European Network of Economic Policy Research Institutes

GENDER DIFFERENCES IN RETIREMENT INCOME AND PENSION POLICY:

SIMULATING THE EFFECTS OF VARIOUS DB AND DC SCHEMES

MICHELE BELLONI AND ELSA FORNERO,
WITH THE RESEARCH ASSISTANCE OF ALESSANDRO MANELLO

ENEPRI RESEARCH REPORT NO. 59
AIM

AUGUST 2008

ENEPRI Research Reports publish the original research results of projects undertaken in the context of an ENEPRI project. This paper was prepared as part of the ***Adequacy of Old-Age Income Maintenance in the EU (AIM) project –*** which has received financing from the European Commission under the 6th Research Framework Programme (contract no. SP21-CT-2005-513748). The views expressed are attributable only to the authors and not to any institution with which they are associated.

ISBN 978-92-9079-807-1
Available for free downloading from the ENEPRI website (http://www.enepri.org)
or the CEPS website (www.ceps.eu)

Gender Differences in Retirement Income and Pension Policy:

Simulating the Effects of Various DB and DC Schemes

ENEPRI Research Report No. 59/August 2008

Michele Belloni and Elsa Fornero, with the research assistance of Alessandro Manello*

Abstract

In this analysis, we evaluate the relative pension positions of men and women, under different characterisations of their respective working lives and pension designs. We consider both a Defined Benefit (DB) and a Defined Contribution (DC) scheme, and a few variants of their basic pension *formula*, each exemplifying a stylised normative framework.

Not surprisingly, the working career is the most relevant factor in determining the relative retirement income of women with respect to men; pension systems can compensate, but only up to a point. As for a comparison between DB and DC systems, taken without explicit redistributive measures, the latter can fare better than the former in providing a more equal distribution of retirement income between men and women, because it removes the greater return to steeper earnings profiles, more characteristic of men. The introduction of a minimum pension provision in the DB system improves the relative position of women with discontinuous or poor careers, while, in DC systems, a formal recognition of women's care activities through pension credits seems less effective than neutralising their longer life expectancy in the determination of the pension benefits using unisex longevity tables.

* Michele Belloni is Researcher at the CeRP (Centre for Research on Pensions and Welfare Policy), Collegio Carlo Alberto, Moncalieri. Elsa Fornero is Professor of Economics at the University of Turin and Director of CeRP.

Contents

Gender Differences in Retirement Income and Pension Policy:

Simulating the Effects of Various DB and DC Schemes

ENEPRI Research Report No. 59/August 2008

Michele Belloni and Elsa Fornero, with the research assistance of Alessandro Manello

1. Aim and background issues

It is a known fact that in many European countries women still experience disadvantage with respect to men in the labour market, which translates into lower participation rates, shorter working lives and poorer compensation levels. It is an equally well-known fact that pension systems generally try to remedy the consequences of women's disadvantages for economic (in)security in old age with more generous provisions, specifically addressed to them. It is a third 'stylised' fact that recent pension reforms in Europe have accentuated the correlation between contributions and benefits and to some extent 'individualised' the system, by reducing the scope for *derived rights*, such as those that depend on being a spouse (widow).

The first two facts reflect a social model that attributes different roles to women, regarded as the main providers of unpaid caring work, with respect to men; on the other hand, the third fact is the result of profound changes in that model and of the transition (which different countries have covered to differing extents) to a model that relies more on equality of opportunity and less on *ex post* compensations. In this model, caring activities are considered complementary, rather than accessory to, paid work in the job market (Fornero and Monticone, 2006).

These changes cause major problems, and policy-makers have become increasingly aware of the gender-related issues embedded in pension systems. At the EU level, the common objective of "review[ing] pension provisions with a view to ensuring the principle of equal treatment between women and men" (European Commission, 2003, p. 83) was agreed upon at the European Council held in Laeken in December 2001, as a step towards the "*modernisation of pension systems*", and is included in the open method of coordination among member states.

The recent attention paid to these issues is partly a consequence of the introduction of notional defined contribution (NCD) pension schemes in Italy, Latvia, Poland and Sweden (but other EU countries are in the process of evaluating the possible introduction of similar reforms). Since they strictly link pension benefits to contributions and to life expectancy at retirement, these schemes are viewed as 'less generous', in particular with respect to individuals with disadvantaged working careers, and thus typically to women. More specifically, a gender perspective on European pension systems reveals a heterogeneous situation with different rules for pension credits, survivor's benefits, annuitisation and retirement age, characterising both the more traditional Defined Benefit (DB) systems and the more recent Defined Contribution (DC) ones, a reflection of the several variants of the European welfare system.

In this analysis, we evaluate the relative pension positions of men and women, under different characterisations of their respective working lives and pension designs. We consider both a DB and a DC scheme, and a few variants of their basic pension formula, each exemplifying a

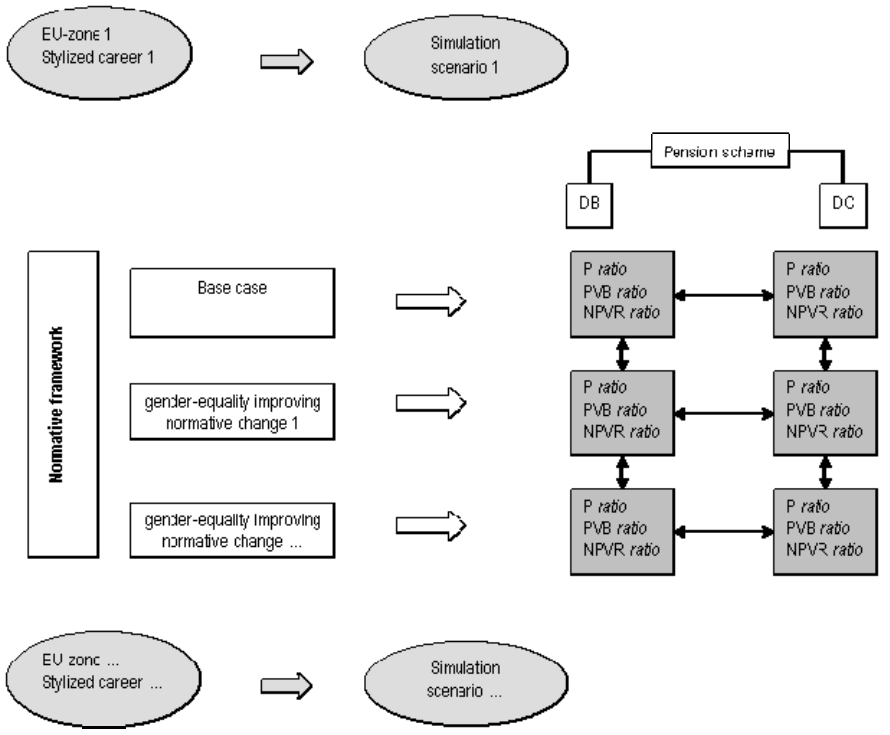
stylised normative framework. We first compare DB versus DC schemes, in order to assess their respective roles (in our specification) in determining the relative pension positions of men and women. We then look within each of the two schemes, and quantify the effectiveness of different provisions (such as pension credits for childbearing and childrearing, and different annuitisation rules for the DC scheme) in obtaining a more equal distribution of retirement resources between the genders.

The main results can be summarised as follows. Not surprisingly, the working career is the most relevant factor in determining the relative retirement income of women with respect to men; pension systems can compensate but only up to a point. As for a comparison between DB and DC systems, taken without explicit redistributive measures (such as a minimum pension provision in the first and pension credits in the second) the latter can fare better than the former in providing a more equal distribution of retirement income between men and women, because it removes the greater return to steeper earnings profiles, more characteristic of men. The introduction of a minimum pension provision in the DB system improves the relative position of women with discontinuous or poor careers, while, in DC systems, a formal recognition of women's care activities through pension credits seems less effective than neutralising their longer life expectancy in the determination of the pension benefits using unisex longevity tables.

2. Methodology

Our methodology is summarised in Figure 1. In order to establish a link with task 6.4.3 of the project, we consider two eurozones (EU-15 and EU-25), even though their characterisation only differs with respect to very few aspects (i.e. productivity, occupation and mortality). In order to capture the different positions of men and women in the labour market, we compare four stylised career patterns for women, against the benchmark of a unique pattern for men, with a further differentiation within each pattern as to the earning rate of growth (according to the level of education). Each combination of these dimensions defines a 'simulation scenario' (represented by the ovals in the figure). We then consider two stylised pension schemes – a DB and a DC system – and different variants of their basic *formula*. Each of these variants defines a '*normative framework*' (represented by the transparent rectangles in Figure 1). In the 'base case', a pension system with no specific provision directed at compensating the disadvantaged position of women in the labour market is considered. In the other normative frameworks, described in detail later on, specific rules addressed to women are introduced ("*gender-equality improving normative change…*" in Figure 1).

Figure 1. The methodology



For each scenario, each pension scheme and each normative framework, three indicators (listed in the grey rectangular forms) are computed: i) the woman/man *pension ratio (P ratio); ii)* the woman/man *present value of benefits ratio* (*PVB ratio*) and iii) the woman/man *net present value ratio* (*NPVR ratio*). The first indicator is just a rough measure of women's relative retirement income position; the second, which is a measure of pension wealth at retirement, also captures the effects of the gender differences in life expectancy at retirement; the third is a measure of the so-called "money's worth" of the pension system, as it is based on a comparison between (the present value of) contributions and benefits (Geanakoplos, Mitchell and Zeldes, 2000).

Finally, we evaluate the indicators by providing two kinds of comparisons, as indicated by the black arrows: *a) between* pension schemes, i.e. DB *versus* DC in the *same* normative framework (horizontal arrows) and *b) within* the same scheme between different normative frameworks (vertical arrows).

We stress that the model is microeconomic and works by representative agents, and therefore does incorporate little individual heterogeneity; accommodates only one composition effect (see note 1) and finally does not allow for feedback effects, as both labour supply and retirement are exogenous.

2.1 Macroeconomic and labour market characterisation

In order to capture the potential contribution of the new accessions to the relative retirement income of men and women, we perform simulations for two eurozones: EU-15 and EU-25. From our perspective, they differ in terms of their macroeconomic and demographic characteristics: the first is simply sketched by the current rates of growth of both employment

and labour productivity (OECD, *Statistical Compendium* 2006/1); the second is summarised by age specific mortality rates.

In our simplified model, the GDP growth rate is given by the sum of the growth rates of employment and labour productivity; both are exogenously given and constant over time, although they can differ across simulations. The average earnings growth of the economy is determined by labour productivity, and is relevant both for the implicit rate of return of the DC system and for the rate of increase of individual earnings, with a (small) variability among representative agents determined by seniority and education level. Inflation is not considered. Demographic features are also exogenous and are relevant only as far as their consequences on the individual pension wealth as well as on the transformation coefficients of DC schemes are concerned.

As for the relative positions of men and women in the labour market, we define a few stylised working careers, consistent with the macroeconomic framework described. A *stylised career* is identified by a *career pattern* – which specifies its length and continuity and essentially depends on having children – and by the *earnings rate of growth*. The age of entry into the labour market is set at 23 for both men and women. Men are assumed to work full-time throughout their whole career and retire at 65.

We consider 4 possible women's *career patterns* (adapted from James et. al., 2003):

a) Full-time (F): the career pattern of this group is the same as men's; these women do not have children and work full-time until retirement;

b) Full-time, part-time, full-time (F/P/F): the women in this group work full-time until the age of 25; part-time from this age to 37, during which period they bear and rear two children, one borne at age 25 and the other at age 28. At 37, they are back to full-time paid job until age 65, when they retire.

c) Full-time, part-time (F/P): the women in this group work full-time until 25, and part-time for the rest of their working life. This pattern is meant to capture not only the bearing and rearing of children (borne, as before, at 25 and at 28) but also, possibly, elderly care in the household.

d) Short career (S): the women in this group work full-time until 25, part-time until age 37 (when they follow the typical maternity pattern) and then retire.

As for *individual earnings*, we assume they depend on three factors: rate of growth of labour productivity, seniority and education. The first one, which defines the average wage growth, depends on the simulated EU-zone. The second one affects individual earnings in a very simple way: it only discriminates between continuous and discontinuous careers, attributing to the first ones a higher rate of growth of earnings.[1]

Education introduces a further differentiation both between and within genders, by attributing a higher earning rate of growth to higher educated workers. However, since in the present work we limit the comparison between men and women, the intra-gender inequality is not considered. It follows that careers as specified in pattern *a)* are identical, also as far as education is concerned, and the comparisons do not depend on it. For the other career patterns, instead, we

[1] The rates of growth of individual earnings respect the following aggregate constraint: $\bar{g}_w = \pi = \sum_{\substack{g=m,f \\ e=h,l}} p_{g,e} g_{g,e}$ where $\bar{g}_w$ is the average rate of growth of individual earnings, π the rate of growth of labour productivity, g is gender and e is education level. Ps are determined proportions of each group within the current labour force in EU.

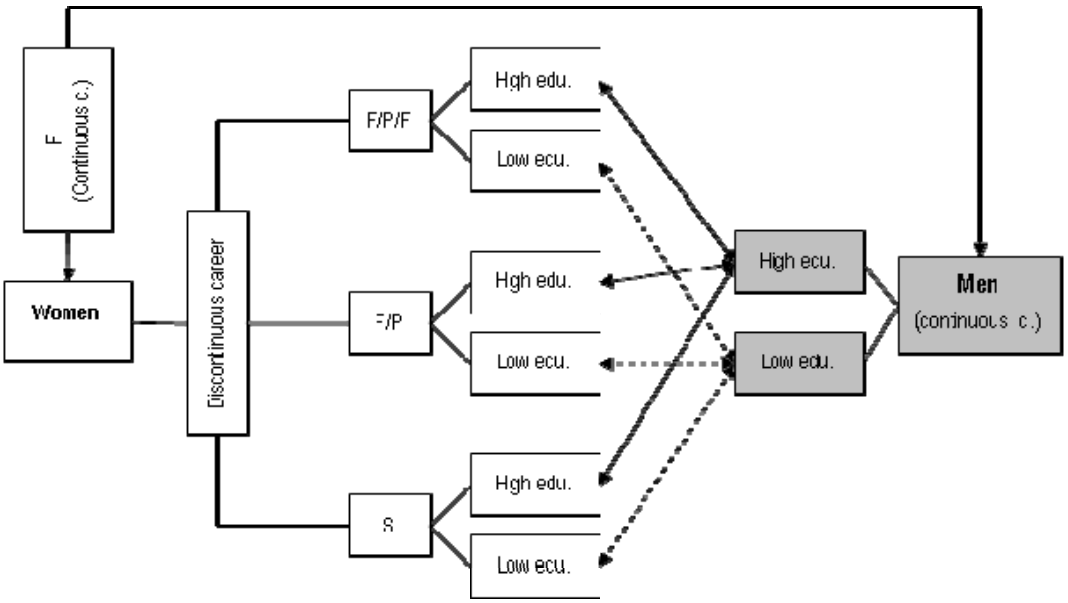
present different simulations for higher and lower educated workers. This additional classification – which provides more heterogeneity in the rate of growth of individual earnings – allows for changes in the wage growth *gap* between genders according to education level. This difference is larger among higher educated workers.

Combining career patterns and rates of growth on individual earnings, we end up with 7 stylised women's careers. Considering both geographical entities (and in addition a 'high productivity' scenario), we finally obtain the simulation plan described in Table B.1 in Appendix B.

Table 1. Macroeconomic assumptions and consequent rates of growth of individual earnings (% points)

Growth rates:	**EU15**	**EU25**	**High growth**
Labour productivity	0.93	1.1	2
Employment	0.49	0.5	0.49
Individual earnings:			
Men/women continuous career	0.93	1.1	2
Men higher edu.	1.85	2.19	3.98
Women higher edu. (discontinuous c.)	0.9	1.06	1.94
Men lower edu.	0.8	0.95	1.72
Women lower edu. (discontinuous c.)	0.3	0.35	0.65

Figure 2. A graphical illustration of our comparisons



2.2 Pension systems characterisation

We consider two PAYGO schemes: a DB and a (N)DC. The DB pension benefit depends on the average wage of the last 5 years of work and on accrued seniority at retirement. We assume that, for women with particularly disadvantaged careers, the DB benefit is replaced by a *minimum pension* (equal to 60% of the entry wage). The DC pension is computed in two steps: first, the contributions paid throughout the working career are capitalised, year-by-year, at a rate equal to

the GDP growth rate; second, at retirement the accrued fund is converted into a pension benefit by means of an age-specific transformation coefficient.[2]

We first evaluate how the poorer performance of women in the labour market – in terms of career pattern and compensation level – would result in lower pension outcomes (with respect to men's), if the pension system did not provide specific rules addressed to women as for childbearing, childrearing and (only for the DC pension) annuitisation: **no pension credits, single-head annuity, gender-specific transformation coefficient**. This is our **'base case'.** We then consider a variant of this base case by including a minimum pension provision in the DB system, to capture its greater redistributive features with respect to the NDC system.

We finally define alternative normative frameworks, by changing in turn one of the above mentioned rules of the base case. In particular, each case incorporates one of the following rules:

- Spells of childbearing and childrearing are considered for the calculation of pension rights, by means of a given number of months (or years) of pension credits for each child born. The following alternative cases are considered:
  a) a 6-month maternity leave;
  b) 2 years for childbearing and childrearing;
  c) 4 years for childbearing and childrearing.[3]
- A survivors' component is incorporated into the computation of the transformation coefficients in the DC pension formula.
- Unisex transformation coefficients replace gender-specific ones when the DC pension is computed.

The base case plus the changes define the normative frameworks shown in Table 2.

Table 2. Normative frameworks

Normative framework	Notional contribution (years)	Social pension (DB only)	Transformation coefficient (DC only)	
			Survivors' component	Mortality rates
Base	no	no	no	Gender specific
Base + 1	no	yes	no	Gender specific
Base + 2a	1	yes	no	Gender specific
Base + 2b	4	yes	no	Gender specific
Base + 2c	6	yes	no	Gender specific
Base + 3	no	yes	yes	Gender specific
Base + 4	no	yes	no	Unisex
Base + 2b + 3	4	yes	yes	Gender specific
Base + 2b + 3 + 4	4	yes	yes	Unisex

[2] These coefficients depend on mortality rates and expected GDP growth (both changing across scenarios) and on other variables, such as gender and the inclusion of a survivors' component (which define different normative frameworks). See Appendix A for further explanations.

[3] Cases a), b), and c) reflect the current normative rules in the UK, Luxembourg and Sweden respectively. In every case, pension credits entirely 'cover' the maternity leaves. We also assume that each additional year of credit can be spread over a period of two years, when the woman works part-time.

For each simulation scenario, pension scheme and normative framework, we finally compute the following indicators:

- woman/man pension *ratio* (P *ratio*);
- woman/man present value of benefits *ratio* (PVB *ratio*);
- woman/man net present value *ratio* (NPVR *ratio*),

where the PVB *ratio* captures, in addition to the P *ratio*, the difference in life expectancy at retirement between genders. The NPVR *ratio* captures instead the overall generosity of the pension system (given that it takes into account the contributory history of the workers).[4] More details on the indicators can be found in Appendix A.

3. Results

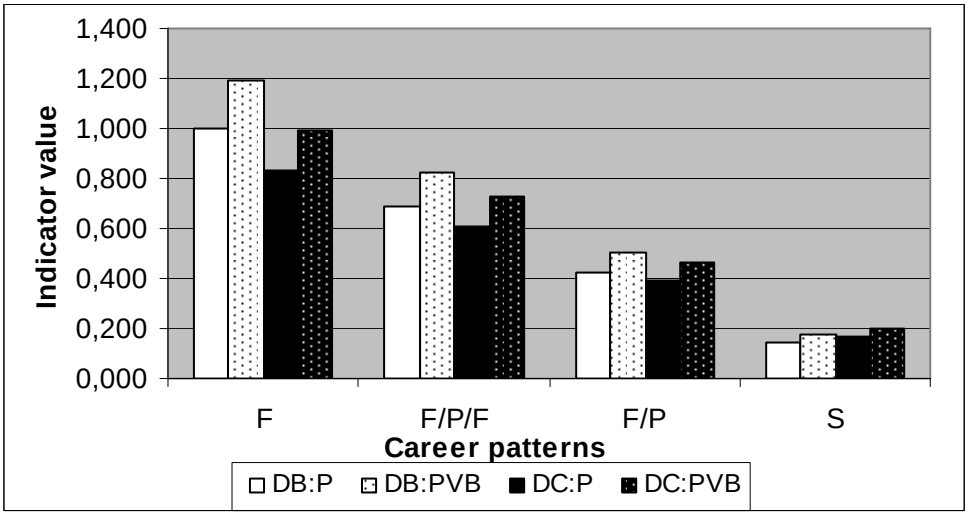
Figures from 3 to 6 present the results of our simulations. In order to interpret them, we stress that our indicators are always representative of the relative position of women with respect to men; thus they do not tell anything in terms of the absolute level of pensions (for example, to establish a comparison to a poverty line) or in terms of individual replacement ratios.

Figure 3, which is relative to our base case, illustrates the basic fact that the relative pension position of women is determined by their relative position in the labour market. The different characterisations of pension systems are secondary factors. Women enjoying the same working pattern and the same compensation level 'fare like men' in the DB system as far as their pension benefit is concerned (the P ratio is equal to 1) and better than men in terms of pension wealth (given their lower mortality, their pension wealth is 1.20 times that of men). In the NDC system, given that the system incorporates life expectancy in the pension formulae, and that mortality tables are differentiated by gender, the situation is reversed: the pension-wealth ratio is equal to one, while the P ratio is 0.8 given women's higher life expectancy.

Moving to the right of the figure, we see that the relative occupational situation of women worsens. In the F/P/F career the pattern of differentiation among the indicators characterising the full career is maintained, although the level is lower, varying between 0.6 and 0.8. Moving further to the right, we see that indicators tend to level out: in the short career case all indicators are around 0.2.

[4] For a description of these indicators (known as "money's worth measures") see e.g. Geanakoplos, Mitchell and Zeldes (2000).

Figure 3. P ratios and PVB ratios for different women's career patterns: EU-15, base case (no social pension)

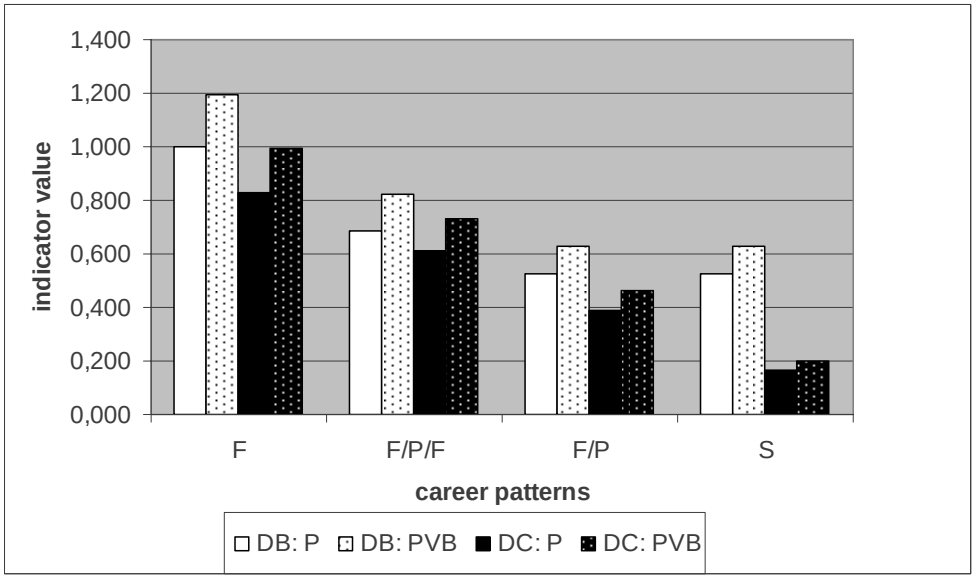


Notes: F is *full-time*, F/P/F is *full-time, part-time, full-time*, F/P is *full-time, part-time*, S is *short career*. Men are assumed to work full-time. Normative framework is *base case*. Scenario is EU-15, lower education.

Source: Our calculations.

The inclusion of a minimum pension provision – equal to one third of the average initial earnings – in the DB system (see Figure 4) leaves unchanged the relative position of the first two groups of women, as their work entitles them to more than the minimum benefit. For the other two groups, this provision significantly improves their relative position, taking them to around 0.5 for the P ratio, and 0.6 for the PVB ratio.

Figure 4. P ratios and PVB ratios for different women's career patterns: EU15, base case + 1 (with social pension)

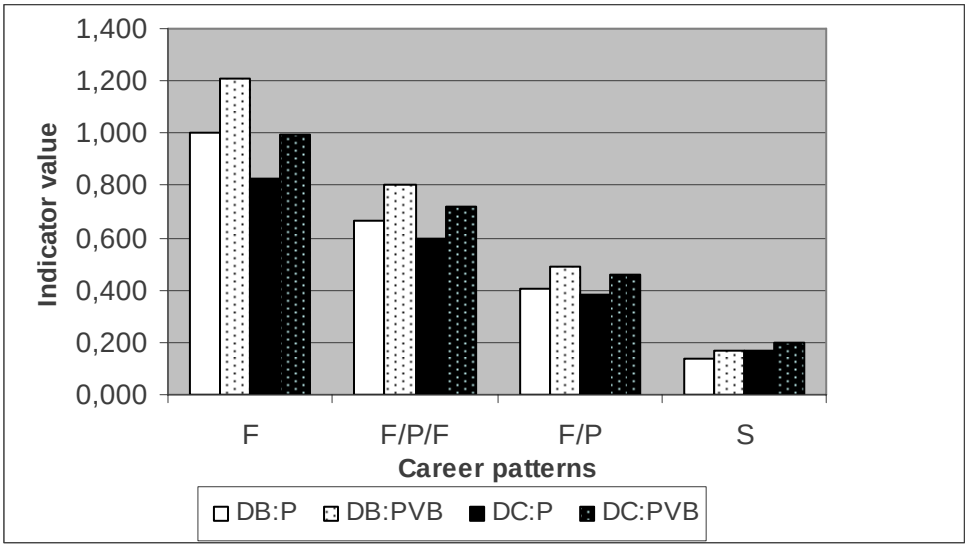


Notes: F is *full-time*, F/P/F is *full-time, part-time, full-time*, F/P is *full-time, part-time*, S is *short career*. Men are assumed to work full-time. Normative framework is *base case + 1*. Scenario is EU-15, lower education.

Source: Our calculations.

Figure 5 considers an enlarged Europe (EU-25), capturing essentially two features: a higher productivity growth and higher mortality rates. Both are almost irrelevant, which is not surprising, given: a) the very limited increase in the productivity growth; and b) that the higher mortality concerns both genders, leaving their relative position unchanged.

Figure 5. P ratios and PVB ratios for different women's career patterns: EU-25

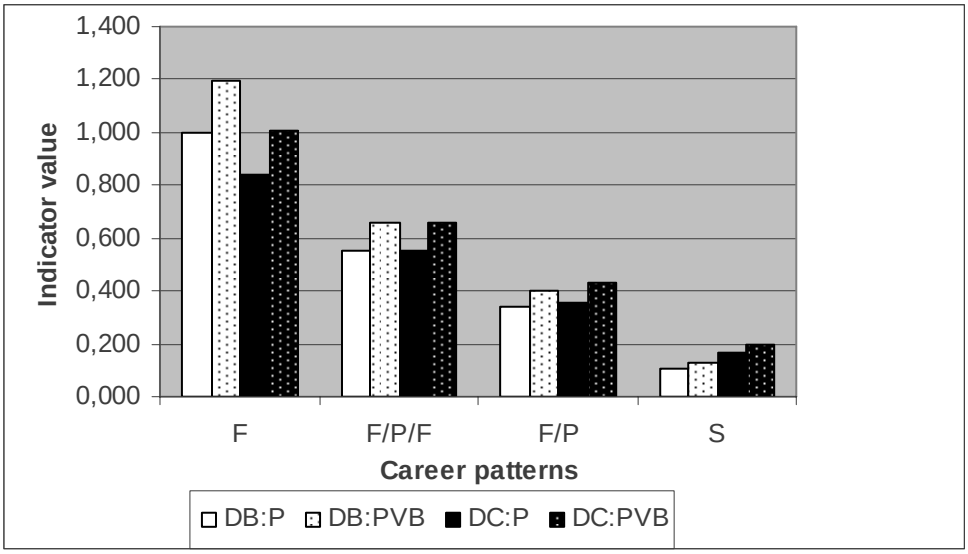


Notes: F is *full-time*, F/P/F is *full-time, part-time, full-time*, F/P is *full-time, part-time*, S is *short career*. Men are assumed to work full-time. Normative framework is *base case*. Scenario is EU25, lower education.

Source: Our calculations.

In order to highlight the effects of higher growth we isolate this factor (Figure 6), by considering a rate of growth of labour productivity equal to 2%, instead of 0.9 (see Table 1). Against the benchmark of a full career, the more dynamic the economy, the more discontinuous are careers penalised, as shown by the worsening of the relative positions of women in Figure 6 with respect to what is shown in Figure 3.

Figure 6. P ratios and PVB ratios for different women's career patterns: high productivity



Notes: F is *full-time*, F/P/F is *full-time, part-time, full-time*, F/P is *full-time, part-time*, S is *short career*. Men are assumed to work full-time. Normative framework is *base case*. Scenario is *high productivity,* lower education.

Source: Our calculations.

Among the policy measures we simulate, the most effective in improving the relative position of women is the introduction of unisex transformation coefficients in the NDC scheme (base + 4). Table B.3 in the Appendix, for example, shows how the P ratio and the PVB ratio increase by 13 and 15% respectively as compared to the base case (from 0.61 to 0.74 and from 0.73 to 0.88). We achieve this result only through our most generous assumption on pension credits, which allows for 6 years of notional contributions. In the other, less generous cases, the effectiveness of pension credits in improving the relative position of women is more limited. If 6 months of pension credits for each child are granted, the P ratio and the PVB ratio only increase by around 2% both in the DB and in the NDC scheme.

Finally, providing a survivors' annuity in the NDC scheme (base + 3) increases the P ratio by 11% (because the additional benefit is greater for men than for women) but it leaves the PVB ratio almost constant (the slight increase of 1% from 0.73 to 0.74 is due to the assumption that the discount rate is greater than the GDP growth rate). The survivors' benefit is in fact fully 'paid' by the main beneficiary, by means of an actuarially-reduced pension. On the contrary, providing survivors' benefits in the DB scheme decreases the PVB ratio by 12% (for the same reason just mentioned).[5]

Results do not change (qualitatively, and very little quantitatively) across scenarios as well as across different career patterns.

[5] Providing survivors' benefits in the DB scheme generates an increase in the pension wealth of both men and women, because the pension is not actuarially corrected and contributions paid are unchanged. This policy is therefore not financially sustainable.

References

Belloni, M. and C. Maccheroni (2006), *Actuarial Neutrality when Longevity Increase: An Application to the Italian Pension System*, CeRP Working Paper No. 47/06.

Economic Policy Committee and the European Commission (2005), "The 2005 EPC Projections of age-related expenditure (2004-2050) for the EU-25 Member States: underlying assumption and projection methodologies" (available at http://ec.europa.eu/economy_finance/index_en.htm).

EUROSTAT (2005), "Employment rate by sex and age" (available at http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/popul/Popula/migrat&language=en&product=EU_MAIN_TREE&root=EU_MAIN_TREE&scrollto=0).

EUROSTAT (2000), "Probability of dying by sex and age" (available at http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/popul/Popula/migrat&language=en&product=EU_MAIN_TREE&root=EU_MAIN_TREE&scrollto=0).

European Commission (2003), *Joint report by the Commission and the Council on adequate and sustainable pensions*, COM (2002)737.

Fornero, E. and C. Monticone (2006), "Women and Pensions: Effects of Pension Reforms on Women's Retirement Security", draft.

Geanakoplos, J., O. Mitchell and P. Zeldes (2000), *Social Security Money's Worth*, NBER Working Paper No. 6722, National Bureau of Economic Research.

Gilbert, N. (2006), *Gender and Social Security Reform, What's Fair for Women?*, International Social Security Administration.

INPS (1989), "Il modello INPS e le prime proiezioni al 2010", *Previdenza Sociale*, No. 3/89.

James, E., A. Cox Edwards and R. Wong (2003), *The Gender Impact of Pension Reform: A Cross-country Analysis*, Policy Research Working Paper No. 3074, Poverty Reduction and Economic Management network, Gender Division, The World Bank.

OECD (2006), *Statistical Compendium*, 2006/1 edition, OECD, Paris.

Appendix A: Model details

Pensions formulae and measures of gender redistribution

- The DB formula is given by:

$$P_{s,X} = \overline{w}_{s,X} \cdot \alpha \cdot sen_{s,X}$$

where: $\overline{w}_{s,X} = \frac{\sum_{i=0}^{4} w_{s,X-i}}{4}$, *sen* is seniority at retirement, *s* the gender (m=male, f=female), *X* the retirement age, *w* the wage and α the incremental benefit per year of seniority.

- The DC formula is given by:

$$P_{s,X} = \delta_{(s),X} \sum_{i=23}^{X} c_{s,i} (1+g)^{X-i}$$

with $c_{s,i} = w_{s,i}\gamma$ and $\delta_{(s),X} = \delta(g^E, \frac{\ell_{(s),X+t}}{\ell_{(s),X}})$

where γ is the contribution rate, *c* the amount of contributions paid, *g* the GDP rate of growth, $\delta_{(s),X}$ the transformation coefficient for retirement at age *X* (and gender *s*), g^E the expected GDP rate of growth and $\frac{\ell_{(s),X+t}}{\ell_{(s),X}}$ the survival probability at age *X*+*t*, conditional on being alive at retirement.

Unisex transformation coefficients are defined as:

$$\delta_X = \left(\frac{\sum_{s=m,f} dir_{s,X} + \Psi ind_{s,X}}{2} \right)^{-1}$$

while gender-specific transformation coefficients as:

$$\delta_{s,X} = (dir_{s,X} + \Psi ind_{s,X})^{-1}$$

with:

$$dir_{s,X} = \sum_{t=0}^{\Omega - x} \frac{\ell_{s,X+t}}{\ell_{s,X}} (1+g^E)^{-t}$$

$$ind_{s,X} = \sum_{t=0}^{\Omega - x} \frac{\ell_{s,X+t}}{\ell_{s,X}} \left(1 - \frac{\ell_{s,X+t+1}}{\ell_{s,X+t}}\right)(1+g^E)^{-t} \sum_{\tau=1}^{\Omega - X - t + \varepsilon_s} \frac{\ell_{-s,X+t+\tau-\varepsilon_s}}{\ell_{-s,X+t+1-\varepsilon_s}} \left(1 - \ell^{ved}_{-s,X+t+\tau-\varepsilon_s}\right)(1+g^E)^{-\tau}$$

where Ω is the lifespan, $\ell_{s,X}$ the survivors from 100.000 live births of gender *s* at age *X*, $\ell^{ved}_{-s,X}$ the probability for the widow(er) (of age *X* and gender –*s*) to marry again after the pensioner's (of gender *s*) death, ε_s the age-difference between pensioner and widow (er) and Ψ the quota of the pension revertible to the widow(er).

- The woman/man pension *ratio* (P *ratio*) is given by: $\frac{P_{f,X}}{P_{m,X}}$

- The woman/man present value of benefits *ratio* (PVB *ratio*) is given by: $\frac{PVB_{f,X}}{PVB_{m,X}}$

  where $PVB_{s,X} = P_{s,X}\frac{1}{\delta_{s,X}}$, assuming in $\delta_{s,X}$ that g^E=r and

  $\Psi = \begin{cases} 0.5 & \textit{if} \text{ normative framework is base + 3, base + 2b + 3, base + 2b + 3 + 4} \\ 0 & \text{otherwise} \end{cases}$.

- The woman/man net present value *ratio* (NPVR *ratio*) is given by: $\frac{NPVR_{f,X}}{NPVR_{m,X}}$ where

  $$NPVR_{s,X} = \frac{PVB_{s,X}}{\sum_{i=15}^{X} c_{s,i}(1+r)^{X-i}}$$

Other model details and assumptions

- Mortality rates for EU15 are approximated by mortality rates of Germany. Mortality rates for EU25 are approximated by mortality rates of Czech Republic,
- $g^E = g$ (static expectations on GDP growth),
- r is 2 percent,
- $\varepsilon_s = 3$ if s = m, $\varepsilon_s = -3$ if s = f,
- $l_{x,s}^{ved}$ is approximated by Italian values (INPS, 1989).
- Notes: the indicators do not depend on α and γ, and vary only a little with respect to changes in r.

Appendix B: Simulation plan and detailed results

Table B.1 Simulation plan

Simulation number	scenario	working career	
		education	pattern
1	EU 15	-	F
2	EU-15	Lower	F/P/F
3	EU-15	Higher	F/P/F
4	EU-15	Lower	F/P
5	EU-15	Higher	F/P
6	EU-15	Lower	S
7	EU-15	Higher	S
8	EU-25	-	F
9	EU-25	Lower	F/P/F
10	EU-25	Higher	F/P/F
11	EU-25	Lower	F/P
12	EU-25	Higher	F/P
13	EU-25	Lower	S
14	EU-25	Higher	S
15	High prod.	-	F
16	High prod.	Lower	F/P/F
17	High prod.	Higher	F/P/F
18	High prod.	Lower	F/P
19	High prod.	Higher	F/P
20	High prod.	Lower	S
21	High prod.	Higher	S

Notes: F is full-time, F/P/F is full-time, part-time, full-time, F/P is full-time, part-time, S is short career.

Table B.2 Simulation 1

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	1,00	1,20	1,20	0,83	0,99	0,99
Base + 1	1,00	1,20	1,20	0,83	0,99	0,99
Base + 2a	-	-	-	-	-	-
Base + 2b	-	-	-	-	-	-
Base + 2c	-	-	-	-	-	-
Base + 3	1,00	1,02	1,02	0,98	1,00	1,00
Base + 4	-	-	-	1,00	1,20	1,20
Base + 2b + 3	-	-	-	-	-	-
Base + 2b + 3 + 4	-	-	-	1,00	1,02	1,02

Table B.3 Simulation 2

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	0,69	0,82	1,13	0,61	0,73	1,00
Base + 1	0,69	0,82	1,13	0,61	0,73	1,00
Base + 2a	0,71	0,84	1,16	0,63	0,76	1,04
Base + 2b	0,76	0,90	1,24	0,69	0,82	1,12
Base + 2c	0,80	0,96	1,32	0,74	0,88	1,21
Base + 3	0,69	0,70	0,96	0,72	0,74	1,01
Base + 4	-	-	-	0,74	0,88	1,21
Base + 2b + 3	-	-	-	0,81	0,83	1,13
Base + 2b + 3 + 4	-	-	-	0,82	0,84	1,16

Table B.4 Simulation 3

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	0,58	0,69	1,02	0,56	0,67	1,00
Base + 1	0,58	0,69	1,02	0,56	0,67	1,00
Base + 2a	0,59	0,71	1,05	0,58	0,70	1,03
Base + 2b	0,64	0,76	1,13	0,63	0,75	1,11
Base + 2c	0,68	0,81	1,20	0,67	0,80	1,19
Base + 3	0,58	0,59	0,88	0,67	0,68	1,01
Base + 4	-	-	-	0,68	0,81	1,20
Base + 2b + 3	-	-	-	0,74	0,75	1,12
Base + 2b + 3 + 4	-	-	-	0,75	0,77	1,14

Table B.5 Simulation 4

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	0,42	0,50	1,07	0,39	0,47	0,98
Base + 1	0,52	0,63	1,32	0,39	0,47	0,98
Base + 2a	0,52	0,63	1,32	0,41	0,49	1,04
Base + 2b	0,52	0,63	1,32	0,46	0,55	1,17
Base + 2c	0,54	0,64	1,36	0,51	0,61	1,30
Base + 3	0,52	0,54	1,13	0,46	0,47	0,99
Base + 4	-	-	-	0,47	0,56	1,19
Base + 2b + 3	-	-	-	0,55	0,56	1,18
Base + 2b + 3 + 4	-	-	-	0,56	0,57	1,20

Table B.6 Simulation 5

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	0,36	0,42	0,99	0,35	0,42	0,98
Base + 1	0,36	0,42	0,99	0,35	0,42	0,98
Base + 2a	0,37	0,44	1,04	0,37	0,44	1,03
Base + 2b	0,41	0,49	1,15	0,41	0,49	1,15
Base + 2c	0,45	0,54	1,27	0,46	0,55	1,27
Base + 3	0,36	0,36	0,85	0,42	0,42	0,99
Base + 4	-	-	-	0,42	0,51	1,18
Base + 2b + 3	-	-	-	0,49	0,50	1,16
Base + 2b + 3 + 4	-	-	-	0,50	0,51	1,19

Table B.7 Simulation 6

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	0,14	0,17	0,80	0,17	0,20	0,92
Base + 1	0,52	0,63	2,88	0,17	0,20	0,92
Base + 2a	0,52	0,63	2,88	0,19	0,23	1,04
Base + 2b	0,52	0,63	2,88	0,24	0,29	1,33
Base + 2c	0,52	0,63	2,88	0,29	0,35	1,60
Base + 3	0,52	0,54	2,46	0,20	0,20	0,93
Base + 4	-	-	-	0,20	0,24	1,11
Base + 2b + 3	-	-	-	0,28	0,29	1,34
Base + 2b + 3 + 4	-	-	-	0,29	0,30	1,36

Table B.8 Simulation 7

	Women/Men ratios					
	DB			DC		
Normative framework	**P**	**PVB**	**NPVR**	**P**	**PVB**	**NPVR**
Base	0,10	0,12	0,67	0,14	0,17	0,91
Base + 1	0,33	0,40	2,16	0,14	0,17	0,91
Base + 2a	0,33	0,40	2,16	0,16	0,19	1,03
Base + 2b	0,33	0,40	2,16	0,20	0,24	1,31
Base + 2c	0,33	0,40	2,16	0,25	0,29	1,60
Base + 3	0,33	0,34	1,85	0,17	0,17	0,92
Base + 4	-	-	-	0,17	0,20	1,10
Base + 2b + 3	-	-	-	0,24	0,24	1,32
Base + 2b + 3 + 4	-	-	-	0,24	0,25	1,35

About AIM (Adequacy & Sustainability of Old-Age Income Maintenance)

The AIM project aims at providing a strengthened conceptual and scientific basis for assessing the capacity of European pension systems to deliver adequate old age income maintenance in a context of low fertility and steadily increasing life expectancy. The main focus is on the capacity of social security systems to contribute to preventing poverty among the old and elderly and more generally to enable persons to take all appropriate measures to ensure stable or "desired" distribution of income over the full life cycle. In addition it will explore and examine the capacity of pension systems to attain broad social objectives with respect to inter- and intra generational solidarity.

Furthermore it will examine the capacity of pension systems to allow workers to change job or to move temporarily out of the labour market and to adapt career patterns without losing vesting of pensions rights. The project will also address the specific challenges with respect to providing appropriate old age income for women.

A general objective of the research project is to clearly identify and analyse the potential trade-offs between certain social policy objectives and overall stability of public debt.

AIM is financed under the 6th EU Research Framework Programme. It started in May 2005 and includes partners from both the old and new EU member states.

Participating institutes

- Centre for European Policy Studies, CEPS, Belgium, coordinator
- Federal Planning Bureau, FPB, Belgium
- Deutsches Institut für Wirtschafsforschung (German Institute for Economic Research), DIW, Germany
- Elinkeinoelämän tutkimuslaitos, (Research Institute of the Finnish Economy), ETLA, Finland
- Fundación de Estudios de Economía Aplicada , FEDEA, Spain
- Social and Cultural Planning Office, SCP, Netherlands
- Instituto di Studi e Analisi Economica (Institute for Studies and Economic Analysis), ISAE, Italy
- National Institute for Economic and Social Research, NIESR, United Kingdom
- Centrum Analiz Spolleczno-Ekonomicznych (Center for Social and Economic Research), CASE, Poland
- Tarsadalomkutatasi Informatikai Egyesules (TARKI Social Research Informatics Centre), TARKI, Hungary
- Centre for Research on Pensions and Welfare Policies, CeRP, Italy
- Institute for Economic Research, IER, Slovak Republic
- Inštitut za ekonomska raziskovanja (Institute for economic research), IER, Slovenia