Tax and Transfer Programs, Retirement Behavior, and Work Hours Over the Life Cycle*

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Abstract

In this paper we use a computable overlapping generations model economy to analyze the quantitative effects of some reforms on tax and transfer programs, aimed at easing the tax burden on the labor supply of older workers. We focus on retirement behavior, work hours over the life cycle, and efficiency gains. We find that the labor supply of older workers is very responsive to changes in tax and transfer programs and show that the gains, in terms of old age work hours, are non-trivial. However, we also find that longer careers may not substantially increase aggregate hours because workers may reallocate labor supply over the life cycle in response to retiring later. Moreover, since longer careers may also reduce saving rates, we also find that changes in tax and transfer programs aimed at boosting the employment rates of the elderly may reduce output per head.

Keywords: Computable general equilibrium, labor supply, retirement, social security
JEL classification: C68, J22, J26, H55

1 Introduction

In most OECD countries, public programs tax older workers more heavily, with tax and transfer programs being the bulk of these programs. Income tax codes generally set marginal tax rates that increase with labor earnings. Because of this, and since average earnings increase with age, a progressive tax code implies that marginal tax rates faced by an average worker increase with age (Gervais, 2012), thus negatively affecting incentives to labor supply. Erosa et al. (2012), for instance, found that differences in marginal income tax rates are partly behind the large cross-country differences in the labor force participation of older workers. Additionally, payroll taxes also negatively affect labor supply late in life (Gruber and Wise, 1997; Blöndal and Scarpetta, 1998). Consequently, to encourage people to work longer, it has been proposed that older workers receive some earned income tax credit (Euwals et al., 2009) or be able to opt out of social security contributions (Burtless and Quinn, 2002; Goda et al., 2007; Laitner and Silverman, 2012).

Public retirement programs also impose high implicit tax rates on the elderly who continue to work. Two features seem to be particularly relevant. First, many social security systems raise annual benefits by little,

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if at all, when workers choose to delay retirement past the full entitlement retirement age, thus imposing an implicit tax on continued work. Therefore, moving to an actuarially neutral system where social security wealth is independent of the retirement age would not distort the retirement decision and would significantly increase the labor supply of older workers (French and Jones, 2012). Secondly, combining work with the receipt of a pension remains limited in most European countries[1]. As shown by Duval (2003), this restriction imposes an important implicit tax on continued work and creates a significant incentive to retire when one first becomes eligible for social security. Wallenius (2013) and Alonso Ortiz (2014) found that restrictions on the combination of work and pension income are also among the most important causes of old-age employment differences in OECD countries.

In this paper we analyze the quantitative consequences of removing each of these taxes on the labor supply of older workers. Specifically, we compare a steady-state benchmark allocation with three steady-state allocations of economies: one that removes all labor income taxes after the first retirement age; another that makes the annual reward for those who continue to work past the full entitlement retirement age actuarially fair; and a third that allows workers to combine work with the receipt of a pension once they are eligible for social security benefits. We study these reforms one at time to explore which reform is quantitatively more important. The aim of this paper is to examine the consequences of removing the aforesaid taxes on continued work for the participation rates and work hours of the elderly, and to analyze whether longer careers lead to significant increases in aggregate work hours and output.

To do so, we use a life-cycle general equilibrium model of labor supply and retirement, where ex-ante educationally heterogeneous workers face idiosyncratic labor income risk[2]. That is to say, heterogeneous workers choose both what fraction of their life to devote to employment and what fraction of their endowment period to devote to work while employed. Moreover, the social security and taxation systems are modeled in great detail. Household heterogeneity and public programs are key features for a framework intended to capture the key forces driving retirement behavior. We parameterize the model to Spanish micro and macro data[3]. Additionally, the model economy is quantitatively consistent with the age-dependent probabilities of exiting the labor force and it also replicates the education-dependent participation rates of older workers.

The findings of this paper are threefold. First, these reforms increase both the participation rates of older workers and the average retirement age, and show that the gains in terms of old-age work hours are non-trivial. Specifically, we find that removing all labor income taxes for workers after the first retirement age increases the hours they work by 13 percent, introducing an actuarial reward for delayed retirement past the full entitlement retirement age increases these hours by 14 percent, and introducing the possibility of combining work with receiving a retirement pension increases these hours by a startling 32 percent. Thus we find that reducing effective tax rates at certain points in the life cycle may be a powerful tool for increasing working lifetimes.

Second, and differently from previous research papers, we find that aggregate hours worked are less responsive to reforms aimed at easing the tax burden faced by older workers. For instance, Laitner and Silverman (2012) analyzed a US social security reform in which older individuals no longer face the OASI payroll tax and their subsequent earnings have no bearing on their benefits, finding that this reform delays retirement ages by one year and that it also brings significant efficiency gains. This is because Laitner and Silverman (2012)

[1] In some European countries, one can earn a small amount while collecting social security benefits, but the limits are tight.

[2] This model economy builds on Díaz-Giménez and Díaz-Saavedra (2015) and is an enhanced version of the model in Díaz-Giménez and Díaz-Saavedra (2009). Like them, we focus the modeling choices on the importance of the key economic and institutional forces that lead to retirement. Unlike them, this new version approximates Spanish fiscal instruments more closely since it introduces a progressive tax code on personal income. Including a progressive tax code is important as it affects the retirement decision, especially for older workers who are in the higher portion of the earnings distribution.

[3] Some dimensions of the Spanish income tax code and public pension system differ from the US system and tend to tax the labor supply of older workers more heavily than in the US. For instance, and as reported by Erosa et al. (2012), high earners in Spain face higher marginal income tax rates than their US counterparts. Moreover, the Spanish public retirement system raises the annual benefit by 3 per cent when a worker chooses to delay claiming benefits past the full entitlement retirement age, a figure that is 8 percent in the US. And finally, workers in Spain are eligible for social security at a younger age, but must stop working to collect social security benefits. Consequently, and unsurprisingly, the participation rates of older workers are higher in the US than in Spain. For instance, in 2012, the participation rates for the 60 to 64 and 65 to 69 age groups were 55.2 and 32.1 percent, respectively, in the US. In Spain, these rates were 37.9 and 5.5 percent that same year.

use a life-cycle model where households cannot adjust their labor supply during the vesting period. This assumption is important for generating a large response of total hours as discussed by Laitner and Silverman (2012). Our quantitative findings, however, show a significant reallocation of work hours over the life cycle, that is, workers work less when young knowing that they will work until an older age. Therefore, we find that the reforms we study reduce aggregate hours by 0.4, 0.1, and 1.4 percent respectively. This result is consistent with the findings of McGrattan and Rogerson (1998), who reported that US workers in the last century both shortened their working period and shifted work hours from older to younger ages as social security coverage increased.

Third, we find that reforms aimed at easing the tax burden faced by older workers may reduce saving rates, since a shorter retirement period reduces the optimal level of assets needed to support consumption when retired, as first suggested by Feldstein (1974). Consequently, and if aggregate hours do not increase, output decreases. Or, put differently, reducing taxes on labor supply late in life could prolong working lifetime at the expense of reduced output per head. For instance, we find that these reforms reduce output per head by 0.4, 1.1, and 1.9 percent respectively. This result contrasts with the view that suggests there are potential efficiency gains from long careers (Herbertsson and Orszag, 2003; Goda et al., 2007; Wise 2010). However, a more comprehensive comparison of the results must consider that these papers assume that total labor input increases strongly with a higher employment rate of the elderly, since they do not explicitly model the intensive margin of labor supply, and that saving rates are not affected by a longer working lifetime. In contrast, this paper takes a life-cycle perspective on both labor supply and consumption. Hence, when we simulate the benchmark and the reformed economies under the assumption that work hours are exogenously given and that factor prices are fixed[4], we find that, in this case, there is a 1.1, 0.9, and 2.2 percent increase, respectively, in output per head in the reformed model economies.

The fact that workers reduce hours worked earlier in the life cycle when they defer retirement raises the question of whether this continuous reduction in work hours is really possible. Undoubtedly, one can think of many frictions that restrict the reallocation of work hours over the life cycle. For instance, if there are significant fixed costs in set-up, hiring, and training, firms may not be indifferent to the hours worked by employees. Consequently, they may offer tied packages of wages and hours, workers choosing their preferred package from among those offered (Dickens and Lundberg, 1985)[5]. Thus, policy analysis that considers individuals' response to tax and transfer changes but does not take account of the effects of such changes on the constraints individuals face, may be misleading. We therefore also study these reforms in a model economy where, following Gustman and Steinmeier (1984), workers have a limited menu of working-hour choices: full time, part time, or no work. In such a model economy, the findings concerning the effects on elderly participation rates are similar. However, the limited menu of working-hour choices restricts the reallocation of work hours over the life cycle such that aggregate hours of work increase by 0.1, 0.6, and 0.7 percent, respectively. As a result, there is no significant variation in output per head between the benchmark and the reformed model economies in this framework.

Finally, we also explore the robustness of our findings with respect to how government allocates tax receipts. Our quantitative experiments assume that, apart from social security benefits, none of the other tax receipts are rebated back to households. However, Prescott (2004) and Erosa et al. (2012), for instance, showed that the labor supply response to income tax reforms depends critically on how transfers are modeled[6]. Hence, we simulate all the previous model economies under the assumption that government distributes the remaining tax receipts, apart from social security benefits, as lump-sum transfers to households. Since removing labor income taxes reduces tax collections, and introducing the possibility of combining labor income with the receipt of a pension increases social security payments, both reforms reduce lump-sum transfers in order to

[4]This choice implies that the exercises can be considered as simulations under the assumption of a small open economy in which capital flows freely across countries and the capital-labor ratio is adjusted to achieve given factor price levels.

[5]Some previous research papers present empirical evidence that many workers are not free to vary their hours within a job. See, for instance, Euwals and Soestand (1999), and Martínez-Granado (2005).

[6]Erosa et al. (2012) showed that an increase in the marginal tax rates of income (similar to a shift from the US to a French income tax code) may reduce labor input per person aged 60-64 by 10 percent when transfers are not rebated back to households. However, when the additional tax collections are rebated back to consumers, the drop in labor input per person aged 60-64 reaches 24 percent, a result that is in line with the findings of Prescott (2004).

balance the government budget[7]. We continue to find that the findings concerning the effects on elderly participation rates are similar. However, after the lower lump-sum transfers, households feel poorer so that the reduction in work hours earlier in the life cycle is lower. Consequently, in this case both reforms increase total hours by 2.6 and 0.9 percent, but output per head remains essentially the same because of the lower savings.

Our paper is most closely related to two branches of the literature. The first studies the effects of tax and transfer programs on labor supply using reduced-form, structural, or computable general equilibrium models. This literature is vast and will not be surveyed here (for a detailed review see French and Jones, 2012). Regarding computable general equilibrium models, the papers by Erosa et al. (2012), Wallenius (2013), and Alonso-Ortiz (2014) are closest to this work. The key difference between their papers and ours is that we focus on the effects of tax and transfer programs on labor supply over the life cycle, whereas they primarily pay attention to the labor supply of older workers. A second branch of the literature considers the possibility of age-adjusted tax rates[8] (see, for example, the papers of Fennell and Stark, 2005; Conesa et al. (2009), Weinzierl (2011), and Laitner and Silverman (2012)). The closest work to that reported here, nevertheless, is the paper by Laitner and Silverman (2012), who studied a US social security reform in which older individuals no longer face the OASI payroll tax and their subsequent earnings have no bearing on their benefits. However, as stated before, certain assumptions may contribute to amplifying the efficiency gains that they obtain.

The paper is organized as follows: section 2 presents the model economy; section 3 presents the calibration results; section 4 describes the simulations; section 5 presents the results; section 6 discusses the robustness of these results; and, lastly, section 7 concludes.

2 The Bechmark Model Economy

We study an overlapping generations model economy with a continuum of heterogeneous households, a representative firm, and a government. For the sake of brevity, we offer only a brief summary of its main features here. A detailed description of this model economy can be found in the technical appendix to this paper which is available at http://www.ugr.es/∼julianalbertodiaz/research/research.html.

2.1 Households

Households in our model economy are heterogeneous and they differ in their age, in their education, in their employment status, in their assets, in their pension rights, and in their pensions.

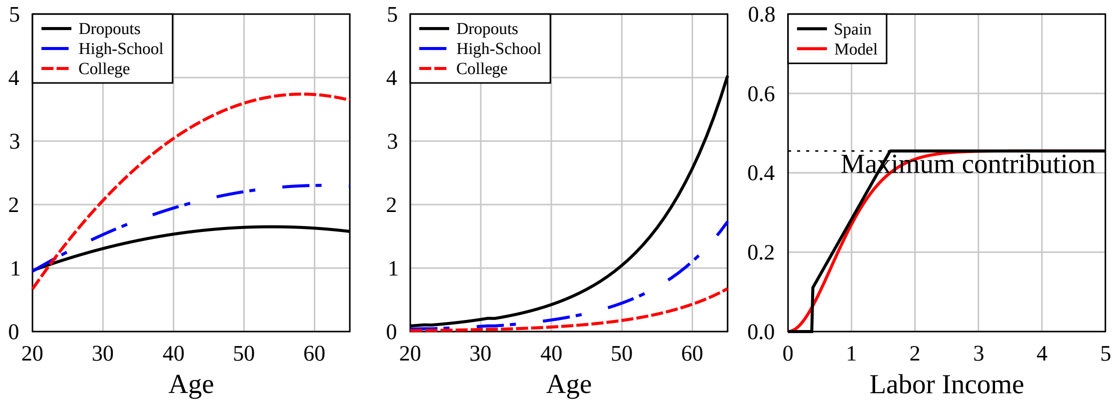
Population. We assume that the model economy is populated by an exogenous measure of heterogeneous households, μ, whose sum is one.

Age and education. Every household enters the economy when 20 years old and is forced to exit the economy at age 100. We also assume that the household faces a conditional probability of surviving from age j to age $j+1$, which we denote by ψ_j. Regarding education, we abstract from the education decision, and we assume that the education of every household, which we denote by h, is exogenously given. We consider three educational levels: dropouts, high school, and college.

[7]Recall that lump-sum transfers remain essentially the same when we implement an actuarially fair annual reward for those who continue to work past the full entitlement retirement age, since fewer retirees are compensated for by higher retirement pensions.

[8]See Banks and Diamond (2010) for an extensive review.

Figure 1: The Endowment of Efficiency Labor Units, the Disability Risk, and the Payroll Tax Function*



Panel A: The Efficiency Units Panel B: The Disability Risk (%) Panel C: The Payroll Tax Function

* The horizontal axis of Panel C measures labor income as a proportion of Spanish GDP per person who was 20 or older. The vertical axis measures payroll taxes as a proportion of that same variable.

Employment status. Households in our model economy are workers, retirees, or disabled households. Every household enters the economy as a worker, and with zero assets. The workers face a positive probability of becoming disabled at the end of each period of their working lives. And they decide whether to retire at the beginning of each period once they have reached the first retirement age of 60. In the model economy, both the disability shock and the retirement decision are irreversible and there is no mandatory retirement age.

Workers. Workers receive an endowment of efficiency labor units every period, where this endowment has two components. The first is a deterministic component, which we denote by ϵ_{jh}, and we use this to characterize the life-cycle profile of earnings. This profile is different for each educational group, and we model it using quadratic functions on age. We represent these profiles in Panel A of Figure 1.

The second component is a stochastic idiosyncratic component, which we denote by s, and we use this stochastic component to generate earnings, wealth, and pension rights inequality within the age cohorts. We assume that s is independent and identically distributed across the households, that it does not depend on the education level, and that it follows a first-order and finite-state Markov chain. Finally, we assume that the process on s takes three values mainly because it turns out that three states are sufficient to account for the Lorenz curves of the Spanish distributions of income and labor earnings in sufficient detail[9].

Retirees. As we have already mentioned, workers who are 60 years old or older decide whether to remain in the labor force, or whether to retire and start collecting their retirement pension. They make this decision after they observe their endowment of efficiency labor units for the period. In our benchmark model economy, retirement pensions are incompatible with labor earnings[10].

Disabled households. We assume that workers of age j and education level h face a probability φ_{jh} of becoming disabled from age $j + 1$ onwards. Workers find out whether they have become disabled at the end of the period, once they have made their labor and consumption decisions. When a worker becomes disabled, she exits the labor market and receives no further endowments of efficiency labor units, but she is

[9] We assume that there are no insurance markets for the stochastic component of the endowment shock.

[10] After the latest reforms of the Spanish pension system, one no longer has to stop working to collect social security benefits. However, the eligibility requirements are tight.

entitled to receive a disability pension until she dies. We represent the calibrated values for φ_{jh} in Panel B of Figure 1.

Preferences. We assume that households derive utility from consumption, $c_{jh} \geq 0$, and from non-market uses of their time and that their preferences can be described by the following standard Cobb-Douglas expected utility function:

$$\max E \left\{ \sum_{j=20}^{100} \beta^{j-20} \, \psi_j \, \varphi_{jh} \, [c_{jh}^{\alpha}(1-l_{jh})^{(1-\alpha)}]^{(1-\sigma)}/1-\sigma \right\} \tag{1}$$

where $0 < \beta$ is the time-discount factor; 1 is the normalized endowment of productive time; and $0 \leq l_{jh} \leq 1$ is labor. Consequently, $1 - l_{jh}$ is the amount of time that the households allocate to non-market activities.

2.2 Technology

We assume that aggregate output, Y, depends on aggregate capital, K, and on the aggregate labor input, L, through a constant returns to scale aggregate production function, $Y = f\,(K, L)$. We choose a standard Cobb-Douglas aggregate production function with capital share θ. Aggregate capital is obtained aggregating the capital stock owned by every household, and the aggregate labor input is obtained aggregating the efficiency labor units supplied by every worker. We assume that capital depreciates geometrically at a constant rate, δ, and we use r and w to denote the prices of capital and of the efficiency units of labor before all taxes.

2.3 Government Policy

The government in our model economy taxes capital income, household income and consumption, and it confiscates unintentional bequests. It uses its revenues to consume, and to make transfers other than pensions. In addition, the government runs a pay-as-you-go pension system.

In this model economy the consolidated government and pension system budget constraint is

$$G + P + Z = T_a + T_s + T_y + T_c + E \tag{2}$$

where G denotes government consumption, P denotes pensions, Z denotes government transfers other than pensions, T_a, T_s, 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. We also assume that Z is thrown to the sea so that they create no distortions in the household decisions.

2.3.1 Taxes

Capital income taxes are described by the function $\tau_a(y^a)$ where y^a denotes the income that the households obtain from their assets. Household income taxes are described by the function $\tau_y(y^b)$, where the tax base is $y^b = y^a + y^l + p - \tau_a(y^a) - \tau_s(y^l)$, and where y^l is labor income before taxes, p is retirement or disability pension, and $\tau_s(y^l)$ are payroll taxes. Consumption taxes are described by the function $\tau_c(c)$. Finally, we assume that at the end of each period, once they have made their labor and consumption decisions, a share $(1 - \psi_j)$ of all households of age j die and that their assets are confiscated by the government.

2.3.2 The Pension System

In our benchmark model economy we choose the payroll tax and the pension system rules so that they replicate as closely as possible the *Régimen General de la Seguridad Social* of the Spanish pay-as-you-go pension system[11].

Payroll taxes. In Spain the payroll tax is capped. In the model economy there is a payroll tax function, $\tau_s(y^l)$, that allows us to replicate the Spanish payroll tax cap. And following the Spanish rules, we assume that workers aged 65+ opt out of social security contributions. In Panel C of Figure 1 we represent the calibrated payroll tax function.

Retirement pensions. A household of age $j \geq 60$, that chooses to retire, receives a retirement pension, p, which is computed following the rules of the Spanish pension system. Specifically, the main component of the retirement pension is the *Regulatory Base* (retirement claims), and it is computed as the average labor earnings, until a maximum covered earnings, during the last 15 years before retirement. In addition, if the household is younger than the full entitlement retirement age 65, her pension claims are reduced with an early retirement penalty rate, but if the household is older than 65, her pension claims are increased by 3 percent for each year worked past this age. And finally, the Regulatory Base is multiplied by a replacement rate[12]. In any case, the retirement pension is bounded by a minimum and maximum retirement pension, both of them set by the government.

Disability pensions. To replicate the current Spanish rules, we assume that there is a minimum disability pension that coincides with the minimum retirement pension, and that the disability pensions are 75 percent of the households' retirement claims, or Regulatory Base.

2.4 The Households' Decision Problem

We assume that the households cannot borrow. They do so accumulating real assets, which we denote by a_t, and which take the form of productive capital. Then, a newborn household with education h solve the following decision problem:

$$\max E \left\{ \sum_{j=20}^{100} \beta^{j-20} \, \psi_j \, \varphi_{jh} \, [c_{jh}^{\alpha}(1-l_{jh})^{(1-\alpha)}]^{(1-\sigma)}/1-\sigma \right\} \tag{3}$$

subject to

$$c_{jh} + a_{j+1h} + \tau_{jh} = y_{jh} + a_{jh} \tag{4}$$

and where

$$\tau_{jh} = \tau_a(y_{jh}^a) + \tau_s(y_{jh}^l) + \tau_y(y_{jh}^b) + \tau_c(c_{jh}) \tag{5}$$

$$y_{jh} = y_{jh}^a + y_{jh}^l + p_{jh} \tag{6}$$

$$y_{jh}^a = a_{jh} r \tag{7}$$

$$y_{jh}^l = w \epsilon_{jh} s l_{jh} \tag{8}$$

$$y_{jh}^b = y_{jh}^a + y_{jh}^l + p_{jh} - \tau_a(y^a) - \tau_s(y^l) \tag{9}$$

[11] The Régimen General de la Seguridad Social is the most important pension program in the Spanish Social Security System. For instance, 82.1 percent of the affiliated workers and 54.9 percent of existing pensions belonged to this program in 2010. And we target the Régimen General de la Seguridad Social in place in 2010, as the effects of later reforms have not yet had time to show up in the data.

[12] In the Spanish pension system, the replacement rate depends on the number of years of contributions. We abstract from this feature of Spanish pensions mainly because it requires an additional state variable.

Notice that every household can earn capital income, only workers can earn labor income, and only retirees and disabled households receive pensions.

2.5 Equilibrium

A detailed description of the equilibrium process of this model economy can be found in the technical appendix to this paper which is available at http://www.ugr.es/∼julianalbertodiaz/research/research.html.

3 Calibration Results: The Benchmark Model

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 - 2010 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 technical appendix to this paper that can be found at http://www.ugr.es/∼julianalbertodiaz/research/research.html.

The single most important feature of the Spanish economy that the model economy should approximate is the retirement behavior of Spanish households if we want to consider the quantitative findings seriously. Consequently, we begin this section by analyzing in great detail the statistics characterizing retirement behavior, both in Spain and in the benchmark model economy. Subsequently, we consider the main aggregates and ratios[13].

3.1 Retirement behavior

An initial overview. In Table 1 we report the average retirement ages and the participation rates of those aged 60 to 64. The table shows that the model predicts an average retirement age of 63.5 years, and that this number is 1.2 years higher than its empirical counterpart. The model also predicts increasing average retirement ages in proportion to the number of years of education. Unfortunately, the actual statistics are not available, but this relationship is highly plausible, since participation rates in Spain also increase with education (see column 3 of Table 1).

The total participation rate of those households aged 60 to 64 is 53.9 percent in the model economy, and 56.6 percent in Spain. The table also shows that participation rates in Spain increase with education. This is because even though all educational types value leisure equally, the foregone labor income (which is the opportunity cost of leisure) is lower for less educated workers. A second reason is that low-educated workers are those who most take advantage of early retirement provisions, such as the minimum retirement pension provided by the Spanish pension system. The model successfully reproduces this tendency, and also does a good job in replicating the participation rates for all educational types[14].

Further details. An examination of other statistics on retirement behavior increases our confidence in the

[13] We find that our model economy replicates the Spanish Gini indices of earnings, income, wealth, and pensions reasonably well. Specifically, Budría and Díaz-Giménez (2006) report that the Spanish Gini indexes of earnings, income, and wealth were 0.49, 0.42, and 0.57 in 2004, and according to Conde-Ruiz and Profeta (2007), the Spanish Gini index of pensions was 0.32 in 2000. In our model economy, these numbers are 0.48, 0.44, 0.57, and 0.36 respectively. See Díaz-Giménez and Díaz-Saavedra (2015).

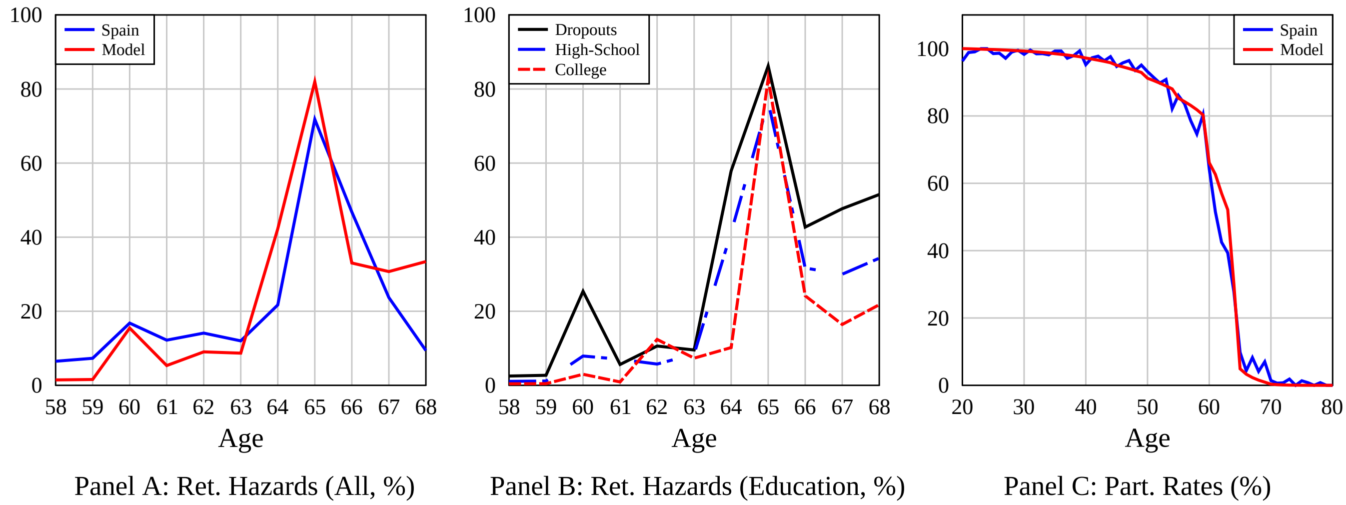
[14] When making this comparison it must be remembered that there exist certain fundamental differences between Spain and the model economy. In Spain, people of working age fall into one of five categories: employed, unemployed, retired, disabled, and other non-participants. In our model economy we only have three: employed, disabled, and retired. This is why we present the Spanish data in these three categories

Table 1: Retirement Ages and Participation Rates

	Avg Ret Ages		Part rates at 60-64 (%)	
	Spain[a]	Model	Spain[b]	Model
All	62.3	63.5	56.6	53.9
Dropouts	*n.a.*	63.1	45.5	40.6
High School	*n.a.*	63.8	61.0	65.2
College	*n.a.*	64.4	75.2	79.5

[a]The Spanish data is for males and females in 2010 (Source: Eurostat).
[b]The Spanish data is from both the *Encuesta de la Población Activa*, and the *Encuesta de Empleo del Tiempo 2010*, excluding the unemployed and non-participants who do not collect either retirement or disability pensions (see the Spanish Institute of Statistics, INE).

Figure 2: Retirement Hazards From The Labor Force and Participation Rates (%)*



* The Spanish data for the retirement hazards is taken from García Pérez and Sánchez-Martín (2010). The Spanish data for the participation rates is computed from the *Encuesta de Empleo del Tiempo (2010)*, reported by the INE.

model economy as a tool for policy analysis. Panel A of Figure 2 shows the age-dependent empirical profile for claiming retirement benefits in Spain. This profile, which displays peaks at the first and the normal retirement age, is a common stylized fact across those countries operating a defined benefit pension system (see Gruber and Wise, 1997). The model economy successfully matches the empirical profile, as the claiming of benefits is also concentrated at the first and normal retirement ages. Close scrutiny reveals that hazard is higher at age 65 in the model economy, reaching 81.9 percent. For Spain, this figure is 71.8.

The model economy also predicts a much higher probability of low-educated workers leaving the labor force at the age of 60, the first retirement age in Spain (see Panel B of Figure 2). In fact, 80 percent of those who retire at this age are dropout workers. This is consistent with the findings of Sánchez-Martín (2010), who report that at age 60 low-income workers have a much higher probability of retiring than high-income workers. In both Spain and the model economy, the minimum retirement pension provided by the pension system is mainly behind this fact, since this type of pension strongly affects retirement behavior, and it is currently received by 27 percent of all retirees in Spain, this number reaching 31 percent in the model economy. Workers can receive this type of pension as of the first retirement age of 60, and are also aware that delaying the receipt of this minimum amount does not increase it. In other words, a worker entitled to this amount faces a significant implicit tax on continued work. Consequently, workers, and especially low-income workers, have the incentive to apply for this benefit at age 60. In the model economy, 97 percent of those who leave the labor force at age 60 receive this minimum pension, while Jiménez-Martín and Sánchez-Martín (2006) find that this figure in Spain is 67 percent.

The picture is different at the age of 65, the full entitlement retirement age in Spain. Because the Spanish pension system provides no economic incentives to delay retirement beyond this age[15], and also because of the drop in the Regulatory Base resulting from a worker's labor income dynamics, pension wealth continues to be reduced for most workers who remain in the labor force. In addition, the marginal tax rate on labor income may turn out to be higher than the marginal tax rate on pension income, due to the high progressivity of the Spanish income tax schedule. Consequently, these workers choose to leave the labor force to avoid the high implicit tax on continuing to work. Boldrin et al. (1997), Argimón et al. (2009), and Sánchez-Martín (2010) find that the probability of retirement at age 65 is independent of salary level, and the model economy replicates this stylized fact reasonably well. For instance, at age 65, retirement hazards are similar for all educational groups, and are over 70 percent (see Panel B of Figure 2).

Finally, Panel C of Figure 2 compares the age-dependent aggregate participation rates in the data and in the model economy. The data are based on the *Encuesta de Empleo del Tiempo (2010)*, reported by the Spanish Institute of Statistics (INE). This panel shows that the model economy is successful in quantitatively matching the decline in the participation rate starting at age 50, then more sharply after age 60, in Spain.

Overall assessment. An accurate assessment of the questions we pose in this paper requires a model economy that captures the key institutional and economic forces leading to retirement. The model economy describes both the Spanish tax system and the rules of the Spanish Public Pension System in great detail. It also incorporates a calibration procedure for the earnings process that is consistent with earnings inequality in Spain. Thus the model economy successfully matches distribution of retirement and other key features of retirement behavior found in Spanish data. This is particularly remarkable since the calibration procedure did not explicitly target the various facts on retirement behavior.

3.2 Aggregates and Ratios

Macroeconomic Aggregates and Ratios. In Table 2 we report the macroeconomic aggregates and ratios in Spain and in the benchmark model economy for 2010. We find that the benchmark model economy does a good job in replicating most of the values for the chosen targets.

Table 2: Macroeconomic Aggregates and Ratios in 2010 (%)

	$C/Y^{*,a}$	K/Y^*	H^b	T_y/Y^*	T_s/Y^*	P/Y^*
Spain	51.5	3.28	37.5	7.4	10.1	10.3
Model	51.4	3.28	38.0	7.7	10.1	10.2

[a]Variable Y^* denotes GDP at market prices.
[b]Variable H denotes the average share of disposable time allocated to the market.

4 The Reforms

This paper studies the consequences of three counterfactual reforms in Spain. The logic of these reforms is supported by the literature on age-dependent taxation, which points to efficiency gains from using age

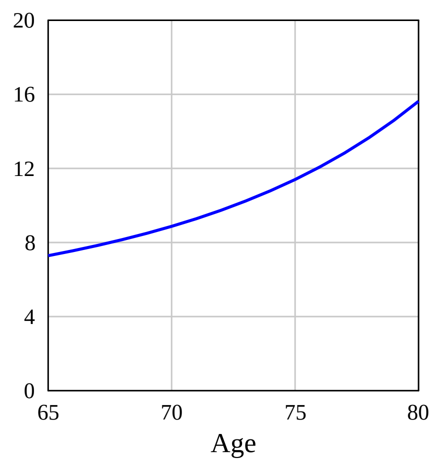
[15]The annual premium for those who delay their retirement past the full entitlement retirement age is 3 percent.

to target lower tax rates at households with greater labor supply elasticities. This section describes these reforms.

Reform 1. This reform eliminates all labor income taxes for workers after the first retirement age, 60. Consequently, such workers are exempt from paying personal income tax imputed to labor activities, and workers in the 60-64 age range are exempt from paying payroll taxes[16].

Reform 2. Under the current Spanish public pension system, the annual pension increase for every year worked after the full entitlement retirement age 65 is 3 percent. Consequently, and since this amount is actuarially less than fair, the Spanish pension system provides strong incentives to claim benefits by age 65. This second reform eliminates this implicit tax, since it increases the annual premium. However, as mortality rates increase with age, the actuarial reward for delayed retirement rises with age in order to compensate workers for their increasing mortality risks. Figure 3 shows that this annual bonus increases steadily from 7.3 percent at age 65 to 15.6 percent at age 80.

Figure 3: Annual bonus per age of delayed retirement after the full entitlement retirement age 65 (%)*



* Source: Author's elaboration based on Spanish mortality rates in 2010.

Reform 3. The fact that agents in Spain must stop working in order to collect social security benefits creates an implicit tax on continued work after the agent becomes eligible for retirement benefits. Therefore, in this reform we assume that workers aged 60+ can combine work with the receipt of a pension. We also assume that the receipt of a pension is not income tested, so that this reform provides workers the possibility of combining labor earnings with the receipt of their full pension.

5 Results

The approach is to compare the steady state allocation of the benchmark economy with the steady state allocation under the reformed model economies. In order to keep the distortions caused by the reforms as low as possible and make the comparisons meaningful, we assume that government expenditure, consumption, income and payroll tax rates are identical in all four model economies. The benchmark and the reformed model economies differ in their income tax and payroll tax collections, in their transfers other than pensions, in their pension payments, and in their unintentional bequests, which are endogenous.

[16]It must be remembered that workers aged 65 or over were exempt from paying payroll taxes in the benchmark model economy.

In Tables 3 and 4, we present the results regarding differences in participation rates and hours of work between the benchmark and the reformed economies. In Figure 4, we compare the age-dependent retirement probabilities from the labor force and participation rates of the elderly. Finally, in Table 5, we present the consequences of the reforms on factor inputs and output. Our principal findings are given immediately below.

Retirement behavior. All the reforms increase retirement ages and hence the participation rates of the elderly (see Panel B of Figure 4). Eliminating all labor income taxes for those aged 60 or over increases the average retirement age by almost 4 months. It also increases the participation rates for workers aged 60 to 64 by almost 4 points (see the second block in Table 3). We also find that highly educated workers delay their retirement by more than their less educated counterparts, since part of this reform eliminates a progressive tax (i.e., the personal income tax imputed to labor activities), which taxes high earners heavily. Note that the longer working lifetime modifies the age-dependent profile of retirement hazards from the labor force (see Panel A of Figure 4), since these probabilities decrease[17].

Table 3: Average Retirement Ages and Participation Rates for Workers Aged 60-64

	Benchmark		Reform 1		Reform 2		Reform 3	
	Ret. Ages (years)	Part. Rates (%)	Diff. in R. Ages	Diff. in P. Rates	Diff. in R. Ages	Diff. in P. Rates[a]	Diff. in R. Ages	Diff. in P. Rates
All	63.51	53.89	0.32	3.80	0.54	9.20	2.68	15.16
Dropouts	63.06	40.55	0.20	2.30	0.46	5.26	2.50	15.98
High School	63.82	65.22	0.43	6.58	0.75	16.93	2.98	15.85
College	64.38	79.47	0.70	4.00	0.65	14.55	3.60	9.93

[a] Difference in participation rates for workers aged 65 to 69 years.

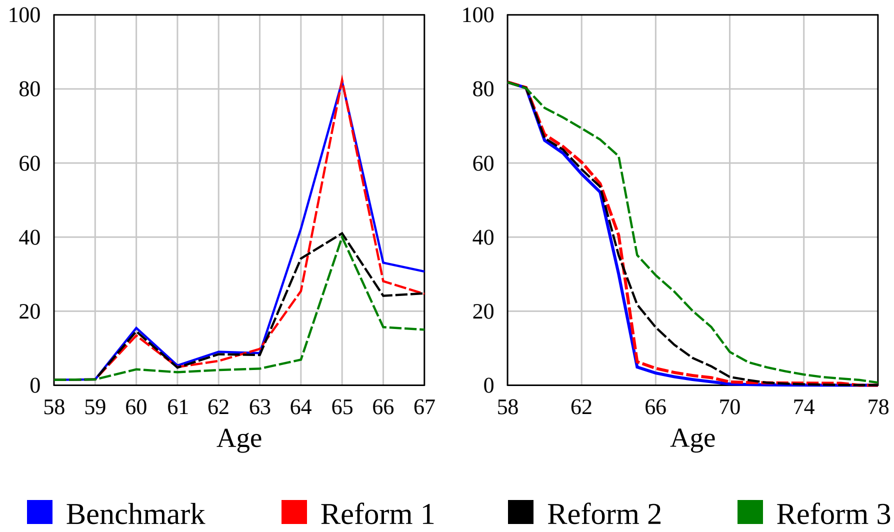
The second reform, which increases the annual pension premium for every year worked beyond age 65, increases the average retirement age by 6 months (see the third block in Table 3) and the participation rate of workers aged 60 to 64 by almost 2 points. However, more importantly, this reform increases the participation rate of those aged 65 to 69 by more than 9 points, specifically from 2.7 to 11.9 percent. Again, high school and college graduate workers are those who most delay their retirement, but this time because these educational groups tend to retire later, and thus benefit more from this reform. Consequently, there is a 17 and 15 point increase in their participation rates and the consequences for retirement hazards are straightforward: as some workers decide to work beyond age 65 following the reform, the retirement hazard at this age falls from 71 to 41 percent (see Panel A of Figure 4).

Finally, after the last reform, which allows households to continue working while collecting pension benefits, there is a striking 2.7-year increase in the average retirement age and a 15.1 percentage point increase in the participation rates of those aged 60 to 64 years (see the fourth block in Table 3). This is because this reform eliminates the large incentive to retire when one first becomes eligible for social security when one cannot continue working while collecting retirement pensions. Consequently, the age-dependent probabilities of exiting the labor force are lower (see Panel A of Figure 4) and, in fact, the first peak at the age of 60 disappears. However, despite the drop in retirement hazards, there continues to be a peak at age 65 because this reform would not be sufficient to bring implicit tax rates down to zero after this age since the annual bonus to defer retirement continues to be 3 percent in this reformed economy.

Thus, we find that changes in tax and transfer programs lead to a major shift in the retirement behavior of older workers. Among the reforms we consider, we also find that allowing working while collecting retirement pensions would create much larger incentives for older workers to stay in the labor force, and that eliminating income taxation for these workers has much milder effects on retirement behavior.

[17]There is a small difference in the retirement hazard at age 60 because retirement probability at this age depends heavily on the minimum retirement pension.

Figure 4: Probabilities of exiting the labor force and participation rates (%)



Work hours over the life cycle. Since all the reforms increase the participation rates of the elderly, they also increase the total number of work hours for those aged 60 or over (see Table 4). In all cases, we find that the additional number of work hours by this age group in the reformed economies is striking. The percentage increase ranges from 14 percent in the first reform to 32 percent in the third reform, showing that the gains in terms of old age work hours are non-trivial. It should be noted that these rises, like the changes in participation rates, differ notably across educational groups. While in the first reform more educated workers are those who most increase their total number of hours, low-educated workers increase their work hours in the third reformed economy by almost 40 percent.

Table 4: Difference in Hours Worked With The Benchmak Economy (%)

	Reform 1				Reform 2				Reform 3			
	Ages 20-39	Ages 40-59	Ages 60+	Total	Ages 20-39	Ages 40-59	Ages 60+	Total	Ages 20-39	Ages 40-59	Ages 60+	Total
All	–0.70	–1.32	13.59	–0.41	–0.40	–0.94	14.29	–0.06	–2.37	–3.25	31.98	–1.42
Dropouts	–0.28	–1.05	12.25	0.58	–0.54	–1.02	16.53	–0.64	–1.52	–2.74	39.00	1.88
High School	–0.76	–1.22	12.85	–0.60	–0.05	–0.73	14.04	1.01	–2.57	–3.22	25.33	–2.12
College	–0.70	–1.81	17.15	–0.47	–0.13	–0.86	10.50	–0.02	–2.16	–3.72	33.17	1.46

The quantitative findings also show a significant reallocation of work hours over the life cycle, that is, workers work less when young knowing that they will defer retirement. Thus, we find that these reforms may not increase aggregate hours[18]. For instance, if workers are allowed to combine labor income with the receipt of a pension, aggregate hours of work decrease by 1.4 percent[19].

We also find, differently from Laitner and Silverman (2012), that the total hours worked are less responsive to an increase in old age after tax wages (see the first block of Table 4). Laitner and Silverman (2012)

[18]In the sensitivity analysis, we show that the effect of these reforms on aggregate work hours depends on some of the features of the model environment.

[19]The willingness of agents to reduce hours along the intensive margin could be reduced, for example, by the complementarity between current human capital and hours worked under a learning by doing skill accumulation technology. See, for instance, Wallenius (2013).

analyzed a US social security reform in which older individuals no longer face the OASI payroll tax and their subsequent earnings have no bearing on their benefits, finding that this reform delays retirement ages by one year and that it also brings significant efficiency gains. This is because these authors present a life-cycle model and assume that households make consumption and retirement decisions and that households cannot adjust their labor supply during the vesting period. This last assumption is crucial for generating a large response of total hours as discussed by Laitner and Silverman (2012). In this paper, however, we model both the intensive and extensive margins and find that the smaller change in total work hours is accounted for by the labor supply response along the intensive margin.

In summary, the results suggest that for the cohort of workers nearing retirement, changes in the tax rates on their labor supply could lead to significant changes in that supply. Younger cohorts, however, could respond in part by adjusting their labor supply at earlier ages, so that lifetime labor and aggregate labor change less. This is consistent with the results of McGrattan and Rogerson (1998), who found that US workers in the last century both shortened their working period and shifted work hours from older to younger ages, as social security coverage increased.

Factor inputs and output. The lower number of total work hours reduces the effective labor supply (see second line of Table 5). Moreover, these reforms may also reduce saving rates and hence the capital stock, since a shorter retirement period reduces the optimal level of assets needed to support consumption when retired, as first suggested by Feldstein (1974). For instance, combining work with the receipt of a pension increases working lifetime by 2.7 years but also reduces capital stock by a significant 2.6 percent (see first line of Table 5). Consequently, there are 0.4, 1.1, and 1.9 percent decreases in output per capita after these reforms are implemented. Put differently, reducing taxes on the labor supply late in life could prolong working lifetime at the expense of reduced output per head.

These results contrast with the view suggesting the potential efficiency gains of long careers (Herbertsson and Orszag, 2003; Goda et al., 2007; and Wise, 2010). However, a more comprehensive comparison of the results must consider that these papers assume that total labor input increases strongly with a higher employment rate of elderly because they do not explicitly model the intensive margin of labor supply, and that saving rates are not affected by a longer working lifetime. Conversely, this paper takes a life-cycle perspective on both labor supply and consumption. Hence, if we simulate the benchmark and the reformed economies under the assumption that both work hours are exogenously given[20] and that factor prices are fixed[21], we find that, in this case, there is a 1.1, 0.9, and 2.2 percent increase, respectively, in output per head in the reformed model economies.

Table 5: Differences in Factor Inputs And Output with the Benchmark Model Economy (%)

	Reform 1	Reform 2	Reform 3
Capital (K)	–0.65	–1.37	–2.63
Labor (N)	–0.21	–0.06	–0.23
Output (Y)	–0.36	–1.07	–1.90

In conclusion, some changes in tax and transfer programs aimed at increasing working lifetimes may not increase output. The results presented here show that it is important to consider both the potential shift in hours over the life cycle and the change in saving rates.

[20]See section 6.1 for a detailed explanation about how we estimate the age profile of hours of work.

[21]This choice implies that this exercise can be considered as simulations under the assumption of a small open economy in which capital flows freely across countries and the capital-labor ratio is adjusted to achieve given factor price levels.

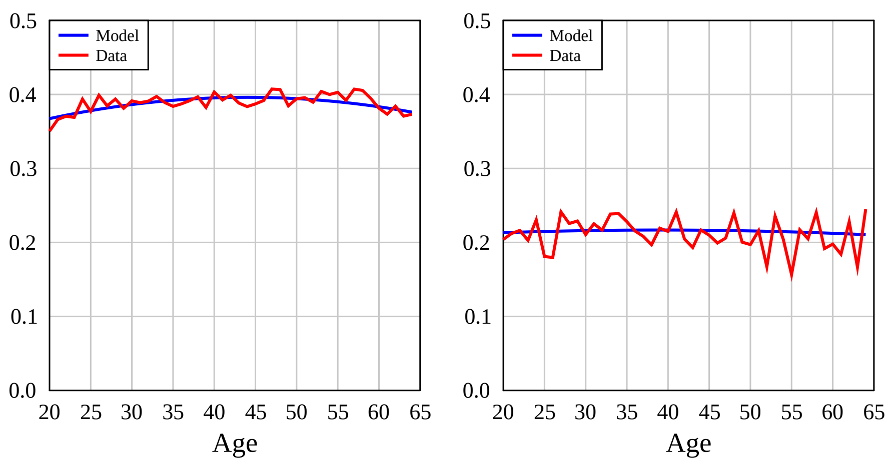
6 Sensitivity Analysis

In this section we conduct a sensitivity analysis on some of the assumptions of the benchmark model economy.

6.1 Limited menu of working hour choices

In the previous section we found that when individuals defer retirement in response to lower taxes on labor supply at older ages, they also reduce hours worked earlier in the life cycle. This, however, raises the question of whether this continuous reduction in work hours early in life is really possible. One can think of many frictions that could restrict the reallocation of work hours over the life cycle. For instance, if there are significant fixed costs in set-up, hiring, and training, firms may not be indifferent to the hours worked by employees, so that firms may offer tied packages of wages and hours and workers will choose their preferred package from among those offered (Dickens and Lundberg, 1985). Thus, policy analysis that considers the individual's response to tax and transfer changes but does not take account of their effects on the constraints individuals face may be misleading. Consequently, we also study these reforms in a model economy where, following Gustman and Steinmeier (1984), workers have a limited menu of working hour choices: full time, part time, or no work.

Figure 5: Share of Disposable Time Allocated to The Labor Market by Age*



Panel A: Full-time hours of work   Panel B: Part-time hours of work

* The Spanish data is computed from the *Encuesta de Empleo del Tiempo (2010)*, reported by the INE.

To characterize the age profile of full-time and part-time hours, we use data from the *Encuesta de Empleo del Tiempo 2010* provided by the Spanish National Institute of Statistics (INE)[22]. We impute hours supplied to the market as a fraction of the total time endowment and, as before, we assume that the time endowment is 14 hours a day, 7 days a week. We then split the sample between those who claim to work either full-time or part-time hours and parameterize the average allocated time to market activities per age for both groups with the help of quadratic curves. Figure 5 plots the average fraction of time spent working for both full-time and part-time workers. Full hours worked rise initially and then they level off. Starting in the 50s, hours decline slightly. In the case of part-time hours worked, the life cycle profile is much flatter.

In this framework, two main findings emerge. First, the shift of hours of work over the life cycle is less

[22]The microdata is available at $http://www.ine.es/jaxi/menu.do?type = pcaxis\&path = \%2Ft25\%2Fe447\&file = inebase\&L = 0$.

Table 6: Difference in Hours Worked With The Benchmak Economy (%)

	Reform 1				Reform 2				Reform 3			
	Ages 20-39	Ages 40-59	Ages 60+	Total	Ages 20-39	Ages 40-59	Ages 60+	Total	Ages 20-39	Ages 40-59	Ages 60+	Total
	Continuos choice of hours of work											
All	–0.70	–1.32	13.59	–0.41	–0.40	–0.94	14.29	–0.06	–2.37	–3.25	31.98	–1.42
	Limited menu choice of hours of work											
All	–0.39	–0.66	8.10	0.12	–0.29	–0.40	15.29	0.60	–1.94	–2.23	35.00	0.67

pronounced (see Table 6). Specifically, the decrease in total hours of work for the 20-39 and 40-59 age groups is lower in all the reformed economies in comparison to the case where workers were free to choose the time they allocate to market activities. Second, total labor input increases after all reforms, so that it tends to decrease the output loss (see Table 7).

Table 7: Difference in Output And Factor Inputs With The Benchmak Economy (%)

	Continuos choice of hours of work			Limited menu choice of hours of work		
	Output (Y)	Capital (K)	Labor (N)	Output (Y)	Capital (K)	Labor (N)
Reform 1	–0.36	–0.65	–0.21	0.08	–0.64	0.21
Reform 2	–1.07	–1.37	–0.06	–1.00	–1.16	0.36
Reform 3	–1.90	–2.63	–0.23	–0.41	–2.92	0.78

6.2 Transfers rebated back to households

So far, our quantitative experiments have assumed that, apart from retirement and disability benefits, none of the other tax receipts were rebated back to consumers. However, this assumption may affect our reported results. For instance, Prescott (2004) and Erosa et al. (2012) showed that the labor supply response to income tax reforms depends critically on how transfers are modeled. Hence we simulate all the previous model economies under the assumption that government distributes the remaining tax receipts, apart from social security benefits, as lump-sum transfers, Z, to households.

Table 8: Difference in Hours Worked With The Benchmak Economy (%)

	Reform 1				Reform 2				Reform 3			
	Ages 20-39	Ages 40-59	Ages 60+	Total	Ages 20-39	Ages 40-59	Ages 60+	Total	Ages 20-39	Ages 40-59	Ages 60+	Total
	Without Transfers to Households											
All	–0.70	–1.32	13.59	–0.41	–0.40	–0.94	14.29	–0.06	–2.37	–3.25	31.98	–1.42
	With Transfers to Households											
All	–0.53	–0.31	15.74	0.77	–0.39	–0.92	14.46	–0.04	0.05	–1.31	36.30	0.87

Note that some of the reforms we study change the magnitude of these transfers, since we do not impose that the reforms be revenue neutral. Consequently, and since the removal of labor income taxes reduces tax collections and the introduction of the possibility to combine labor income with the receipt of a pension increases social security payments, both these reforms reduce lump-sum transfers in order to balance the government budget[23].

Table 9: Difference in Output And Factor Inputs With The Benchmak Economy (%)

	Without Transfers to Households			With Transfers to Households		
	Output (Y)	Capital (K)	Labor (N)	Output (Y)	Capital (K)	Labor (N)
Reform 1	–0.36	–0.65	–0.21	0.08	–0.87	0.38
Reform 2	–1.07	–1.37	–0.06	–0.37	–1.03	–0.04
Reform 3	–1.90	–2.63	–0.23	–0.39	–3.12	0.90

Overall, we now find that the reduction in hours of work earlier in the life cycle following Reforms 1 and 3 is lower, and this is because the lower tax rebates make households poorer. Thus, aggregate hours increase by 0.8 and 0.9 percent, and this reduces the drop in output (see Tables 8 and 9).

6.3 Open Economy

The baseline experiments consider closed economies. However, given the size of the Spanish economy and its integration within the EU, it is useful to understand the impact of the reforms in a small open economy. Therefore, as a final robust analysis, we simulate all the previous model economies under the assumption of fixed prices, so we assume as factor prices those obtained in the steady state equilibrium of the benchmark model economy. This choice implies that the exercises can be considered as simulations under the assumption of a small open economy in which capital flows freely across countries and the capital-labor ratio is adjusted to achieve given factor price levels. We find that the microeconomic and macroeconomic consequences of the reforms do not depend significantly on whether the economy is open to international capital flows or not.

7 Conclusions

This paper presents a life cycle general equilibrium model of labor supply and retirement where ex-ante educationally heterogeneous workers face idiosyncratic labor income risk. We calibrate the model economy to the Spanish economy and find that it successfully replicates many important stylized facts regarding the retirement behavior of older workers in Spain. We use this model economy to study the consequences of three counterfactual experiments aimed at reducing labor supply taxes for older workers. The rationale for these exercises rests on the literature on age-dependent taxation, which points to efficiency gains from using age to target lower tax rates at households with a greater labor supply elasticity.

We find three main results. Firstly, reducing the labor supply taxation of the elderly significantly increases their participation rates so that the gains in terms of old-age work hours are non-trivial. Secondly, we find that longer careers may not substantially increase aggregate hours because workers may reallocate labor supply over the life cycle in response to retiring later. And thirdly, longer careers may also reduce saving rates. Consequently, some changes in tax and transfer programs aimed at increasing working lifetimes may not increase output, and if they do, the efficiency gains may be distant from previous estimates.

Therefore, one policy message that this paper intends to give is that when considering changes in tax and transfer programs aimed at boosting the employment rates of the elderly, the potential effects of these changes on work hours over the life cycle and saving rates should also be considered. Put differently, it may

[23] In this framework, lump-sum transfers remain essentially the same when we implement an actuarially fair annual reward for those who continue to work past the full entitlement retirement age, since fewer retirees are compensated by higher retirement pensions.

be the case that the government should take additional policy measures to avoid a possible loss of efficiency in the economy. Obviously, government has a range of options for this, fiscal policy being one of them. For example, to avoid possible reductions in the savings rate, fiscal policies focused on increasing household saving could be implemented, such as an investment tax credit, or the availability of special tax preferred savings accounts. On the other hand, if the aim is to increase hours worked, particularly in the middle-aged work force, a selective reduction in the marginal types of personal income tax could be considered as an option.

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