Flexible Employment Contracts and Pension Systems

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Abstract

This paper develops a model of one-sided search to analyse the ability of a public pension system to account for flexible employment contracts in the labour market. Individual careers are simulated in a frictional environment where workers can be employed under different types of contracts before they retire. The unemployment dynamics is also affected by the distribution of types of employed contracts. Simulated labour careers are used as the base to assess the adequacy of different pension regimes in terms of income maintenance, inequality and poverty among retirees.

Some policy measures are proposed to correct the standard design of a pension system. Differentiated contribution rates by age of the worker or by the tenure of the contract seem to restore adequacy along the three dimensions. While, in general, a defined benefit pension regime prevails over a standard pension contribution regime in terms of income maintenance, it also implies a relatively higher level of dispersion in the corresponding pension distribution. This trade-off is overcome by differentiated pension regimes. Within this category, an age-specific contribution rule slightly prevails over a tenure-specific pension regime in terms of income maintenance but with a slightly higher level of inequality. All four pension regimes share the same adequacy performance only if employment state is absorbing.

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1 Introduction

Over the last thirty years, the majority of European economies experienced reforms of both labour markets and pension systems. Implemented flexicure[1] policies have introduced new forms of job arrangements besides that of a standard employment relation, that is a full-time open-ended contract with a decent level of wage. Moreover, rules for dismissals have been relaxed.

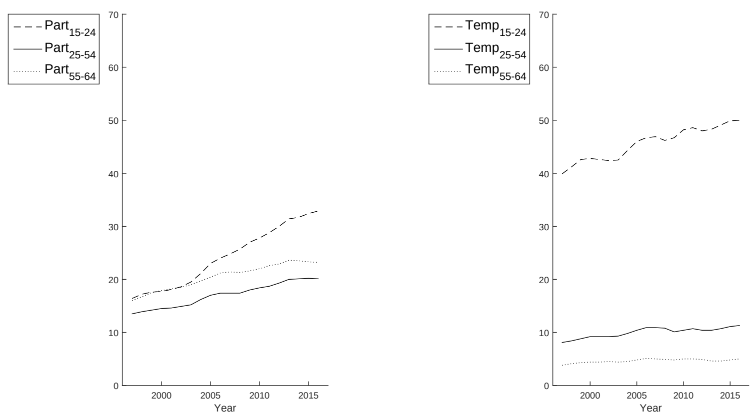

Figure 1: *Time evolution of share of employed part-time and temporary contracts for the Eurozone-19 over the period 1997-2016 (source: Eurostat).*

At the same time, population ageing put pressure on the financial sustainability of welfare programs, especially of pension systems. Reforms promoted the shift from defined benefit to defined contribution pension schemes, thus increasing the sensitivity of pension entitlement to the entire individual labour market history. Other retrenchment measures were and are increase retirement age and contributory periods for eligibility.

The interplay between the labour market and pension system has become more intense. For instance, relatively lower wages and more interrupted careers are likely to deliver lower pension payments and, at the same time,

[1] Flexicurity is defined as a strategy that attempts, synchronically and deliberatively, to enhance the flexiblity of labour markets relations while maintaining employment and income security for worker groups in and out employment relations (Wilthagen and Tros, 2004). See also Atkinson (1984) for a seminal definition of flexible employment relation.

weaken the intergenerational support from the current working generation to sustain pensions paid to the current generation of retirees[2]. Lower contributions will reduce the inflow of resources directly used to finance pension payments and, in turn, will increase the need for external funds. This is then compensated either by increasing public expenditure and, eventually, debt or by cutting pension expenditure (e.g. by lowering replacement rates). Incentivised participation in supplementary pillars does not seems to be such an effective policy in this sense (Whiteside, 2014).

In an ageing world, the public pension is the main source of income for their remaining lifetime[3]. Thus, reforms affecting public pensions will have an impact on an increasing part of an ageing society. In a context of flexible labour contracts, indexed retirement strategies and stricter eligibility conditions are likely to exacerbate not only inequalities among retirees but also induce a regressive (a non-progressive) distributional mechanism and, thus, to increase poverty[4]. This is true for either a DB and, as shown by Ayuso et al. (2017a), for an earnings-related DC pension regime. A new design of a pension system, based on differentiated contribution rates, can be part of the solution (Ayuso et al. 2017b).

[2]As firstly noted by Hinricks and Jessoula (2012), among young and in Southern European countries, the common assumption of 35-40 working years, necesssary to have a decent level of pension, in a stable uninterrupted career, is now hard to be satisfied.

[3]In most countries, retirement is an irreversible choice. In some countries (e.g. USA), retirees can decide, instead, to work part-time. This corresponds the fourth pillar as promoted by the Geneva Association (Giarini, 1990).

[4]Unfortunately, empirical evidence is not mature to fully highlight these effect. Indeed, since reforms promoting more flexible arrangements in the labour market started in the early ′90s (e.g. 1997 in Italy), considering a full career of (at least) 40 years of contribution, one needs to wait (at least) until 2030 for a complete phased-in of such policies of (fully) flexible labour careers.

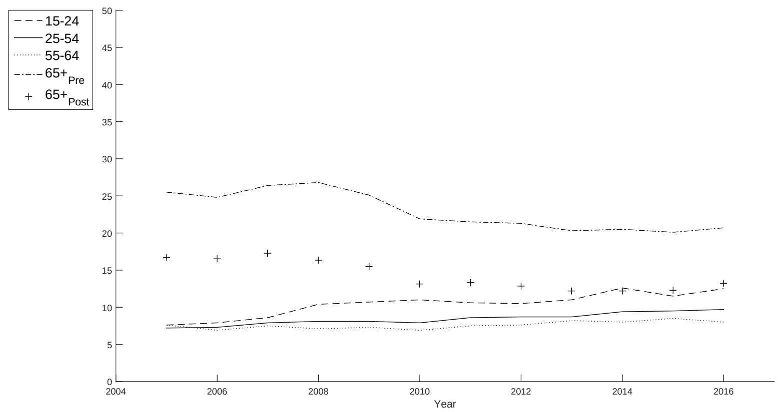

Figure 2: *Time evolution of poverty risk for the Eurozone-19 over the period 1997-2016 (source: Eurostat).*

This paper is structured as follows. Section 2 illustrates the literature focusing on the relationship between labour market and pension system; section 3 describes the model and provides a baseline calibration; section 4 shows results of different pension regimes along the adequacy dimensions; section 5 concludes.

2 Literature

The topic of pension has always been considered by the economic literature since the establishment of the first public pension systems of a DB type (Brooks, 1892; Baldwin, 1910). Castellino (1969) introduces the notion of DC pension system, where pension depends on contributions paid during the whole labour career and not, as in DB, on the mean wage computed by averaging over a pre-specified time window (usually the last 10-20 years). Population ageing and lower economic growth have then made economists interested in the analysis of the financial sustainability of a pension system[5]. The relation between unemployment and pension system has been firstly analysed within the macroeconomic literature of endogenous growth (Corneo

[5] A shift from an unfunded to a funded pension system generates a transitional cost whose burden must be in somehow financed (Breyer 1989; Brunner, 1996). See Lindbeck and Persson (2003) for a survey on gains from structural reforms of the pension system.

and Marquadt, 2000; Brauninger, 2005; Ono, 2007; Ono, 2010; Thogersen, 2010). But their simplified modelling environment, namely a two-OLGs economy with a single-price contract, allows neither to study lifecycle profiles of variables of interest nor to address the issue of flexibility of labour market careers.

If one wants to consider in a fully specified lifecycle framework employment breaks and contract flexibility, the theory of frictional unemployment is the natural candidate modelling framework. Unemployment is an equilibrium outcome resulting from labour market institutions: workers flow between unemployment and employment status, firms create and destroy vacancies and set wages by posting or bargain (Pissarides, 2000). Important extensions moves from single-price to a wage-tenure structure of contracts (Mc Call, 1970; Burdett and Coles, 2003), coexistence of temporary and permanent jobs (Berton and Garibaldi, 2012; Faccini, 2014; Berson and Ferrari, 2015; Cahuc, 2016), lifecycle and retirement (Hairault et al., 2010; Chéron et al., 2013; De La Croix et al., 2013; Hairault et al., 2015; Batyra et al., 2017). While the first two branches of literature highlight the importance and heterogeneity of contractual arrangments, the third focuses on the implications of ageing and labour market frictions.

Despite that, the interplay between labour market and pension system has received less attention. This work tries to fill this gap. The model presented below is able to analyse issues related to temporary jobs and pensions in a lifecycle framework and it can be considered an attempt to highlight some importante feature of the feedback mechanism involing labour market (careers) and the design of pension systems.

Even thou the role of firms is kept silent, the presented model extends the wage-tenure structure of contracts by introducing a factor for wage-growth as well as the lifecycle framework to more than sixteen OLGs. On the top of it, a post-retirement period is considered together with a pension system module to study the interplay between labour market and pension system design.

A unique contribution that jointly studies the evolution of labour careers and corresponding pension entitlement is Bravo and Herce (2017), which focuses on the influence of employment breaks on pension benefits at different stages in the worker's lifecycle. In particular, they simulate unemployment shocks lasting from one to five years and occurring either at beginning or middle or at the end of the worker's career. By focusing of a DB pension system (i.e. of Portugal and Spain), they conclude that employment breaks occurring in

the early stage are less harmful to pension entitlements if compared to those occurring prior to retirement since they fall within the time window used as the base to compute the reference average wage. The model presented below is innovative since it also extends Bravo and Herce (2017) and allows to properly study feedback mechanisms involving labour market, retirement and pension system in an environment that endogenously generates atypical labour careers featuring employment breaks as well as contract flexibility.
Among the potential feedback mechanisms involving labour market and pension system, this paper focuses on the effect of flexible contracts on the adequacy of pension systems measured in terms of income maintenance, inequality and poverty in old age.

3 Model

3.1 Lifecycle and Labour Market

The following model generates atypical labour careers in the sense that employment contracts possibly differ from a standard (full-time) permanent employment relation. Augmented with a specific pension regime, it allows to explore issues related to the interplay between labour market and public pension systems[6] in a frictional framework.
An individual enters the labour market as unemployed, stays active until the retirement age a_R and leave the economy once age $a_{max} > a_R$ is reached.

[6]Throughout the analysis, only work-related pension is considered. Disability, survival and social pension are excluded.

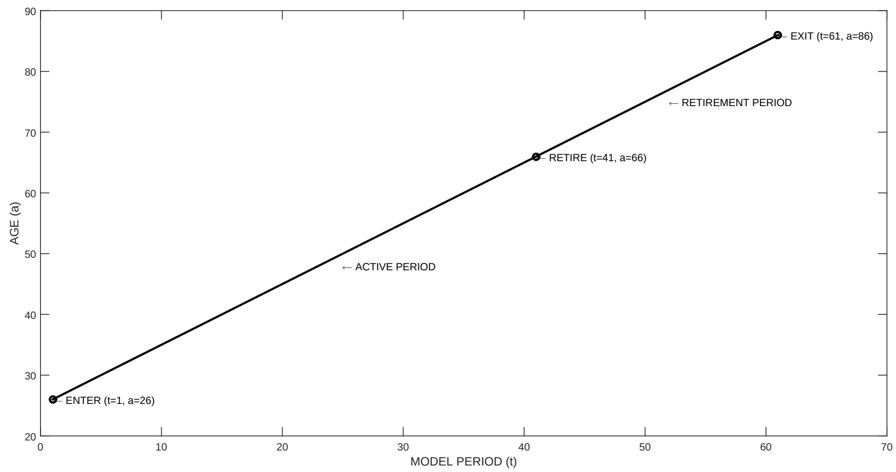

Figure 3: *Individual Lifecycle.*

This simple framework assumes that workers do not make any choices nor they have endowments. Thus, unemployment is assumed to be involuntary. When active, for $a = 1, ..., a_R - 1$, worker i can be either unemployed, $\mu_{i,a} = 1$, or employed, $\mu_{i,a} = 0$. When unemployed[7], with probability $\phi \in (0, 1)$, worker i aged a will be employed[8] since $a + 1$ at the (randomly) received contract $(w, t, s)_{i,a}$. It is assumed that workers cannot receive nor can be employed at more than one contract at a time.
This tridimensional object $(w, t, s)_{i,a}$ specifies a contract received by worker i when aged a starting next period $a+1$ with initial wage $w_{i,a} \in [w_{min}, w_{max}] \subset R_{++}$ for a tenure of $t_{i,a} \in [t_{min}, \rho_{i,a} - 1] \subset \mathcal{N}^*$ periods growing at a factor $s_{i,a} \in [s_{min}, s_{max}] \subset (0, 1)$ per period, where $\rho_{i,a} = a_R - a$ indicates the distance to retirement a worker i if aged a[9]. Equivalenty, it can be expressed as a series of $t_{i,a}$ wage payments $\omega_{i,a+1}$ starting next period from $w_{i,a}$ and

[7]In this context of random search, workers supply labour inelastically and only the extensive margin of labour supply is considered in this context of a random search. Indeed, since the benefit from unemployment state is assumed to be zero, the (implicit) reservation-wage rule implies that any workers accept at any at age any contract offer (w, t, s) as far as the starting wage $w > 0$, for any $t \in \mathcal{N}^*$ and any $s \in (0, 1)$.

[8]From a modelling perspective, since no post-matching procedure is assumed between the worker who receives the contract offer, and viceversa, the notion of (contract) offer arrival and (contract) hiring rate coincide.

[9]A unit is subtracted under the assumption that workers start a new job next period $a + 1$. Note that, under the assumption of flexible contract, the maximal offered tenure

growing at a factor $s_{i,a}$ for additional employment period:

$$(w,t,s)_{i,a} = \{\omega_{i,a+\tau}\}_{\tau=1,...,t_{i,a}} \tag{1}$$

where $\omega_{i,a+\tau} = w_{i,a}(1+s_{i,a})^{\tau}$ and $\tau \in \mathcal{N}^*$ (indeed, $\tau_{i,a}$) indexes the wage schedule associated to $(w,t,s)_{i,a}$ of worker i when aged a. Each component of (w,t,s) is a r.v. with cdf $F_W(\cdot)$, $F_T(\cdot)$ and $F_S(\cdot)$, respectively.[10]
If worker i is employed when aged a at an ongoing contract $(w,\tau,s)_{i,a}$, for some $\tau_{i,a} = 1,...,t_{i,a}$, she can be unemployed next period $a+1$ either because she can be fired with probability λ at any period of employemnt[11] or because the contract naturally terminates. If not separated, she will climb up the ongoing employment contract $(w,\tau+1,s)_{i,a}$ to possibly arrive at the end of the contract when $\tau_{i,a} = t_{i,a}$. Workers do not search while employed.
For $a = 1,...,a_R-1$, the individual unemployment dynamics of worker i when aged a obeys to the following linear (non-homogenous) difference equation:

$$\mu_{i,a+1} = \mu_{i,a}(1-\phi) + (1-\mu_{i,a})[(1-\varepsilon_{i,a})\lambda + \varepsilon_{i,a}] \tag{2}$$

where ϕ and λ are exogenous probabilities of job arrival and separation, respectively, while $\varepsilon_{i,a}$ is a dummy variable equal to one if the employed worker i is in the last period of contract when aged a. Note that, the closer retirement, the more likely individuals will arrive at termination of contracts since tenure of new offers become shorter and shorter. For this reason, age profile of unemployment rate convexifies when workers approach retirement. This is a simple way of connecting the contractual structure of the labour market with the (steady-state) dynamics of the unemployment rate. It is assumed that, prior to retire when $a = a_R - 1$, if a worker is unemployed, she will remain unemployed during her last (active) age since her age does not satisfy the requirement of a positive tenure, i.e. $t_{i,a} = 0$ for $a = a_R - 1$

decreases with age a approaches to the retirement age a_R, i.e. when the distance to retirement $\rho_a = a_R - 1 - a$ reduces. As such, the maximal tenure of a new contract will never exceeds the maximal employable age of the worker.

[10] It would represents an extension of the random wage lottery model introduced by Rogerson (1985) further developed by Lentz (2005) along a (high/low) single-price lottery. See also Lammers (2014) for an application.

[11] In order to maintain a common separation rate across different contract duration, one needs to assume that the EPL of permanent and temporary contracts are identical. Accordingly, a worker employed on a permanent contract has the same (periodal) probability of being fired if compared to a worker employed in a temporary contract. Results still hold when a tenure-specific separation rate, specified as $\frac{\lambda}{t_{i,a}}$ or as $\lambda^{t_{i,a}}$, is adopted.

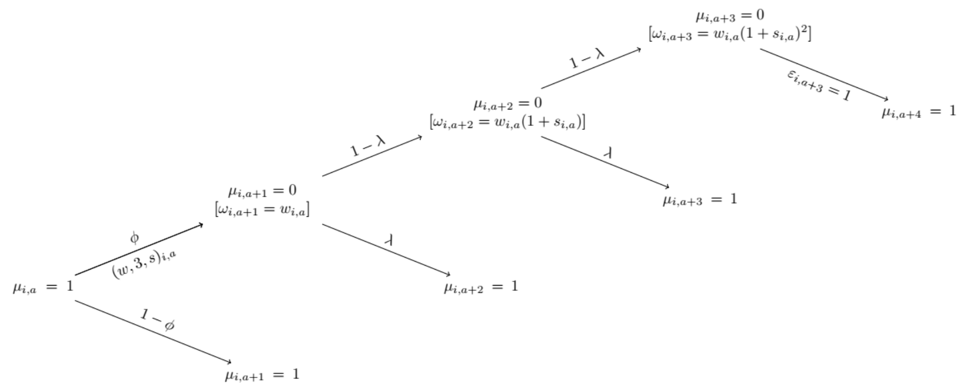

Figure 4: *Event tree for Worker* i *if a contract of 3 periods,* $(w, t, s)_{i,a}$ *with* $t = 3$*, is drawn when aged* a*.*

for any worker $i = 1, ..., N$.

At aggregate level, the age profile of unemployment rate u_a, obtained as the sum of unemployed individuals over the total number of workers, i.e. $u_a = N^{-1} \sum_{i=1}^{N} \mu_{i,a}$, where $\mu_{i,a} = 1$ refers to the unemployed worker i for $a = 1, ..., a_R - 1$. The correspoding difference equation is given by:

$$u_{a+1} = u_a(1 - \phi) + (1 - u_a)[(1 - \varepsilon_a)\lambda + \varepsilon_a] \tag{3}$$

where $\varepsilon_a = N^{-1} \sum_{i=1}^{N} \varepsilon_{i,a}$ refers to the rate of workers who are in the last period of their contract, aka termination rate. As such, this rate acts as a leading predictor for the unemployment rate since the higher the number of workers arrived at the edn of the scheduled employment relation (without renewal), the higher the actual unemployment rate will be.

3.2 Pension Regimes

When aged $a = a_R$ workers retire and receive a pension benefit for which contributions have been paid while employed. Their labour careers are used to compute individual profiles for pension contributions and payments according to a specific pension regime, that is a specification for contribution rule and pension formula, indexed by ps. In particular, a defined-benefit pension regime ($ps = DB$) is compared against a standard (notional) defined-contribution setting ($ps = DC$). Those regimes are then compared with two variants of the standard design of a DC, obtained by differentiating the pension contribution rate with respect to age a of the worker i ($ps = DAC$) and to tenure $t_{i,a}$ of the contract ($ps = DTC$)[12].

3.2.1 Defined Benefit (DB)

A DB pension regime[13] is a pension system with a fixed contribution rate r_{pc} and a pension equal to the product of the average wage over last Y years prior to retirement. Given the wage $\omega_{i,a}$ received by worker i when aged a currently employed at $(w, \tau, s)_{i,a}$, for some τ, pension contribution $pc_{i,a,DB}$ and final pension $p_{i,DB}$ under the DB pension regime are respectively given by:

$$pc_{i,a,DB} = \omega_{i,a} r_{pc} \tag{4}$$

$$p_{i,DB} = tr_{DB} \left(Y^{-1} \sum_{a=a_R-Y}^{a_R-1} \omega_{i,a} \right) \tag{5}$$

where tr_{DB} refers to the transformation rate of the DB pension regime.

3.2.2 Defined Contribution (DC)

A DC pension regime[14], similar to a DB, features an homogenous contribution rate r_{pc}, hence $pc_{i,a,DC} = pc_{i,a,DB}$. Unlike a DC, pension $p_{i,DC}$ is given by the product between accumulated, and notionally capitalised at rate r_{NC}[15],

[12]Since Erosa and Gervais (2002), seminal in introducing the concept of age-specific taxation, several works applied it for labour income taxation (Weinzierl, 2011; Gervais, 2012), employment protection (Chéron et al., 2011) and unemployment subsidies. In line with this idea, this paper presents the first application of age and tenure specific pension contribution rates.

[13]E.g. that of Austria, Belgium, Spain, Portugal, the Netherlands, European Commission.

[14]E.g. that of Italy, Sweden, Latvia and Poland.

[15]Pension contributions are said to be *notionally* capitalised since there is no real fund which guarantees workers to be reimbursed for their contributions once they retire. In an unfunded pension system (as the majority of public pension systems), it lies on an intergenerational promise. About the indexation mechanism of pension contributions, in his seminal work Castellino (1969) proposes the average wage growth as indexation variable. Nowadays, different countries have chosen different variables. For example, in Italy, the five year average of nominal GDP is adopted. Moreover, the capitalisation mechanism is lagged by one period.

pension contributions $pc_{i,DC}$ and the transformation rate tr_{DC}:

$$p_{i,DC} = tr_{DC}\left(\sum_{\alpha=a}^{a_R-1} pc_{i,\alpha,DC}(1+r_{NC})^{\rho_{i,\alpha}}\right) \tag{6}$$

where $\rho_{i,a} = a_R - 1 - a$ refers to the distance to retirement.
Both DB and DC pension regimes contribution profile of workers depends only on the actual level of wages. Since Mincer (1974), both theory and empirical evidence have explained and confirmed that age-profiles of earnings are increasingly concave due to human capital stock and accumulation. In a standard DC pension regime, this profile is, *sic et simpliciter*, used as the base to compute final pension. Accordingly, contributions paid in earlier contributions regard the lower part of the lifetime earning profile. On the contrary, capitalisation factors are higher for younger ages.

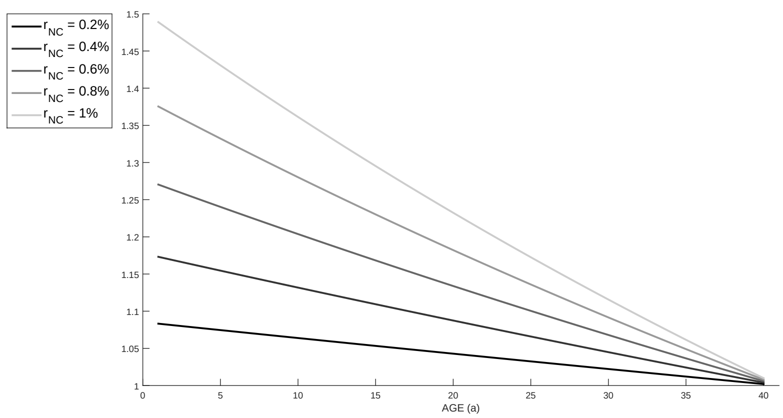

Figure 5: *Capitalisation factors* $cf_a = (1+r_{NC})^{\rho_a}$ *for different (notional) capitalisation rates* r_{NC}*, where* $\rho_a = a_R - a$ *with* a_R *being the retirement age.*

3.2.3 Defined Age-specific Contribution (DAC)

Both a DB and a DC pension regime share the same computational rule for contributions. But in a DC, unlike a DB, final pension strictly depends on the sum of capitalised contributions. For a given capitalisation rate r_{NC}, earlier contributions have a higher capitalisation factor since they strictly depend on duration which, in this context, corresponds to the distance to retirement $\rho_{i,a} = a_R - a$. The higher r_{NC}, the higher the influence of earlier contributions. This is the underlying rationale for a more efficient design of a DC pension regime based on differentiated contribution rules[16]. A DC pension regime with an age-specific contribution rate (DAC) differs from a standard DC only inasmuch the pension contribution rate is age-specific. Indicating with δ_{DAC} the augmenting factor for the pension contribution rate r_{pc}, the age-profile of contribution rate is:

$$pc_{i,a,DAC} = \omega_{i,a} r_{pc} (1 + \delta_{DAC})^{\rho_{i,a}} \tag{7}$$

Note that, *ceteris paribus*, the longer the distance from retirement $\rho_{i,a}$, the higher the pension contribution rate in a DAC pension regime. Whereas the pension formula for $p_{i,DAC}$ remains the one of a DC:

$$p_{i,DAC} = r_{DC} \left(\sum_{\alpha=a}^{a_R-1} pc_{i,\alpha,DAC} (1 + r_{NC})^{\rho_{i,\alpha}} \right) \tag{8}$$

3.2.4 Defined Tenure-specific Contribution (DTC)

A DC pension regime with a tenure-specific contribution rate (DTC), unlike a DAC, features a tenure-specific profile for pension contribution rates. The rationale behind this differentiation relies on the fact that workers employed in contracts with shorter tenure experiences lower probabilities of moving to permanent positions, which renders more difficult for workers in atypical positions to fill the gap with respect to a standard permanent position in terms of pension contributions[17]. If flexible contracts are used as a screening device during the early stage of a worker's labour career, tenure-adjusted capitalisation rates, similar to the age-specific case, allows to better exploit

[16]Without a loss of generality, in a context of one-sided search, to maintain public budget neutrality, this additional tax burden is neither on firms nor on employed or active workers. It is assumed that only workers earning over a certain wage threshold would contribute redistributing resources in a progressive way. In general, any unfunded pension regime in which the benefit is positively correlated with income, if life expectancy is also positively correlated with income, it triggers a regressive redistribution: if rich people live longer than poor, while pension is computed on the assumption of a homogenous life expectancy, then the poorer people are, the more their contribution will be used to finance pensions to those rich people who are living longer than the average life expectancy.

[17]Gagliarducci (2005), with multi-spell duration model for Italian data, finds that probabilities of moving from temporary to permanent positions increase with duration (tenure) of the contract.

the duration dependence of capitalisation factors towards higher rates for flexible, younger, workers. Moreover, unlike a DAC, a DTC pension regime delivers higher contribution rates also if old workers are employed in them. Given the augmenting factor δ_{DTC}, corresponding pension contributions $pc_{t_{i,a},DTC}$, are defined as:

$$pc_{i,a,DTC} = \omega_{i,a} r_{pc} (1 + \delta_{DTC})^{t_{i,a}} \tag{9}$$

for $a = 1, ..., a_R - 1$ and for $t_{i,a} = t_{min}, ..., \rho_{i,a} - 1$. Note that the longer the tenure of the contract $t_{i,a}$, the smaller the tenure-specific increase in pension contribution rate in a DTC compared to standard DC, i.e. a DTC with $\gamma_{DTC} = 0$.

Similar to DC and DAC pension regimes, the pension formula for a DTC is expressed as:

$$p_{i,DTC} = r_{DC} \left(\sum_{\alpha=a}^{a_R-1} pc_{i,\alpha,DTC} (1 + r_{NC})^{\rho_{i,\alpha}} \right) \tag{10}$$

Based on simulated labour market careers, results will show implications of each pension regime $ps = DB, DC, DAC, DTC$ in terms adequacy.

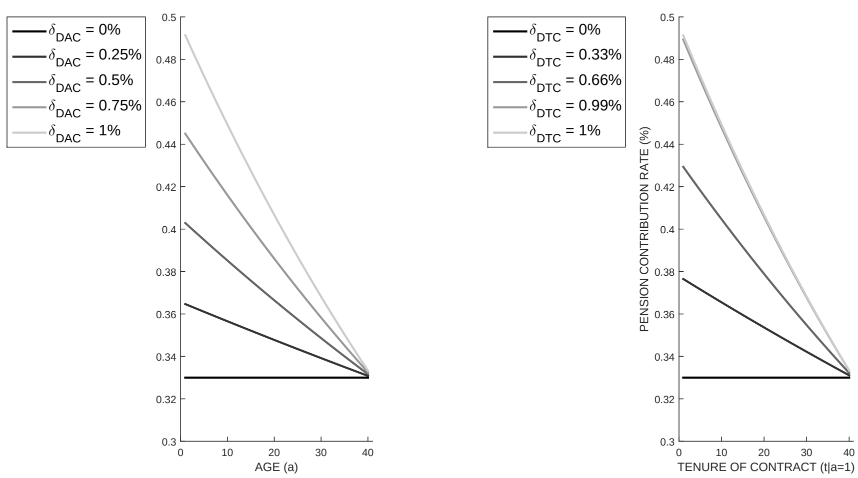

Figure 6: *Profiles of contribution rates in a DAC (left) and DTC (right) pension regimes for different values of* δ_{DAC} *and* δ_{DTC}*.*

Note that the additional percentage points, from 4% (5%) to 16% in a DAC (DTC) pension regime would need to be financed somehow. In a context where neither firms nor government (debt) play a role, (progressive) distributive policies are necessary[18] to ensure fiscal neutrality of the policy reform. However, financial sustainablity of pension systems, despite a very relevant issue for their intergenerational implications, is excluded from this work.

The analysis of the adequacy of each pension regime would provide some hint towards a better understanding of the design of a pension system in a context of flexible contracts and fragmented careers. Among the feedback mechanisms characterising the interplay between labour markets and pension systems, it could be the case that an increasing taxation would discourage firms to issue short term contracts, while it would encourage workers to not receive a not-declared contract.

3.3 Adequacy

The model is able to generate i.i.d labour careers for N individuals indexed by i. Once simulated, these are aggregated and adequacy of each pension regime $ps = DB, DC, DAC, DTC$ is analysed through measures of income maintenance, inequality and poverty in old-age[19].

The ability of a pension regime ps to maintain income in old age is described by (aggregate) replacement rates $\bar{rr}_{ps}$ and $\tilde{rr}_{ps}$ respectively computed as[20]:

$$\bar{rr}_{ps} = \frac{\bar{p}_{ps}}{\bar{\omega}_{a_R-1}}, \qquad \tilde{rr}_{ps} = \frac{\tilde{p}_{ps}}{\tilde{\omega}_{a_R-1}}$$

where $\bar{p}_{ps}$, $\bar{\omega}_{a_R-1}$ and $\tilde{\omega}_{a_R-1}$, $\tilde{p}_{ps}$ refer to mean and median pensions and wages prior to retirement, respectively.

[18] The necessity of more progressive adjustments in the pension system would be of utmost importance if one considers that pension systems of the majority of countries imply a regressive (not progressive) redistribution of resources. If pension transformation rates are based on the average life epectancy, those who will live longer will benefit more relative to those who lived less. If life expectancy is positively correlated with income, then a regressive distribution of resources is in place (Ayuso et al., 2017a,b).
With no loss of generality, I assume that extra resources needed to finance such differentiated designs are, *ad hoc*, withdrawn from workers earning more than a certain wage threshold.

[19] Since there are no other source of income in the model, retirement income and pension wealth coincide.

[20] Besides, it is possible to analyse the whole distribution of the individual replacement rates. For alternative measures of income maintenance see Biggs and Springstead (2008), Borella and Fornero (2009) and Chybalski and Marcinkiewicz (2016).

Another dimension of the adequacy of a pension system relates to the inequality of the pension wealth distribution. To this purpose, pension regimes will be evaluated according to the Atkinson index $At_{\epsilon,ps}$ (Atkinson, 1970), Theil index Th_{ps} (Theil, 1979) and the squared coefficient of variation CV^2_{ps}. Once individual pensions are non-increasingly ordered for each pension regime ps, i.e. $p_{i,ps} \leq p_{i+1,ps}$ for $i = 1, ..., N-1$, these indices are defined as[21]:

$$At_{\epsilon,ps} = 1 - \frac{1}{\bar{p}_{ps}} \left(\frac{1}{N} \sum_{i=1}^{N} p_{i,ps}^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}, \qquad Th_{ps} = \frac{1}{N} \sum_{i=1}^{N} \frac{p_{i,ps}}{\bar{p}_{ps}} \log \left(\frac{p_{i,ps}}{\bar{p}_{ps}} \right)$$

$$CV^2_{ps} = \left(\frac{\sigma_{ps}}{\bar{p}_{ps}} \right)^2$$

where $\epsilon \in [0,1]$ refers to the inequality aversion coefficient expressing the sensibility of the Atkinson index to changes at the lower end of the pension (wealth) distribution. While $\bar{p}_{ps}$ and σ_{ps} to the mean and standard deviation of pension p_{ps} under the pension regime ps.

Lastly, to assess the capacity of a pension system to prevent poverty in old-age, the head count ratio HCR_{ps} and the poverty gap index PGI_{ps} are computed for each pension distribution. For each pension regime ps, computed the poverty line PL_{ps}, they are defined as[22]:

$$HC_{ps} = \frac{N_{PL_{ps}}}{N}, \qquad PGI_{ps} = \frac{1}{N_{PL_{ps}}} \sum_{j=1}^{N_{PL_{ps}}} \frac{\mathbf{1}(p_{j,ps} < PL_{ps})(PL_{ps} - p_{j,ps})}{PL_{ps}}$$

where $N_{PL} = \sum_{i=1}^{N} \mathbf{1}(p_{i,ps} < PL_{ps})$ indicates the number of poors under the pension regime ps, i.e. retirees with a level of pension below the corresponding poverty line PL_{ps}.

3.4 Calibration

To calibrate this model, parameters and functional forms aree provided with a specification (see Table 1).

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[21] Note that, for a given distribution of pension, p_{ps}, $At_{ps} < Th_{ps} < CV^2_{ps}$. The reason is that these indices of inequality are special cases of the generalised entropy index $GEI_{\alpha,ps}$ for $\alpha \in (0,1)$, $\alpha = 1$ and $\alpha = 2$, respectively, where α refers to the parameter for inequality aversion (Shorrocks, 1980)

[22] Both HCR_ps and PGI_{ps} are special cases of the Foster-Greer-Thorbecke index $FGT_{\alpha,ps}$ for $\alpha = 0$ and $\alpha = 1$ respectively (Foster et. al., 1984).

Time frequency is a year. For consistency, $N = 100000$ simulations of individual labour careers are run in a Montecarlo fashion. Age thresholds are set to consider an individual who enters the labour market when aged 26[23], retiring when aged $a_{ret} = 66$ and leaving the economy when aged $a_{max} = 86$[24], corresponding to an active life of 40 years and a retirement period of 20. Flow rates for job arrival ϕ and separation λ are to 0.8 and 0.2, respectively. Chosen cdfs for wage w and corresponding seniority growth factor s are a Beta, $beta(\alpha_\beta, \beta_\beta)$ for $\alpha_\beta = \beta_\beta = 2$ with bounds for support $w_{min} = 500$ and $w_{max} = 2000$, and a continuous Uniform $U_c(s_{min}, s_{max})$, for $s_{min} = 0.001$ and $s_{max} = 0.005$. The extracted contract tenure t is a discrete r.v. distributed according to a discrete Uniform defined on an age specific support, characterised by a fixed lower bound $t_{min} = 1$ and variable upper bound corresponding to the distance to retirement $t_{max} = a_{ret} - a - 1$.
Parameters of the pension system are either general or specific to a given pension regime $ps = DB, DC, DAC, DTC$. Regarding the contributory parameters, the rate of pension contribution r_{pc} is overall set to 33% for both DB and DC, while contribution augmentation factors δ_{DAC} and δ_{DTA}, are set to 0.5% and 0.33%. In the DB pension regime, the time window Y over which the reference wage is computed is 20 years with a transformation coefficient tr_{DB} of 70%. For the DC pension regime, as well as for its variants DAC and DTC, the contribution capitalisation rate r_{NC} is set to 0.1% per year while transformation rate tr_{DC} is set to 5%.
All calibrated values are summarised in the following table.

[23] It would correspond to workers with ISCED-2011 level 5-8, i.e. after completion of higher education.

[24] Accordingly, people aged 85+, so called big Old,are excluded from the analysis.

Module	Symbol	Description	Value
Workers	N	*Number of Individual Careers*	100000
	a	*Age*	1 year (unit time)
	a_R	*Retirement Age*	41 (66 years old)
	a_{max}	*Exit Age*	61 (86 years old)
Labour Market	ϕ	*Job Arrival Rate*	0.8 (80 %)
	λ	*Job Separation Rate*	0.2 (20 %)
	w_{min}	*Wage - Lower Bound*	500
	w_{max}	*Wage - Upper Bound*	2000
	$F_W(\cdot)$	*Wage - Cdf*	$\beta(2,2)$
	t_{min}	*Tenure - Lower Bound*	1
	$F_T(\cdot)$	*Tenure - Cdf*	$U_d(t_{min}, a_R - a - 1)$
	s_{min}	*Seniority - Lower Bound*	0.001 (0.1%)
	s_{max}	*Seniority - Upper Bound*	0.005 (0.5%)
	$F_S(\cdot)$	*Seniority - Cdf*	$U_d(s_{min}, s_{max})$
Pension System	r_{pc}	*Pension Contribution Rate*	0.33 (33%)
	$pwtw$	*DB - Wage Time Window*	20 (Year)
	tr_{DB}	*DB - Transformation Factor*	0.7 (70%)
	r_{NC}	*DC - Notional Capitalisation Rate*	0.001 (0.1%)
	tr_{DC}	*DC - Transformation Factor*	0.05 (5%)
	δ_{DAC}	*DAC - Augmentation Factor*	0.005 (0.5%)
	δ_{DTC}	*DTC - Augmentation Factor*	0.0033 (0.33%)
Inequality	ϵ	*Atkinson - Inequality Aversion*	0.5

Table 1: Baseline Calibration

4 Results

This section shows results from simulation and aggregation of N individual labour careers. Different scenarios are then compared.

4.1 Baseline Scenario

4.1.1 Labour Market Results

In the baseline scenario, individual labour careers are simulated according to the calibrated values.

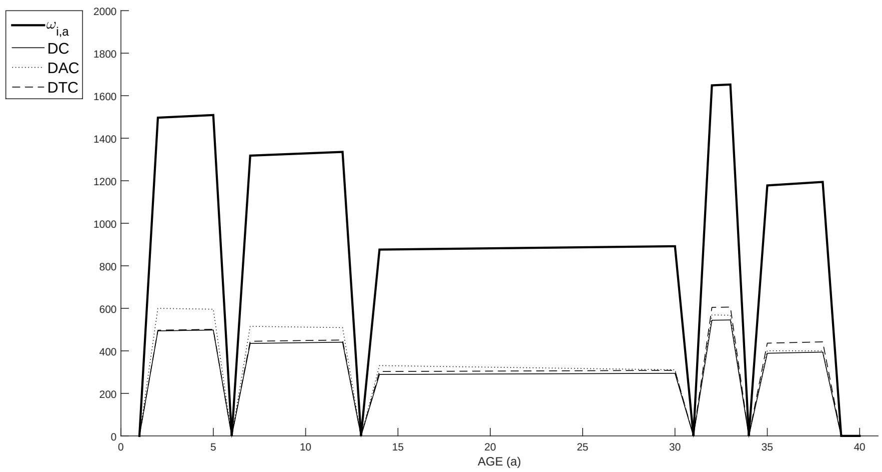

Figure 7: *Example of an individual labour career and the associated pension contribution profiles.*

Labour careers feature interruptions and employment under different contracts that fully characterise the labour market history of each single worker i, for $i = 1, ..., N$. Regarding the associated pension contribution profiles, while DAC and DTC are always larger than DC, for younger ages DAC prevails over DTC while the opposite is true for contracts in which old workers are employed.

Concerning unemployment dynamics in 2), subtracting u_a from both sides and setting $u_{a+1} - u_a = 0$, the steady state value u_a^* is given by:

$$u_a^* = \frac{(1-\varepsilon_a)\lambda + \varepsilon_a}{(1-\varepsilon_a)\lambda + \varepsilon_a + \phi} \tag{11}$$

If $\varepsilon_a = 0$, the above equation collapses to the standard case of a flat unemployment rate. Instead, an age increasing termination rate ε_a convexifies the age profile of the unemployment rate in steady state. Since the distance to retirement $\rho_a = a_R - a$ is age decreasing so the maximal tenure $\rho_a - 1$ is. The shorter the tenure $t_{i,a}$ of the offered contract and the more likely it will terminate, i.e. $\varepsilon_{i,a} = 0$.

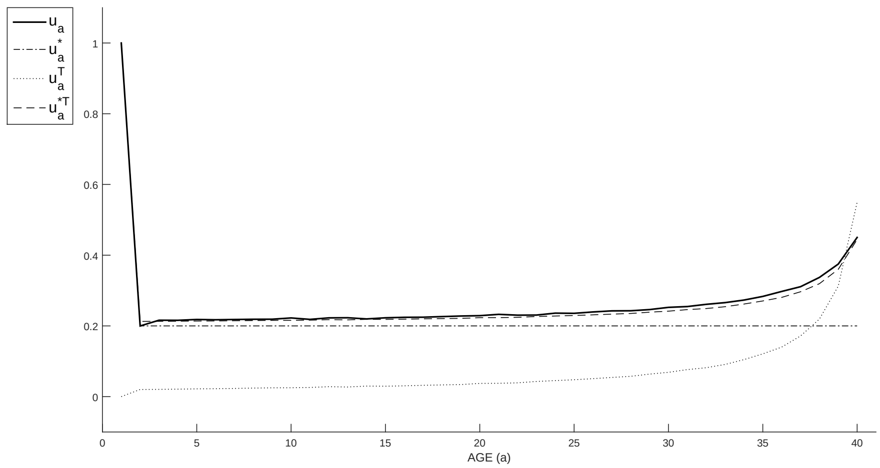

Figure 8: *Age profile of unemployment rate: actual (u_a), equilibrium (u_a^*), termination rate (u_a^T) and termination rate augmented equilibrium (u_a^{*T}).*

At aggregate level, the convex age profile of unemployment rate u_a is coherent with previous findings in the literature of lifetime equilibrium unemployment. The increase of the unemployment rate for higher ages depicts the time-horizon effect, i.e. the presence of a retirement age decreases both their employability and re-employability once they approach retirement (Saint-Paul, 2009; Khaskoussi, 2009; Hairault et al., 2010; Chéron et al., 2013; Hairault et al., 2015; Batyra et al., 2017).
Specularly, the age profile of cumulated employment spells results to concavify for higher ages (73.3%) if compared to an environment with employment as absorbing state (97.5%) or with frictional environment with only permanent contracts (78%). In this profile, a higher concavity implies a more interrupted labour history and, thus, a shorter accumulation of pension contributions in DC, DAC and DTC, as well as gaps in the reference time window *pwtw* for a DB pension regime.

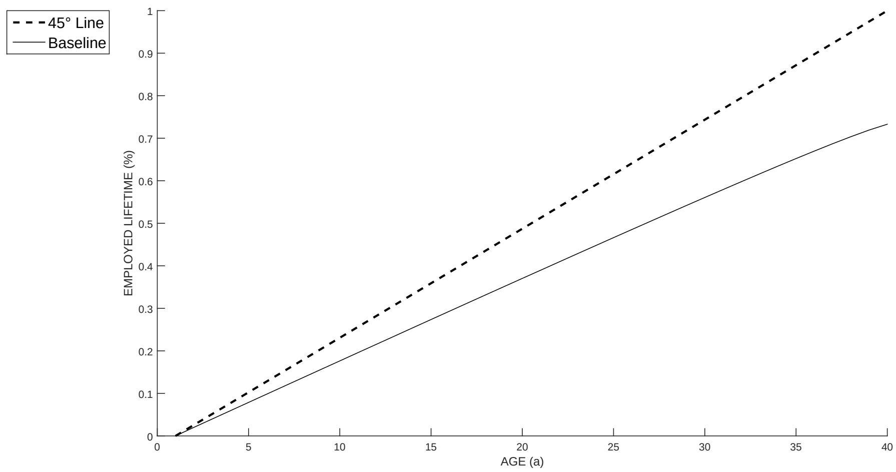

Figure 9: *Age profile of average employment spells expressed as percentage of the active lifecycle. The* 45° *line represents the case of employment as an absorbing state.*

The age profile of average employment spells is informative on how much one could be expected to be employed throughout their active lifetime in an environment with flexible contracts and non-absorbing employment state. In terms of pension contribution profiles, it corresponds to the average period of active contribution, where the bisectrix represents the case of everlasting employment.

Another result regards the age profile of the average wage among employed, $\bar{\omega}_{E,a}$, and at population level, $\bar{\omega}_{UE,a}$. Associated median values, $\tilde{\omega}_{E,a}$ and $\tilde{\omega}_{UE,a}$, and standard deviations, $\sigma_{\omega_{E,a}}$ and $\sigma_{\omega_{UE,a}}$, are also reported.

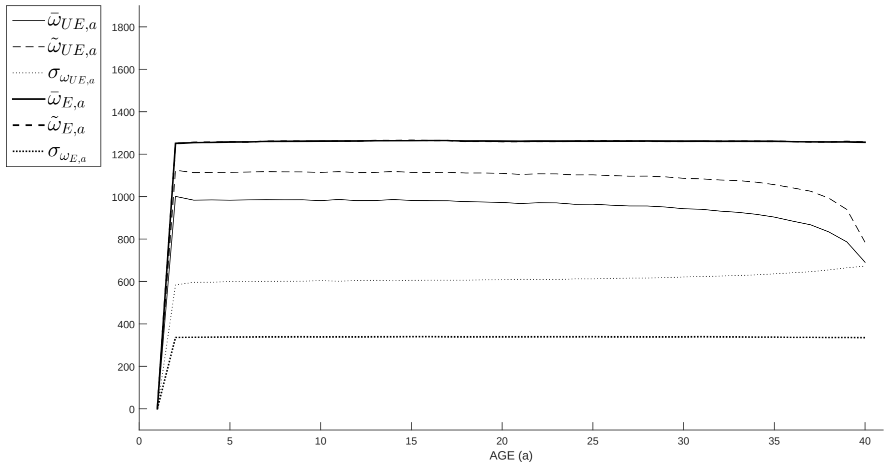

Figure 10: *Age profile of average wage among overall ($\bar{\omega}_{UE,a}$) and employed population ($\bar{\omega}_{E,a}$) together with associated median values ($\tilde{\omega}_{UE,a}$ and $\tilde{\omega}_{E,a}$) and standard deviations ($\sigma_{\omega_{UE,a}}$ and $\sigma_{\omega_{E,a}}$).*

Both wage distribution across overall and employed population exhibit dispersion, i.e. positive standard deviations $\sigma_{\omega_{UE,a}}$ and $\sigma_{\omega_{E,a}}$. Note that $\sigma_{\omega_{UE,a}} > \sigma_{\omega_{E,a}}$ for any $a < a_R$ since it is assumed that a worker earns zero if unemployed. Moreover, $\sigma_{\omega_{UE,a}}$ is slightly increasing over age due to the convexity of the age profile of unemployment rate. About the age profiles of average and median wages, while they indicate a symmetry wage distribution over the employed population, $\bar{\omega}_{E,a} = \tilde{\omega}_{E,a}$, the median wage is greater than the average wage at population level, $\bar{\omega}_{UE,a} < \tilde{\omega}_{UE,a}$, indicating a negatively skewed distribution due to an age-increasing mass of unemployed workers earning zero.

4.1.2 Pension Results

The main focus of the paper is to analyse the ability of a pension system to account for flexible contracts in an environment where unemployment is a persistent feature of the economy. This provides a richer environment where resulting labour careers show to be consistent with a flexible labour market, i.e. where workers can move back and forth from employment under a different types of contracts. In particular, the distribution of actual wage is informative on how wealth is distributed across employed workers once search frictions are considered. This distribution is then related to the distribution of pension p_{ps} through the set of rules specific to each pension regime $ps = DB, DC, DAC, DTC$.

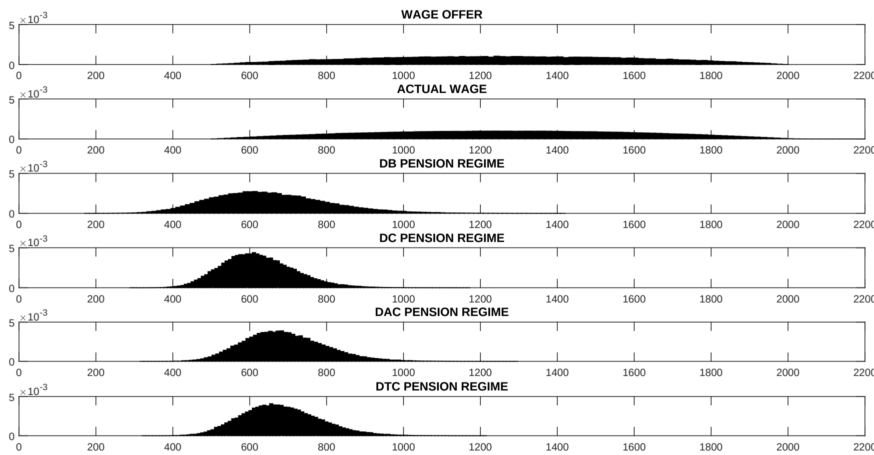

Figure 11: *Histograms for pdf of wage offers (f_W), actual wage (f_Ω) and pensions ($f_{P,DB}$, $f_{P,DC}$, $f_{P,DAC}$, $f_{P,DTC}$).*

The figure above depicts the main findings of the paper. The distribution of offered wage f_W and actual wage f_Ω are pretty identical in their first four central moments, namely central tendency, dispersion, skewness and kurtosis. The search process seems to not alter the main features of the wage offer distribution f_W. On the contrary, those of pensions are quite different, either if compared to those of wages and if compared within the four pension regimes considered.
Mean and variance of f_Ω is higher than those of f_W due to tenure t and seniority factor s components of the contract. Skewness is null as result of a $\beta(2, 2)$, which is perfectly symmetric, as specification for f_W. Kurtosis is identical in both cases. Compared to the distributions of any $f_{P,ps}$, for $ps = DB, DC, DAC, DTC$, both wage distributions have an higher mean and variance. While they are symmetric and platykurtic, distributions of pensions are positively skewed and leptokurtic.

Distribution	Mean	Variance	Skewness	Kurtosis
Wage Offer (f_W)	1250.5	112250	-0.0001	2.144
Actual Wage (f_Ω)	1260.4	114580	0.0022	2.1442
DB Pension ($f_{P,DB}$)	651.76	22997	0.4662	3.2686
DC Pension ($f_{P,DC}$)	622.43	9073.5	0.4407	3.3182
DAC Pension ($f_{P,DAC}$)	691.08	11290	0.443	3.3182
DTC Pension ($f_{P,DTC}$)	681.66	10402	0.3825	3.1906

Table 2: *First four (central) moments of distributions of wages and pensions.*

Among the distributions of pensions, one can see that proposed variants of a DC, i.e. DAC and DTC, have a higher first moment due to higher contribution rates. In terms of variance, the distribution $f_{P,DB}$ show the highest, followed by DAC, DTC and, lastly, DC. Even though all are positively skewed, with DC and DAC showing identical values, DTC is the least skewed while DB is the most. Pension distributions $f_{P,DC}$ and $f_{P,DAC}$ share also the same first four centered moments, while DTC shows the lowest kurtosis and DB is in the middle. In a nutshell, both DAC and DTC pension regimes seem to be superior in terms of distribution of pension wealth. They produce higher pensions, even higher than a DB, without altering skewness (symmetry) and kurtosis (tailedness).

Besides the evaluation of distributional features of the endogenous pension distributions, pension regimes are also examined in terms of their ability to maintain income in old age as well as to preserve inequality and poverty among retirees.

Pension Measure	**DB**	**DC**	**DAC**	**DTC**
Mean Pension ($\bar{p}_{ps}$)	651.76	622.43	691.08	681.67
Median Pension ($\tilde{p}_{ps}$)	639.3	615.27	683.2	674.81
Pension St. Dev (σ_{ps})	151.65	95.25	106.25	101.99
Mean Repl Rate ($r\bar{r}_{ps}$)	0.5189	0.4956	0.5502	0.5427
Median Repl Rate ($r\tilde{r}_{ps}$)	0.5083	0.4892	0.5432	0.5366
Atkinson Index (At_{ps})	0.0134	0.0058	0.0058	0.0055
Theil Index (Th_{ps})	0.0273	0.0116	0.0117	0.0111
Squared Coeff Var (CV^2_{ps})	0.0541	0.0234	0.0236	0.0224
Poverty Line (PL_{ps})	383.58	369.16	409.92	404.89
Head Count Ratio (HCR_{ps})	0.0217	0.0004	0.0004	0.0004
Poverty Gap Index (PGI_{ps})	0.0196	0.0004	0.0004	0.0004

Table 3: Analysis of adequacy of pension regimes $ps = DB, DC, DAC, DTC$.

In terms of average pension, a DB pension regime does not deliver the highest level if compared with that of DAC and DTC. This is because DB pension formula considers only wages entering in the specific time window *pwtw*. If in this period a worker experiences employment breaks, these periods of non-wage directly and negatively affect the level of pension in a DB regime (Bravo and Herce, 2017). Median values are always larger than corresponding mean values, which confirms a positive skewness, where DB shows to have the largest mean-median gap. The DB pension regime is also characterised by the highest variance in pension wealth. while a standard DC is the lowest dispersed and the two variants DAC and DTC are slightly more dispersed. Comparison of among replacement rates across pension regimes confirm that both DAC and DTC are superior with respect to standard DB and DC in term of income-maintenance.

Inequality measures At_{ps},Th_{ps} and CV^2_{ps} highlights a peculiar feature of DC-type pension regimes, i.e they reduce the dispersion of the pension wealth distribution compared to that of labour income. On the contrary, for a given actual wage distribution, a DB pension regime acts an inequality-preserving mechanism in the sense that it delivers a pension wealth distribution whose dispersion is very close to the one of the actual wage distribution.

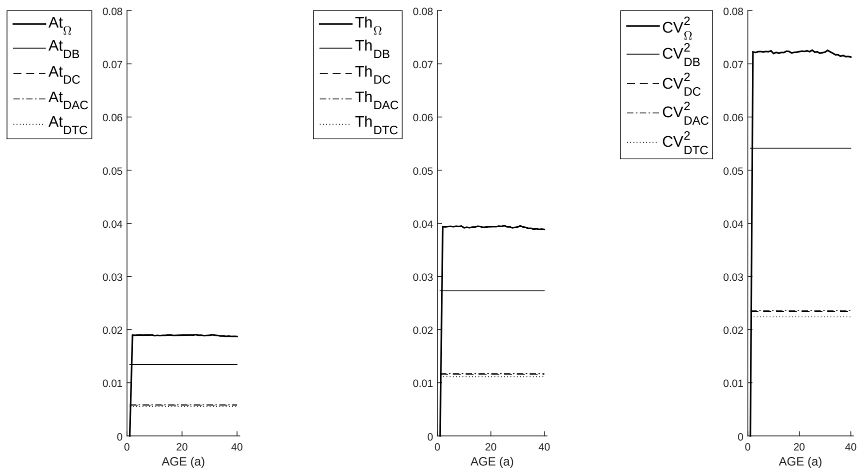

Figure 12: *Inequality indices for actual wage* Ω_a *and pensions* p_{DB}*,* p_{DC}*,* p_{DAC}*,* p_{DTC}*.*

Compared to DB pension regime, inequality is halved in all DC-types pension regimes, namely DC, DAC and DTC. Thus, the ability of a pension system to reduce inequality in old age is better pursued if a DC-type pension regime, i.e. a standard DC or a DAC or a DTC, is in place.
The same conclusion is true if one analyses ouctomes of pension distributions in the four regimes in terms of poverty. Even if the poverty line PL_{DB} is the lowest, a DB pension regime delivers the worst result in terms of poverty. This result is due to the fact that the pension distribution in DB is more dispersed and positively skewed compared to the one in of the other pension regimes. In particular, a DB pension regime increases poverty by around two percent when compared to any of the DC-type pension regimes. Apart from an higher poverty line for DAC and DTC, no significant difference characterise DC, DAC and DTC if compared along the other two measures of poverty, where they show to have almost identical values very close to zero.

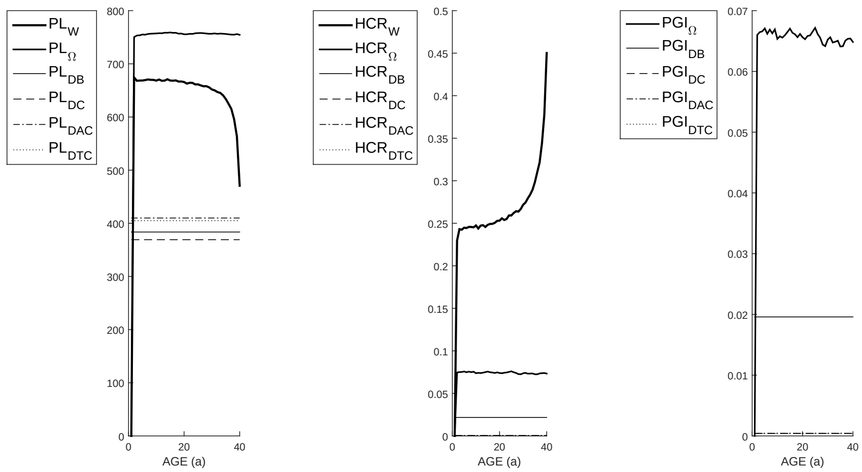

Figure 13: *Poverty indices for actual wage* Ω_a *and pensions* p_{DB}, p_{DC}, p_{DAC}, p_{DTC}.

At the ligh of this results, it is possible to conclude that both DAC and a DTC pension regimes are superior to both DB and DC in terms of income maintenance, inequality and poverty prevention. Results are robust to different scenarios in which values of parameters are changed once at a time to conduct a sensitivity analysis.

4.2 Sensitivity Analysis

A sensitivity analsis confirms that differentiated pension regimes are superior in terms of income maintenance, inequality reduction and poverty prevention. Besides, performed sensitivity analysis is helpful in examine which parameters affect more than others the distribution of pension among retirees.
Hence, different scenarios are compared: number of workers ($N = 10^5, 2\times 10^5, 5\times 10^5, 10^6$), retirement age ($a_R = 40, 41, 42$), exit age ($a_{max} = 60, 61, 62$), retirement and exit age ($a_R = 40$ and $a_{max} = 60$, $a_R = 41$ and $a_{max} = 61$, $a_R = 42$ and $a_{max} = 62$), job arrival rate ($\phi = 0.7, 0.8, 0.9$), job separation rate ($\lambda = 0.1, 0.2, 0.3$), tenure specific separation rate ($\frac{\lambda}{t_{i,a}}$ and $\lambda^{t_{i,a}}$), support for wages ($w_{min} = 450, 500, 550$ and $w_{max} = 1950, 2000, 2050$) and seniority seniority ($s_{min} = 0, 0.001, 0.002$ and $s_{max} = 0.004, 0.005, 0.006$), mini-

mum tenure ($t_{min} = 1, 2, 3$), different specifications for the wage pdf ($F_W = \beta(a_W, b_W)$, with $a_W, b_W = 2, 3, 4, 5$) and seniority pdf ($F_S = U(s_{min}, s_{max})$, $\beta(a_S, b_S)$ with a_S, $b_S = 2, 3$). In a similar fashion, sensitivity of results to parameters of various pension regimes $ps = DB, DC, DAC, DTC$ (i.e. r_{pc}, $pwtw$, tr_{DB}, tr_{DC}, r_{NC}, δ_{DAC} and δ_{DTC}), are provided in a supplementary appendix.
Last, but not the least, output from the baseline scenario is compared against a Permanent ($t_{i,a} = \rho_a - 1$) and a Neoclassical scenario with employment ans absorbing state ($\phi = 1, \lambda = 0, t_{i,a} = \rho_a - 1$).
In this case, age profiles of unemployment rate u_a confirm that, unlike the case of flexible contracts, no worker is unemployed under the neoclassical scenario where types of contracts collapse into a single, permament, contract lasting until a worker reach the retirement age. This is also true for the equilibrium unemployment rate u_a^*.

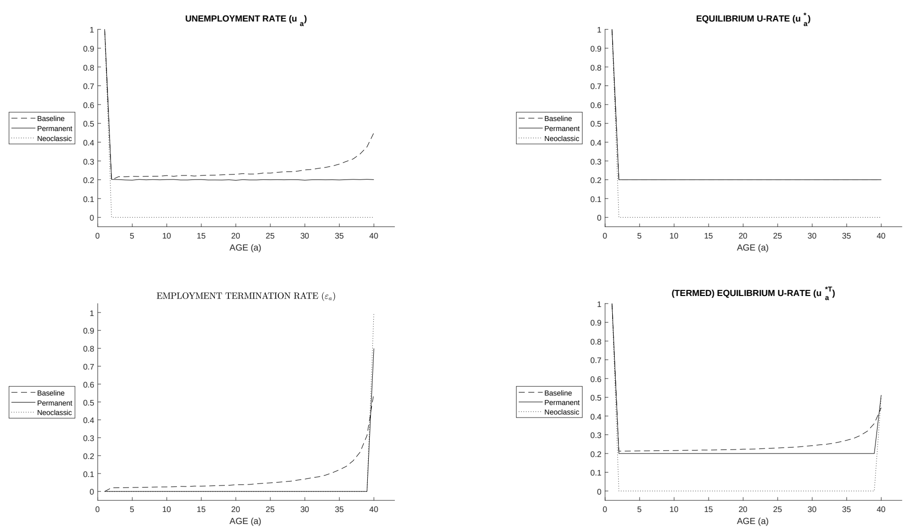

Figure 14: *Unemployment Rate Dynamics in Baseline, Permanent and Neoclassical Scenarios.*

The termination rate u_a^T spikes more for the neoclassical case since the mass employed worker arrived at end of the contract regards the totality of the active population, which coincides in a neoclassical framework with the employed population. Overall, the (termed) equilibrium unemployment rate

u_a^{*T} depicts the main differences among the three scenarios: while flow rates impact on the level of the unemployment rate, the structure of contracts by their tenure affects the concavity of the unemployment age profile which increases when age increases, i.e. when the distance to retirement ρ_a reduces. Regarding the comparison of the three scenarios in terms of employment statistics, the percentage of employment spells in the neoclassical scenario obviously dominates the others[25].

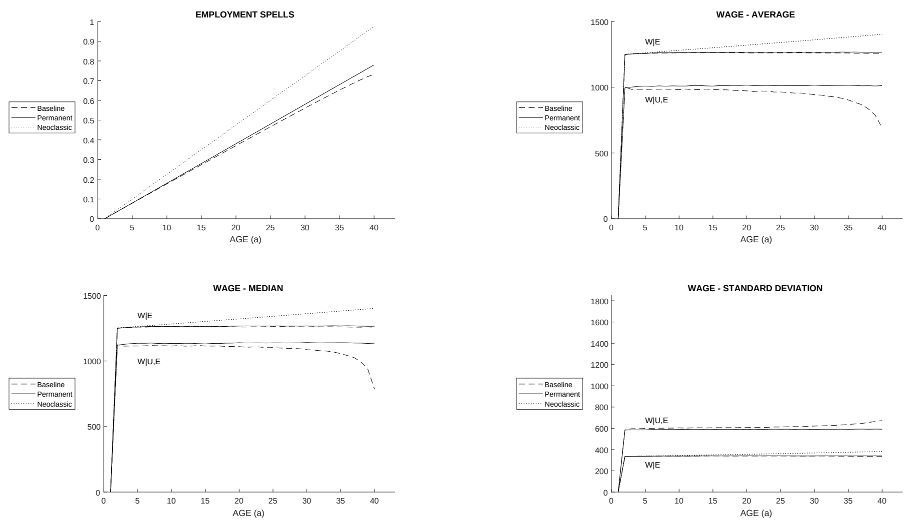

Figure 15: *Employment Spells and Wage Statistics in Baseline, Permanent and Neoclassical Scenarios.*

The age profile of mean, median and standard deviation of employed wages ($W|E$) in the Neoclassical scenario tend to be relatively higher for higher age if compared to the Baseline and Permanent scenarios, due to the role of wage seniority factor s which increases the (drawn) initial wage of the contract once the worker's tenure in that contract increases. For the same reson, the seniority factor in the Neoclassical case is responsible also for the increase of the standard deviation of employed wages.

[25] Note that it does not coincide with the bisectrix since workers are enter the economy as unemployed. Accordingly, the final employment spells would be less than 100% (indeed, 97.5% since $\frac{1}{40} = 0.025$).

About the measures of inequality, they seem not to be affected by changes in the tenure structure of contracts.

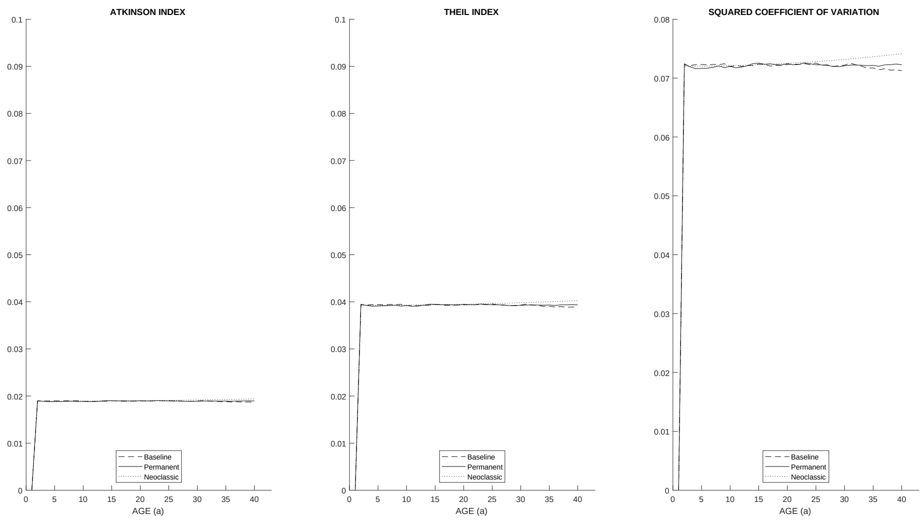

Figure 16: *Wage Inequality in Baseline, Permanent and Neoclassical Scenarios.*

The only noteworthy difference regards the squared coefficient of variation CV^2, which is directly influenced by the dynamics of the standard deviation of employed wage which, increases for higher ages in the employed population. Finally, the three different scenarios seem not to have an impact on the poverty measures, apart from the poverty line PL.

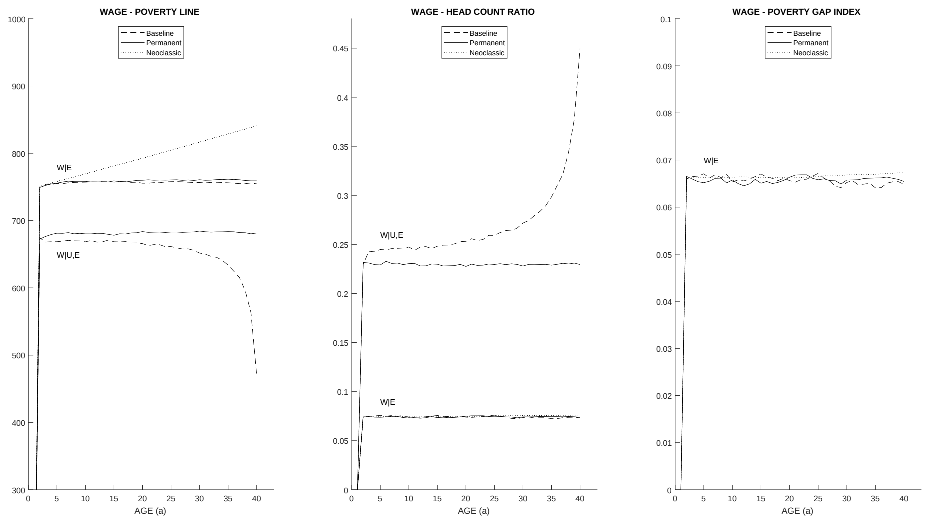

Figure 17: *Wage Poverty in Baseline, Permanent and Neoclassical Scenarios.*

In particular, the age-increasing profile of the poverty line increases since both average and median wages increases among the employed workers. Moving to the analysis of pension outcomes, let us start by considering the impact of the different scenarios on the distribution of wages and pension in the four different pension regimes DB,DC,DAC and DTC.

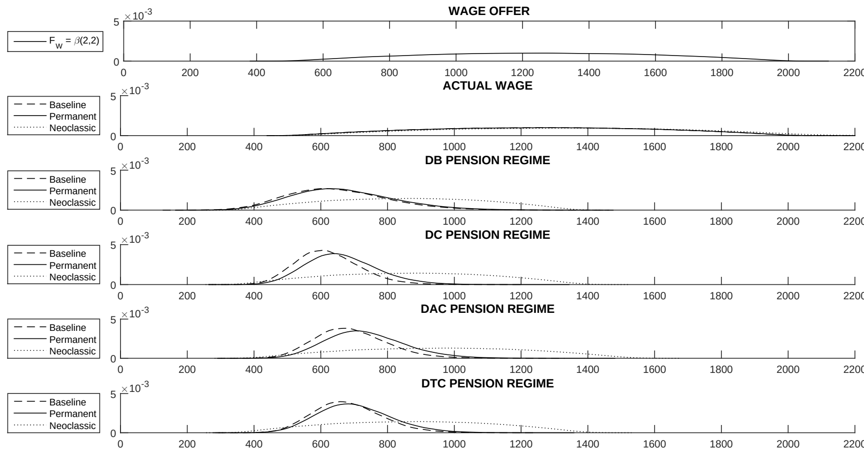

Figure 18: *Distribution of Wages and Pensions Poverty in Baseline, Permanent and Neoclassical Scenarios.*

If employment is considered an absorbing state ($\phi = \lambda = 0$), then the features of the actual wage distribution is projected to the pension distribution in all four regimes. Only the DAC pension regime still delivers an higher and more dispersed pension wealth.

Focusing on simple statistics of the distribution of pension p_{ps}, for all regimes $ps = DB, DC, DAC, DTC$, one can trivially see that the Neoclassical scenario delivers higher level of pension, but they are equal across pension regimes (apart in the DAC case). Comparison with median values confirm that the simmetry of the wage offer distribution is maintained both across scenarios and pension regimes. Similarly, the standard deviation of pension in the Neoclassical scenario is unaltered by the different pension regimes apart in the DAC regime where it is higher.

Moving to the analysis of adequacy of pension regimes, (aggregate) mean and median replacement rates are coherent with previous findings. Precisely, a less and less flexible structure of contracts in the economy is beneficial for the level of pension and it is true across pension regimes. No changes across pension regimes seems to occur in terms of inequality reduction and poverty prevention. The only noteworthy features is that, by moving from less flexible structure of contracts in the economy, a DB does not imply a higher level of pension. This result is due to the fact that, if a worker finds a better

Measure	Scenario	DB	DC	DAC	DTC
Mean Pension	*Baseline*	651.76	622.43	691.08	681.67
	Permanent	671.07	663.86	735.02	703.43
	Neoclassical	854.47	870.05	961.74	875.81
Median Pension	*Baseline*	639.3	615.27	683.2	674.81
	Permanent	657.29	655.52	725.47	695.48
	Neoclassical	855.55	870.06	961.74	865.82
Pension St Dev	*Baseline*	151.65	95.25	106.25	102
	Permanent	154.1	106.57	118.15	110.87
	Neoclassical	229.5	234.25	258.84	235.8
Avg Repl Rate	*Baseline*	0,5189	0,4956	0,5502	0,5427
	Permanent	0.53	0.5243	0.5805	0.5555
	Neoclassical	0.6091	0.62	0.6851	0.624
Med Repl Rate	*Baseline*	0.5083	0.4892	0.5432	0.5366
	Permanent	0.5196	0.5181	0.5734	0.5497
	Neoclassical	0.6104	0.6208	0.6862	0.6249
Atkinson Index	*Baseline*	0.0134	0.0058	0.0058	0.0055
	Permanent	0.013	0.0063	0.0064	0.0061
	Neoclassical	0.0189	0.019	0.019	0.019
Theil Index	*Baseline*	0.0273	0.0116	0.0117	0.0111
	Permanent	0.0264	0.0127	0.0128	0.0123
	Neoclassical	0.0392	0.0395	0.0395	0.0395
Squared Coeff Var	*Baseline*	0.0541	0.0234	0.0236	0.0224
	Permanent	0.0527	0.0258	0.0258	0.0248
	Neoclassical	0.0721	0.0726	0.0725	0.0726
Poverty Line	*Baseline*	383.52	369.16	409.92	404.89
	Permanent	394.37	393.31	435.28	417.28
	Neoclassical	513.33	522.04	577.05	525.49
Head Count Ratio	*Baseline*	0.0217	0.0004	0.0004	0.0004
	Permanent	0.0184	0.00069	0.0007	0.00068
	Neoclassical	0.075	0.0749	0.0748	0.0749
Poverty Gap Index	*Baseline*	0.0196	0.0004	0.0004	0.0004
	Permanent	0.0168	0.0007	0.0007	0.0006
	Neoclassical	0.0664	0.0663	0.0662	0.0663

Sensitivity Analysis*: Baseline vs Permanent vs Neoclassical scenarios.*

job during the last year of active life, it will imply a higher average wage in the reference years considered by the DB pension formula. he other two measures of poverty highlight the impact of the contract flexibility in terms of poverty among reitrees. Both poverty measures, one for the incidence and the other for depth of poverty, confirm that that a neoclassical framework alter the base of analysis of alternative pension regimes, since they seem to deliver the same perfomance in terms of adequacy.

5 Conclusions

Differentiation of pension contributions (that is, of a tax rate) with respect to age of the worker or tenure of the contract seems to be very promising tools that can be used to correct for indirect effect of a pension system design, allowing to overcome the trade-off between higher (lower) replacement rates and greater (lower) inequality typical of DB (DC) pension regimes. Proposed pension regimes DAC and DTC can be introduced as a sort of auto-balanced mechanism to reduce pension-rules-induced inequality and to restore income maintenance in old age (Godinez-Olivares et al., 2016).
In real world, the interlink between labour market and pension system is supported by at least three (non beneficial) feedbacks. First, the existence of a retirement age leads to an increase of unemployment rate for workers close to that age, so-called distance to retirement effect (Saint-Paul, 2009; Hairault et al., 2010). Second, a context of flexible contracts, as the one depicted in this paper, implies shorter labour careers and thus on lower levels of pension (Bravo and Herce, 2017). Third, in a context of longevity heterogeneity, pension formulas based on an average life expectancy triggers a regressive distribution from those who live less to those who will live longer, with the latter being the richer if increases in life expectancy are positively correlated with income (Ayuso et al. 2017a,b).
Further research is needed in order to have a more complete understanding of the complex interlink joining labour market and pension systems. Recent developments in the theory of equilibrium unemployment can help the researchers to provide an integrated view about the labour career-pension nexus. In such a context, differentiation in the pension contribution rule as well as other similar parametric reforms can, or need to, be introduced in order to mitigate the increasing inequality and poverty in an ageing society.

References

[1] Ayuso, M., Bravo, J. M. and Holzmann, R. (2017a). On the heterogeneity in longevity among socioeconomic groups: scope, trends, and implications for earnings-related pension schemes. **Global Journal of Human-Social Science Research**, 17(1).

[2] Ayuso, M., Bravo, J. and Holzmann, R. (2017b). Addressing Longevity Heterogeneity in Pension Scheme Design. **Journal of Finance and Economics**, 6(1), 1-24.

[3] Atkinson, A. B. (1970). On the measurement of inequality. **Journal of Economic Theory**, 2(3), 244-263.

[4] Atkinson, J. (1984). Manpower strategies for flexible organisations. **Personnel Management**, 16(8), 28-31.

[5] Baldwin, F. S. (1910). Old age pension schemes: A criticism and a program. **Quarterly Journal of Economics**, 24(4), 713-742.

[6] Batyra, A., de la Croix, D., Pierrard, O. and Sneessens, H. R. (2017). Structural Changes in the Labor Market and the Rise of Early Retirement in France and Germany. **German Economic Review**, 1-32.

[7] Berton, F. and Garibaldi, P. (2012). Workers and firms sorting into temporary jobs. **Economic Journal**, 122(562).

[8] Berson, C. and Ferrari, N. (2015). Financial incentives and labour market duality. **Labour Economics**, 37, 77-92.

[9] Biggs, A. G. and Springstead, G. R. (2008). Alternate measures of replacement rates for social security benefits and retirement income. **Social Security Bulletin**, 68, 1.

[10] Borella, M. and Fornero, E. (2009). Adequacy of pension systems in Europe: an analysis based on comprehensive replacement rates. **ENEPRI Research Report**, no. 68.

[11] Bräuninger, M. (2005). Social security, unemployment, and growth. **International tax and public finance**, 12(4), 423-434.

[12] Bravo, J. M. V. and Herce, J. A. (2017). On the Influence of Employment-Breaks on Pension Benefits. **BBVA Working Paper**, 19.

[13] Breyer, F. (1989). On the intergenerational Pareto efficiency of pay-as-you-go financed pension systems. **Journal of Institutional and Theoretical Economics**, 643-658.

[14] Brooks, J. G. (1892). Old age pensions in England. **Quarterly Journal of Economics**, 6(4), 417-435.

[15] Brunner, J. K. (1996). Transition from a pay-as-you-go to a fully funded pension system: the case of differing individuals and intragenerational fairness. **Journal of Public Economics**, 60(1), 131-146.

[16] Burdett, K. and Coles, M. G. (2003). Wage/tenure contracts and equilibrium search. **Econometrica**, 71(5), 1377-404.

[17] Cahuc, P., Charlot, O. and Malherbet, F. (2016). Explaining the spread of temporary jobs and its impact on labor turnover. **International Economic Review**, 57(2), 533-572.

[18] Castellino, O. (1969). Un sistema di pensioni per la vecchiaia commisurate ai versamenti contributivi effettuati e alla dinamica dei redditi medi di lavoro. **Giornale degli Economisti e Annali di Economia**, 1-23.

[19] Chéron, A., Hairault, J. O. and Langot, F. (2011). Age-Dependent Employment Protection. **Economic Journal**, 121(557), 1477-1504.

[20] Cheron, A., Hairault, J. O. and Langot, F. (2013). Life-cycle equilibrium unemployment. **Journal of Labor Economics**, 31(4), 843-882.

[21] Chybalski, F. and Marcinkiewicz, E. (2016). The replacement rate: an imperfect indicator of pension adequacy in cross-country analyses. **Social Indicators Research**, 126(1), 99-117.

[22] Corneo, G. and Marquardt, M. (2000). Public pensions, unemployment insurance, and growth. **Journal of Public Economics**, 75(2), 293-311.

[23] De La Croix, D., Pierrard, O. and Sneessens, H. R. (2013). Aging and pensions in general equilibrium: Labor market imperfections matter. **Journal of Economic Dynamics and Control**, 37(1), 104-124.

[24] Erosa, A. and Gervais, M. (2002). Optimal taxation in life-cycle economies. **Journal of Economic Theory**, 105(2), 338-369.

[25] Faccini, R. (2014). Reassessing labour market reforms: Temporary contracts as a screening device. **Economic Journal**, 124(575), 167-200.

[26] Foster, J., Greer, J. and Thorbecke, E. (1984). A class of decomposable poverty measures. **Econometrica**, 761-766.

[27] Gagliarducci, S. (2005). The dynamics of repeated temporary jobs. **Labour Economics**, 12(4), 429-448.

[28] Gervais, M. (2012). On the optimality of age-dependent taxes and the progressive US tax system. **Journal of Economic Dynamics and Control**, 36(4), 682-691.

[29] Giarini, O. (1990). Introduction: the Opportunities of the Four Pillars' Strategy. **Geneva Papers on Risk and Insurance**, 95-99.

[30] Hairault, J. O., Sopraseuth, T. and Langot, F. (2010). Distance to retirement and older workers 'employment: The case for delaying the retirement age. **Journal of the European Economic Association**, 8(5), 1034-1076.

[31] Hairault, J. O., Langot, F. and Zylberberg, A. (2015). Equilibrium unemployment and retirement. **European Economic Review**, 79, 37-58.

[32] Hinrichs, K. and Jessoula, M. (2012). Labour market flexibility and pension reforms: Flexible Today, Secure Tomorrow?

[33] Khaskhoussi, F. (2009). Job-search effort, retirement decision and pension reform: A wage bargaining investigation. **Economics Bulletin**, 29(2), 1255-1263.

[34] Lindbeck, A. and Persson, M. (2003). The gains from pension reform. **Journal of Economic Literature**, 41(1), 74-112.

[35] Michelacci, C. and Ruffo, H. (2015). Optimal life cycle unemployment insurance. **American Economic Review**, 105(2), 816-859.

[36] Mincer, Jacob A. (1974). Schooling and earnings. **National Bureau of Economic Research**, 41-63.

[37] McCall, J. J. (1970). Economics of information and job search. **Quarterly Journal of Economics**, 113-126.

[38] Godínez-Olivares, H., Boado-Penas, M. D. C. and Pantelous, A. A. (2016). How to Finance Pensions: Optimal Strategies for Pay-as-You-Go Pension Systems. **Journal of Forecasting**, 35(1), 13-33.

[39] Ono, T. (2007). Unemployment dynamics in an OLG economy with public pensions. **Economic Theory**, 33(3), 549-577.

[40] Ono, T. (2010). Growth and unemployment in an OLG economy with public pensions. **Journal of Population Economics**, 23(2), 737-767.

[41] Saint-Paul, G. (2009). Does the welfare state make older workers unemployable?. **IZA Discussion Paper**, no. 4440.

[42] Shorrocks, A. F. (1980). The class of additively decomposable inequality measures. **Econometrica**, 613-625.

[43] Theil, H. (1979). World income inequality and its components. **Economics Letters**, 2(1), 99-102.

[44] Thøgersen, J. (2010). Unemployment, Public Pensions, and Capital Accumulation: Assessing Growth Effects of Alternative Funding Strategies. **Journal of Institutional and Theoretical Economics**, 166(3), 502-520.

[45] Watts, H. W. (1964). An economic definition of poverty. **Institute for Research on Poverty**, 316-329.

[46] Weinzierl, M. (2011). The surprising power of age-dependent taxes. **Review of Economic Studies**, 78(4), 1490-1518.

[47] Whiteside, N. (2014). Privatization and after: time, complexity and governance in the world of funded pensions. **European Review of Labour and Research**, 20(1), 69-81.

[48] Wilthagen, T. and Tros, F. (2004). The concept of Flexicurity: a new approach to regulating employment and labour markets. **European Review of Labour and Research**, 10(2), 166-186.