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European Pension Systems: A Simulation Analysis

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Abstract

Pension systems in different countries vary widely in such aspects as the dependence of benefits on earlier labour income, the minimum permitted retirement age and limits on labour supply after retirement. This paper uses a simulation model of a rational, utility-maximising household facing the detailed pension provisions of eight European countries to study microeconomic distortions induced by the different rules and regulations. We examine in particular the impact on savings, labour supply, retirement age decisions and welfare.

JEL classification: H55, J26, J65.

I. INTRODUCTION

1. The Basic Approach

Budgetary pressures have obliged a range of countries to consider substantial reforms in their retirement income policies. For example, Spain and the UK have implemented large cuts in the actuarial value of future benefits in their state-sponsored earnings-related pension systems, while the Italian government is currently endeavouring to push through similar changes. Major reforms have also been discussed in Eastern Europe (see Hambor (1992), Diamond (1994) and Perraudin and Pujol (1994)). At such a time of reform, it is important that the economic implications of different pension rules be clearly understood. Broadly speaking, three aspects of pension regulation have been studied.

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First, much recent research has been directed at analysing the macroeconomic implications of pension systems in the presence of an ageing population. Bös and von Weiszäcker (1989), Marchand and Pestieau (1991) and Hageman and Nicoletti (1989) describe the problem and apply generational accounting methods, while Auerbach, Kotlikoff, Hageman and Nicoletti (1989), Cutler, Poterba, Scheiner and Summers (1990), Chauveau and Loufir (1997) and Kenc and Perraudin (1997a), among others, use full general equilibrium analyses.

Second, the distributional consequences of different pension system rules have been extensively studied, particularly in the cases of the UK and the US. Examples of papers in this literature are Orcutt, Merz and Quinke (1986), Creedy, Disney and Whitehouse (1993), Hurd and Shoven (1995) and Owen and Joshi (1990).

A third implication of pension rules which has been less extensively researched, is the distortions that the detailed regulations on contributions and benefits may induce in microeconomic behaviour.[1] To address this issue, in this paper, we study the behaviour of a single intertemporally utility-maximising household facing the detailed rules and regulations of the pension schemes currently in operation in eight different European countries.

The countries we consider are Germany, France, Italy, the Netherlands, the United Kingdom, Spain, Finland and Sweden. We examine the effects of these countries' pension schemes on (i) labour supply decisions, (ii) retirement date choices and (iii) savings behaviour. These three aspects of pensions have been intensively studied in the recent literature but not in an integrated way and not with our particular focus on international comparisons.

The framework for our analysis is a dynamic programming model of household decision-making. The household is presumed to choose the time paths of consumption and leisure subject to the complicated budget constraint implied by the tax and pension regulations of a series of European countries. Throughout the analysis, we shall assume that households are fully rational in their choices. While this is perhaps an extreme assumption,[2] it provides a useful bench-mark.

We simulate our model under the assumption that agents face non-negativity constraints on household financial wealth. In this aspect, our analysis resembles that of Hubbard and Judd (1986), who looked at tax distortions in a simulation model that included borrowing constraints. In our view, the inclusion of borrowing constraints adds realism to the analysis. For countries such as Spain and Italy, in which government transfers in later life are very substantial, with reasonable parameters, it is not possible to obtain sensible figures on savings unless capital market imperfections are assumed.

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[1]Sheshinski (1978) and Burbidge and Robb (1980) examine the effects of social security on retirement decisions but there has been no systematic study that compares the impact of several different countries' pension systems on microeconomic incentives.

[2]In his classic analysis of pension economics, Diamond (1977) argues that myopia may provide a rationale for state provision of pensions.

2. Pension System Rules

In comparing different countries' pension systems, we concentrate on regulations (i) that restrict retirement dates either directly or by adjusting benefit levels for early or late retirement, (ii) that require a cessation of labour supply once an agent has begun to receive state pension benefits and (iii) that link pension benefit levels to the average labour income obtained in some sub-period of an agent's earlier working life. In addition, we analyse the impact (iv) of different accrual factors linking years of labour-force participation to pension benefit levels and (v) of the presence or absence of a flat-rate pension.

The different national pension schemes we examine embody combinations of these various types of regulation.[3] To study their impact on incentives and behaviour, we conduct a series of six simulations in which, starting from a baseline equivalent to the German pension system, we successively introduce more heterogeneity. For each country, the last of our series of simulations shows the full effect of the national pension scheme in question, while the intermediate simulations show the implications of particular pension regulations.

Throughout our analysis, we abstract from differences across countries in labour productivity and preference parameters. This enables us to isolate the impact of pension system and tax regulations. The regulations we examine may appear minor aspects of different pension systems but, as we shall demonstrate, they can have quite large effects on lifetime utility. Basing utility comparisons on equivalent monetary measures, we find that the distortionary effects of particular rule changes may easily be several per cent of an agent's discounted lifetime endowment.

As a first example, consider the way in which benefit entitlements depend on labour supply earlier in life. In most countries, state pensions are earnings-related in that pension entitlements depend on past labour income. Often, benefits are calculated as a percentage of household earnings averaged over a given period and then scaled up by subsequent increases in wages or consumer prices. Contributions, on the other hand, are levied on employers and employees throughout the household's working life, just like a labour income tax.

Clearly, pension contributions on their own will tend to discourage household labour supply, exacerbating the distortion already introduced by income taxes. During the averaging period, however, the work disincentives attributable to contributions will be offset by the fact that rational households will anticipate the marginal increase in discounted future pension benefits that they will receive if they work more. If the averaging period is short, the impact of this substitution effect can be very large, leading to substantially negative marginal tax rates during the averaging period.

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[3]Tables 2, 3 and 4 provide summary information on pension systems in our sample of eight countries.

As a second example, state pension rules, applied in many countries, require a cessation in labour supply before pension benefits may be received. Lazear (1979) argues[4] that firms may include this feature in their own supplementary pension schemes as part of an efficient multi-period contract with their employees. Sala-i-Martin (1992) suggests that public schemes adopt such rules because the presence of old workers reduces the productivity of the young. In any case, from the viewpoint of an individual worker, such rules resemble quantity constraints on labour supply after the beginning of state pension benefits. As one might imagine, quantity constraints may significantly reduce total welfare.

3. The Limitations of the Analysis

It is important to be aware of the limits of our analysis. First, we suppose that contribution rates and benefit entitlements are constant throughout the life of the household whose behaviour we study. This is not realistic in the sense that, in most countries, agents may reasonably expect that pension arrangements will change in coming decades. To suppose non-constant contribution rates, however, introduces arbitrary assumptions into the analysis unless one employs a full general equilibrium model to ensure consistency. In other work, we have analysed pension system reform in dynamic, general equilibrium models with overlapping generations (see Kenc and Perraudin (1997a and 1997b)). It is not possible in a general equilibrium model to study pension regulations in the detailed way that we do here, however, and we regard that kind of analysis as complementary to the more microeconomic approach followed in this paper.

Second, we presume perfect certainty. This is a strong assumption and probably the greatest weakness of the model employed in this paper. Stock and Wise (1990) and Lazear and Moore (1988) show that uncertainty tends to induce later retirement by introducing an option value of delay.[5] Furthermore, uncertainty regarding length of life may mean that pension schemes significantly affect welfare levels if annuity markets are less than perfect. Lastly, as stressed by Deaton (1991), uncertainty and liquidity constraints may interact in that agents may be willing to save even if they are relatively impatient if they fear possible deterioration in income and hence binding liquidity constraints.

Third, we suppose that households may be treated as a single agent, and thus omit the complications of joint labour supply decisions,[6] survivor pensions and divorce.[7] Fourth, we do not examine the distributional implications of different

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[4]See also Lazear (1983).

[5]Fully rigorous treatment is very difficult, however, unless a very simple framework is employed. See Rust (1989).

[6]Craig and Batina (1991) examine a number of generic social security provisions in an overlapping generations model in which female and male labour supply are carefully distinguished. A limitation of their study is that households are presumed to live only for two periods, which constrains the life-cycle dynamics they examine. Nor do they attempt to incorporate detailed pension provisions of the kind included in our model.

[7]On the latter, see Joshi and Davies (1991).

countries' pension schemes. Fifth and last, we do not separately identify or model consumption of services from durables or from housing. This is probably not too serious a restriction in the present context.

4. Structure of the Paper

The paper has the following structure. Section II describes the simulation model and the parametrisation adopted. The algorithm is based on one employed in Perraudin and Pujol (1994). Section III sets out broad features of pension arrangements in eight European countries, focusing particularly on the heterogeneity of the different schemes and emphasising those aspects that are likely to have the most substantial impact on households' economic decisions.

Section IV describes the basic results. The simulations assume basic tax rates appropriate to different countries and then successively introduce heterogeneity across countries in more and more aspects of pension systems. Section V concludes the paper. The Appendix provides brief technical descriptions of the model and of its numerical solution, plus more information about the sources used in the parametrisation.

II. THE MODEL

1. The Basic Framework

Our basic framework is the dynamic programming problem of a fully rational agent planning its consumption, leisure and bequest behaviour over time. A technical description of the household's optimisation problem is provided in the Appendix. Utility is assumed to take a nested Constant Elasticity of Substitution (CES) form and to be additively separable across time. This allows us to treat household decision-making as a two-stage process. At the higher level, the household decides between bequests and full consumption (an aggregate index of leisure and goods consumption) received each period and discounted by a subjective discount rate. At a lower level, the household decides between the components of full consumption, leisure and goods in each period.

Utility is maximised subject to a lifetime budget constraint in which discounted labour and transfer income plus the discounted value of bequests (received at the age of 60) is set equal to the discounted cost of expenditure on goods and the discounted value of bequests conferred (at the time of death). The economic life of households is assumed to begin at age 20 and we suppose that they die at 80 years old.

In addition to the wealth constraint, household decisions are limited by non-negativity constraints on labour supply and on financial wealth. The latter, referred to as liquidity constraints, are incorporated to add realism to our analysis. It is clearly difficult in the economies we are studying to borrow in an unsecured way against future labour and transfer income. In addition, however, we found in simulating our model that it is difficult to generate plausible savings behaviour (especially in Spain and Italy, where substantial government transfers are made to households late in life) unless capital markets are presumed to be imperfect. Liquidity constraints are therefore needed if the model is to generate sensible results for all our countries.

2. The Parametrisation

Values for tax and contribution rates are mainly taken from OECD publications. Details are given in the Appendix. Where possible, we selected parameters appropriate for production workers, married with two children (a standard category used by the OECD). We took 1991 to be the base year for our study. This choice is justified below. Throughout the study, we supposed that utility function parameters and prices are the same across countries. While preferences probably do differ systematically across countries, this approach was justified by our aim of isolating the impact of the pension system and tax parameters.

Choosing our baseline utility function parameters was a matter of educated guesswork. A summary of all the parameters used in the simulations is provided in Table 1. In making our selection, we drew on the large number of empirical studies that estimate utility function parameters. In particular, the intertemporal elasticity of substitution — the parameter that determines the household's willingness to adjust the time path of planned full consumption in response to changes in interest rates and effective marginal tax rates — has attracted much interest among researchers. Estimated values are commonly either in a low range of 0.2 to 0.4 (see Hall (1988): US time-series data, Bayoumi (1990): UK time-series data and Patterson and Pesaran (1992): US and UK quarterly time-series

TABLE 1

Baseline Parametrisation

Parameter	*Symbol*	*Value*
Utility function parameters		
Subjective discount rate	d	0.02
Elasticity of intertemporal substitution	a	0.80
Consumption–leisure elasticity of substitution	r	0.80
Consumption–leisure parameter	a_0	0.20
Bequest substitution elasticity	m	0.80
Bequest preference parameter	a_1	1.00
Maximum lifespan (assuming adult life begins at 20)	T	80.0
Prices		
Real interest rate	r_t	0.05
Average per-period wage rate	$\overline{w}$	2.79
Official average wage	w_{av}	2.23

data) or in a high range of 1.0 to 1.3 (see Lawrance (1991): US panel data and Mankiw, Rotemberg and Summers (1985): US quarterly time series). We take a value of 0.8 as an average of these estimated values.

Of the other utility function parameters, we chose a subjective discount rate of 0.02 (see Lawrance (1991) for some justification). We set the consumption–leisure parameter and the consumption–leisure elasticity of substitution at 0.2 and 0.8 respectively. These combined to yield an uncompensated wage elasticity of labour supply of 2 per cent, which seems a reasonable figure for the combined labour supply of a married couple. Such a value may be justified by the various studies surveyed in Hum and Simpson (1994). See, for instance, Bourguignon and Magnac (1990). The bequest preference parameter and the bequest substitution elasticity are hard to establish. Our chosen values of 1.0 and 0.8 respectively imply reasonable ratios of bequests to peak savings and seem broadly consistent with the levels estimated by Kotlikoff and Summers (1981).

Finally, at any given date, the wage–age profile we used is hump-shaped in accordance with the findings of Kotlikoff and Gokhale (1992), Davies (1992) and Gottschalk and Joyce (1992). Kotlikoff and Gokhale (1992) argue that cross-sectional productivity peaks at around age 45 and declines thereafter. Productivity at age 65 is one-third below the peak. Davies (1992) and Gottschalk and Joyce (1992), both using cross-country data, find that the ratios of mean earnings for 40- to 49-year-old men to mean earnings for 25- to 29-year-old men are in the range 1.08 to 1.30. In our assumed profile, productivity drops to zero at 65, enforcing exit from the labour market at that age. Finally, we assume aggregate productivity growth of 2 per cent. For a given individual, the productivity growth each year is the sum of (i) growth in the cross-sectional productivity profile described above and (ii) the 2 per cent aggregate growth.

III. EUROPEAN PENSION SYSTEMS IN 1991

1. Pension System Comparisons

As mentioned above, we took 1991 as our base year. Detailed tax and pension system data were available on a comparable basis for that year. It might be argued that using the most up-to-date pension arrangements as the basis for our analysis would be preferable. However, in the case of Italy, for example, the pension system has been subject to several major reforms in recent years and further significant changes are likely in the near future. It is difficult to say even what the 'current' Italian system is, therefore. For this reason, we prefer the simple approach of analysing pension and fiscal systems in Italy and other countries as they were in the early 1990s.[8]

[8]Kenc and Perraudin (1997a) study recent reforms of the Italian system in a full general equilibrium model with actual population dynamics.

FIGURE 1

Costs and Benefits: Eight Pension Systems

Sources: Replacement rates — Pestieau (1992); contribution rates — OECD (1992).

The pension systems we analyse had some broad similarities but differed considerably in their detailed provisions. The variation was both quantitative, in that the basic generosity of the schemes differs substantially, and qualitative, in that some systems constrain agents' choices in ways that others do not. An idea of the scale of different schemes may be obtained from Figure 1. The replacement rate (i.e. pension benefits as a percentage of final wages) was highest for Spain, Italy and Sweden and lowest for the Netherlands and the UK. The variation was substantial, ranging from just over 30 per cent for the Netherlands to 100 per cent for Spain.

Comparing the upper and lower panels of Figure 1, one may see that the correlation between replacement rates and contribution levels in the same country was surprisingly low. For example, total contributions were highest for France even though the French replacement ratio was less than average. Discrepancies between the ordering of benefit and contribution rates partly reflected surpluses or deficits in the pension scheme that were balanced by general tax receipts. However, it is hard to draw firm conclusions that schemes were in deficit, for example, since different systems were more or less far from maturity.

The major differences in the regulations of our sample of eight state pension systems are summarised in Tables 2, 3 and 4. For the purposes of our current analysis, one may divide the various rules into three categories: first, regulations about the date of retirement; second, the formula used to calculate benefit entitlements; and third, contribution rules. Some important aspects of schemes, such as benefit rules for spouses and indexation provisions, do not fit neatly into one of these three categories but we do not focus on these in the current study.

In practice, indexation can play a very important role in pension reform efforts. In the UK, for example, the adoption of price rather than wage indexation of lump-sum elements in the pension system means that the nature of the scheme will change very substantially in coming decades. Modelling indexation in a detailed way is difficult, however, since its impact on different parts of a pension system may be complex and subtle (see Creedy, Disney and Whitehouse (1993)). Also, governments tend to change it quite frequently. For example, in Spain, indexation was suspended in the period 1983–88, leading to a significant erosion in benefits.

TABLE 2

Tax Parameters in 1991

Parameter	*Ger*	*Fra*	*Ita*	*Nld*	*UK*	*Spa*	*Fin*	*Swe*	*Ave.*
Contribution rates									
Public schemes[a]									
1. Average employee	10.9	11.0	5.5	15.4	4.9	4.3	1.0	0.0	6.6
2. Marginal employee	18.2	17.1	9.0	26.9	7.6	6.0	2.6	0.0	10.9
3. Average employer	12.9	23.1	20.4	6.1	6.3	20.3	1.4	9.5	12.5
4. Marginal employer	18.2	43.8	50.1	9.1	10.4	30.2	3.6	33.2	24.8
5. Total average (1)+(3)	23.8	34.1	25.9	21.5	11.2	24.6	2.4	9.5	19.1
6. Total marginal (2)+(4)	36.4	60.9	59.1	36.0	18.0	36.2	6.2	33.2	35.8
Supplementary schemes[b]									
7. Employee	0.0	2.0		5.0	6.5		3.0	0.0	2.1
8. Employer	15.0	3.0		5.0	10.0		3.0	5.0	3.9
Wage tax[c]									
9. Average rate	8.7	1.0	14.2	32.5	15.4	6.4	21.8	28.0	16.0
10. Marginal rate	17.6	6.7	23.7	47.8	25.0	24.0	37.6	31.2	26.7
Contribution + tax rates									
11. Average (5)+(9)	32.5	35.1	40.1	53.0	26.6	31.0	24.2	37.5	35.1
12. Marginal (6)+(10)	54.0	67.6	82.8	83.8	43.0	60.2	43.8	64.4	62.5
Other taxes									
13. Savings tax rate[d]	39.1	4.5	12.5	42.0	24.0	31.5	10.0	30.0	24.2
14. VAT rate	14.0	18.6	12.6	18.5	17.5	12.0	22.0	25.0	17.5

[a]Marginal contribution rates are OECD calculations for production worker with two children for the year 1991. Average social security contributions are defined as the ratio of contributions relative to compensation and are taken from OECD (1992).
[b]A negligible percentage of Italian and Spanish pensioners possess private, supplementary pensions so we omit such pensions in the relevant simulations for these countries.
[c]OECD calculations for production worker with two children for the year 1991.
[d]Defined as marginal tax rate on interest income.
Sources: OECD (1991a, 1991b and 1992).

TABLE 3

Public Pension Schemes in 1991: Germany, France, Italy and the Netherlands

	Germany	*France*	*Italy*	*Netherlands*
Retirement age (M/W)	65/65 (normal)	60/60 (minimum)	60/55[a] (normal)	65/65 (normal)
Early retirement provisions (M/W)	63/60: 0.3% benefit cut for each month	55: 35% benefit cut	No[b]	No
Late retirement provisions (M/W)	67: 0.5% benefit rise for each month	No	No	No
Work–pension link	No	Yes	No	No
Flat-rate scheme replacement ratio	—	—	—	Universal 33%
Other minimum provisions	Social assistance	Guaranteed minimum	Guaranteed minimum	—
Averaging period	Career	Best 10 years	Last 5 years	—
Minimum contribution period	5	3 months	15	—
Contribution period for full pension	Working life	37.5	40	—
Accrual factor	1.5%	1.75%	2%	—
Maximum replacement ratio	50%	50%	80%	—
Indexation	Wages	Wages	Wages	Wages

[a]In Italy, normal retirement age is being increased by one year for every two over the period 1993–2002 from age 60(55) to age 65(60) for men(women).
[b]Those retiring early in Italy who have enough contribution years may claim seniority pensions which have traditionally offered benefits equivalent to the standard pension. This system has provided strong incentives for early retirement.
Note: Lengths of time are in years unless otherwise stated.
Sources: Foster, 1994; Van den Noord and Herd, 1993.

2. Retirement Age

Of the eight countries in our sample, all except the UK and Italy applied the same retirement age to both men and women. Most countries had a basic retirement age for men of 65. France and Italy were the exceptions, having standard retirement ages of 60.[9] If agents chose to retire early or late, in Germany, Finland and Sweden, their benefits were adjusted for the change in the actuarial value of their pension. Some other countries, such as the UK, adjusted benefits for late but not

[9]In Italy, retirement ages will gradually rise to 65 for men and 60 for women by 2002 under current plans.

TABLE 4

Public Pension Schemes in 1991: the UK, Spain, Finland and Sweden

	UK	*Spain*	*Finland*	*Sweden*
Retirement age (M/W)	65/60[a] (normal)	65/65 (normal)	65/65 (normal)	65/65 (normal)
Early retirement provisions (M/W)	No	No	60: 0.5% benefit cut for each month	60: 0.5% benefit cut for each month
Late retirement provisions (M/W)	70/65: 7.5% benefit rise for each year	Yes	70: FRP 1% benefit rise for each month	Yes 0.6% for each month
Work–pension link	ERP: yes FRP: no	Yes	ERP: yes FRP: no	No
Flat-rate scheme replacement ratio	Accrual 20%	—	Means-tested 30%	Means-tested 20%
Other minimum provisions	Guaranteed minimum	Guaranteed minimum	Guaranteed minimum	Guaranteed minimum
Averaging period	Career	Last 8 years	Last 4 years	Best 15 years
Minimum contribution period	Quarter of working life	15	1 month	—
Contribution period for full pension	Nine-tenths of working life	35	40	30
Accrual factor	0.4%	3%	1.5%	2%
Maximum replacement ratio	20% (ERP)	100%	60% (ERP)	60% (ERP)
Indexation	Prices	Wages	Wages	Wages

[a]The normal retirement age for women in the UK is to increase from 60 to 65 over the period 2010–20.
Note: Time is in years unless otherwise stated. ERP and FRP denote earnings-related and fixed-rate pensions respectively.
Sources: Foster, 1994; Van den Noord and Herd, 1993.

for early retirement. Italy and the Netherlands, on the other hand, were unusual in that they made no adjustment to benefit levels for different retirement dates.

An interesting question is why, in many state pension systems, eligibility for a pension benefit requires that the agent cease supplying labour. Work–pension links were applied in France, Finland, Spain and the UK, for example. By constraining agents' choices, it seems as though such rules are welfare-reducing. Our simulations below tend to confirm this. One may speculate that governments introduce such rules in attempts to reduce short-term slack in the labour market or simply to reduce costs and target those who are incapable of continuing work. These are not fully satisfactory explanations, however.

3. Benefit Formulas

The most complex aspect of pension schemes we analyse here is the formula used in calculating pension benefits. In all countries except the Netherlands, state pension benefits depended on labour income in the period before retirement. The usual approach consists of designating some portion of an agent's working life — for example, the last five years as in Italy, or the entire working career as in Germany and the UK. Pension benefits are, broadly speaking, proportional to average wage income in the designated period.

This dependence can generate a complicated profile for effective marginal tax rates over the life cycle. The discounted value of additional future benefits that an agent receives if he supplies an extra unit of labour may be thought of as a negative tax. Such negative taxes depend on how far one is from retirement and on whether or not the current year is included in the averaging period. The fluctuations in marginal tax rates that short averaging periods and generous benefit levels can generate are illustrated in Figure 2.

A crucial parameter for determining the 'generosity' of a pension scheme is the accrual rate. The accrual rate equals the percentage of average wage income in the averaging period by which pension benefits increase for each additional year of contributions to the scheme. The variation in accrual rates across countries was great, ranging from 3 per cent for Spain to 0.4 per cent in the UK. The latter was so low partly because the UK has a flat-rate pension scheme in addition to its state earnings-related scheme (SERPS) and partly because the overall level of UK benefits is very low.

4. Contributions

The contribution rates for pensions are summarised in the upper part of Table 2.

FIGURE 2

Marginal Tax Rates over the Life Cycle

The data given there, which are based on OECD estimates, again show great variation across countries in both marginal and average rates. The total average rate was 2.4 per cent in Finland and 11 per cent in the UK, while in France and Italy, it was 34 per cent and 26 per cent, respectively. In most countries, the larger part of contributions was levied on employers.

Further information on contributions, including minimum contribution periods for pension and for full pension eligibility, is given in Tables 3 and 4. Again, there is wide variation from country to country.

IV. SIMULATIONS

1. Presentation of the Results

We conduct seven different experiments, successively introducing different types of heterogeneity in national pension schemes. To maintain neutrality as far as the government budget is concerned, in each simulation we adjust lump-sum taxes so that the discounted value of the household's total lifetime tax payments is constant. Which fiscal variable one chooses to maintain fiscal neutrality is clearly somewhat arbitrary. We prefer to employ lump-sum taxes (which one may think of as the personal allowance component of the tax–contribution system in each country) since this does not introduce an additional distortion (as distortionary wage taxes, for example, would) and hence leads to results that are slightly easier to interpret.

We report our results in the form of tables and figures. Table 5 shows goods and leisure consumption, total savings and preferred retirement ages. The first three of these four variables are summed over the lifetime of our household (i.e. the annual levels are totalled to get the numbers in the table). The interest of this form of presentation is that it gives a rough idea of the macroeconomic impact of a change in pension rules. If the economy and population were in steady state with factor prices given from the rest of the world, aggregate consumption, for example, is just the sum of the consumption of different age cohorts and hence would correspond to the numbers in the table.

The units of our model are basically determined by the fact that we normalise the household's leisure endowment to unity per period. Given that the household's economic life is presumed to last 60 years, a leisure consumption sum of, say, 33 indicates that, on average, the household consumes a fraction $^{33}/_{60}$ of its leisure endowment and supplies $^{27}/_{60}$ in the form of labour. The average per-period wage rate is 2.79 (see Table 1). Goods consumption is much higher than $2.79 \times 60 \times ^{27}/_{60}$ because labour is supplied early in life and there is a positive real interest rate.

TABLE 5

Summary Simulation Results with Liquidity Constraint

	Simulation[a]					
	1	*2*	*3*	*4*	*5*	*6*
Goods consumption						
Germany	172.2	170.8	172.2	172.2	172.2	172.2
France	173.8	174.4	169.3	167.8	167.6	167.6
Italy	133.4	133.4	133.4	122.5	104.3	104.3
Netherlands	120.2	120.2	120.2	106.2	106.2	105.0
UK	186.3	188.7	188.7	189.0	186.2	185.6
Spain	168.4	168.4	167.2	164.4	123.3	123.3
Finland	187.9	190.5	190.5	189.6	188.8	189.0
Sweden	158.8	156.2	156.2	156.2	155.4	154.6
Leisure consumption						
Germany	32.8	32.5	32.8	32.8	32.8	32.8
France	34.8	33.6	37.3	37.2	37.5	37.5
Italy	40.4	40.4	40.4	38.1	33.1	33.1
Netherlands	43.9	43.9	43.9	44.2	44.2	43.5
UK	31.8	31.6	31.6	31.3	32.1	31.9
Spain	33.9	33.9	35.2	34.4	27.9	27.9
Finland	32.6	31.9	31.9	31.6	32.0	32.0
Sweden	36.9	36.4	36.4	36.5	36.6	36.4
Total savings						
Germany	308.3	313.1	347.8	347.8	347.8	347.8
France	664.6	608.7	670.8	518.4	576.6	576.6
Italy	554.2	554.2	554.2	257.2	33.3	33.3
Netherlands	276.5	276.5	276.5	378.5	378.5	257.7
UK	559.9	517.7	517.7	484.5	712.2	630.2
Spain	437.7	437.7	461.3	318.9	48.1	48.1
Finland	817.0	743.0	743.0	531.3	779.2	673.7
Sweden	441.4	465.7	465.7	478.9	502.7	409.5
Retirement age						
Germany	65	63	63	63	63	63
France	65	60	60	60	60	60
Italy	65	65	65	65	65	65
Netherlands	65	65	65	65	65	65
UK	65	68	68	68	68	68
Spain	65	65	65	65	65	65
Finland	65	68	68	68	68	68
Sweden	65	61	61	60	60	60

[a]Heterogeneity is introduced successively in 1 (tax rates), 2 (retirement age), 3 (labour supply limits), 4 (averaging period), 5 (accrual factor) and 6 (flat-rate pension).
Note: Figures are summed over the life cycle.

TABLE 6

Lifetime Utility

	Simulation[a]				
	2	*3*	*4*	*5*	*6*
Without liquidity constraint					
Germany	–0.77	0.00	0.00	0.00	0.00
France	–1.01	–1.39	–2.28	–0.08	0.00
Italy	0.00	0.00	–12.53	–0.40	0.00
Netherlands	0.00	0.00	–16.90	0.00	0.00
UK	0.99	0.00	0.02	–0.90	–0.00
Spain	0.00	–0.29	–3.34	–0.51	0.00
Finland	1.07	0.00	–1.03	0.14	0.00
Sweden	–1.92	0.00	–2.77	–0.23	–0.00
With liquidity constraint					
Germany	–1.51	0.76	0.00	0.00	0.00
France	–2.13	–0.96	–3.58	1.12	0.00
Italy	–0.00	0.00	–5.72	–14.46	0.00
Netherlands	0.00	0.00	–14.06	0.00	–4.57
UK	1.47	0.00	–0.29	1.58	–1.12
Spain	0.00	–0.04	–2.16	–33.11	0.00
Finland	1.02	0.00	–2.25	1.94	–0.56
Sweden	–2.78	0.00	–0.50	0.07	–1.82

[a]Heterogeneity is introduced successively in 1 (tax rates), 2 (retirement age), 3 (labour supply limits), 4 (averaging period), 5 (accrual factor) and 6 (flat-rate pension).
Note: Figures show the percentage change in total discounted lifetime wealth equivalent to the utility change induced by the alteration in pension rules. The baseline utility level is that of Simulation 6.

Constraints on space mean that we present summary simulation results for consumption etc. only for the case *with* liquidity constraints. As mentioned above, capital market imperfections are necessary if one is to obtain sensible results for countries, such as Italy and Spain, where official transfers towards the end of life are very substantial. Table 6 gives equivalent variation welfare changes for our various simulations for *both* models with and without liquidity constraints. Figures 3 to 6 show, for Simulation 6, the paths over the life cycle of consumption, leisure, savings and taxes paid. These are presented for both the liquidity-constrained and non-liquidity-constrained cases.

2. Simulation 1: Different Tax Rates

Our simulations begin with a baseline case, denoted Simulation 1, in which the only difference between countries is their tax and contribution rates. Apart from the contribution rates and the fact that the retirement age is fixed at 65, the pension system parameters in this simulation are set to values appropriate to Germany, our baseline country. The results for Simulation 1 show the importance of the cross-country variation in tax rates. In the case with liquidity constraints, total lifetime consumption ranges from 120.2 in the Netherlands to 187.9 in Finland. Where countries have low consumption, this reflects either high total tax rates on labour income which discourage labour supply and lead to lower lifetime income, or high savings tax rates which depress saving, again reducing total lifetime consumption.

The figures we provide for consumption should not be regarded as *predictions* of the observed variation in consumption across the countries. What we are studying here is differences in the behaviour of *a given household* when faced with specific countries' tax systems. The high actual consumption levels observed in the Netherlands economy, for example, probably reflect differences in utility function parameters and initial capital endowments. In the present analysis, we wish to abstract from such differences so as to isolate the effects of tax and pension systems.

3. Simulations 2 and 3: Retirement Age Rules

In Simulation 2, we introduce the rules on retirement age and the treatment of early and late retirement appropriate for each country. As one may see from Tables 3 and 4, there is considerable variation in retirement ages across countries if one allows agents to choose their retirement date optimally. In France, the agent would retire at 60, while in the UK or Finland, he would retire at 65.[10]

Two factors influence these choices. First and most obvious, each country has a standard retirement age, and generally benefit levels are adjusted if agents retire early or late compared with this age. For example, the French rules encourage retirement when quite young, and indeed the simulations for France show the earliest retirement ages.

Second and perhaps less obvious, the level of after-tax wages matters for retirement age decisions. If one compares Sweden, for example, with Finland and the UK, the three countries have similar rules on early and late retirement, but in our simulations for Finland and the UK, our representative agent retires much later than he would in Sweden. The explanation is that the overall tax burden on wage income is much greater in Sweden, lowering the incentive to supply additional labour.[11]

In fact, the operation of this effect is quite complex. In our model, we suppose that, unless a country's rules specifically prohibit it, agents may continue to

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[10]In our simulations, we took the official Italian retirement age to be 65, the level at which the Italian authorities intend that it will be by 2002.

[11]OECD figures suggest the total marginal rate of wage taxes and state pension contributions is 64 per cent in Sweden compared with 43 per cent in the UK and 44 per cent in Finland — see Table 2.

supply labour after the official retirement when they start to claim pension benefits. Often, in practice, however, agents receive lower wages if they supply part-time labour after official retirement as they typically have to change profession or place of employment.

To capture this productivity fall, we assume that wages drop by 50 per cent upon retirement. The decline is partially offset by the fact that pension contributions are not paid on labour income after retirement. Nevertheless, a decline still occurs and the degree to which it influences the optimal retirement date will depend on the net wage, i.e. on wage taxes since we assume the agent receives the same pre-tax wage in different countries.

Now let us turn to Simulation 3. In the baseline country, Germany, there is no link between retirement and withdrawal from the labour force. In Simulation 3, we introduce the explicit restrictions on labour supply after retirement that hold in several countries. Particularly in France, where retirement is quite early, the welfare effect of obliging recipients of state pension benefits to suspend labour-force participation is considerable, with welfare losses equivalent to 1.4 per cent of lifetime income when liquidity constraints do not bind (see Table 6).

4. Simulation 4: Averaging Periods

An important way in which pension systems differ is in the formulas used in calculating benefits. Most countries link pension entitlements to past labour supply by making each individual's pension benefit proportional to his average labour income in part of his earlier working life. If workers rationally anticipate their future pension income, such a link between wage income and benefits tends to encourage labour supply *during* the averaging period since each additional unit of labour income boosts both current wage income *and* future benefits.

The effect of averaging is thus to reduce the effective marginal tax rate in the averaging period. However, in years outside the averaging period, pension contributions act like distortionary, dead-weight taxes. Relatively short averaging periods may, therefore, generate substantial fluctuations in marginal tax rates. Figure 2 shows total marginal tax rates, including the effects of averaging, for households in each of the eight countries in our sample. As one may observe, in countries with short averaging periods, such as Finland, total marginal tax rates vary greatly over the life cycle. The effects are magnified if a short averaging period is combined with very generous pension entitlements, as is the case in Italy, for example, where replacement rates are around 80 per cent while the averaging period is just five years.

What are the welfare implications of fluctuations in marginal tax rates? A standard argument in public finance is that, abstracting from differences in price elasticities, to raise a given government revenue, it is preferable to impose the same tax rate on a broad basket of commodities rather than to concentrate the tax burden on a few goods. The intuition is that, since dead-weight losses due to taxes increase with the square of the tax rate, aggregate welfare losses are minimised by having low rates of tax and a wide tax base.

Big fluctuations in marginal tax rates imply large welfare costs for the simple reason that they impose a different tax burden on different 'dated goods' and hence fail to satisfy the above argument. As one may see from Figure 2, the fluctuations in tax rates in countries such as Spain, Italy and Finland are considerable, with tax rates varying from +24 per cent, +24 per cent and +38 per cent to –87 per cent, –142 per cent and –25 per cent respectively in the three countries. Countries such as Germany and the UK, which calculate earnings-related pension entitlements based on labour income over the whole working life, have far more stable marginal tax rates.

In Simulation 4, we include the averaging rules and benefit formulas appropriate to our different countries. Like all our model runs, this simulation is neutral for the government in that discounted tax payments over the life cycle are constant. An immediate point to note is the substantial welfare losses associated with short averaging periods. In the case of Italy, for example, in the absence of liquidity constraints, welfare is 12.5 per cent lower after the switch from the baseline approach of career averaging to the Italian practice of using the last five years (see Table 6).

The main source of these losses may be found in the numbers on total leisure consumption given in Table 5. The short averaging period reduces total leisure consumption from 40.4 to 38.1. If one removes the leisure consumption during retirement (15×1), the decline is from 25.4 to 23.1, i.e. around 10 per cent. Most of the distortion comes early in life, which tends to magnify the impact on our equivalent welfare measure.

The Netherlands also shows a major welfare loss between Simulations 3 and 4, reflecting the fact that state pensions in the Netherlands are purely flat-rate and thus allow no link between pension benefits and earlier wage income. In consequence, pension contributions in the Netherlands are entirely distortionary in that there is no offset for current contributions from anticipated future pension benefits. The 16.9 per cent welfare loss between Simulations 3 and 4 in the case without liquidity constraints reflects the cost of moving from the German career-averaging system to a scheme in which all contributions are distortionary.

It is interesting to note the large differences in the welfare losses in the Italian and Finnish cases, given that the averaging periods are both very short. The reason why the welfare losses are so much less in the Finnish case is that the overall level of marginal tax rates is much lower in Finland than in Italy. Dead-weight losses are very substantially magnified when one compounds some already high marginal tax rates with an additional levy, and fluctuations around a high basic level are, therefore, very costly in welfare. (As an experiment, we carried out a simulation for the Italian case but with a lower marginal wage tax rate and found that the welfare losses incurred when the short averaging period is introduced were much lower.)

Lastly, it is interesting to note that the welfare losses associated with short averaging periods are greater when capital markets are perfect. Given that the agents we are examining are far from an undistorted Pareto optimum, the relative magnitudes of welfare losses with and without liquidity constraints are difficult to predict. It may be that imposing liquidity constraints has the effect of reducing price elasticities and hence partially mitigates the impact of short averaging periods which distort labour supply choices in different periods.

5. Simulations 5 and 6: Accrual Rates

In Simulation 5, we introduce national rather than German accrual rates for pensions. Up to now, the overall coverage ratios (ratios of pension benefits to wages just prior to retirement) have been roughly equal for each of the countries in our sample. For countries with relatively high contributions, surpluses in earlier simulations were effectively redistributed to households through lump-sum taxes.

FIGURE 3

Life-Cycle Consumption (Simulation 6)

FIGURE 4

Life-Cycle Leisure (Simulation 6)

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Broadly speaking, higher accrual factors translate into lower utility, although the effects are not very substantial in the case of perfect capital markets. When borrowing constraints apply, the effects seem to be non-linear in that small changes in accrual rates lead to positive or negative welfare effects depending upon the country. However, large increases in accrual rates, which one observes, for example, in the simulations for Italy and Spain, generate very large welfare losses when borrowing constraints are binding.

The explanation is simply that high accrual rates imply high coverage ratios which, in turn, require substantial contributions early in life when households are typically liquidity-constrained. The effect is to exacerbate the borrowing constraints, thus lowering welfare. The interaction between transfer policies and capital market imperfections has perhaps received too little attention, and the simulations reported here demonstrate the significant welfare costs that may result.

FIGURE 5

Life-Cycle Savings (Simulation 6)

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The welfare losses in the Italian and Spanish cases are so large that they may be regarded as implausible. Their size, however, should be seen as 'illustrative' of the substantial welfare losses that may result if ‘generous’ pension schemes are combined with imperfect capital markets. Again, it is important to note that the main welfare cost of liquidity constraints is felt early in life. Since utility from period to period is discounted (using the subjective discount factor), the cost in lifetime utility of liquidity constraints is large. Lastly, note that the desire of younger households to borrow, and hence the degree to which liquidity constraints ‘bite’ and generate welfare losses, might change if we allowed utility to change over the life cycle (for example, reflecting family size).[12]

In the last simulation, we introduce flat-rate pensions in the four relevant countries — the Netherlands, the UK, Finland and Sweden. These simulations are illustrated in Figures 3, 4, 5 and 6, which respectively show goods and leisure consumption, savings and taxes paid. As one may see from Table 6, welfare and other variables are completely unaffected when capital markets are perfect. The reason is that introducing an additional flat-rate pension simply changes the timing of transfer payments over the life cycle. Our assumption that discounted lifetime tax payments are held constant between simulations (where the discount factor is the pre-tax interest rate) is just enough to eliminate any income effects that might arise from this transfer.

[12]It is hard to infer from actual behaviour of households what the lifetime weighting of consumption within the utility function should be, since the observed behaviour includes the influence of capital market imperfections.

FIGURE 6

Life-Cycle Net Taxes (Simulation 6)

As with Simulation 5, introducing borrowing constraints changes the picture considerably in that a flat-rate pension implies significant welfare losses, especially in the case of the Netherlands, for which the flat-rate pension is relatively large. Once again, the basic mechanism here is that switching income from young to old, even when quantities are discounted at the interest rate, tightens borrowing constraints, raising the implicit shadow interest rate and lowering welfare.

Our algorithm inclusive of borrowing constraints performed well in all cases except for Simulation 6 using Italian parameters. In this case, the household was constrained up to and including the retirement date, which tended to produce numerical instability. Rather than changing the parameters, we preferred to perform this particular simulation under the assumption that borrowing constraints applied until the agent was 55 years old. As one may see from the upper right panel in Figure 5, the resulting life-cycle path for savings involves some slight dissaving just prior to retirement.

V. CONCLUSION

What features of pension systems induce serious microeconomic distortions? This is an important question, given the reforms in pension systems currently under consideration in several European countries. In this paper, we gauge the impact on welfare, labour supply and savings incentives of different aspects of eight European pension systems. Our main findings are:

1. Constraining households to cease labour supply when they retire may impair utility by the equivalent of around 1 per cent of lifetime wealth. This may seem a low figure but the welfare loss for currently old households is much larger as the distortions are not so heavily discounted in their case.
2. The response of savings to changes in the retirement age is non-linear, with early retirement in France and late retirement in Finland both being associated with lower savings.
3. Averaging over short periods leads to major welfare losses, especially in countries such as Italy in which the overall level of taxes on wage income is so high. The intuition here is the familiar public finance argument that smoothing tax rates over time tends to reduce dead-weight losses. Short averaging periods generate welfare losses since they induce big fluctuations in marginal tax rates.
4. High replacement ratios, such as those observed in Spain and Italy, can reduce welfare significantly through their interaction with borrowing constraints. By switching income from liquidity-constrained younger agents to unconstrained older households, they reduce welfare for Italian and Spanish households by the equivalent of 14.5 per cent and 33.1 per cent of lifetime income respectively, according to our calculations. While these figures may seem implausibly high, they illustrate the very substantial costs that may be imposed by ‘generous’ pension schemes in the presence of imperfect capital markets.
5. Flat-rate pensions may seem an innocuous way of achieving distributional objectives but they may have quite large welfare effects. If they are financed by contributions proportional to wage income, they distort choices between labour supply and leisure. Even if they are financed by lump-sum taxes, they switch income from young to old people in a way that exacerbates borrowing constraints.

To summarise, our analysis suggests that a well-designed pension system should (i) include long averaging periods, (ii) allow labour supply after retirement and (iii) limit the burden of contributions imposed on younger households, which may face borrowing constraints, either by limiting the generosity of replacement ratios or by allowing a fraction of contributions to be voluntary.

APPENDIX

1. Technical Description of the Model

In this Appendix, we describe the model we employ and the solution algorithms. Our deterministic approach with complex rules on tax and pension rules may be contrasted with recent work by Deaton (1991) and Hubbard, Skinner and Zeldes (1995). One may think of the latter as employing much simpler budget constraints so that analysis of models with liquidity constraints and uncertainty is feasible.

The household's utility function may be written as

$$(1) \qquad \max_{\{C_t, L_t\}_{t=1}^{T}} \sum_{t=1}^{T} \frac{1}{(1-1/a)} \frac{U_t^{1-1/a}}{(1+d)^{t-1}} + \frac{a_1}{(1-m)} \frac{B_T^{1-m}}{(1+d)^{T-1}}$$

where

$$(2) \qquad U_t \equiv \left(C_t^{1-1/r} + a_0 L_t^{1-1/r}\right)^{\frac{1}{1-1/r}} .$$

Here, C_t and L_t respectively denote consumption and leisure in period t, while T is the household's lifespan. B_T is the household's bequest in T, equal to savings accumulated up to that date. The parameters d, a, r, a_0, a_1 and m are constant. d, a and r equal respectively the rate of time preference, the coefficient of intertemporal substitution and the leisure–consumption substitution elasticity.

The household we consider maximises the lifetime utility function in equation (1) subject to the following wealth constraint:

$$(3) \qquad \sum_{t=1}^{T} \frac{w_t(1-t_{wt})(1-L_t) + Z_t + W_t - (1+t_c)P_t C_t}{\prod_{i=0}^{t-1}\{1+r_i(1-t_{si})\}} - \frac{(1+t_h)Q_T B_T}{\prod_{i=0}^{T}\{1+r_i(1-t_{si})\}} = 0$$

where P_t is the price of the consumption good, W_t is bequests received in period t, w_t is the wage rate, Z_t is lump-sum transfers, r_t is the gross interest rate, t_{wt}, t_{st}, t_c and t_h are tax rates on labour and savings income, consumption goods and inheritances respectively, all at time t. Here, total labour endowment in each period is normalised to unity. Q_T is a price index for 'full consumption' (comprising consumption goods and leisure) and equals

(4) $$Q_T \equiv [\{(1+t_c)P_T\}^{1-r} + a_0^r\{(1-t_{wt})w_T\}^{1-r}]^{1/(1-r)} .$$

We also wished to allow for the possibility that households face constraints on their borrowing in anticipation of future labour and transfer income. We therefore suppose that

(5) $$S_t \geq 0 \quad t = 1,2,\ldots,T$$

where S_t is private sector financial wealth at period t and equals the first expression in the budget constraint but summed from 1 to t rather than from 1 to T.

2. Numerical Solution of the Model

The solution of the household's optimisation problem is complicated by the presence of the borrowing constraints. First, consider the case without borrowing constraints and bequest motive. One may then obtain the optimal paths for the decision variables by solving the following system of equations:

(6) $$(1+d)^{1-t}U_t^{1/r-1/a}C_t^{-1/r} = l_t(1+t_c)P_t$$

(7) $$(1+d)^{1-t}U_t^{1/r-1/a}a_0L_t^{-1/r} = l_t w_t(1+t_{wt}) \quad \text{for} \quad t < t_r$$

where t_r is the date of retirement from the workforce and l_t is the marginal utility of wealth in period t. In each pair of adjacent periods, t and t+1, the marginal utilities of wealth satisfy the relation $l_{t+1} = l_t / \{1 + r_{t+1}(1 - t_{st+1})\}$. In other words, there is effectively just a single discounted Lagrange multiplier for the agent's optimisation problem, associated with the single lifetime wealth constraint. The last degree of freedom in the problem is then resolved by choosing l_1 such that savings at the end of life are zero. Introducing the bequest motive changes this terminal condition to

(8) $$(1+d)^{1-T}a_1B_T^{-m} = l_T Q_T$$

so that the marginal utility of an extra unit of bequests in the final period of life divided by the price of bequests is equal to the terminal utility of wealth.

The borrowing constraints complicate matters. For each period, an additional complementary slackness condition must be added to the basic maximisation problem. As far as the above equations are concerned, these imply that we must replace l_t by $l_t + g_t$, where g_t is a Lagrange multiplier that is strictly positive in periods in which the borrowing constraints bind and otherwise zero. Suppose one knows in advance in which periods the constraints bind. One may then compute the optimal path by substituting out consumption in the periods in which the constraints bind using the borrowing constraints. The extra equations that one then has can be used to find the values of the additional Lagrange multipliers.

However, the fact that one does not know in advance the periods in which the borrowing constraints bind complicates the solution. In principle, one may employ brute-force methods, solving the problem for different combinations of binding Lagrange multipliers and then taking the solution to be the one that yields the maximum utility without contravening the constraints. But such methods are not feasible using conventional computers. The approach taken in the algorithms employed in this paper is to assume that the constraints bind at the start of the household's 'life' and then hold continuously until some date at which the household becomes unconstrained. While this is not a general solution technique, it works well for commonly observed lifetime wage patterns.

3. Sources for Parametrisation

Tax Rates

Wherever feasible, we employ average and marginal income tax rates for married couples with two children. Wage income tax rates come from OECD (1991a, 1992 and 1993).

Average and marginal social security contribution rates also come from OECD (1991a), while marginal rates are taken from OECD (1992 and 1993).

The savings tax rates we employ are for taxes on interest income and are drawn from OECD (1991b). Finally, VAT rates are taken from the series *OECD Economic Surveys* of individual member countries.

Pension Schemes

The treatment of retirement age we assume is based on Foster (1994), while replacement ratio parameters come from Commission of the European Communities (1993). We also use Pestieau (1992) and Foster (1994) for the non-EC countries: Finland and Sweden.

Some aspects of minimum pension provisions come from Van den Noord and Herd (1993) and Foster (1994). Averaging period details are taken from Foster (1994), as are contribution periods for full pensions and maximum replacement ratios. Accrual factors come from Foster (1994) for most countries, supplemented with information from Van den Noord and Herd (1993) in the cases of Germany and France. Replacement ratios for unemployment are taken from OECD (1993).

Tables 3 and 4 describe features of the different types of public pension regimes in the countries in our sample. These include retirement age, whether benefits are lump-sum payments or other, earnings-related pension elements such as averaging period, contribution period and accrual factor, maximum replacement ratio and indexation. Values for parameters describing pension systems across European countries can be found in Foster (1994) and for EU countries in EUROSTAT. We take male retirement age as standard retirement age.

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