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Financial Balance & Inter-Generational Fairness In Pay-As-You-Go Pension Systems

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FINANCIAL BALANCE & INTER-GENERATIONAL FAIRNESS IN PAY-AS-YOU-GO PENSION SYSTEMS
– Empirical Illustrations in an Alternative Framework

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1 Introduction

Pension systems of the pay-as-you-go variety[1] are well known to be sensitive to changes in the age-structure of the population. If the population is ageing, either contribution rates will have to be raised, or pensions will have to be lowered. This implies that individuals of different generations will either pay different contribution rates for the same level of pensions, or the same contributions for a different level of pensions. This type of inter-generation unfairness can be a problem for both the credibility and the legitimacy of pay-as-you-go pension systems.

Some of the variation between what different generations pay in contributions and what they receive in pensions is due to temporary peaks or dips in birth rates; to this extent, the variation can be avoided by introducing a buffer fund and using an "actuarially correct" contribution rate. This paper outlines a method for calculating this contribution rate. We call this method *actuarial accounting*.

The actuarial-accounting method is here used to *identify* and *illustrate* the factors that bring about a sustainable matching of contribution rates and pension levels. For purposes of illustration, calculations of the critical factors are presented for a diverse set of countries. The choice of countries was determined by the quality of readily available UN[2] and ILO[3] data. Even though our quality criteria were very generous, they were only met by the population and labour force participation data of 41 out of a total of 229 countries in the UN/ILO statistics.

The estimates of contribution rates are very rough. The approximate nature of these estimates reflects both the inadequacies of the statistical data and the methodological shortcuts that have consequently been required. Arguably the tables provided can still be used as a quick guide to the long-term required contribution rate for any intended pension level under different demographic and economic conditions. Of course, sophisticated assessments and policy recommendations can only be made after thorough analysis of the particular circumstances in each case.

The actuarial accounting method has been developed for the new Swedish pension system and is a part of its legislation. It is essentially a method for calculating the assets and liabilities of the pay-as-you-go pension system. It is used in the so-called automatic balance mechanism of the Swedish system to ensure that the liabilities of the system cannot become larger than its assets. This effect is obtained by immediately reducing the indexation rate for pensions and notional pension capital if liabilities in absence of such a measure would become larger than assets. The swift reaction of the system implies that the burden of accommodating to a negative development will be broadly distributed at an early stage over the collective of insured persons.[4]

1.2 The Model

The "model" pension system used for the calculations has only one rule: it provides for a certain fixed *pension level*. By pension level we mean the average pension for each cohort of retired individuals in relation to the average wage for all cohorts. This level has more or less arbitrarily been set at 50 %. As defined, this level is an ambitious one; however, any other pension level could have been used for the purpose of the paper.[5]

As the model pension system is designed to provide a certain pension level and adjusts the contribution rate to achieve this level, it can be considered a defined-benefit scheme. The chosen manner of accommodating demographic and economic developments – i. e., by adjusting the contribution rate rather than the pension level – is the same as in most public pay-as-you-go schemes.

2 The Support Ratio

In discussions on the financing of pay-as-you-go pension systems, the number of contributors per retired individual, or the support ratio, is an often-used concept. (The support ratio is the inverse of the so-called dependency ratio.)

$$\text{Support ratio} = \frac{\text{Number of contributors}}{\text{Number of retirees}}$$

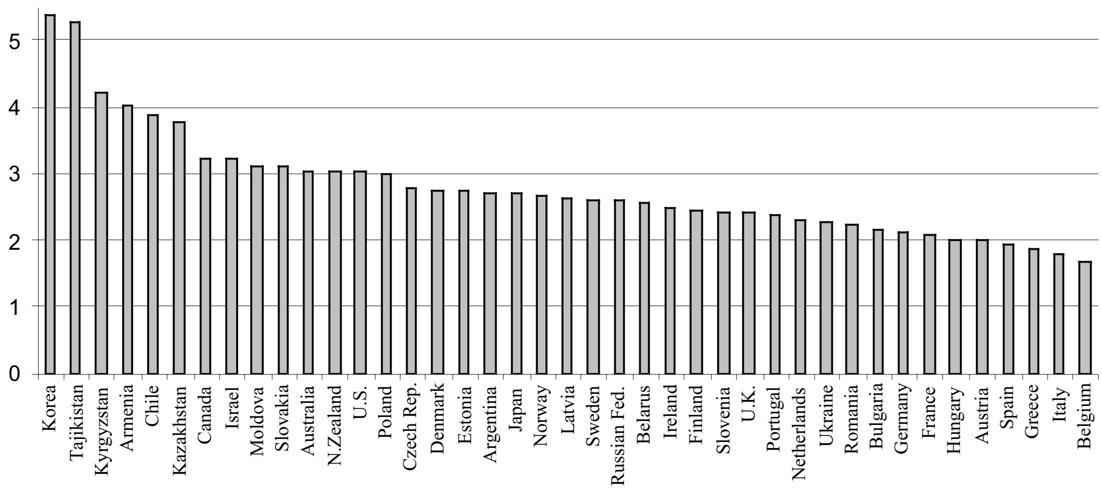
With two contributors for each retired individual, for example, the support ratio is 2.0. The support ratio tells us directly what contribution rate will be necessary in any period to result in a specified pension level, provided that the pay as-you-go system is designed so that in every period contributions in principle will equal pension payments. In such a system there will be no buffer fund. With a support ratio of 2.0, the contribution rate required to produce a pension level of 50 percent is 25 percent.

$$\text{Contribution rate} = \frac{50\ \%}{\text{Support ratio}}$$

If, instead, the contribution rate is assumed to be fixed, the support ratio tells us the pension level for that rate. For example, if the system has a fixed contribution rate of 25 percent, and the support ratio decreases from 2.0 to 1.8, the pension level will drop from 50 percent to 45 percent (25 % x 1.8).

Diagram 1 shows the support ratio for the 41 countries in the study. The statistical data used only indicate the labour force as a proportion of each age group. We have assumed that everyone aged 55 or older and *not* in the labour force either is “retired” or receives some other benefit from the system. Thus, the system is assumed to finance a “pension” benefit that includes disability and early retirement. The assumption that everyone 55 or older not in the labour force is “retired” has a particularly negative impact on the support ratio in countries with low female participation in the labour force.[1] The median support ratio is 2.61 contributors per “retired” individual.

Diagram 1. Support Ratio – Ranking of Countries

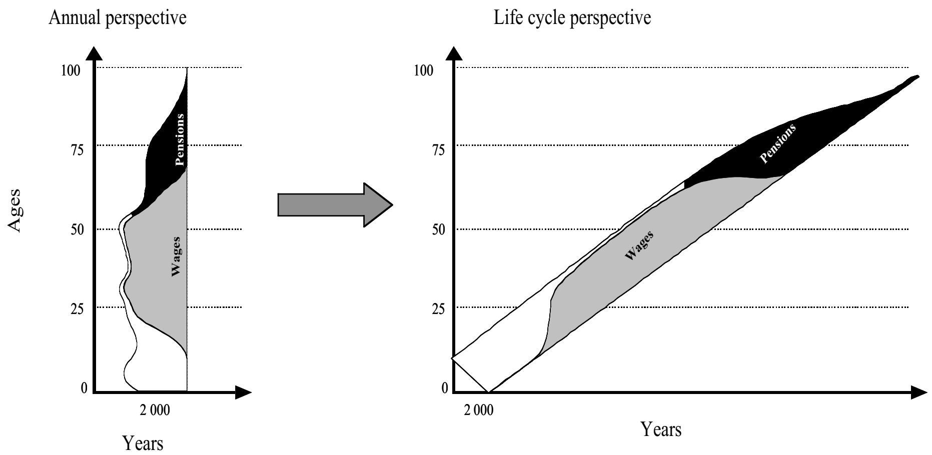


2.1 Drawbacks of Using the Support Ratio to Set the Contribution Rate

The support ratio reflects both the age distribution of the population and the rate of labour-force participation. If some unusually large cohorts enter the labour force, the support ratio will increase. Since there is no provision for a buffer fund in an annual perspective, an increase in the support ratio will cause either the contribution rate to decrease or the pension level to increase. If the pension level is fixed, the large cohorts (and other cohorts working at the same time) will pay less in contributions for the same pensions. By contrast, the relatively small cohorts working after the large cohorts have retired will pay a larger share of their income in contributions (taxes) for the same pension benefit.[2]

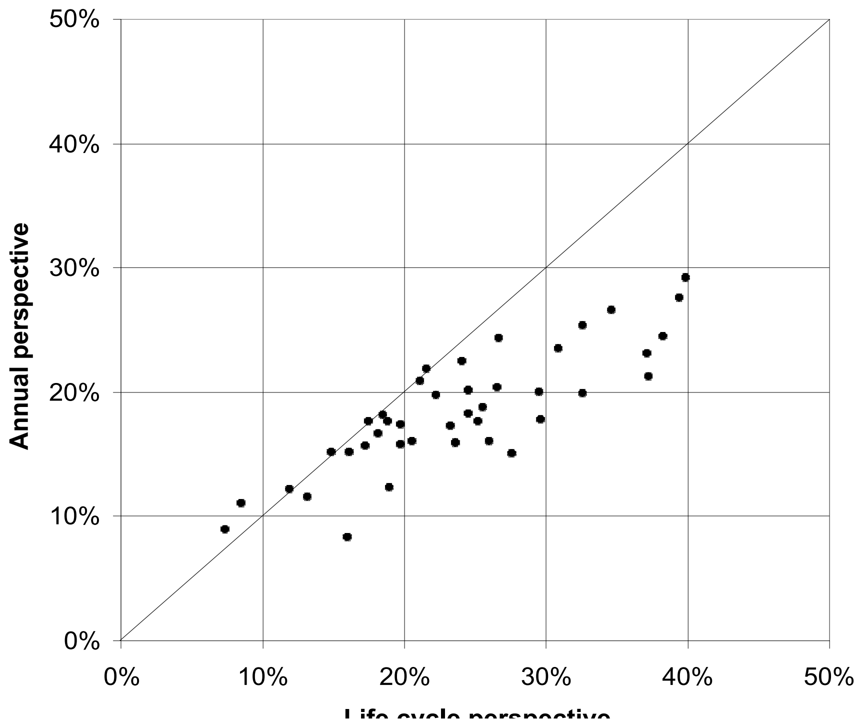
If the contribution rate is more variable than required for the system to be financial stable, the system is arguably "unfair" in that it treats some generations more favourably than others. The design of the system causes financially unwarranted variations in the relationship between contributions and pensions for individuals in different cohorts. These variations lead to inequitable transfers of income between generations. Such transfers of income can be prevented in an appropriately designed system, one feature of which will be a buffer fund.[3] Specifically, the system would be designed to avoid anticipated changes in contribution rates, thus allowing only for variations in the contribution rate due to unexpected developments. This implies a shift from an *annual perspective* to a *life-cycle perspective*. The focus would no longer be on the number of contributors per retiree at regular intervals, but on the expected life-cycle pattern of cohorts (see Figure 1).

Figure 1.   Wages and Pensions – an Annual vs. a Life-cycle Perspective



Shifting from an annual to a life-cycle perspective will affect contribution rates. This is illustrated in Diagram 2 where the contribution rate implied by the annual perspective has been plotted against the contribution rate implied by the life-cycle perspective, explained in Section 3, for each country in the study. For all countries situated below the diagonal line, the contribution rate will be higher with a life-cycle perspective than with an annual perspective. This situation is due primarily to the present demographic age structure with its large cohorts of working age (post World War II baby boomers) and relatively smaller cohorts past retirement age.

Diagram 2.   Contribution Rate for 41 Countries – for a Pension Level of 50 %
(see Table 1 for the Year to Which the Contribution Rate Refers)



The current median contribution rate with an annual perspective is 17.7 % for the intended pension level of 50 %. The median "life-cycle contribution rate" for the 41 countries is 23.6 %. The future expected contribution rates have been calculated for a very simple set of assumptions. The median of the 41 highest expected contribution rates for a purely "pay-as-you-go" system with an annual perspective is 26.8 %. Most countries reach their highest levels in 2020-2030, see the appendix, Table B. Charging the lower than life-cycle contribution rate "now" will thus force future contribution rates that are higher than the contribution rate implied by the life-cycle perspective. Leading to the discussed inter-generation unfairness. This exemplifies that the annual perspective in pay-as-you-go financing increases the expected variations in contribution rate, and thus the potential inter-generation unfairness.

In a *steady state* the contribution rate with an annual perspective will equal the contribution rate with a life-cycle perspective. In that unlikely situation all countries would be spread along the diagonal.

3 The Life-cycle Support Ratio

To minimise the variations in contribution rate, and thus "maximise" inter-generation fairness, we look for the contribution rate that will be fixed if our expectations of the future come true. To put it differently, we want to determine the contribution rate that will be altered only if our experience deviates from our assumptions and/or if our expectations of the future are altered. We call this the life-cycle perspective.

The principal determinants of the life-cycle support ratio are explained and calculated in Sections 3.1-3.3 for each country in the study. Readers who prefer to see the outcome at once, without detailed explanation, should go directly to Section 3.4 on page 13.

3.1 Expected Ratio of Working Years to Retirement Years

With the life-cycle perspective, it is necessary to eliminate the effects of mere variations in cohort sizes on the support ratio when the contribution rate is set. This is easily done by dividing the expected number of working years by the expected number of retirement years for a stable population. If wage earners according to present labour-force patterns will work an average of 40 years and according to present post-retirement mortality rates will live an average of 20 years after retirement,[1] the life-cycle support ratio will be 2.0. The expected contribution rate required for a pension level of 50 percent will then be 25 percent.[2] This contribution rate is independent of present variations in cohort sizes. For this reason it will differ from the contribution rate implied by the support ratio. The pension system will then accumulate a cash-flow surplus or deficit, thus giving rise to, or creating a need for, a buffer fund.

Box 1. Assumptions for the Calculation of the Life-cycle Support Ratio

The life-cycle support ratio can be calculated without forecasts of future demographic and economic development. If calculated without forecasts the calculation will turn out "correct *ex post*" if:

1. the age-related wage and mortality patterns are constant,
2. the return on the buffer fund is equal to the growth of the wage base,
3. the population-growth rate is zero.

We can consider factors 1-3 to be implicit assumptions of a calculation that does not use projections. The life-cycle support ratios in this paper have been calculated on the basis of the implicit assumptions 1 and 2, whereas we have estimated a population growth rate for each country.

The population growth has been estimated from the cross section UN population data and life tables by analysing their relation to each other. However, there is no generally accepted "best method" for estimating the population-growth trend. In the calculations the estimated population growth in different ages has been averaged to smooth out demographic waves. An advantage of the method used is that it produces stable estimates over time. To obtain this stability, we included a large number of cohorts when estimating the growth trend. The estimated population growth is sensitive to the number of cohorts chosen in the estimate. This is a weakness of the study, especially as there is no theory supporting our choice of number of cohorts in estimating population growth. The details of the procedure for estimating population growth are described in the Mathematical Supplement.

Calculating the life-cycle support ratio without forecasts may be rational in some circumstances. For example, we might not believe that we can make long-term forecasts of age-related wage and mortality patterns, interest on the fund, and population growth that are better than the implicit assumptions. More important, however, even if we can make such forecasts, it may still be rational not to use them to set the contribution rate. There can be a trade-off between a higher degree of sophistication and the real or perceived increased risks of manipulation that arguably follow from it. If these two reasons for not making explicit assumptions are considered inapplicable, the life-cycle support ratio can be calculated for any explicit assumption on the development of factors 1-3. It is necessary, however, to assume that the system at some point will reach a steady state. Note also that an implicit or explicit assumption on the growth in the average wage must be made if the system indexes pensions by some other factor than average wage growth.

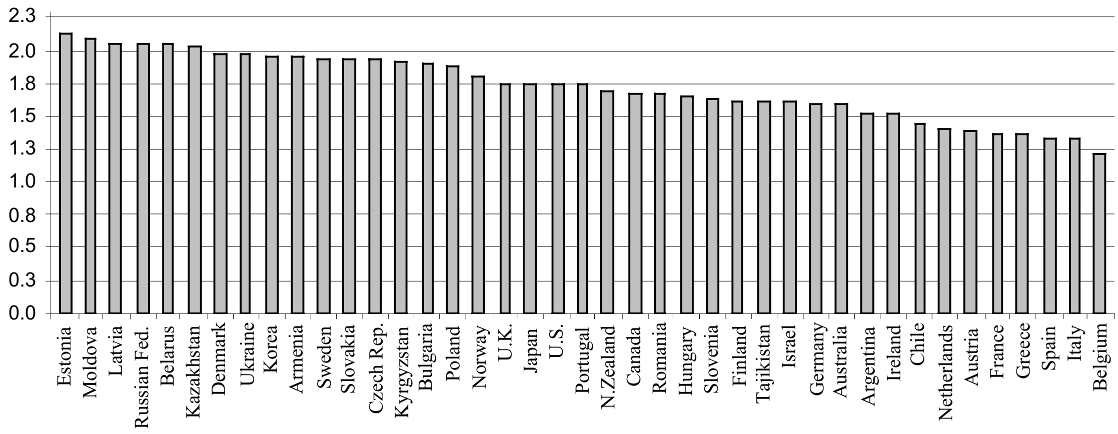
Assumptions used in the Swedish system

The financial position of the new Swedish pension system will be disclosed (and governed) annually without forecasts, i.e. with the implicit assumptions 1-3. The principal reason for this policy is a strong emphasis on transparency, including a desire to use only objectively based "assumptions"; another consideration is a relatively stable demographic situation. In the lack of sophistication in the implicit assumptions of the Swedish system, the method resembles traditional accounting, and it has similar strengths and weaknesses.

It should be noted that the real world deviations from the implicit assumptions 1-3 will be considered as they successively affect the financial balance of the Swedish system. For example an increase in life expectancy, i.e. a deviation from the implicit assumption of constant mortality patterns, will increase the pension liability as this increase in life expectancy is identified in the yearly measurement of the financial status of the system. Another example is the effect of a buffer fund return in excess of the implicitly assumed return equal to that of the growth in wage base. Such a higher return will make the future buffer fund larger than what is implicitly assumed. This larger size of the fund will strengthen the system as the return is identified. Both increases in life expectancy and "high" buffer fund return will be acknowledged as they show up, but they will not be anticipated. The same successive adaptation is made for all deviations from the implicit assumptions 1-3.

The ratio of expected working years to expected retirement years can be seen as the basic determinant of the life-cycle support ratio. This relationship has a strong, direct, and inevitable impact on the sustainable combination of contribution rate and pension level. With short expected working periods and long expected retirement periods, life-cycle support ratios will be low and high contribution rates will be necessary, and *vice versa*. In Diagram 3 the countries in the study have been ranked by expected ratio of working years to retirement years, from highest to lowest.[3]

Diagram 3. Expected Ratio of Working Years to Retirement Years – Ranking of Countries



In the high-ranking countries, expected period of work is approximately twice as long as the period of retirement; in other words, working time is 100 percent longer than retirement time. In the low-ranking countries, working time exceeds retirement time by less than 50 percent; in Belgium, by only 21 percent, and in Italy, by 32 percent. If the minimum retirement age is raised to 65, these percentages increase to 66 percent for Belgium and 75 percent for Italy.[4] Generally, countries with low support ratios also report low ratios of expected working years to expected retirement years.

The ranking of countries in Diagrams 1 and 3 is influenced by differences in their rates of early retirement. These are largely attributable, in turn, to national differences in the design of public pension systems, together with the effects of occupational schemes and tax rules. Differences in design have a substantial impact on incentives and there is a strong correlation between social-security incentives and unused capacity.[5] Where older workers have economic incentives to leave the labour force, the ratio of expected working years to retirement years will decrease, and pension systems will be more expensive.

Related to this issue is the manner in which pension schemes treat changes in life expectancy. Most pension schemes pay the same yearly pension from the same age regardless of changes in life expectancy over time. This feature of a public pension scheme is hard to justify if an increase in life span includes a number of healthy, potentially productive years.

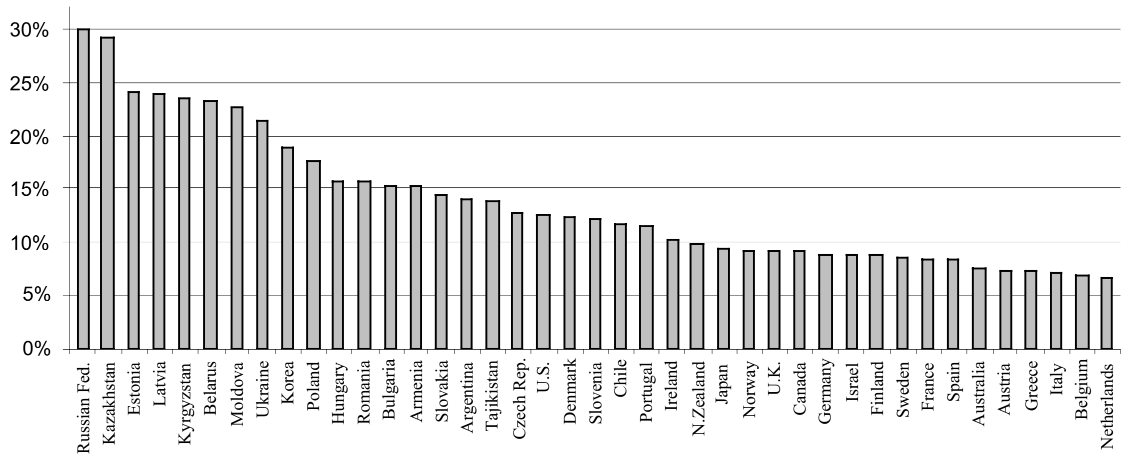
It is important to note that the figures used for calculating the support ratio and the ratio of expected working years to retirement years are unisex figures. In “rich” countries with relatively long working time in relation to retirement time, such as Denmark (+ 98 percent) and Sweden (+ 93 percent), this is due largely to a high rate of female participation in the labour force. Although the rate is lower in Denmark than in Sweden, Denmark with its lower life expectancy still ranks higher than Sweden.

3.2 Expected Inheritance Gains

With a life-cycle perspective, the (implicit) pension liability eliminated by deaths of insured non-retired persons constitutes an *inheritance gain* for the system. The life-cycle support ratio increases by the same percentage as the expected percentage of the total pension liability that is annulled for each cohort because of death prior to retirement. Inheritance gains are in our model system, as in defined benefits in general, distributed to survivors in the form of a lower contribution rate.[6]

The size of inheritance gains depends on the mortality rate for ages below the retirement age and on the pension liability of the system to the deceased. If the system provides for an income-related pension, the higher the lifetime income of those who die prior to retirement, the larger the inheritance gains, and *vice versa*.[7]

Diagram 4. Expected Inheritance Gains – Ranking of Counties



Expected inheritance gains in countries with higher GDP per capita are generally rather low, 7 to 15 percent. For some countries, especially those in Eastern Europe, expected inheritance gains are remarkably high – 30 percent in Russia, for example. The reason is a particularly high rate of male mortality.

3.3 Expected Growth

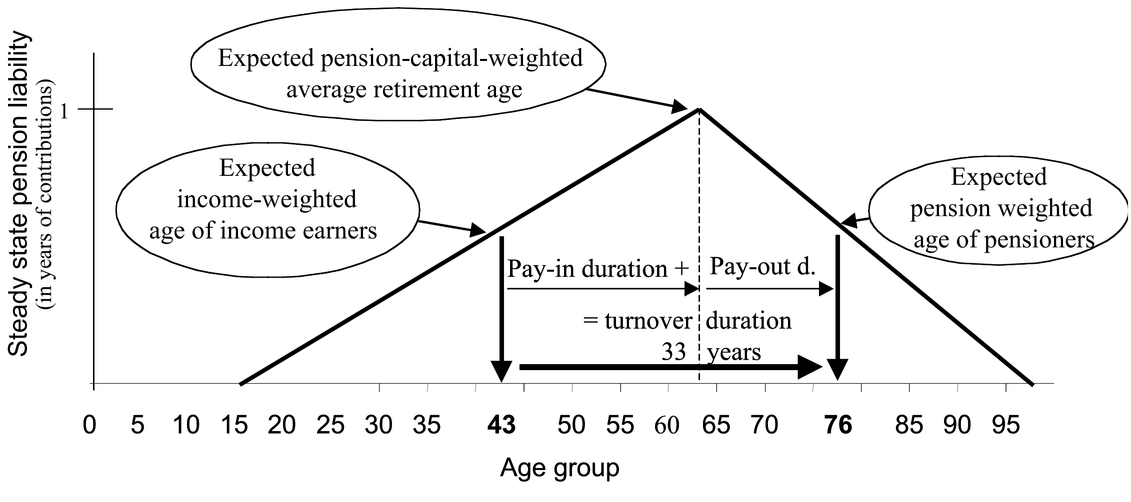
The growth of the wage base can be viewed as a kind of interest received by the pay-as-you-go system. This growth will be due to increases in average wages and any expansion of the labour force. Just as in several existing pension systems, pensions in our model system keep pace with the development of average wages. For this purpose, pensions are indexed to the increase in the average wage. This feature is convenient; when applying the model we need not make any assumption about the growth in the average wage.

If the number of individuals in the labour force increases, then the wage base will grow faster than the average wage. This element of interest, *growth of wage base in excess of growth in average wage*, can be considered to increase the value of each unit of contributions paid into the system. It thereby increases the life-cycle support ratio. Slower growth of the wage base in relation to the growth in the average wage will constitute a form of negative interest that will decrease the value of each unit of contribution, thus also reducing the life-cycle support ratio.

The wage base may grow faster than average income for two reasons: an increase in labour-force participation or an increase in the working-age population. By the same token, a drop in labour-force participation or a decrease in the working-age population will lead to slower growth in contributions than in the average wage. We will study only the effects on the size of the labour force due to population growth and decline; thus, it is assumed that labour-force participation at every age is constant. Further, we assume that working-age population growth (or decline) is entirely dependent on the birth rate.

It is well known that the *accumulated* interest earned at a given rate will be higher the longer the money is invested at this rate. Even though pay-as-you-go systems are largely non-funded, they function in a basically similar manner. The total "interest revenue" earned by the pay-as-you-go system is larger the longer the time *from* when wages are earned by an individual *to* when pension benefits are paid to that individual. This time span can be measured as the number of years elapsing *from* the expected average age at which wages are earned *until* the expected average age at which a pension is received. We call this time span the *expected turnover duration*. Figure 2 illustrates the concept on the basis of the age-related wage and mortality patterns of Sweden in 1998.

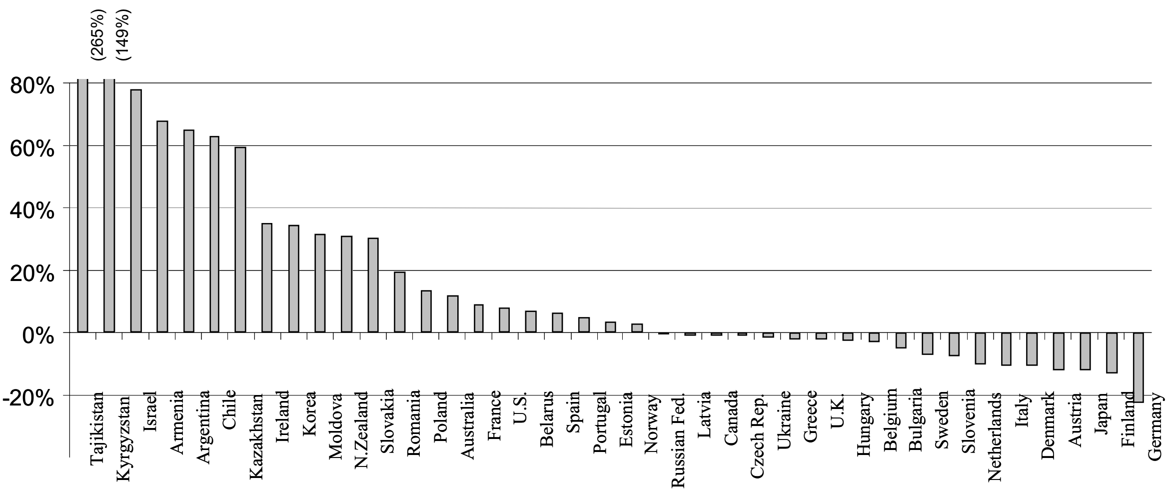
Figure 2. Illustration of the Concept of Expected Turnover Duration



The expected turnover duration concept has been developed in conjunction with the Swedish pension reform. Calculating it is simple,[8] it basically follows the same method used as when calculating life expectancy.

In Diagram 5, turnover duration and estimated population growth are used to rank the countries from highest to lowest in terms of expected accumulated interest in excess of average wage growth. The diagram clearly illustrates the acknowledged sensitivity of pay-as-you-go financing to working-age population growth.

Diagram 5. Expected Accumulated Interest in Excess of Average Wage Growth – Ranking of Countries[*]



Tajikistan represents the upper extreme. Its expected accumulated interest in excess of average income growth is 265 percent, a factor of 3.65.[9] This result is due to the very high estimated working-age population growth of 3.8 percent, which is expected to "compound" wages for an average of 35 years. Germany is at the lower extreme. Our method to estimate working-age population growth yields a large negative growth rate for Germany, minus 0.8 percent.[10] This strong negative growth results in substantial "accumulated negative interest": minus 22 percent.[11] The estimated negative working-age population growth make the contribution rate for Germany to increase by almost 30 percent, in relation to an assumption of zero growth rate. For Denmark, Japan,

[*] With the expected turnover duration (D), the expected total interest in excess of average wage growth (TI) resulting from any estimated population growth in percent (g) can be determined by a standard formula for calculating compound interest:

$$TI \qquad (1+g)^{D}-1$$

Let us assume that the estimated population growth is 1 percent and that the expected turnover duration is 33 years. This means that the estimated population growth of 1 percent will be the rate at which wages will be compounded for an average of 33 years per insured, for total accumulated interest of 0.39 units per unit of contribution $(1+0.01)^{33}-1= 0.39$. The growth of 1 percent for 33 years of turnover duration thus increases the life-cycle support ratio by 39 percent, or by a factor of 1.39.

A complicating factor in the turnover duration measure is that it is affected by the population growth.

Finland, and Austria, a fairly rapid working-age population decline is expected: minus 0.4 percent. This yields a negative expected cumulated interest of 11 to 13 percent. It is also estimated that Sweden, Netherlands, and Italy will show negative working-age population growth: minus 0.3 percent, yielding a negative expected cumulated interest of 7 to 10 percent. The median working-age population growth for the 41 countries is plus 0.1 percent.

The median turnover duration is 32.7 years. The turnover duration does not vary greatly between the countries.[12]

3.4 Contribution Rates with the Life-cycle Perspective

The life-cycle support ratio is calculated by multiplying the ratio of working years to retirement years and the factors for expected inheritance gains and interest in excess of average wage growth:

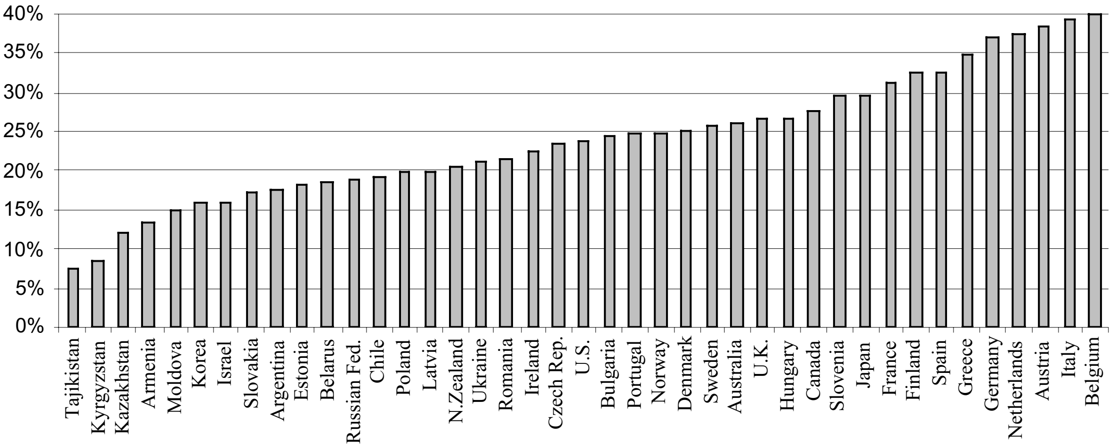
[illegible]

The support ratio and life-cycle support ratio of the 41 countries for which the UN/ILO statistics are sufficiently complete are summarised in Table 1. The factors that make up the life-cycle support ratio are also entered into the table. Some of the interesting intermediary numbers for Table 1 are summarised in the appendix, Table A. One such intermediary figure of interest is the estimated population/labour force growth.

The contribution rate that is applicable with a life-cycle perspective, the *life-cycle contribution rate*, can be calculated simply by dividing the intended pension level by the life-cycle support ratio. The intended pension level in this case, 50 percent, is divided by the life-cycle support ratio to obtain the life-cycle contribution rate.

$$\text{Life-cycle contribution rate} = \frac{50\ \%}{\text{Life-cycle support ratio}}$$

Diagram 6. Life-cycle Contribution Rates – Ranking of Countries



The countries in Table 1 and Diagram 6 are ranked from lowest to highest life-cycle contribution rate. The life-cycle support ratio and thus the life-cycle contribution rate vary greatly among the countries studied. The lower extreme life-cycle-contribution rate is 7.4 percent (Tajikistan); the upper extreme is 39.9 percent (Belgium). If the age limit for receiving benefits is increased to 65, the lower and upper life-cycle contribution rates drop to 4.4 percent (Tajikistan) and 28.3 percent (Italy).[13] Changing the age limit changes the ranking by country only slightly.

Table 1. Support Ratio, Life-cycle Support Ratio & Contribution Rate

Individuals 55 years or older and not in the labour force are assumed to receive benefits from the pension system that on average amount to 50 % of the average wage.

[illegible]

Country	Year	Support ratio	[illegible]	1 + Inheritance gains	1 + Interest	Life-cycle support ratio	Life-cycle. contribution rate
Tajikistan	1991	5.26	1.62	1.14	3.65	6.74	7.4%
Kyrgyzstan	1995	4.21	1.90	1.24	2.49	5.86	8.5%
Kazakhstan	1996	3.79	2.04	1.29	1.60	4.20	11.9%
Armenia	1993	4.04	1.95	1.15	1.68	3.78	13.2%
Moldova	1994	3.12	2.09	1.23	1.31	3.37	14.8%
Korea Rep.	1991	5.40	1.95	1.19	1.34	3.12	16.0%
Israel	1994	3.22	1.60	1.09	1.78	3.11	16.1%
Slovakia	1995	3.09	1.93	1.15	1.30	2.89	17.3%
Argentina	1990	2.71	1.52	1.14	1.65	2.85	17.5%
Estonia	1996	2.72	2.14	1.24	1.03	2.74	18.2%
Belarus	1996	2.58	2.05	1.23	1.07	2.70	18.5%
Russian Fed.	1995	2.59	2.05	1.30	1.00	2.66	18.8%
Chile	1997	3.88	1.45	1.12	1.63	2.63	19.0%
Poland	1996	2.98	1.89	1.18	1.14	2.53	19.8%
Latvia	1996	2.61	2.06	1.24	0.99	2.52	19.8%
New Zealand	1990	3.04	1.69	1.10	1.31	2.44	20.5%
Ukraine	1993	2.27	1.98	1.21	0.99	2.37	21.1%
Romania	1992	2.22	1.68	1.16	1.20	2.32	21.5%
Ireland	1990	2.47	1.51	1.10	1.35	2.24	22.3%
Czech Rep.	1996	2.80	1.93	1.13	0.99	2.15	23.3%
U.S.	1995	3.02	1.74	1.13	1.08	2.12	23.6%
Bulgaria	1993	2.14	1.90	1.15	0.95	2.07	24.1%
Portugal	1992	2.39	1.74	1.12	1.05	2.04	24.5%
Norway	1996	2.66	1.81	1.09	1.03	2.03	24.6%
Denmark	1994	2.75	1.98	1.12	0.89	1.99	25.2%
Sweden	1996	2.59	1.93	1.09	0.93	1.95	25.6%
Australia	1994	3.04	1.59	1.08	1.12	1.92	26.0%
U.K.	1996	2.40	1.76	1.09	0.98	1.88	26.6%
Hungary	1996	2.02	1.65	1.16	0.98	1.87	26.7%
Canada	1992	3.23	1.68	1.09	0.99	1.81	27.6%
Slovenia	1993	2.43	1.63	1.12	0.92	1.69	29.6%
Japan	1990	2.70	1.75	1.09	0.88	1.69	29.6%
France	1995	2.09	1.37	1.08	1.09	1.61	31.0%
Finland	1996	2.46	1.62	1.09	0.87	1.54	32.6%
Spain	1990	1.93	1.33	1.08	1.07	1.53	32.6%
Greece	1995	1.84	1.37	1.07	0.98	1.44	34.7%
Germany	1994	2.11	1.59	1.09	0.78	1.35	37.2%
Netherlands	1995	2.33	1.40	1.07	0.90	1.34	37.3%
Austria	1996	2.02	1.38	1.07	0.88	1.31	38.3%
Italy	1994	1.79	1.32	1.07	0.90	1.27	39.4%
Belgium	1994	1.70	1.21	1.07	0.97	1.25	39.9%

Box 2. Ensuring Financial Balance

In Section 3 we showed how a life-cycle perspective can be applied to avoid expected variations in contribution rate. If the contribution rate for the “initial year” is set at the level implied by a life-cycle perspective, the rate will be fixed for subsequent years if the assumptions behind the life-cycle support ratio materialise. Normally, however, there will be some deviations between assumed and actual developments. Also, the assumptions about the future may change. To account for these deviations and for changes in assumptions, the contribution rate must be adjusted on a regular basis. (The same general method could be used instead, as it is in the Swedish system, to index pensions so that long-term financial stability is ensured with a fixed contribution rate.)

These required adjustments should be consistent with a life-cycle perspective. The method of ensuring financial stability very briefly outlined here is similar to the one normally used by economic associations with long-term liabilities in that it entails preparing a balance sheet showing the financial position of the system.

The pension liability (*L*) is easy to calculate for any pension system and set of assumptions.

The value of contributions to a pay-as-you-go pension system depends on the degree to which the contributions can finance, or amortise, the pension liability. The capacity of a given amount of contribution to amortise the pension liability depends in turn on the age-related wage and mortality patterns of those covered by the system as measured by the *expected turnover duration*. The assets of a pay-as-you-go pension scheme, and thus its capacity to finance the pension liability through contributions, can be calculated with the following formula:

Where, r = contribution rate, W = wage base, D = turnover duration and F = buffer fund.

A financially stable pay-as-you-go pension system is one in which assets and liabilities are equal, i.e. a system with a net present value of zero. Its financial stability can be ensured by annually calculating the contribution rate, r, satisfying the condition that:

Assets = Liabilities

The calculation of r is accomplished with the formula:

(1)

From this simple formula it follows that the contribution rate will increase under any of the following conditions:

- The pension liability (*L*) increases by more than the buffer fund (*F*). This will be the case if contributions paid are less than the value of pensions credited, or if life expectancy increases, or if the return on the buffer fund is less than the growth in the wage base.
- The wage base (*W*) increases by less than the net pension liability (*L-F*). This will be the case if labour-force participation decreases or if growth in the working-age population falls short of estimates.
- Turnover duration (*D*) decreases. This can happen, for example, if the average age of entry into the labour force is postponed or if the average wage of older workers increases more than the average wage of younger workers (both cases represent shifts in wage patterns).

4. Conclusions

This study is based on the view that a pay-as-you-go old-age pension system works much like any other kind of savings system. On an aggregate level, what one gets back from it depends on the following factors: the amount saved each period (the contribution rate), the length of time during which savings are made (average working years), the length of time during which the accumulated savings will be consumed (average retirement years), and the rate of interest on the savings (growth of the wage base in excess of average wage growth). Quite surprisingly, the time during which interest is earned, referred to here as *turnover duration*, does not seem to have been isolated previously.[1] Explicit consideration of turnover duration opens the way for the type of analyses made above.

This paper holds two types of conclusions; one concerns the result of the calculations, the other the method involved to get them.

Our calculations point in the same direction as several other, more elaborate, studies.[2] We have concluded, namely, that a large number of countries will be facing

— *either* sharp increases in contribution rates,
— *or* substantial cost-cutting changes in their pension systems that will result in lower pension levels.

For the large majority of the countries covered, the life-cycle perspective outlined in this paper would also entail sharp increases in contribution rates. The new rates, however, would be less than the highest contribution rate required with the annual perspective used in most pay-as-you-go pension systems. With a life-cycle perspective the bill for the pension system would be picked up earlier and more evenly over generations. Our rough calculations are summarised in Table 2.

Table 2. Summary of the Calculations

	Median contribution rate (for pension level 50 %)	Median support ratio (irrespective of pension level)
Annual perspective*	17.7 %	2.61
Life-cycle perspective*	23.6 %	2.12

* See Table 1 for the years to which the calculations refer. (Table B discloses highest expected contribution rate for each of the 41 countries. The median of those contribution rates is 26.8 %.)

If inter-generation fairness is an issue of concern for a pay-as-you-go pension system a life-cycle perspective should be adopted and a buffer fund should be introduced. Arguably such measures may also strengthen the legitimacy and credibility of many national pay-as-you-go pension schemes.

Regardless of financial time perspective, one way of reducing the cost of an aging population is of course to alter some of the factors that determine the (life-cycle) support ratio. The principal option here is to postpone the effective retirement age, thus raising the number of working years in relation to retirement years.

Our calculations have only been performed for a simple hypothetical pension system, but the same type of analysis can be applied to systems in the real world. While several complicating factors would then arise, the analytical concept to be used would essentially remain the same. This concept is based essentially on the measure referred to as turnover duration, which makes it possible to prepare *balance sheets* for pay-as-you-go pension systems. This standard way of showing the solvency of a system with a long-term liability, together with the potential objectivity of the method, could perhaps lessen some of the information or credibility problems faced by many pay-as-you-go systems. Reliable balance sheets may build confidence in cases where the credibility problem is unfounded. In other cases, balance sheets might be a forceful means of presenting the need for reform.

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Notes

1. Introduction

[1] The pay-as-you-go variety of pension systems is here defined as pension systems that do not have any legal or by other means imposed requirement to fund any share of the pension liability. This definition allows for periodic differences between contributions to the system and payments from it and thus introduces a buffer fund.
[2] Demographic Yearbook, Historical Supplement 1948-1997.
[3] Economically Active Population 1950-2010 Fourth Edition.
[4] The automatic balance mechanism is presented in Settergren (2000) and in Government Bill 2000/01:70, Automatisk balansering av ålderspensionssystemet, both in Swedish. For an introduction in English, see Settergren (2001).
[5] The results of the calculations can be scaled to fit any pension level that a specific pension system is intended or believed to yield.

2. The Support Ratio

[1] Calculations have also been made for a higher assumed minimum retirement age. In the appendix, Tables C, D & E, the lowest age for receiving a pension benefit is set at 65. Under this assumption, the number of retired persons decreases while the number of contributors remains the same. This implies higher ratios of contributors to retirees (support ratio). There is a sharp reduction in the costs of the system when persons between 55 and 65 and not in the labour force receive income from other sources.
[2] If instead the contribution rate is fixed and the pension level is variable, the inter-generation effect is different. The relatively small older cohorts will benefit from a higher pension level when the support ratio increases; the large cohorts that follow will receive lower pensions when they retire and the support ratio decreases.
[3] We will not explore the question whether it is actually possible to fund assets for future consumption on a national or "global" scale. Nor will we discuss the option of operating with budget surpluses and deficits to assure inter-generation fairness.

3. The Life-cycle Support Ratio

[1] The expected average number of working years is calculated for a normalised population, assuming constant age-related labour-force participation of individuals reaching retirement age. The expected number of retirement years is also calculated for a normalised population, assuming constant age-related retirement patterns and mortality. The definition of a stable population allows for population growth and decline, provided this growth or decline is constant.
[2] $50\%/(40/20) = 25\%$
[3] The nominator and denominator of the ratio are calculated in Table A in the appendix.
[4] See Table D in the appendix.
[5] This issue has been thoroughly analysed in *Social Security and Retirement in the World*.
[6] In a defined contribution system inheritance gains would be distributed to survivors in the form of higher pensions.
[7] Mortality tends to be correlated with lifetime income. Low-income earners will typically have a higher mortality than high-income earners of the same sex. However, the rather strong correlation between income and mortality for persons of the same sex is not generally applicable to the combined population of men and women. The reason is that typically both earnings and mortality are lower for women than for men. In the calculations it is assumed that in every age group individuals who died before reaching retirement age would on average have received an average pension had they lived to retirement.
[8] For the formula for calculating turnover duration in the Swedish system, see RFV Analyserar 2000:1, or Government Bill 2000/01:70.
[9] $(1 + 3.8\ \%)^{35}$ 3.65

[10] We have tried to relate this figure, calculated only with cross-section UN demographic statistics, to the official German forecast. The population projection that is used by the German government 11-04 2001 (Mittlere= Bundesregierungs-Variante) implies an average annual decrease of 0.6 % in the working-age population during the period 2001-2050.
[11] $(1 - 0.8\ \%)^{32}$ 0.78.
[12] The low variation in turnover duration (a standard deviation of 0.9 years) is due to the weighted character of the measure, which makes it rather robust. One factor that may partially explain this limited variation is that the ILO statistics on age-related labour-force participation seem to be rather rough estimates. Another factor may be the artificial assumption that the average individual wage is the same for all ages, although this assumption has had little impact on turnover duration for Sweden.
[13] See Table D in the appendix.

4. Conclusions

[1] The concept of turnover duration was presented in Settergren (1999).
[2] See, for example, Averting the Old Age Crisis (The World Bank), Maintaining Prosperity in an Ageing Society (OECD).

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