the values of those 19 parameters we need 19 equations. Of those equations, 14 require that model economy statistics replicate the value of the corresponding statistics for the Spanish economy in 2014, 4 are normalization conditions, and the last one is the government budget constraint that allows us to determine the value of Z/Y^* residually.

Aggregate Targets. According to the BBVA database, in 2014 the value of the Spanish capital stock was 3,194,730 million euros.[5] According to the *Instituto Nacional de Estadística* (INE) in 2014 the

[5]This number can be found at $http://www.fbbva.es/TLFU/microsites/stock09/fbbva\_stock08\_index.html$.

Table 2: Macroeconomic Aggregates and Ratios in 2014 (%)

	C/Y^{*a}	P/Y^{*}	U/Y^{*b}	K/Y^{*c}	W^{d}	I^{e}
Spain	56.4	11.1	2.4	3.08	46.9	14.6

[a] Variable Y^* denotes GDP at market prices.
[b] The ratio U/Y^* is the Unemployment benefits as a share of Output at market prices.
[c] The target for K/Y^* is in model units and not in percentage terms.
[d] Variable W is the share of workers in the Spanish population with 20+ years old.
[e] Variable I is the share of inactive in the Spanish population with 20+ years old.

Spanish Gross Domestic Product at market prices was 1,037,250 million euros. Dividing these two numbers, we obtain $K/Y = 3.08$, which is our target value for the model economy capital to output ratio.

According to the INE, Private Consumption plus indirect taxes was 586,080 million euros in 2014 (see Díaz-Giménez and Díaz-Saavedra (2017) for an explanation). That same year, pension payments were 114,410 million euros and unemployment benefits ammounted 24,570 million euros. Consequently, the ratios of these variables to GDP at market prices are 56.4, 11.1, and 2.4 percent.

Finally, and according to the Encuesta de Población Activa (INE), in Spain in 2014 there were 36,804,100 people aged 20+ years old. That same survey reports that 17,264,850 were workers and 5,436,500 were unemployed. Consequently, these numbers imply that the share of workers was 46.9 percent and the share of unemployed were 14.8 percent.

Distributional Targets. We target the 3 Gini indexes and 5 points of the Lorenz curves of the Spanish distributions of earnings, income and wealth. We have taken these statistics from the Spanish National Institute of Statistics (INE), the OECD, and Budría and Díaz-Giménez (2006), and we report them in bold face in Table 18. Castañeda et al. (2003) argue in favor of this calibration procedure to replicate the inequality reported in the data. These targets give us a total of 8 additional equations.

Normalization conditions. In our model economy there are 4 normalization conditions. The transition probability matrix on the stochastic component of the endowment of efficiency labor units process is a Markov matrix and therefore its rows must add up to one. This gives us three normalization conditions. We also normalize the first realization of this process to be $z(1)=1$.

The Government Budget. Finally, the government budget is an additional equation that allows us to obtain residually the government transfers to output ratio, T_r/Y^*.

Table 3: The Distributions of Earnings, Income, and Wealth*

		Bottom	Quintiles					Top
	Gini	10	1st	2nd	3rd	4th	5th	10
The Earnings Distributions (%)								
Spain	**0.35**	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
The Income Distributions (%)								
Spain	**0.35**	2.1	**6.3**	**12.1**	17.2	23.7	**40.7**	25.0
The Wealth Distributions (%)								
Spain	**0.57**	0.0	**0.9**	6.6	12.5	20.6	**59.5**	42.5

*The source for the Spanish data of earnings and income are the Spanish National Institute of Statistics (INE) and the OECD. The source for the Spanish data of wealth is the 2004 *Encuesta Financiera de las Familias Españolas* as reported in Budría and Díaz-Giménez (2006).

The Parameters. The 14 parameters determined by the system are the following:

- Preferences: β, α, and γ.
- Technology: δ.
- Stochastic process for labor productivity: $z(2), z(3), z_{11}, z_{12}, z_{21}, z_{22}, z_{32}$, and z_{33}.
- Pension system: ϕ.
- Fiscal policy: b_0.

3.3.3 Methodology

To solve this system of equations we use a standard non-linear equation solver. Specifically, we use a modification of Powell's hybrid method, implemented in subroutine DNSQ from the SLATEC package.

The DNSQ routine works as follows

1. Choose the weights that define the loss function that has to be minimized
2. Choose a vector of initial values for the 14 unknown parameters
3. Solve the model economy
4. Update the vector of parameters
5. Iterate until no further improvements of the loss function can be found.

Table 4 provides the parameter values of our calibration and of their accuracy.

Table 4: Initial Values, Final Values, Weights, and Errors.

Parameter	Initial Value	Final Value	Statistic	Weight (%)	Target	Result	Error (%)
β	0.9950	1.0043	K/Y^*	300	3.08	3.08	0.00
α	0.6824	0.5624	W (%)	800	54.13	54.30	0.31
γ	0.3412	0.2812	I (%)	800	4.88	3.28	–32.79
δ	0.0860	0.0858	$(C + T_c)/Y^*$ (%)	50	56.41	48.55	–13.94
ϕ	0.6657	0.6555	P/Y^* (%)	300	10.60	10.66	0.56
b_0	0.2200	0.2188	U/Y^* (%)	300	2.41	2.87	19.08
$z(2)$	2.5082	2.3490	GY	800	0.34	0.33	–2.95
$z(3)$	7.0000	5.9042	GE	800	0.35	0.34	–2.86
z_{11}	0.9908	0.9821	1QY (%)	50	6.30	8.07	28.09
z_{12}	0.0091	0.0177	4QW (%)	1	20.60	24.81	20.43
z_{21}	0.0303	0.0291	2QW (%)	1	6.60	3.98	–39.70
z_{22}	0.9696	0.9708	5QY (%)	50	40.70	41.13	1.05
z_{32}	0.0001	0.0003	2QY (%)	50	12.10	12.45	2.89
z_{33}	0.9998	0.9996	GW	800	0.57	0.60	5.26

4 Comparing economies with different public insurance systems

In this section, we compare economies that differ in terms of the public insurance systems that are available to households. Our baseline economy, described above, features an unemployment insurance (UI) system and a pension system for retirees, as in Spain. We compare this economy to an economy where there is only the pay-as-you-go pension system but no unemployment insurance; one in which in addition to the pension system, there is a backpack system (but no UI); and finally one in which all the three systems are available (denoted BP Economy). The backpack system introduced is parametrized with a contribution rate of $\tau_b = 19.0\%$ of labor earnings, as described in Section 2.4. When we compare different steady states indexed by the contribution rate, and calculate the difference in average social welfare relative to the baseline economy (without backpack system), $\tau_b = 19.0\%$ emerges as the welfare maximizing backpack rate. More precisely, we take as welfare criteria the average lifetime utility of an agent about to enter the economy with 20 years old (the first model age). The average is calculated using the cross-sectional probability distribution over the possible initial states (education, productivity, employment status).

The description of household's problem changes slightly, with the backpack b_t becoming a relevant state variable. With the law of motion of the backpack described in 2.4, it is straightforward to extended the optimization problem presented in 2.5 to account for the new state variable. Another issue we must take a stand on once we add a positive BP contribution rate to the baseline economy is the clearing of the government budget constraint. The assumption we follow in the main text is to fix per capita lump-sum transfers at the baseline level, and let τ_p adjust to clear the entire budget. All other tax rates remain unchanged. Recall that in the baseline economy (no BP), τ_p is set to clear the social security part of the government budget, i.e. pensions and unemployment

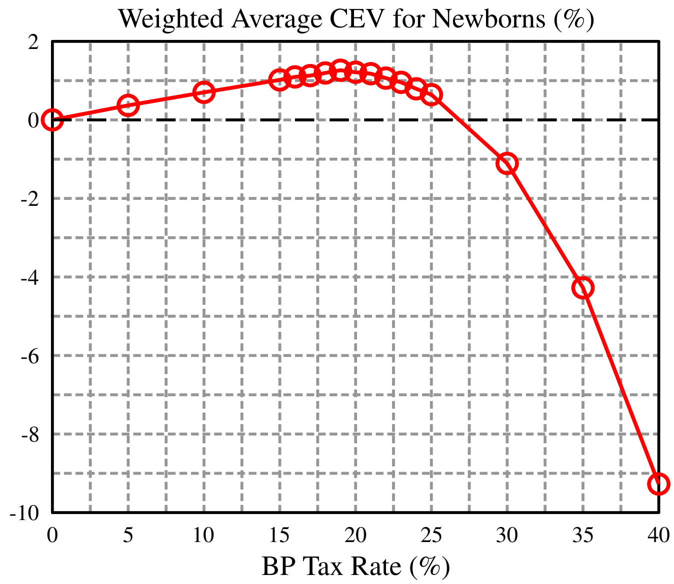

Figure 1: Consumption Equivalent Variation (CEV) in average lifetime utility for newborn agents.

benefit expenditures. Since τ_b and τ_p enter additively in the worker's net income position, second order changes in the government budget after the introduction of τ_b are, following this assumption, reflected in changes in τ_p alone, while all other margins are not directly. In the appendix we analyse a different approach, where τ_c is used to satisfy the overall government budget, while τ_p continues to clear the social security component as in the baseline economy.

The introduction of the backpack system affects individual decisions and aggregate variables. There are several direct effects of the backpack system at the individual level. The backpack is a substitute for private insurance, and discourages savings. It helps to smooth consumption after a job loss, when jobless individuals can withdraw from their backpack; and it affects the allocation of consumption over the life-cycle, since workers can use the accumulated backpack savings to finance consumption after retirement.

Since we assume that there are no annuity markets in the economy, households leave accidental bequests when they die. Such bequests are wasted at the individual level, therefore an increase in private savings or in backpack savings generates additional bequests.[6] In addition, since the backpack system is financed with taxation of labor income, it affects the labor supply decision. It allows to reduce individual tax payments, since both backpack assets and private assets are subject to capital taxation, backpack income is not subject to household income taxation whereas capital income is. Shifting savings from private capital holdings into the backpack account allows for a

[6]This is in contrast with the tax-transfer pension system that directly transfers resources from young workers to old retirees hence helps avoid accidental bequests.

reduction in tax payments. Finally, at the retirement age, the value of the accumulated backpack assets affects the retirement decision. The worker faces the tradeoff between leaving the labor force and collecting the retirement pension and cashing out backpack savings, or prolonging the career and continuing accumulating backpack savings while working.

The resolution of these individual tradeoffs affect aggregate outcomes. The introduction of the backpack influences aggregate investment and the capital stock in the economy, depending on the offsetting effects on private savings and accumulation of backpack assets. It affects aggregate labor supply, depending on the impact of taxes and labor supply incentives through the employment-linked savings technology. By distorting the allocation of capital and labor, it affects aggregate output and consumption, that may increase or decrease if there is under- or over-accumulation of capital in the economy. As a consequence, the equilibrium market prices of capital and labor may change, again influencing savings and labor supply decision of households. The introduction of different policies and the corresponding household and market forces also impact the government budget constraint. Longer retirement periods and higher average wages increases pension payments and hence social security taxes on workers. Higher unemployment and wages also increase taxes, necessary to finance unemployment benefit expenditures. More production, consumption, and private investment enlarge the tax base and, for a given level of government expenditures, imply lower tax rates. These changes in government policy further influence households decisions and welfare, and are accounted for in the results presented below.

When comparing the different scenarios, there are a few policy parameters that we change and others we intentionally keep fixed. Specifically, in order to isolate the effects of introducing the backpack policy, we fix the level of all tax rates. We also fix the level of the individual lump sum transfer. Therefore, given that all other tax rates are fixed, changes in total tax revenue are thrown into or fished from the sea (in the form of wasteful government consumption). In the next subsection, we evaluate social welfare across the different economies by calculating the implied *consumption equivalent variation* (CEV) in the expected lifetime utility of individuals entering the economy at age 20, relative to the benchmark model that is calibrated to the Spanish economy in 2014. We calculate the welfare changes for specific groups in the population, depending on education, labor market productivity, and labor market status. After we introduce the backpack system in the model, we further dissect the welfare consequences by isolating the more important channels discussed above.

4.1 Unemployment Insurance and Backpack System

Compared with the baseline economy, replacing the existing unemployment benefit system with a backpack system (BP) with a contribution rate of 19.0% has a large impact in the economy. Households enter the economy without backpack claims. Absent an unemployment insurance policy, young households need to privately insure the risk of loosing a job early in life. Aggregate savings increase substantially, more than 40% relative to the baseline economy. The return on capital goes down from 5.2% in the baseline to 3.3% in the economy with no unemployment insurance. Relative to total output, this increase in precautionary savings raises investment 33.5% and the share of output allocated to private consumption goes down by more than 3.5%.

Table 5: Aggregates and output ratios in the baseline economy and in the economy without UI but with BP system (Only BP).

	Values			Y Ratios*		
	Baseline	Only BP	%Δ	Baseline	Only BP	$\Delta p.p.^{a}$
Y	2.1536	2.4433	13.45	100.00	100.00	0.00
K	7.3296	9.6701	31.93	3.40	3.95	55.00
L	0.7228	0.7188	–0.54	33.56	29.41	–4.15
H	0.2118	0.2108	–0.48	9.83	8.62	–1.21
C	0.9290	0.9670	4.09	43.13	39.57	–3.56
G	0.4729	0.4729	0.00	21.95	19.35	–2.60
I	0.7517	1.0034	33.48	34.90	41.06	6.16
w	1.5738	1.7999	14.36			
r (%)	5.2435	3.3079	–36.92			

Only BP is the alternative economy without UI but with BP system. Y: output, K: capital stock, L: labor in efficiency units, H hours of labor supply, C: aggregate private consumption plus consumption tax collections, G: government consumption, I: investment, w: wage rate, r: interest rate. The ratio K/Y measured in model units and not in percentage terms.
[a] : Difference in percentage points.
$*$: As a share of output at factor cost.

The over-accumulation of capital in the economy is unproductive and costly in terms of social welfare, as Table 6b below shows. Low productivity workers are hurt the most. The negative welfare effects are almost the same as if the unemployment system is eliminated and there is no 'backpack' to replace it, as Table 6a below shows.

Table 6: Consumption Equivalent Variation (%) in average lifetime utility relative to the baseline economy, in an alternative scenario:

(a) Without Unemployment Insurance.

Education	Labor Productivity		
	Low	Medium	High
Dropouts	-14.41	-7.37	-3.79
High School	-18.16	-9.88	-4.60
College	-27.72	-19.70	-11.17

(b) With only a Backpack System.

Education	Labor Productivity		
	Low	Medium	High
Dropouts	-15.49	-8.86	-5.55
High School	-19.15	-11.30	-6.03
College	-28.25	-20.56	-11.61

4.2 Pension System and Backpack System

In contrast to the previous results, adding the backpack system in the baseline economy (that features unemployment insurance and the pay-as-you-go pension system) implies significant positive welfare gains for all demographic groups. As described above, the introduction of the backpack account affects individual decisions, aggregate quantities and prices. Households partially substitute private savings by saving through the backpack system. While private asset holdings go down, the backpack savings that are added to the supply of capital in the economy imply that, at the new equilibrium, the aggregate capital stock is 22.7% larger. Hours worked slightly increase, but high productivity workers work more, such that the aggregate effective labor increases 1.7%. This implies that the level of output increases by almost 11%. In the baseline economy, capital is productive at the margin and the interest rate is relatively high. Hence the backpack system, by increasing the capital stock, improves the allocation of resources in the economy. A larger capital stock decreases the interest rate to 3.91% and makes labor more productive at the margin, therefore the wage rate increases slightly more than 9%. Aggregate consumption increases by 4%. Relative to output, aggregate consumption declines by almost 3%.

Table 7: Aggregates and output ratios in the baseline economy and in the economy with the BP system (BP Economy).

	Values			Y Ratios*		
	Baseline	BP Economy	%Δ	Baseline	BP Economy	$\Delta p.p.^a$
Y	2.1536	2.3897	10.96	100.00	100.00	0.00
K	7.3296	8.9947	22.71	3.40	3.76	36.00
L	0.7228	0.7351	1.70	33.56	30.76	–2.80
H	0.2118	0.2135	0.80	9.83	8.93	–0.90
C	0.9290	0.9677	4.16	43.13	40.49	–2.64
G	0.4729	0.4729	0.00	21.95	19.78	–2.17
I	0.7517	0.9491	26.25	34.90	39.71	4.81
w	1.5738	1.7214	9.37			
r (%)	5.2435	3.9194	–25.26			

The BP Economy is the alternative economy with BP system. Y: output, K: capital stock, L: labor in efficiency units, H hours of labor supply, C: aggregate private consumption plus consumption tax collections, G: government consumption, I: investment, w: wage rate, r: interest rate. The ratio K/Y measured in model units and not in percentage terms.
^{a} : Difference in percentage points.
$*$: As a share of output at factor cost.

The breakdown of the welfare gains across education and productivity types is presented in Table 8.

Table 8: Consumption Equivalent Variation (%) in average lifetime utility in the economy with a backpack system (BP), relative to the baseline economy: workers.

Education	Labor Productivity		
	Low	Medium	High
Dropouts	0.56	0.95	-0.86
High School	-0.04	1.27	0.15
College	-2.29	0.26	1.49

Table 9: Consumption Equivalent Variation (%) in the economy with a backpack system (BP), relative to the baseline economy: unemployed, inactive and retirees.

Labor Status	Education		
	Dropouts	High School	College
Unemployed	1.55	1.65	1.05
Inactive	1.70	1.72	1.44
Retirees	7.22	7.79	7.32

Table 10: Labor Market Shares (% of population).

	W	U	I	R
Spain[a]	54.13	17.04	4.88	23.92
Baseline	54.30	15.29	3.28	27.13
Only BP	54.04	14.23	4.35	27.36
BP Economy	54.72	15.25	2.63	27.37

[a]Spanish data is from 2014, retired households include those collecting other pensions than retirement pensions (disability pensions, widowhood pensions, etc.) W: workers, U: unemployed, I: inactive, R: retirees. All shares correspond to people aged 20+.

The income tax exemption on backpack asset income eases the distortionary effects of taxation relative to the baseline economy. Table 11 shows the decline in capital income tax collection, which is also reflected in the decline of household income tax collection. With the fall in capital and income tax revenues, τ_p increases to 32.55% and accordingly payroll tax collections increase by almost 27%. Relative to output, this represents a 2.1% increase.

Table 11: Policy Parameters and tax revenue ratios in the baseline economy and in the economy with the BP system (BP Economy).

	Tax Rates			Tax Revenues			Revenue Y Ratios (%)*		
	Baseline	BP Economy	%Δ	Baseline	BP Economy	%Δ	Baseline	BP Economy	$\Delta p.p^{a}$
τ_c	0.2439	0.2439	0.00	0.2266	0.2361	4.16	10.38	9.87	–0.51
τ_y	0.1259	0.1259	0.00	0.1842	0.1447	–21.45	8.55	6.05	–2.50
τ_k	0.1237	0.1237	0.00	0.0475	0.0436	–8.22	2.21	1.82	–0.39
τ_p	0.2859	0.3255	13.85	0.3231	0.4095	26.74	15.00	17.13	2.13
τ_b	–	0.1900	–	–	0.2654	–	–	11.10	–

τ_c: consumption tax rate, τ_y: household income tax rate, τ_k: capital income tax rate, τ_p: payroll tax, τ_b: backpack contribution tax.
[a] : Difference in percentage points.
[*] : As a share of output at factor cost.

Regarding inequality, moving from the baseline to the BP economy increases wealth inequality since low earners (those who receive the stochastic productivity shock 1) reduce their holdings of liquid assets proportionately more than those medium and high earners. Specifically, the Gini of Wealth increases from 0.60 to 0.66 (see Table 18). There is no significant variation in earnings inequality, while income inequality slightly decreases from 0.34 to 0.29.

Table 12: The Distributions of Earnings, Income, and Wealth*

		Bottom	Quintiles					Top
	Gini	10	1st	2nd	3rd	4th	5th	10
The Earnings Distributions (%)								
Spain	0.35	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Baseline	0.34	3.6	8.4	11.7	15.3	23.7	40.9	25.5
BP Economy	0.34	3.6	8.3	11.6	15.1	23.6	41.3	26.1
The Income Distributions (%)								
Spain	0.34	2.1	6.3	12.1	17.2	23.7	40.7	25.0
Baseline	0.33	3.3	8.0	12.4	16.0	22.4	41.1	25.4
BP Economy	0.29	3.8	8.8	12.6	17.4	23.1	38.0	22.1
The Wealth Distributions (%)								
Spain	0.57	0.0	0.9	6.6	12.5	20.6	59.5	42.5
Baseline	0.60	0.0	0.3	4.0	10.7	24.8	60.1	38.4
BP Economy	0.66	0.0	0.0	1.9	9.1	22.7	66.3	44.0

[*]The source for the Spanish data of earnings and income are the Spanish National Institute of Statistics (INE) and the OECD. The source for the Spanish data of wealth is the 2004 *Encuesta Financiera de las Familias Españolas* as reported in Budría and Díaz-Giménez (2006). The model economy statistics correspond to 2014.

5 Conclusions

We have shown that there can be important allocative and welfare gains in introducing a 'backpack' , system in an economy with a pay-as-you-go pension system and unemployment insurance with unlimited benefits. The main mechanism behind these gains is the partial substitution of private savings by backpack savings, while total savings and capital increase; as a result, the economy interest rate decreases while wages increase. Associated with this change there is a better allocation of employment, with a lower share of unemployed and inactive and a higher percentage of high productive agents within the employed. Effectively, there is a more efficient allocation of savings in the economy, with a shift from pure transfers – to the unemployed and retirees – to savings and, therefore, investment in productive capital. Nevertheless, unemployed are better off due to the prospect of higher wages, and retirees are better off since in our economy pension benefits are linked to productivity, which is higher in the BP economy. Similarly, while the price changes – higher wages and lower interest rates – unambiguously benefit medium productivity workers, high school and college high productivity workers, and high productivity dropouts do not benefit as much given the lower return on their savings. Despite the differential effects, the positive effect of a better employment and consumption allocation (e.g. later retirement age) results in an overall benefit from the reform.

Further robustness checks are needed, but, in any case, all these effects and results would not had been possible to capture without a calibrated exercise such as the one that we have carried out. One important dimension still missing, that we plan to add to the present paper, is the transition period from the introduction of the backpack system until the new steady state is reached.

Our results also suggest new ones. Within the current single-country analysis: from further improving our calibration and performing further robustness checks, to the partial substitution of the existing pension system by pottentially an even bigger 'backpack'. Furthermore, as it is done in Ábrahám et al. (2018), we can extend our analysis to other European economies, In fact, as we have mentioned in the introduction, employment (retirement) funds, such as TIAA-CREF, have played, and play, a major role in improving labor mobility (e.g. across US universities). An *European backpack* can be a great complement to existing public savings systems, not only by the effects shown here at the national level but also by improving labor mobility across the European Union.

Appendices

A BP financing using the consumption tax τ_c

The tables below document the steady state comparison between the baseline calibrated Spanish economy and the BP economy where, after the introduction of the BP tax, the τ_p payroll tax is used to balanced the social security budget (pensions and unemployment benefit expenditures), while the τ_c consumption tax is used the balance the remaining components of the government budget (see section 2.3).

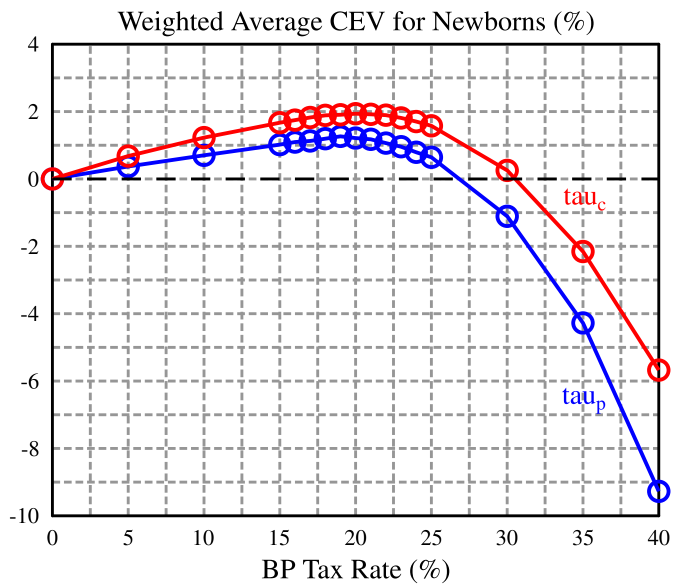

Figure 2: Consumption Equivalent Variation (CEV) in average lifetime utility for newborn agents.

Under this assumption, the average welfare maximising is 20%.

Table 13: Aggregates and output ratios in the baseline economy and in the economy with the BP system (BP Economy).

	Values			Y Ratios*		
	Baseline	BP Economy	%Δ	Baseline	BP Economy	$\Delta p.p.^a$
Y	2.1536	2.4304	12.85	100.00	100.00	0.00
K	7.3296	9.3180	27.12	3.40	3.83	43.00
L	0.7228	0.7356	1.77	33.56	30.26	–3.30
H	0.2118	0.2138	0.94	9.83	8.79	–1.04
C	0.9290	0.9733	4.76	43.13	40.04	–3.09
G	0.4729	0.4729	0.00	21.95	19.45	–2.49
I	0.7517	0.9842	30.92	34.90	40.49	5.59
w	1.5738	1.7496	11.17			
r (%)	5.2435	3.6927	–29.58			

The BP Economy is the alternative economy with BP system. Y: output, K: capital stock, L: labor in efficiency units, H hours of labor supply, C: aggregate private consumption plus consumption tax collections, G: government consumption, I: investment, w: wage rate, r: interest rate. The ratio K/Y measured in model units and not in percentage terms.

[a] : Difference in percentage points.

$*$: As a share of output at factor cost.

Table 14: Consumption Equivalent Variation (%) in average lifetime utility in the economy with a backpack system (BP), relative to the baseline economy.

Education	Labor Productivity		
	Low	Medium	High
Dropouts	1.59	1.80	-0.54
High School	1.05	2.21	0.56
College	-1.20	1.20	1.95

Table 15: Consumption Equivalent Variation (%) in the economy with a backpack system (BP), relative to the baseline economy: unemployed, inactive and retirees.

Labor Status	Education		
	Dropouts	High School	College
Unemployed	2.24	2.38	1.71
Inactive	0.69	0.58	0.03
Retirees	4.86	5.51	5.11

Table 16: Labor Market Shares (% of population).

	W	U	I	R
Spain[a]	54.13	17.04	4.88	23.92
Baseline	54.30	15.29	3.28	27.13
Only BP	53.89	14.20	4.51	27.38
BP Economy	54.81	15.27	2.57	27.33

[a]Spanish data is from 2014, retired households include those collecting other pensions than retirement pensions (disability pensions, widowhood pensions, etc.) W: workers, U: unemployed, I: inactive, R: retirees. All shares correspond to people aged 20+.

Table 17: Policy Parameters and tax revenue ratios in the baseline economy and in the economy with the BP system (BP Economy).

	Tax Rates			Tax Revenues			Revenue Y Ratios (%)*		
	Baseline	BP Economy	%Δ	Baseline	BP Economy	%Δ	Baseline	BP Economy	$\Delta p.p^a$
τ_c	0.2439	0.2826	15.86	0.2266	0.2751	21.40	10.38	11.31	0.93
τ_y	0.1259	0.1259	0.00	0.1842	0.1498	–18.68	8.55	6.16	–2.39
τ_k	0.1237	0.1237	0.00	0.0475	0.0425	–10.53	2.21	1.74	–0.47
τ_p	0.2859	0.2906	1.64	0.3231	0.3717	15.04	15.00	15.29	0.29
τ_b	–	0.2000	–	–	0.2574	–	–	10.59	–

τ_c: consumption tax rate, τ_y: household income tax rate, τ_k: capital income tax rate, τ_p: payroll tax, τ_b: backpack contribution tax.
[a] : Difference in percentage points.
[*] : As a share of output at factor cost.

Table 19: Government Budget: Closure with the consumption tax rate

	Public Expenditure				Public Revenues				
	G	T_r	P	U	T_c	T_k	T_y	T_p	E
Baseline	0.4729	0.562	0.2538	0.0685	0.2266	0.0475	0.1842	0.3231	0.0698
BP economy	0.4729	0.562	0.2954	0.0765	0.2751	0.0425	0.1498	0.3717	0.0618

Table 20: Government Budget:Closure with the payroll tax rate

	Public Expenditure				Public Revenues				
	G	T_r	P	U	T_c	T_k	T_y	T_p	E
Baseline	0.4729	0.562	0.2538	0.0685	0.2266	0.0475	0.1842	0.3231	0.0698
BP economy	0.4729	0.562	0.2910	0.0751	0.2361	0.0436	0.1441	0.4092	0.0614

Table 18: The Distributions of Earnings, Income, and Wealth*

		Bottom	Quintiles					Top
	Gini	10	1st	2nd	3rd	4th	5th	10
The Earnings Distributions (%)								
Spain	0.35	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Baseline	0.34	3.6	8.4	11.7	15.3	23.7	40.9	25.5
BP Economy	0.34	3.6	8.3	11.6	15.1	23.6	41.2	26.1
The Income Distributions (%)								
Spain	0.34	2.1	6.3	12.1	17.2	23.7	40.7	25.0
Baseline	0.33	3.3	8.0	12.4	16.0	22.4	41.1	25.4
BP Economy	0.29	3.9	8.8	12.7	17.3	23.0	38.2	22.9
The Wealth Distributions (%)								
Spain	0.57	0.0	0.9	6.6	12.5	20.6	59.5	42.5
Baseline	0.60	0.0	0.3	4.0	10.7	24.8	60.1	38.4
BP Economy	0.66	0.0	0.0	1.7	9.1	22.9	66.3	43.8

*The source for the Spanish data of earnings and income are the Spanish National Institute of Statistics (INE) and the OECD. The source for the Spanish data of wealth is the 2004 *Encuesta Financiera de las Familias Españolas* as reported in Budría and Díaz-Giménez (2006). The model economy statistics correspond to 2014.

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