How Mandatory Pensions Affect Labor Supply Decisions and Human Capital Accumulation? Options to Bridge the Gap between Economic Theory and Policy Analysis

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Options to Bridge the Gap between Economic Theory and Policy Analysis*

Jak obowiązkowe systemy emerytalne wpływają na decyzje dotyczące podaży siły roboczej i akumulację kapitału ludzkiego?

Możliwości zmniejszenia luki między teorią ekonomii a analizą polityki gospodarczej

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Abstract

Mandatory pension systems can have a negative impact on individual savings and labor supply decisions. In particular, defined benefit pension schemes that are not actuarially fair, can create incentives for early retirement, and therefore, reduce labor supply and the stock of human capital. After a review of frequently applied approaches to assess the incentives generated by a pension system, the paper develops an indicator to predict the age-specific retirement probabilities induced by a particular pension system given heterogeneous individual preferences. The paper then describes how this indicator could be used to project the size of the labor force by gender, age and skill level, and correspondingly, the dynamics of human capital accumulation. Finally, the paper develops a set of life-cycle income measures to assess how the pension system affects decisions regarding the supply of labor in the public and private sectors. The methods are illustrated in the case of Morocco.

Keywords: life cycle models, labor supply, human capital, retirement policies, job and occupational mobility

JEL: D91, J22, J24, J26, J62

Streszczenie

Obowiązkowe systemy emerytalne mogą mieć negatywny wpływ na indywidualne decyzje dotyczące oszczędności oraz podaży siły roboczej. W szczególności systemy emerytalne o zdefiniowanym świadczeniu, które nie są aktuarialnie sprawiedliwe, mogą stwarzać zachęty do wcześniejszego przechodzenia na emeryturę, ograniczając tym samym podaż siły roboczej oraz zasoby kapitału ludzkiego. W niniejszym artykule, po dokonaniu przeglądu często stosowanych sposobów oceny zachęt tworzonych przez systemy emerytalne, opracowaliśmy wskaźnik, który służy do określenia prawdopodobieństwa przejścia na emeryturę (według wieku), wymuszonego konkretnym systemem emerytalnym, po uwzględnieniu indywidualnych preferencji o niejednorodnym charakterze. W dalszej części artykułu pokazujemy, jak można wykorzystać ten wskaźnik do prognozowania wielkości siły roboczej, według płci, wieku i poziomu umiejętności, a także dynamiki akumulacji kapitału ludzkiego. W końcowej części artykułu omawiamy zbiór mierników dochodu w cyklu życiowym służących do oceny sposobu, w jaki system emerytalny wpływa na decyzje dotyczące podaży siły roboczej w sektorze państwowym i prywatnym. Do zilustrowania tych metod użyliśmy przykładu Maroka.

Słowa kluczowe: modele cyklu życia, podaż pracy, kapitał ludzki, programy emerytalne, zasady przechodzenia na emeryturę, mobilność siły roboczej

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1. Introduction

Defined benefit (DB) pension systems, usually financed on a pay-as-you-go basis, often embed bad microeconomic design features that create distortions in savings and labor demand/supply decisions. This paper focuses on two that are relevant from the point of view of labor markets: (i) incentives to retire early; and (ii) institutional fragmentation that can affect the mobility of the labor force. None of these features is inherently built into a DB system, but the fact is that an overwhelming majority worldwide offer incentives to retire early and are split into separate subsystems for different professional groups (typically civil servants, military and private sector workers). The contribution of this paper is to develop analytical tools that can be used to assess the magnitude of these distortions, particularly in the presence of limited data, and to conduct ex-ante assessments of the impacts of alternative reforms. The methods and results presented here are still preliminary and should be seen as part of a broader research agenda to improve the assessment of the labor market impacts of reforms in the social insurance system.

Most of the research on the impact of incentives on early retirement has concentrated on OECD countries, which have experienced steady drops in retirement ages despite substantial increases in longevity throughout the 20th century. Most recently, the international research project conducted in twelve OECD countries using the same methodology (Gruber, Wise 1999; 2004; and forthcoming) has found that the great majority of social security systems in these countries provide incentives to leave the labor force at early ages and that there is a strong relationship between these incentives and the withdrawal of older workers from the labor force. In addition, Herbertsson and Orszag (2003) have estimated that early retirement provisions in the OECD countries cost on average 7.5% of potential annual OECD output. They also showed that the distortions created by early retirement can be further accentuated by the ageing of the population. For example, they estimated that male labor force participation in OECD countries would have to rise from 66% to 70% (from 2003 to 2010) to keep the costs of early retirement at the 2003 level in 2010. More generally, it has been suggested that eliminating incentives for early retirement is an important policy intervention to mitigate the macroeconomic impact of a shrinking labor force as the population ages (see Oliveira et al. 2005). The evidence from OECD countries also shows that cutting down on early retirement incentives through the reform of social security systems can have an important effect on labor force participation and positive fiscal implications from two sources: (1) reduced demand for fiscal support as the financial situation of the program improves; and (2) increased government tax revenues. The expected savings are very large (20 to 40% of current program costs) and countries could generate as much as 1% of GDP in government revenues resulting from higher labor force participation among older workers.[1]

The institutional fragmentation of the pension system is another source of labor market distortions. Fragmentation is explained by the emergence of occupational pension schemes that preceded the development of mandatory government pension schemes. Indeed, in some countries the pension schemes for certain occupations (e.g. public servants) offer a significant portion of the total employee compensation package. This fragmentation of the pension system is a significant source of economic inefficiency in several cases. Beyond the loss of economies of scale in administration we see the lack of (or limited) portability of pension rights across pension schemes which induces labor market friction. Indeed, the lack of portability of pension rights makes the price of separation from potentially inefficient matches too high for the separation to happen. The labor market is the "place" where the dynamic matching process of physical capital and labor happens. Any administrative rule that prevents the occurrence of productive matches, or that does not allow the separation of matches that can be dominated in efficiency by another labor-capital match, ultimately causes economic inefficiency and does not allow the full utilization of the gains from trade.[2]

The other problem with institutional fragmentation is the emergence of different implicit rates of returns on contributions across the various pension schemes. These distort the role of wages as the system informing about the price/value of labor effort. High indirect compensation through high internal rates of return (IRR) in the public sector for instance, can create incentives for unemployed individuals to queue for government jobs. Distorted IRRs also create incentives towards biased investment in human capital towards the skills demanded in the public sector. If certain skills queue for jobs in the public sector, shortages can be observed in the private sector – which compromises investment and growth.

The paper proposes three classes of instruments to analyze supply side distortion in labor markets emerging from the mandatory pension system. First, we develop an indicator to measure incentives for early retirement, which takes into account the trade-off between consumption and leisure even when the distribution of individual preferences is not known. We show that this indicator is superior to standard proxies used to analyze incentives for early retirement, such as the slope of the curve of internal rates of return on contributions and the marginal change in pension wealth. Second, we

[1] For more on the labor supply consequences of generous early retirement provisions, see Blondal, Scarpetta (1998), and Borsch-Supan, Schnabel (1998).

[2] For an extensive review of the 'segmented labor markets (SLM)' literature, please see Taubman, Wachter (1986). Furthermore, for a take on segmented labor markets in the case of Switzerland, see Sousa-Poza (2003).

show how this indicator could be linked to a model that projects the skills composition of the labor force by age and gender, to assess the effects that pension policy has on retirement decisions, the accumulation of human capital and through this channel economic growth. Finally, we develop a methodology to assess how fragmented pension systems affect incentives to move across sectors and decisions about investments in education. To illustrate the use of these tools, we take the case of Morocco. Indeed, we consider Morocco a good representative of middle-income countries with badly designed and fragmented defined-benefit pay-as-you-go pension schemes. Hence, our conclusions can be applicable for other middle-income and, to some extent, high-income countries.

The structure of the paper is as follows. The next section (Section 2) develops an indicator to measure incentives for early retirement. The methodology to assess the economic costs of early retirement is presented and illustrated in Section 3. Section 4 is concerned with the analysis of distortions related to investments in education and the mobility of the labor force. Finally, Section 5 concludes.

2. Measuring distortions in retirement decisions

The standard indicators used to assess incentives for early retirement are the internal rate of return (IRR) on contributions and the change in pension wealth at a given retirement age.[3] These indicators, however, have three major problems. First, they do not capture the trade-offs between consumption and leisure, which are at the core of the retirement decision. Second, they ignore the interplay between benefit formulas, eligibility conditions and individual attitudes towards risk. Third, they would suggest the same retirement behavior to people with identical or similar career path whereas we observe heterogeneous retirement ages even for individuals who are similar or identical in their observable characteristic from the perspective of the pension system. The implication is that any conclusion in terms of whether individuals have weak or strong incentives to delay retirement can be misleading. In this section, we propose a complementary indicator that takes into account the trade-off between consumption and leisure as well as the level of risk aversion of individuals. The indicator is based on the standard inter-temporal utility maximization framework.

In this framework, individuals choose how much to save, how much to work, and when to retire in order to maximize some "utility" function of consumption and leisure. Formally, we have:

$$\begin{aligned} &\underset{s^*,l^*,R^*}{Max}: \sum_{t=a}^{R^*} U(c_t, l_t^*) v_t \rho^t + \sum_{t=R^*+1}^{X} U(c_t, h) v_t \rho^t \\ &s.t.\ \ c_t = y_t(1 - s_t^*) \\ &\qquad s_t^* \in [0,1]\ \forall t \\ &\qquad y_t = \bar{w}_t (h - l_t^*)\ \ if\ \ t \le R^* \\ &\qquad y_t = P(\{s\}_a^{t-1}, \{y\}_a^{t-1}, \{r_t\}_a^{t-1}, \theta)\ \ if\ \ t > R^* \end{aligned} \tag{1}$$

where $U(.)$ is a standard utility function capturing the trade-off between consumption (c) and leisure (l), v_t is the probability of survival to age t, ρ is the rate of time preference, y is income, w labor productivity, h total available working time at time t, s the savings rate, R the retirement age, X is the maximum number of years an individual can live and a is the entry age to the labor market. The function $P(.)$ gives the value of retirement income, which depends on past savings, wages, interest rates, as well as policy parameters θ (i.e. the type of pension system). We acknowledge the very strong implicit assumption that individuals who retire can only receive pension income – as opposed to working in the informal sector (or formal sector without contributing). This simplification is necessary in this version of the paper that focuses mainly on general methods. It can and should be relaxed in real world policy applications.

Ideally, one would like to solve a system such as (1) for every member in a given pension plan and estimate econometrically the key unknown parameters: the preference for leisure and the coefficient of risk aversion. This could be done in principle by using individual records for retired individuals. The optimal retirement age by individual and therefore the implied density of retirement ages do not accept a close form solution, but simulators of the density can be used to estimate the model parameters by say maximum likelihood or expected non-linear least squares (see Gourieroux, Monfort 1996). One could then assess how changes in policy parameters would affect retirement patterns and the associated economic costs – given the expected evolution of wages for different plan members and other macroeconomic and demographic variables.[4] Often, however, the necessary data are not available. The exercise is also computationally time

[3] The internal rate of return on contributions is the rate that equates the present value of contributions with the present value of pensions. It can be interpreted as the implicit interest rate that the pension system pays to plans' members on their contributions. The pension wealth, on the other hand, is the present value of expected future pensions. For a discussion on the use of the IRR and the incremental change in pension wealth in assessing the incentive structures of pension systems, see Queisser, Whitehouse (2006).

[4] An alternative more classical approach would be to estimate reduced form models of retirement ages as a function of individual characteristics, pension system parameters, and maybe macro indicators at the regional level. A first problem with this approach, however, is that the variation in policy parameters usually does not exist. Second, even if it existed, benefit formulas and eligibility conditions are very complex. One could bundle some rules in binary vectors, but then one would not be able to assess how changes in rules would affect retirement behavior. Finally, and more importantly, depending on the structure of the model, it is likely that the estimated parameters reflect actually individual decisions given the structure of the pension system. If the rules change, then the parameters would need to change. Thus, the need for a structural model.

demanding. Hence, in this version of the paper we focus on a simplified version of model (1) that assumes deep uncertainty in the distributions of preferences regarding consumption, leisure and risks.[5]

The simplified version that we analyze here only focuses on the retirement decision, taking the savings rate and labor supply as given. It fixes the savings rate equal to the contribution rate (during retirement consumption is equal to the pension) and sets the maximum labor supply equal to 260/365 (260 is the total number of working days in a year). So a retired individual would have leisure equal to 1 while a working individual would have leisure equal to (365–260)/365. It further assumes a period utility function of the form:

$$U(c,l) = \frac{\left[c^{\alpha}(lw)^{1-\alpha}\right]^{1-\lambda}}{1-\lambda} \qquad (2)$$

where α captures trade-off between consumption and leisure and λ is the coefficient of risk aversion. The concept of utility seems abstract but in practice it is simply a way to introduce a non-linear link between changes in the levels of consumption and leisure and the value/happiness derived from them. The "curvature" of the utility function with respect to the combined consumption-leisure argument is affected by the coefficient of risk aversion. The higher this coefficient, the higher the curvature. The essence of risk aversion is that risk averse individuals value a level of consumption c_1 that is achieved with 100% probability, more than a level of consumption c_2 that is realized with a probability $p \in [0,1]$ even if $c_1 = c_2 \cdot p + 0 \cdot (1-p)$ [i.e. even if the expected value of consumption is identical in both cases].

Given the utility function, a given assumption for the path of wages, and the parameters of the pension system, it is possible to calculate the optimal retirement age as a function of the parameters α and λ.[6] The optimal retirement age would be the age where the marginal benefit of delaying retirement by one year falls below the marginal costs – all measured in utility terms. The benefits are, presumably, a higher pension, a higher consumption path, and consequently a higher consumption component in the expected utility calculation. The cost is delaying the increase in the level of leisure and reducing net income given the contribution rate.

Formally, the net gain at age R of delaying retirement by one year is as follows:

$$ngu(R->R+1) = u(c_R, 0.28) + \rho \sum_{t=R+1}^{X} u(p(R+1,t),1) v_t \rho^{t-(R+1)} - \sum_{t=R}^{X} u(p(R,t),1)\, v_t \rho^{t-R} \qquad (3)$$

$$s.t.: \quad c_R = w_R(1-\tau); \quad p(R,t)_t = P\left(\{w\}_a^R, \theta\right)$$

where w_i is the wage received by the individual at age i and τ is the contribution rate. So, individuals will delay retirement as long as $ngu(R)>0$.[7]

Clearly, one does not know the joint distributions of the parameters α and λ within the population of plan members. Assuming that the individuals are identical in all other dimensions, the joint distribution of the parameters could be sampled to replicate the observed distribution of retirement age.[8] Hence, one can explore a large number of cases assuming that the parameters are uniformly distributed within their supports. The probability of keeping a case is then equal to the probability of observing a given retirement age in the empirical sample. Moreover, through the sampling process, it is possible to derive a map of functions $ngu(R; \alpha, \lambda)$ that, we argue, provides a unique characterization of the pension system and informs about the magnitude of possible incentive problems. In addition, one can compute a summary indicator that gives the percentage of cases where the optimal retirement age is below a given threshold. In fact, as this indicator can be calculated at all possible retirement ages, the entire age profile of retirement can be generated for a given pension system. This in fact is very relevant to inform changes in the distribution of retirement probabilities that result from changes in parameters within pension systems actuarial models.

We next apply these indicators to the three mandatory pension schemes in Morocco. The CNSS (Conseil National de Sécurité Social) is the scheme for private sector workers. The CMR (Caisse Marocaine de Retraites) is the acronym for the civil servant pension scheme. Other public sector workers enroll in the RCAR (Régime Collectif d'Assurance et de Retraites).[9] We compare our indicators to the standard measures, the IRR and the pension wealth.

In the case of three pension funds, the IRR and the pension wealth indicate the existence of incentives problems. The IRR is downward slopping for the CNSS and the CMR, suggesting that individuals "receive less" on their contributions if they delay retirement (see Figure 1). For example, an individual retiring at age 55 from

[5] A forthcoming paper discusses in detail methods for more complex real world applications where savings and labor supply are endogenous.

[6] The implicit assumption here is that the distribution of individual retirement ages can be generated using a sample of "imaginary" individuals who are heterogeneous in their preference parameters but identical otherwise (even in terms of wage and employment histories). This is an extreme case but that still can provide useful insights on the effects of the pension system on retirement decisions. The assumption is relaxed in a forthcoming paper.

[7] The decision rule that relies on the sign change of *ngu*(.) assumes that *ngu*() is monotonically decreasing.

[8] This is an extreme case but that still can provide useful insights on the effects of the pension system on retirement decisions. The assumption is relaxed in a forthcoming paper.

[9] The key parameters of the three systems are summarized in the Appendix.

the CNSS would receive an implicit real rate of return on contributions of 5% per year, while an individual retiring at age 60 would receive only 4%. This occurs because the accrual rate is not adjusted as a function of the retirement age to correctly take into account that individuals retiring earlier, and therefore contributing for a shorter period of time and receiving pensions for longer periods, should also receive lower pensions. Contrary to the CNSS and the CMR, the RCAR does adjust the accrual rate as a function of the retirement age, to the point that individuals retiring late receive higher IRRs. Hence, one would like to conclude that in the case of the RCAR, there are positive incentives to delay retirement. How strong are they?

A different picture of the situation is given by the change in the net pension wealth occurring as a result of a delay in the retirement decision. Similarly to the gain in utility defined in equation (3), the change in net pension wealth resulting from delaying retirement from age j to age $j+1$ is given by:

$$gpw(j->j+1)=(1-\tau)w_j+PW_{j+1}\rho-PW_j \qquad (4)$$

where PW_i is the value of the pension wealth retiring at age i.

According to this measure, in the case of Morocco, none of the pension funds provides true incentives for delayed retirement. Changes in pension wealth are negative for all retirement ages (see Figure 2). Even for the RCAR, the results suggest that current adjustments to the accrual rate would not be sufficient to motivate individuals to delay retirement. The CMR is a peculiar case. The system provides strong incentives to individuals who are 59 years old to delay retirement by one year. This is because at age 60 the accrual rate increases to 2.5% from 2% for all previous years of service.

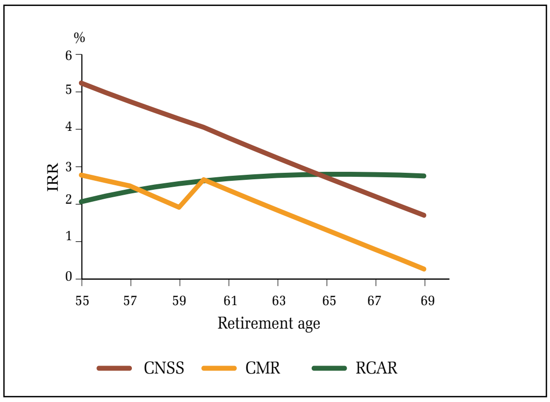
In practice, however, we do observe that in all pension funds individuals retire at various retirement ages. The question is really in which pension fund the probability of retiring early is higher. It is here where the maps $ngu(R, \alpha, \lambda)$ for each of the pension funds become helpful. These maps were calculated under the assumption that wages grow in real terms at 3% per year and the rate of time preference ρ is 0.98 annually. One hundred combinations of the parameters α and λ were used with $\alpha \in [0.2, 0.7]$ and $\lambda \in [0.5, 5]$. The results are presented in Figure 3.

The map for each fund is very different and characterizes the benefit formulas and eligibility conditions in a unique way. Each "line" within the map is associated with a given combination of the parameters α and λ. In all funds, the lines can be grouped into three categories. First, lines which are always below the horizontal axis. These are associated with utility functions that never generate incentives to delay retirement. The gain in expected utility from delaying retirement is always negative and individuals retire as soon as possible – in our example at age 55. The second type involves lines that are always above the horizontal axis indicating that the gains from delaying retirement are always positive. These lines correspond to individuals who never have incentives to retire in the period of analysis (they could retire afterwards). Finally, there are lines which cross the horizontal axis. The more relevant are the ones that cross the axis from above. In this case, the point of crossing gives the optimal retirement age.[10]

In the case of the CNSS, the majority of lines are either above or below the horizontal axis. So in the CNSS, individuals with a certain propensity for retirement will most likely retire as soon as possible. In the CMR, the majority of lines start below the horizontal axis, cross the line from below and then cross the axis again from above. Hence, for individuals it is optimal

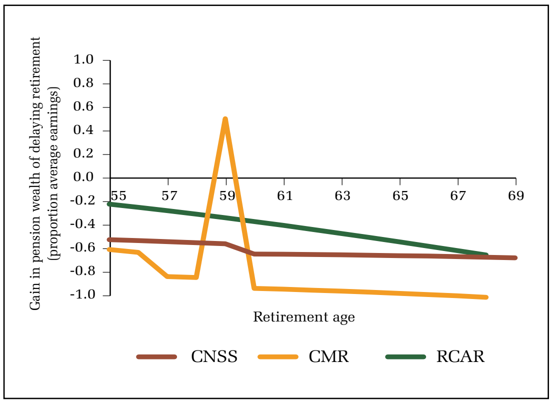
[10] The discussion here is simplified so not all the special cases of the nonmonotone ngu(.) lines with multiple intersections with the horizontal axis are not discussed here; however, the behavioral consequences can be easily determined using the same framework for these individuals as well.

Figure 1. *Internal rates of return on contributions*



Note: The IRRs are for men with a salary equal to average earnings, who join the system at age 25 and contribute continuously until retirement. Real wages are assumed to grow at 3%.
Source: Authors' calculations.

Figure 2. *Changes in net pension wealth by retirement age*



Note: Same assumptions as for Figure 1. In addition, the discount rate used for present value calculations is set at 2%.
Source: Authors' calculations.

to retire as soon as possible up to age 58. At age 59 it is better to wait one more year. As discussed below, the "distorted" map that emerges reflects the peculiarity of the benefit formula based on final wages where the accrual rate increases from 2% to 2.5% at age 60. The map of the RCAR corresponds to a system that is more actuarially fair. A majority of individuals will not retire immediately regardless of their propensity to do so. This is because of the upward slopping IRR function.

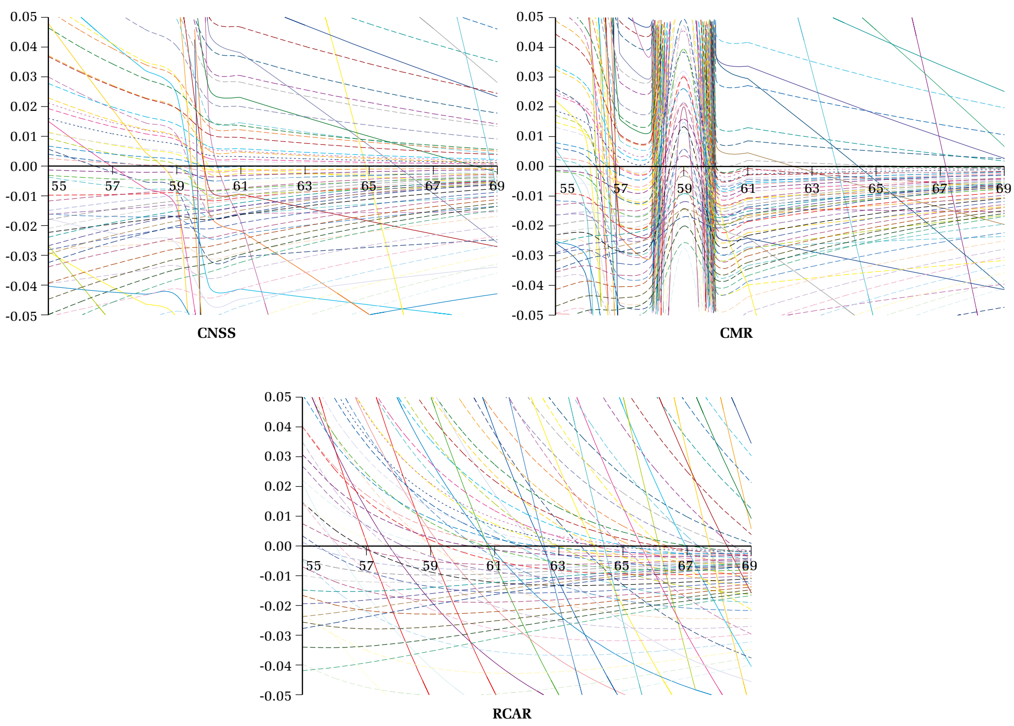
The information captured in the maps can be summarized by the probability of early retirement, defined here as the probability of retiring at age 55. In effect, the normative probability of early retirement at a given age is the share of lines staying below the horizontal axis for all ages plus the ones crossing the horizontal axis from above at a lower age than the given fixed retirement age. As suggested by the charts, the probability of early retirement is highest in the CNSS. Indeed, for 40% of the cases the optimal retirement age is 55. For the CMR, the probability of early retirement is somewhat lower (36%). As previously indicated, the lowest probability of early retirement corresponds to the RCAR (17%). So even if the pension wealth indicator suggested a lack of incentives for delayed retirement, in reality, most probably, the RCAR does encourage retirement at higher ages – which is also consistent with the slope of the IRR function.

In conclusion, the utility maps and the normative estimator of the probability of early retirement provide more precise information about the incentives to retire early, given individuals with heterogeneous preferences. The slope of the IRR function and the change in pension wealth are useful to flag distortions, but one needs to be careful when deriving conclusions on actual retirement behavior based on these measures. Another attractive feature of the proposed indicator is that the calculations are simple. Therefore, future assessments of pension institutions and international comparisons of the effects of benefit formulas and eligibility conditions on retirement decisions could benefit from the proposed calculations. Finally, the indicator is useful to assess, ex-ante, the potential impact that policy changes can have on retirement decisions. As discussed in the next section, these decisions can affect the level of human capital of a given country and therefore its growth potential.

3. Estimating the cost of early retirement in terms of the loss of productive capacities of the economy

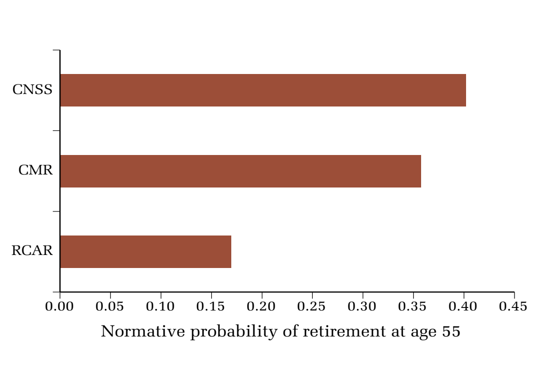
As discussed in the previous section, from the individual's point of view the decision to retire is a choice that reflects

Figure 3. *Utility maps for the retirement decision*



Source: Authors' calculations.

Figure 4. *Normative probability of early retirement*



Source: Authors' calculations.

preferences between leisure and consumption. From the point of view of the country, however, retirement represents a loss of human capital, particularly when it occurs at early ages. Standard analyses in pension policy focus on the fiscal costs of early retirement (the loss of contributions and the increase in the pension wealth that individuals receive). Here we argue that the economic cost of early retirement should be also taken into account. In this section, we propose a methodology to assess the impact that a pension system can have on human capital accumulation and economic growth by influencing retirement decisions[11] and therefore labor force participation rates for individuals with different skill levels.[12]

3.1. The model – from skill formation to human capital

The model developed here projects the labor force by gender, age and education level.[13] Assuming a competitive environment, we characterize the human capital of individuals with the marginal product of their labor. This marginal product is approximated by standard wage functions that we describe in the next section.[14]

The fist step is to project the total population by age and gender on the basis of expectations about future fertility and mortality rates. Hence a vector Pop(g, a, t) is computed where g=1 if male and g=2 if female, a refers to age and t refers to the time period.

[11] The model could be used as well to assess the economic impact of the effect of the pension system on the age of entrance to the formal labor market.

[12] In this paper, the term human capital is used for the human capital actually offered for work, i.e. the human capital stock does not include the potentially highly productive, but inactive population. For various concepts of human capital, see Becker (1993).

[13] The methodology developed here builds upon Cörvers et al. (2002), and Heijke (1994).

[14] The empirical analysis of the household survey presented in the following section includes the economic sector in the set of explanatory variables determining wages. Since the labor force projection model does not have a sector dimension, the specification of the wage equation omits economic sector from the set of right-hand side variables.

The next step is to project the supply of skills by the education sector. This supply is characterized by the vector Skill(σ, g, a, e, t) where σ=1 refers to "enrolled in an institution of the education system", σ=2 refers to those who are "not enrolled in the system of education", while e $\in$ {no education, 1st year of primary education, 2nd year of primary education, ...} is an element of the complete set of educational attainment categories.

We start by modeling enrollment in primary education. We have:

$$\begin{aligned} &Skill(\sigma=1,g,a=6,e=P1,t)\\ &\quad = Pop(g,a=6,t)*SR(g,a=6,t)\\ &Skill(\sigma=2,g,a=6,e=NoEd,t)\\ &\quad = Pop(g,a=6,t)*\left[1-SR(g,a=6,t)\right] \end{aligned} \tag{5}$$

where SR(g, a=6, t) is the scholarization rate at the mandatory primary education entry age. (P1 refers to "1st year of primary education", NoEd refers to "no education"). Those who do not enter primary education are registered as "out of school" population without education.

Based on the time series on education enrollment stocks, advancement rates, repetition rates and drop-out rates, an Ex(E+1) skills development transition matrix (TR) is generated, where E is the number of distinct educational attainment categories. $TR(e_1, e_2)$ is the probability of "advancing" from education category e_1 to education category e_2. In the special case when e_1=e_2, $TR(e_1, e_2)$ refers to repetition probability.[15] $TR(e_1, E+1)$ is defined as the probability of successfully completing educational level e_1 and leaving the education system after the successful completion. So how does the model follow educational attainment in society? A particular education level "e" can be reached because individuals advance in their education or repeat. In the general case, we therefore have:

$$\begin{aligned} &\Delta Skill(\sigma=1,g,a,e,t]=\left[1-Mort(g,a-1,t-1)\right]*\\ &\quad *\sum_{i=1}^{E} Skill(\sigma=1,g,a-1,i,t-1)*TR(i,e) \end{aligned} \tag{6}$$

where $Mort$(g, a, t) is the gender and time specific mortality probability of dying between ages a–1 and a. Clearly, for many cases TR(i, e)=0, meaning that here is no transition path between i and e. Also, note that the model is only concerned about net flows. Beyond the age of entering primary education, the net flows are always within and from (never from outside) the education system.

Those who finish successfully their intended level of education are transitioned out the school system according to the following equation:

[15] Note that this formulation assumes that the transition probabilities only depend on the "to" and "from" education categories, and independent of gender, age and time. The reason why we do not present a more general formulation is that we assumed an only 2 dimensional transition array in the quantitative example we present in this paper.

$$\Delta Skill(\sigma = 2, g, a, e, t) = [1 - Mort(g, a-1, t-1)] * \\ * Skill(\sigma = 1, g, a-1, e, t-1) * TR(e, E+1) \quad (7)$$

The probability of dropping out of school is the difference between 1 and the sum of the elements in a given row of the transition matrix. We have:

$$\Delta Skill(\sigma = 2, g, a, e, t) = [1 - Mort(g, a-1, t-1)] * \\ * Skill(\sigma = 1, g, a-1, e, t-1) * \left(1 - \sum_{i=1}^{E+1} TR(e, i)\right) \quad (8)$$

Finally, the evolution of those who already left the education system is according to the following equation:

$$\Delta Skill(\sigma = 2, g, a, e, t) = [1 - Mort(g, a-1, t-1)] * \\ * Skill(\sigma = 2, g, a-1, e, t-1) \quad (9)$$

The third step is to model the participation in the labor force among those individuals who are out of the education system. Given information on the size of the labor force and labor force participation rates, the following identity needs to hold:

$$LF(g, a, e, t) = LFPR(g, a, e, t) * \sum_{i=1}^{2} Skill(i, g, a, e, t) \quad (10)$$

where *LF* is the labor force array and *LFPR* is the labor force participation array. From (10) we then estimate *ELFPR*(*g*, *a*, *e*, *t*), or the effective labor force participation rates that only apply to individuals out of the school system.[16]

Finally, we are ready to turn the *LF* array into a measure of human capital. Recall that we can predict the individual human capital value for all combinations of gender, age and educational attainment categories *HCCat*(*g*, *a*, *e*). Then, the evolution of human capital is given by

$$SumHumCap(t) = \sum_{g=1}^{2} \sum_{a=1}^{A} \sum_{e=}^{E} LF(g, a, e, t) * HCCat(g, a, e) \quad (11)$$

By adding σ=3, as the "retirement" category, this simple setting can be used to directly assess the effects that changes in retirement probabilities have on the labor force by gender, age, and type of skills and therefore in the level of human capital. Hence, one can compare the dynamics of human capital under the status-quo with the dynamics of human capital in the case where participation rates change as a result of changes in pension benefit formulas and eligibility conditions.

Admittedly, there are limitations with the proposed analytical framework. First, the choice of the measure of human capital only considers the supply side of the labor market, i.e. implicitly assumes that those who enter the labor force will actually get a job and thus become a part of the (productive) human capital stock. Hence, our projections really constitute an analysis of potential human capital. In addition, the individual productivity values that we derive are associated with the interaction of labor supply and demand at a given point in time, and then we assume that this interaction is applicable to the future. Note that the productivity of a given unit of human capital can change as a result of technological progress. Our estimates of human capital should therefore be considered as a lower bound.

3.2. Quantitative example: The case of Morocco

We illustrate the use of the model in the case of Morocco. Figure 5 illustrates the dynamics of population growth and the skills composition of the labor force as projected in the baseline scenario for Morocco. The question that we ask is how changes in participation rates – induced by changes in retirement probabilities – would affect these baseline dynamics.

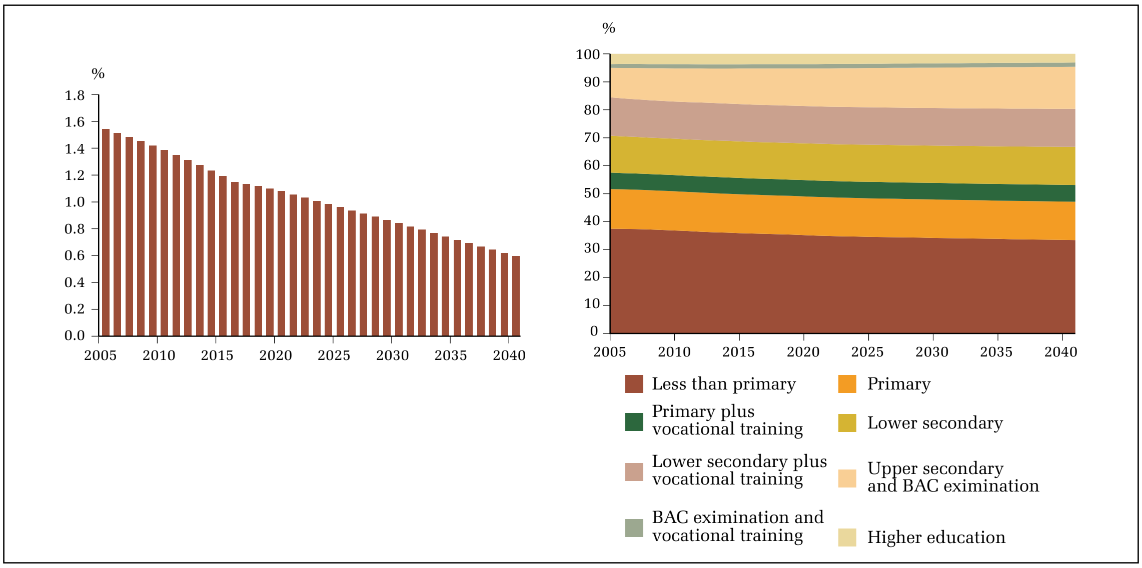
The right-hand panel of Figure 6 illustrates that male labor force participation rates are high across the board including ages potentially affected by early retirement (that is prior to age 60, which is the "standard" retirement age). This is in part due to the low coverage of the pension system in Morocco. The male labor force participation rate for the 59 year-old age cohort is 84.3%! There seems to be little room for further increasing male activity rates, but these could fall as the coverage of the pension system expands. In fact, the range of labor force participation rates of 51–59 year-old men is expected to move from 84.3%-95.7% to 74.7%-94.3% by 2040. In contrast, female labor force participation rates are low across the board and steeply decreasing from ages 51 to 59 from 28.7% to 16.1%. While female activity is expected to increase, the steeply decreasing activity prior to age 60 is expected to persist (e.g. in 2040, 48.8% of 51 year-old women are expected to be employed or seeking employment, while only 35.3% of the 59 year-old women is expected to belong to the labor force).[17]

We assess 5 possible scenarios for changing early retirement behavior and associated labor force participation. The first scenario assumes that female labor participation patterns change immediately and the new labor force participation rates of women aged 51 to 60 are identical to that of the 50 year-old cohort. The second scenario is the same for women, but we also

[16] In practice, we had to make certain homogeneity assumption in the case of the labor force participation rate array since the level of the desegregation of the available data along the educational attainment dimension was insufficient. Indeed, the only data available in the case of Morocco comes from the ILO, which only publishes age and gender specific labor force participation rate (see LABORSTA database).

[17] We do not address labor force participation patterns beyond age 60 for two reasons: 1) early retirement rules are not applicable to this age group and only delayed retirement bonuses could affect the activity of these generations; 2) the dispersions of the state of individual health conditions are so large beyond 60 that retirement incentives cannot be effectively assessed without considering this constraint.

Figure 5. *Population growth and skills composition of the labor force in Morocco*

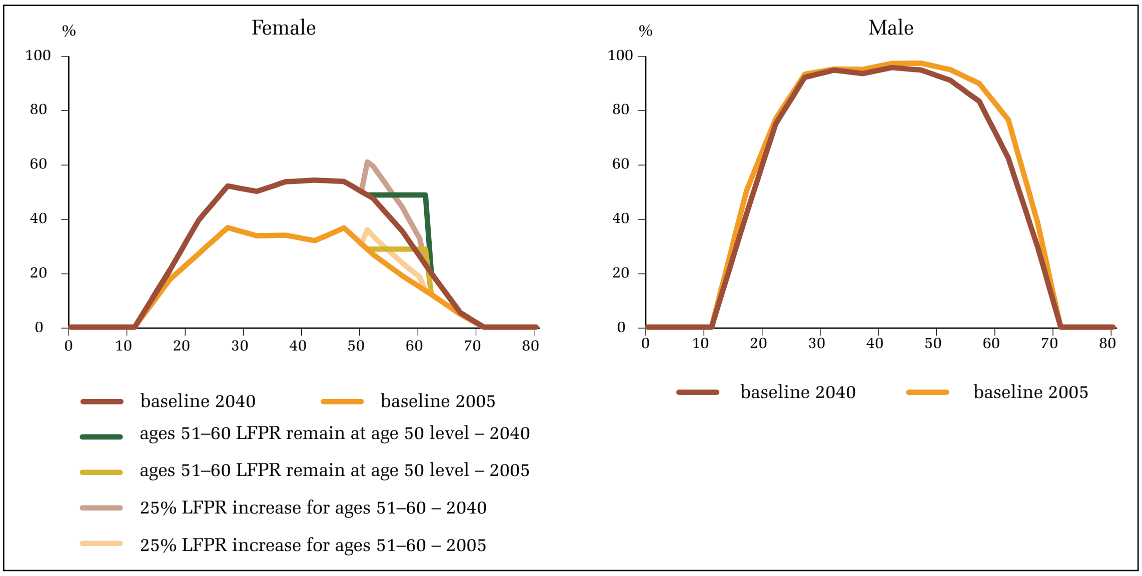


Source: ILO, authors' calculation.

fix the male labor force participation rates at 2005 levels – we do not allow male participation rates to fall like in the baseline scenario. The third scenario assumes the same time invariant male activity rates at the 2005 level, but in this case female activity patterns do not change. Scenarios 4 and 5 increase the labor force participation rates of women aged 51 to 60 by 25% immediately without imposing a time invariant male labor force participation rates, respectively.

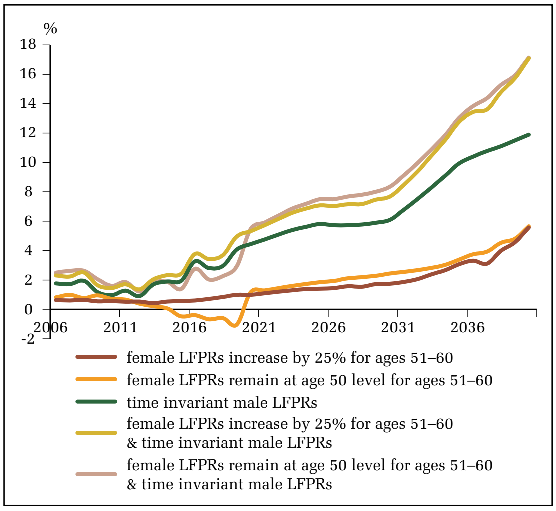
Figure 7 summarizes the results. Recall that the major determinants of the evolution of human capital, i.e. population growth, skills development through education and the baseline labor force participation path determine a baseline increasing path for human capital. In the case of Morocco, the annual rate of human capital growth stands at 3.56% in 2006 and this rate is expected to decrease to 1.1% by 2040. In most cases, the human capital growth rate would be higher than the baseline if corrected early retirement incentives convince a significantly higher ratio of those who are close to the standard retirement age to remain in the labor force.

Figure 6. *Age/gender specific labor force participation rates in 2005 and 2040*



Notes: For female participation rates are assumed to deviate from the baseline due to changes in early retirement provisions (see main text).
Gender and age group specific activity rate projections are available from the ILO until 2020, beyond that linear convergence assumed to the activity rates of the ILO aggregate category "more developed regions" reaching its level in 2075.
Source: ILO Laborsta Economically Active Population Estimates and Projections and authors' calculations.

Figure 7. *Changes in the growth rate of human capital due to changes in labor force participation rates*



Source: Authors' calculation based on ILO labor force participation projections.

4. Pension system fragmentation and labor mobility

This section illustrates the effects that a fragmented pension system can have on incentives to supply labor in a given sector as well the mobility of the labor across sectors. The analysis is based on micro simulations of career paths for individuals with different levels of education working in different economic sectors – and therefore belonging to different pension plans.

Formally, at time *t*, the wage of an individual of gender *s*, age *i*, education category *e*, working in sector *j*, expressed as a share of average earnings is given by:

$$w_t(s,i,e,j) = \exp\left(\beta_0 - \ln(\overline{w}_0) + \beta_{1sej} i + \beta_{2sej} i^2\right) \quad (12)$$

where *s*, *i*, *e* are respectively the gender, age, and level of education of the individual and *j* is the economic sector where he or she operates.[18] Hence, the marginal effect that age (experience) has on wages depends on the characteristics of the individual and the economic sector.

Given equation (12), for any given individual we can compute net income flows across life. These are given by:

$$\begin{aligned} nif(s,i,e,j) = {} & E(e,i)(1-R)w_t(s,i,e,j)\overline{w}_i(1-\tau_j) + \\ & + (R)P\left(\left\{w(s,i,e,j)_a^t, \overline{w}_i, \theta_e\right\}\right) \end{aligned} \quad (13)$$

where *R*=1 if the individual is retired or *R*=0 otherwise, *P*(.) is the function returning the pension of the individual as a function of policy parameters of the relevant pension system in the sector, and *E*(*e*, *i*) is a function that is equal to 1 if an individual that will achieve education level *e* is out of school at age *i* or 0 otherwise. Also, for simplicity we set the initial age and the initial time at 1 so t and i are substitutes.

Using (13) we can compute internal rates of return to marginal investments in education. The internal rate of return $r^*(s, i, e, j)$ of moving from education level *e* to education level *e*+1 is characterized by:

$$\sum_{i=1}^{X} \left(nif(s,i,e+1,j) - nif(s,i,e,j)\right)\left(1 + r^*(s,e,e+1,j)\right)^{-t} v_i = 0 \quad (14)$$

Finally, we can compute the expected net gain of taking a job in sector *j* at time *t*, or waiting to take a job in sector *j'* at time *t*+1 with probability p(*j*). This is given by:

$$\begin{aligned} & ngw_t(s,i,e,j,j') = \\ & = \left(p(j')PV_{t=i+1}^{X}[nif(s,t,e,j')] + (1-p(j'))PV_{t=i+1}^{X}[nif(s,t,e,j)]\right) - \\ & \quad - PV_{t=i}^{X}[nif(s,t,e,j)] - \sum_{k=a}^{i} nif(s,k,e,j) b (1+r)^{(i-k)} \end{aligned} \quad (15)$$

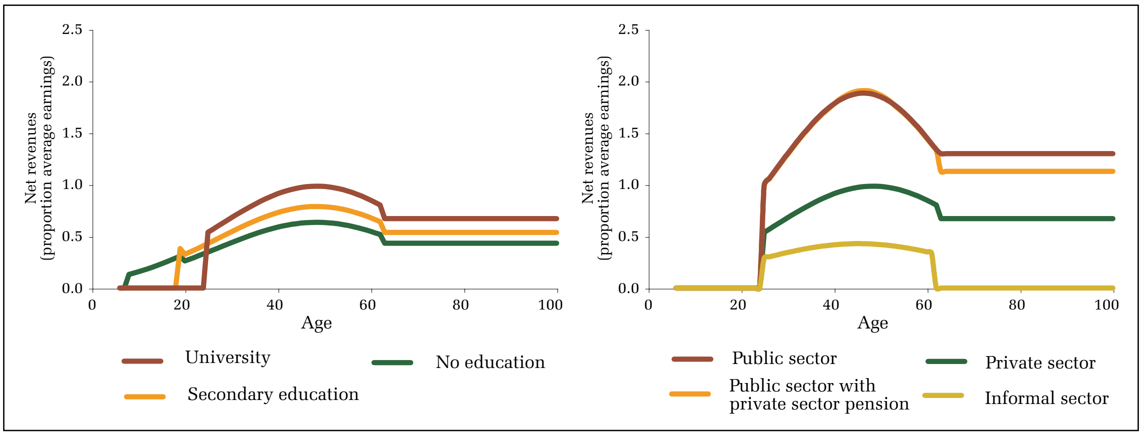
where PV[] is the present value function. The last term in equation (15) is used to take into account that an individual who continually delays taking the job in sector *j* might have to accumulate some level of debt to finance its consumption. The parameter *a* gives the age when the individual is first offered the job in sector *j*. Here the assumption is that the individual borrows a fraction *b* of the net income flow that he or she would have achieved by taking the job in sector *j*.

We again apply this framework to the case of Morocco. Equation (12) was estimated by using the 2002 household survey for Morocco. We defined 10 levels of education for the purposes of the analysis. In addition, we consider four economic sectors: private, formal non-agricultural sector, the public sector, and the agricultural/informal sectors. In the analysis, we constructed 120 career paths. These paths cross 10 levels of education, with four economic sectors, and with three types of pension funds. As before, in all cases, the growth rate of real average earnings is set at 3% per year and the discount rate is 4%.

The results show marked differences in the dynamics of wages across education levels. The left-hand panel of Figure 8 shows the career path of three individuals who work in the private sector. One has no education, the other has only secondary education and the third one has higher education. Not surprisingly, for the individual with no education the wage curve starts at a lower level and is also flatter. The various career paths also show that individuals working in the public sector, regardless of the level of education, enjoy a better situation both in terms of wages and pensions (see right-hand panel in Figure 8). On the contrary, individuals working in the agricultural sector and/or the urban informal sector receive lower wages than in the private sector – and they do not have pensions.

[18] Note that the variable 's' refers to savings rate in earlier section, to gender in the application of this section.

Figure 8. *Selected career paths by level of education and economic sector*

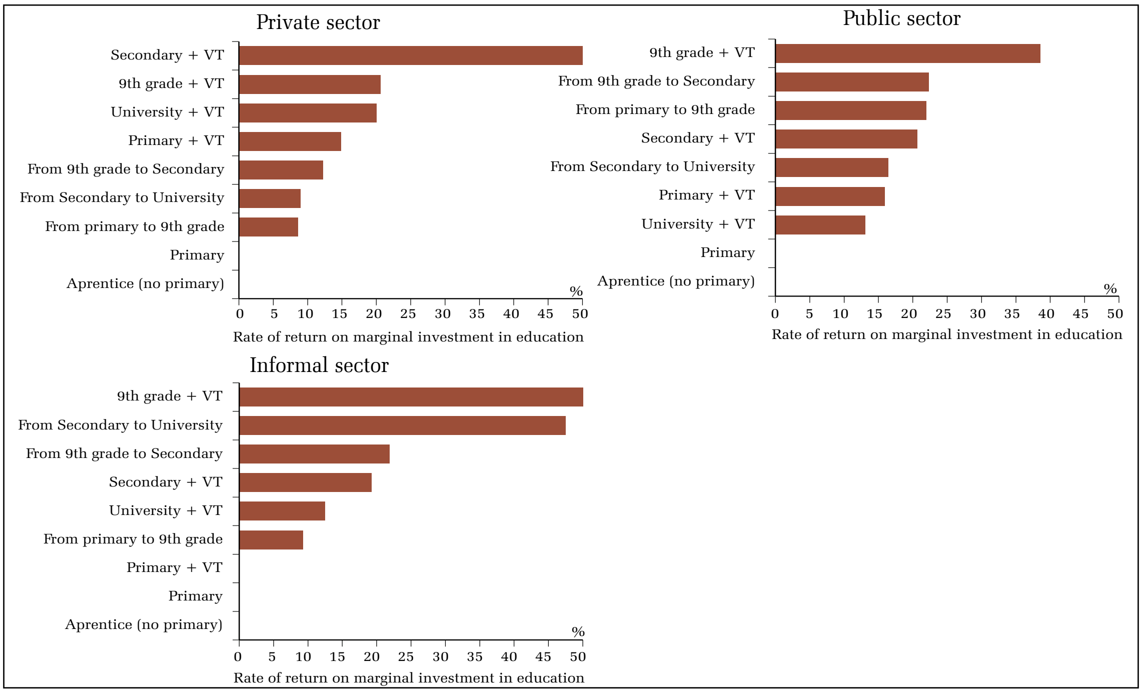


Source: Authors' calculations.

There are also important variations across sectors in terms of the internal rates of return on investments on different levels of education. Higher education, for instance, is better valued in the public sector (Figure 9). Secondary education with a technical diploma from a vocational training institution is highly valued in the private sector. In the informal sector, on the other hand, the highest rates of return are for investments in 9 years of basic education plus a technical diploma from a vocational training institution. In all sectors, investments in only primary education or primary education plus a technical diploma are not worth much. These investments are important, only as that they allow individuals to access higher educational levels.

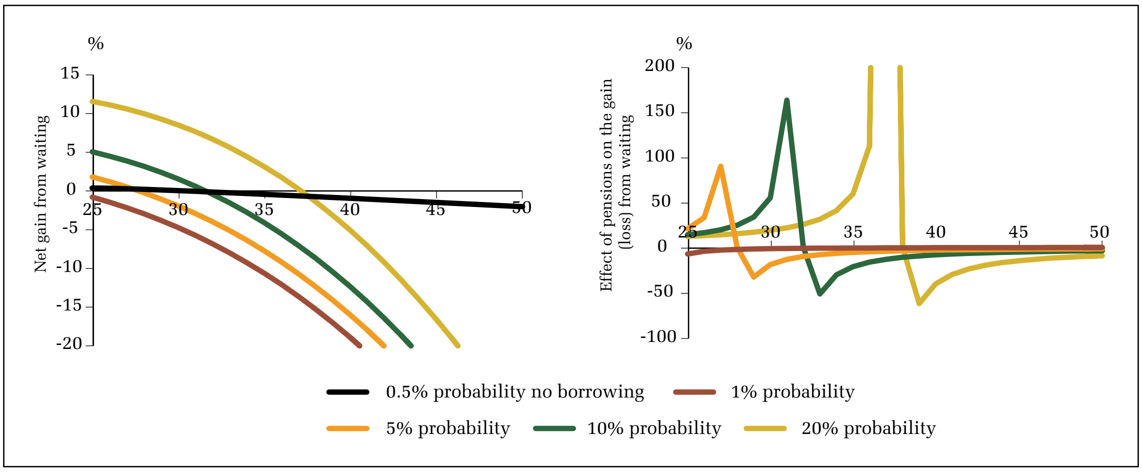
What are the incentives for individuals to queue for jobs in the civil service? To answer this question, we compute equation (15) for a 25 year-old individual having to decide whether to take a job in the private sector at time *t*, or wait for a job in the public sector that can occur with probability *p*. We simulate four values for *p*: 1%, 5%, 10% and 20%. We also assume that if the individual does not work he/she has to borrow an amount equivalent to 50% of the salary paid by the private sector job. The net gains from waiting for the public sector job are graphed in the left-hand panel of Figure 10. Each

Figure 9. *Internal rates of return on investment in education by economic sector*



Source: Authors' calculations.

Figure 10. *Incentives to Queue for Jobs in the Public Sector*



Source: Authors' calculations.

line corresponds to one value of *p*. We observe that even in the case of a very low probability of finding a public sector job, the individual has an incentive to wait for one year. If the probability of finding a job is 10% then the individual would have incentives to wait for 8 years. If the probability is 20% then the individual would have incentives to wait for 12 years. With no borrowing needs ($b=0$) even with a 2% probability of finding a job in the public sector, the individual would have incentives to wait for 10 years (see dotted line).

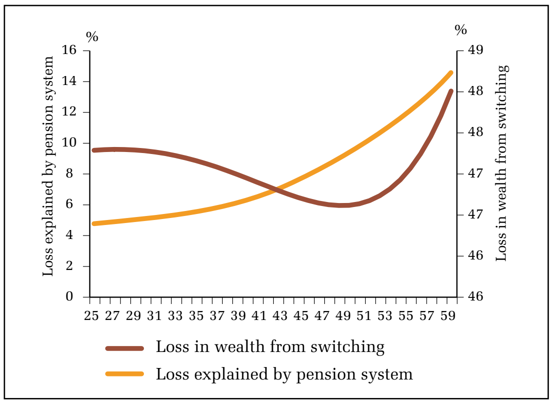
How much of the incentive to delay taking the job in the private sector is explained by the pension system? To answer this question we calculate equation (15) assuming that pensions in the civil service respond to the same rules as pensions in the private sector. We then compare the resulting *ngw*(.) functions. The percentage differences between the net gains of waiting at different ages are graphed in the right panel of Figure 10. The results show that differences in the pension system have strong effects around the age where waiting is no longer optimal. Depending on the probability of finding a job in the public sector, differences in pensions can increase by 10 to 40% of the net gain of waiting and therefore provide strong incentives to let the job in the private sector pass. Similarly, pensions can reduce by 10% to 30% the loss from waiting and also contribute to queuing.

The final question that we address is: what are the incentives to switch from a public sector to a private sector job? We do this analysis for an individual with higher education considering the possibility of switching at various ages. The relevant measure in this case is the change in the financial wealth, which is the present value of future wages and pensions. The results are presented in Figure 11. Not surprisingly, our calculations show that individuals switching would face important losses; the financial wealth could be reduced by 46% to 48%.

Most of the losses in financial wealth are of course attributable to lower salaries in the private sector. A sizable part of the losses, however, is also explained by the move to a less generous pension system. Hence, the change in pension system reduces the financial wealth by between 5% and 15%, depending on the age of the switching. The longer the individual waits, and therefore the higher the expected pensions are, the higher the loss (see orange line in Figure 11).

This section has analyzed incentives for labor mobility across main economic sectors. The analysis is based on the simulation of career paths and the calculation of three indicators: internal rates of return on education, net gains from queuing for jobs in the public sector, and the change in wealth resulting from switching jobs across sectors. These indicators can be easily computed on the basis of labor force or household survey data. When applied to Morocco, the indicators show that its fragmented pension system, more generous for civil servants, distorts rates of return on education, reduces incentives to supply labor in the private sector, and discourages mobility between the public and private

Figure 11. *Incentives to switch jobs between the public and private sectors*



Source: Authors' calculations.

sectors. The corollary is that pension reforms that unify the pension system can contribute to facilitate labor mobility across sectors and therefore contribute to improved economic efficiency.

5. Conclusions

In this paper we discuss and attempt to measure two of the distortions that badly designed defined benefit pension system (lacking actuarial connection between contributions and benefits) can impose on labor markets: incentives for early retirement, and incentives to queue for jobs in the public sector.

In the case of early retirement we argue that the standard indicators used to assess incentive problems, the internal rate of return (IRR) on contributions and the pension wealth are not appropriate. This is mainly because the indicators do not capture the trade-offs between consumption and leisure, which are at the core of the retirement decision. Thus, we proposed a complementary indicator – the normative estimator of the probability of early retirement based on utility maps. This indicator takes into account the trade-off between consumption and leisure as well as the heterogeneity of preferences of individuals.

We applied the indicator to the case of Morocco, a fairly representative country for the middle-income group. We showed that incentives for early retirement are important, particularly in the national scheme. We also illustrated how the indicators can be used in the context of a model that projects the labor force by age, gender, and skills level, to assess how changes in benefit formulas and eligibility conditions affect the accumulation of human capital. In the case of Morocco, on average, in the period 2006–2040, corrected early retirement incentives could increase the human capital growth rate by approximately 2% under conceivable stylized scenarios. We find this impact quite significant in light of current pension reform discussion/decision-making practices that fail to quantify the effects of pension reform on labor markets.

Subsequently, we analyzed incentives to supply labor in the private and public sector. The analysis was based on micro simulations of career paths for individuals with different levels of education working in different economic sectors – and therefore belonging to different pension plans. We focused on three indicators: internal rates of return on education, net gains from queuing for jobs in the public sector, and the change in wealth resulting from switching jobs across sectors. When applied to Morocco, the indicators showed that *a fragmented pension system distorts rates of return on education, reduces incentives to supply labor in the private sector, and discourages mobility between the public and private sectors*. The corollary is that pension reforms that unify the pension system can contribute to facilitate labor mobility across sectors and therefore improve economic efficiency.

There are both methodological and policy conclusions from our paper. Regarding the methodology, we believe that future assessments of pension institutions and international comparisons of the effects of benefit formulas and eligibility conditions on retirement decisions could benefit from the calculation of the normative estimator of the probability of early retirement based on the utility maps. The indicator is useful to assess, ex-ante, the potential impact that policy changes can have on retirement decisions. In addition, we believe that a complex analysis of the consequences of early retirement should go beyond the narrow assessment of the impact on the financial sustainability of the pension scheme and its fiscal implications. It should address the impacts on labor force participation rates, human capital accumulation and ultimately economic growth. The methodology described in this paper using the gender, age and educational attainment specific projection of the labor force and the associated measure of human capital seems a suitable framework for this type of analysis.

Regarding policies, the paper strengthens the argument for the existence of significant economic benefits of reforms that reduce incentives for early retirement, and eliminate differences in benefit formulas and eligibility conditions for different segments of the labor force. While those benefits have been pointed out in the literature, there are still a significant number of policy-makers in high- and middle-income countries that consider them exaggerated, especially when compared to the political costs of introducing pension reforms. Our paper will hopefully contribute to some re-assessment of the cost-benefit analysis of pension reforms, by showing that the benefits may have been so far underestimated.

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Table A.1. *Characteristics of the CMR and the CNSS in Morocco*

Characteristic	CMR		CNSS
	civil servants	military	
Eligibility conditions			
Age	60 years for men and women	45 or 50, depending on grade	60 years for women and men
Vesting period	None	No	15 years
Rules for early retirement	15 for women; 21 for men; the accrual rate is reduced by 0.5 percentage point	Same as for civil servants	55 years for women and men; no penalties apply, but the employer pays the pension between ages 55 and 60
Rules for delayed retirement	–	–	–
Rules for abandoning the system	Employee receives his or her contributions (not employer's) without interest	Same as for civil servants	Individuals can only receive benefits if they meet eligibility conditions
Social security contribution rates	14% of gross wage (employer, 7%; worker, 7%); for old-age pension, 14%; for other benefits, noncontributory. Contribution increases to 20 percent at a rate of two percentage points per year. Other benefits are financed directly by the government.	21% of gross wage (employer, 14%; worker, 7%) to finance old-age pension. Other benefits are financed directly by the government.	20.39%(employer, 16.09%; worker, 4.29%). Old-age, disability, and survivor pensions, 11.89%; family allowance, 7.5%; short terms benefits , 1%
Accrual rate	2.5%	2.5%	3.3% first 15 years; 1 percent afterward (law indicates 50% t of the income measure for the first 3,240 days, then 1 percent for each block of 216 days; simplification assumes that one year is 216 days of work)
Income measure	Last salary	Last salary	Last 8 years (no revalorization applies)
Ceiling on covered wage	No	No	DH 6,000
Maximum replacement rate or maximum pension	Maximum pension is 100% of net wage	Maximum pension is 100% of net wage	70% of gross wage
Pension indexation	Ad hoc	Ad hoc	Ad hoc
Minimum pension	DH 500 a month	DH 500 a month	DH 500 a month
Economy-wide minimum wage	DH 2,009 a month		
Economy-wide average wage	DH 2,750 a month		

Source: CMR and CNSS.
- Not available or not offered

Table A.2. *Characteristics of the RCAR in Morocco*

Characteristic	RCAR (basic regime)
Eligibility conditions	
Age	60 years for women and men
Vesting period	21 years
Rules for early retirement	55 years for both women and men with 21 years of contributions. The pension is reduced by 4.8% for each year missing to reach the normal retirement age (60).
Rules for delayed retirement	If individual retires after age 60 the pension increases by 4.8% for each year above the age of 60.
Rules for abandoning the system	Receives capital accumulated in the individual accounts
Social security contribution rates	18% of gross wage (employer, 12%; worker, 6%). Of these, individual accounts, 12%; family allowances, 0.65%; disability and survivor pensions, 1%; general fund covering future unfunded obligations of the scheme, 4.35%
Accrual rate	2 percent
Income measure	All remunerations (revalorized by the growth rate of the average covered wage)
Ceiling on covered wage	Four times the average salary (DH 11,000 in 2003)
Maximum replacement rate or maximum pension	90%
Pension indexation	Automatic indexation to consumer price index
Minimum pension	No
Economy-wide minimum wage	–
Economy-wide average wage	DH 2,750 a month

Source: RCAR.
- not available or not offered