

Notional Defined Contribution Pension Schemes and Income Patterns

Sergio Nisticò and Mirko Bevilacqua

University of Cassino and Southern Lazio

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Abstract During the 1990s, some important European countries such as Italy and Sweden radically transformed their public pension systems by adopting defined-contribution rules while retaining a pay-as-you-go financial architecture. The paper inquires into the theoretical properties of such “notional defined contribution” pension schemes in order to identify the determinants of the replacement rates awarded to individuals with different income patterns. Three typical career patterns are taken into consideration, according to whether the individual’s wage growth is equal to, higher than, or lower than average wage growth. The impact of, and the possible remedies to, a possible discontinuity in replacement rates is assessed by means of a sensitivity analysis of replacement rates with respect to career length (for a given retirement age), the retirement age, and the rate of return credited to individual accounts.

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Correspondence Sergio Nisticò, University of Cassino, Department of Economics, Cassino, University of Cassino and Southern Lazio, Italy; e-mail: s.nistico@caspur.it. Mirko Bevilacqua, Creativity and Motivations Economic Research Center, University of Cassino and Southern Lazio, Italy.

1 *Introduction*

Evaluating whether the pensions provided by a public pension system to its members are 'adequate' according to some standard is not an easy task. From the viewpoint of the State, the adequacy of pension provisions depends essentially on some essential elements, such as financial and social sustainability, fairness and transparency.

On the other hand, when providing an overall judgment about the adequacy of a stream of pension annuities from the viewpoint of the individual, essentially three elements should be taken into account:

1. *The extent to which the flows of pensions that will be awarded to the individual allow enjoying the pre-retirement standard of living for the whole retirement period; the replacement rate and the yearly rate of pension adjustment provide synthetic information about 'adequacy' along this dimension.*

2. *The number of annuities that will (or are expected to) be paid, and hence the (expected) length of the retirement period allowed for by the system; the legal retirement age is what counts on this respect, since the lower the age at which the pension can be withdrawn, the more a stream of pensions tends to be considered an 'adequate' compensation for the past working life (provided that work is considered painful).*

3. *The contribution rate whose payment has generated the 'property right' on the stream of pensions and hence the benefit-cost ratio of the participation in a pension system; in this perspective, the individual rate of return that, implicitly or explicitly, the individual expects to earn on contributions provides a measure of the 'adequacy' of a stream of pension benefits (in that it allows a comparison with both the return of alternative forms of precautionary savings and with the, possibly different, return earned by other individuals within the same pension system).*

The first of these three dimensions of adequacy is important especially for low-wage workers, whose standard of living remains very close to the 'subsistence level' for the whole working period and cannot be compressed significantly during retirement, without implying a fall of her standard of living below the 'poverty line'. The second dimension is especially relevant for those who, having long been employed in hard jobs, need to retire, for purely physical reasons, earlier than other workers. Of course, early retirement age can be a crucial

issue also for those workers, whose need to retire is induced by psychological rather than physical distress. Insofar as some careers are characterized by both low wages and job hardness, the need emerges for close-to-one replacement rates and early retirement.

Finally, the third dimension of adequacy essentially determines the extent to which the labour market is ready to acknowledge that the gross wage (income) rate must somehow include a high enough compulsory savings rate to finance a pension plan covering the expected length of life remaining after retirement.

As it is well known, most of the public, pay-as-you-go pension systems are earnings related and of the defined-benefit (DB) sort, in that they promise to pay a stream of pension annuities commensurate to the earnings of the active period. As a result, these systems tend to award similar replacement rates between the first pension installment and the last earned incomes to all individuals, regardless of their income patterns. The reforms enacted in Italy and Sweden in the '90s and, above all, the theoretical works that have been produced both during and after their gestation period,¹ have allowed to clarify that granting uniform replacement rates implies actuarial unfairness, i.e. a marked difference among the individual rates of return with which the system rewards compulsory savings². The circumstance of being able to remedy the disparities in individual internal rates of return typical of the earnings-related, DB schemes has definitely enhanced the interest towards the Notional Defined Contribution (NDC) model, whose main feature with respect to the above mentioned three dimensions can be summarized as follows:

1.a contrary to what happens in most of the earnings based DB schemes, it *does not* grant similar replacement rates to all individuals for the same retirement age, while the overall (average) level of replacement rates exhibits a trade off with the yearly adjustment rate during retirement;

2.a its fairness and financial sustainability is compatible with individually chosen retirement patterns, including flexible and partial retirement as well as with the possible supplement of the individual's account balance with contributions deriving from 'external' sources of revenue such as unemployment allowances and other types of welfare benefits;

¹ For a summary of the debate, see Gronchi and Nisticò (2008, p.132 n.3)

² For a comparison of the degrees of actuarial fairness in the pension systems of the main OECD countries both before and after the reforms of the '90s, see Lindbeck and Persson (2003).

3.a insofar as longevity is managed by annuity divisors that reflect each cohort's life expectancy, and the account balance of all members of the scheme is credited with the 'appropriate' yearly rate of return, it ensures both substantial financial stability and actuarial fairness (see Gronchi and Nisticò 2008).

The aim of this paper is to inquire whether, and to what extent, a fair and financially sustainable NDC pension scheme is able to provide to its members pensions that are also socially sustainable, i.e. that the individuals feel as adequate in the sense discussed above. In this perspective the next section provides an analytical framework that allows assessing the impact on NDC pensions of different career patterns. Section 3 investigates the complex relationship between the level of the NDC pensions on the one hand and the contribution rates, the length and the dynamics of the working career on the other hand. Section 4 concludes.

2 The NDC scheme and the interaction between the individual's wage path and the replacement rate³

Within an NDC pension scheme, the contributions that each individual pays in the system are credited on a personal account, whose balance is transformed into a stream of pension annuities according to life expectancy at retirement. The 'shape' of this stream depends on the share of the 'future returns' embedded in the annuity divisors by which the account balance at retirement is divided in order to calculate the level of the first of annuity. In fact, any NDC system that wants to be free to anchor the rate of return to be credited each year on workers' as well as on retirees' notional accounts to some variable economic indicator should adopt a 'flexible' pension adjustment rule such that the pensions that the individual is expected to withdraw 'exhaust' exactly the account balance at retirement. It can be shown that adopting the following formula for the adjustment rate in each year i is a necessary condition to ensure both actuarial fairness and financial sustainability:

$$(1) \quad \sigma_i = \frac{1 + \pi_i}{1 + \delta} - 1 \quad \forall i,$$

³ The argument of this section draws inspiration from Nisticò (2012).

where π_i is the rate of return to be credited on the account balance in year i and δ the rate of return anticipated and embedded in the annuity divisors.⁴

The interaction between the NDC rules and each individual's wage pattern can be easily analyzed by starting from the following expression of the account balance at retirement (AB_R) as the sum of n 'pieces', each deriving from the contributions paid in the i^{th} of the n working years and from the interests matured on those same contributions:

$$(2) \quad AB_R = \sum_{i=1}^n \alpha \cdot w_i \cdot \prod_{j=i}^n (1 + \pi_j),$$

where α denotes the fixed contribution rate, w_i the wage earned in year i . According to (2), the relative 'weight', within AB_R , of the contributions paid in year i with respect to those paid in any year $i-x$ depends essentially on the difference between the growth rate of the individual wage and the rate of return credited on the individual account between year $i-x$ and year i .

Both the average wage growth earned by any individual across the $i-x$ periods of time, which will be denoted as α^i , and the average, conventional rate of return credited on each account across the same $i-x$ periods of time can be expressed in terms of a 'deviation' with respect to the growth rate of the average wage of the economy,

$$(3) \quad \begin{aligned} \alpha^i &= (1 + \alpha) \cdot (1 + \delta_w) - 1; \\ \pi &= (1 + \alpha) \cdot (1 + \delta_\pi) - 1 \end{aligned}$$

where α is the growth rate of the average wage of the economy registered between period $i-x$ and period i , while δ_w and δ_π are the above defined deviation rates of, respectively, the growth rate of the individual wage and of the conventional rate of return.

According to (3), the relative weight, $\tau_{i/i-x}$ of the contributions paid in year i with respect to those paid in year $i-x$ can therefore be expressed as:

$$(4) \quad \tau_{i/i-x} = \frac{\alpha \cdot w_i}{\alpha \cdot w_{i-x} \cdot [(1 + \alpha) \cdot (1 + \delta_\pi)]^x} = \frac{w_{i-x} \cdot [(1 + \alpha) \cdot (1 + \delta_w)]^x}{w_{i-x} \cdot [(1 + \alpha) \cdot (1 + \delta_\pi)]^x} = \frac{(1 + \delta_w)^x}{(1 + \delta_\pi)^x}.$$

⁴For a discussion of the trade off between the value of δ - hence of the first pension annuity - and the yearly adjustment rate imposed by equation (1), see Gronchi and Nisticò (2008, pp. 135-8).

2.1 Three cases

If one assumes that the conventional rate of return credited on the account balance of each individual coincides with the average wage growth, so that the denominator of the last of (4) is equal to one, an interesting ‘benchmark case’ emerges, namely that of a worker whose individual wage growth coincides with that of the average wage, so that also the numerator, and hence the whole fraction in (4), is equal to one. In other words, when the average wage growth of the economy is credited as rate of return on all account balances, for an individual whose wage grows in line with the average wage, all yearly contributions have the same weight in AB_R independently of their ‘age’. as shown in column (4) of **Table 1**. The table simulates the interaction between the career pattern and the account balance at retirement for three typical workers. The assumption is made that the three individuals start to work at the age of 24 (earning a yearly wage equal to 100 money units) and retire when 67 after having contributed to the pension system, and having been credited on their NDC account, 30% of their yearly wage together with a yearly rate of return of 2%.

On the other hand, two other typical cases can be pointed out on the basis of the last of (4), according to whether the worker’s wage growth is higher or lower than the average wage growth (still considered to be equal to the conventional rate of return). In the former case, since the numerator of the last of (4) is greater than the denominator, the weight of the more recent contributions in AB_R exceeds that of the older ones, as shown in column (7) of **Table 1**. Finally, in the latter case, simulated in column (10) of **Table 1**, namely that of a worker whose individual wage grows less than the average wage does, the weight of the ‘old’ contributions in AB_R exceeds that of the more recent ones.

Table 1
Weights of yearly contributions in the account balance at retirement for three typical workers
(Average wage growth=2%; contribution rate=30%; contribution record:43 years)

Age	Individual wage growth = average wage growth			Individual wage growth = average wage growth +1%			Individual wage growth = average wage growth -1%		
	wage	contrib.	weight AB_R	wage	contrib.	weight AB_R	wage	contrib.	weight AB_R
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
24 years	100,0	30,0	68,9	100,0	30,0	68,9	100,0	30,0	68,9
25	102,0	30,6	68,9	103,0	30,9	69,6	101,0	30,3	68,2
26	104,0	31,2	68,9	106,1	31,8	70,3	102,0	30,6	67,6
27	106,1	31,8	68,9	109,3	32,8	71,0	103,0	30,9	66,9
28	108,2	32,5	68,9	112,6	33,8	71,7	104,1	31,2	66,3
29	110,4	33,1	68,9	115,9	34,8	72,4	105,1	31,5	65,6
30	112,6	33,8	68,9	119,4	35,8	73,1	106,2	31,8	65,0

...
...
60	204,0	61,2	68,9	289,8	86,9	97,9	143,1	42,9	48,3
61	208,1	62,4	68,9	298,5	89,6	98,9	144,5	43,4	47,9
62	212,2	63,7	68,9	307,5	92,2	99,8	146,0	43,8	47,4
63	216,5	64,9	68,9	316,7	95,0	100,8	147,4	44,2	46,9
64	220,8	66,2	68,9	326,2	97,9	101,8	148,9	44,7	46,5
65	225,2	67,6	68,9	336,0	100,8	102,8	150,4	45,1	46,0
66	229,7	68,9	68,9	346,1	103,8	103,8	151,9	45,6	45,6
Retirement age: 67 years									
- AB _R				2.963,5		3.664,0			2.427,6
- First Pension				164,6		203,6			134,9
- Replacement Rate				71,7%		58,8%			88,8%

2.2 Discontinuity in the contribution history within the NDC scheme

The last three rows of **Table 1** show the values of the account balance at retirement, of the first pension⁵ and of the replacement rate (at the age of 67) for each of the three working careers, all characterized by a full contributive record, 43 years long. Due to the strict correspondence between contributions and benefits characterizing actuarially fair NDC schemes, any gap in the contributive history with respect to the full record, will have a negative impact on the account balance and hence on both the first pension annuity and the replacement rate.

Let us imagine that, for whatever reason, the three individuals whose career is synthesized in **Table 1**, ‘miss’ two years of contributions and that the gaps in the contribution history occur at the very beginning of the three individuals’ career. The ensuing values for the account balance, the first pension and the replacement rate of the three individuals are reported in Table 2.

⁵ The first pension annuity for the three cases reported in **Table 1** has been calculated by assuming a divisor equal to 18 for those retiring at 67, a higher (less generous) value than those presently used both in Italy and Sweden that have taken the decision to anticipate a rather high interest rate (δ) in the annuity divisors (1,5% in Italy and 1,6% in Sweden). Our choice aims to mirror a hypothetical reformed NDC scheme in which higher divisors, due to lower values of δ , can give room to adjustment rates that can follow, at least in part, real wage growth. Actually, given the present mortality rates, a divisor equal to 18 corresponds to an anticipated interest rate of about 0,65%, which would leave room for a yearly adjustment of about 1% in real term if productivity will grow around 1,65% per year in the next decades (see equation (1) above).

On the other hand, the choice to assume a contribution rate equal to 30% fits a quite hypothetical scenario in which the NDC scheme absorbs all forms of retirement savings (including the occupational and voluntary pillars), thus ensuring, alone, retirement income to all workers in proportion to the contributions paid in the system during the active period.

Table 2. Account balance, first pension and replacement rate for three typical workers with early discontinuity in contribution history

(Average wage growth=2%; contribution rate=30%; Retirement age: 67 years; contribution record:41 years)

	Individual wage growth = average wage growth	Individual wage growth = average wage growth +1%	Individual wage growth = average wage growth -1%
Initial wage	100,0	100,0	100,0
Last wage	229,7	346,1	151,9
AB_R	2.825,61	3.525,47	2.290,48
First Pension	156,98	195,86	127,25
Replacement Rate	68,3%	56,6%	83,8%

It is now convenient to run the same simulation with reference to a case of late discontinuity. The ensuing values for the account balance, the first pension and the replacement rate of the three individuals are reported in Table 3.

Table 3. Account balance, first pension and replacement rate for three typical workers with late discontinuity in contribution history

(Average wage growth=2%; contribution rate=30%; Retirement age: 67 years; contribution record:41 years)

	Individual wage growth = average wage growth	Individual wage growth = average wage growth +1%	Individual wage growth = average wage growth -1%
Initial wage	100,00	100,00	100,00
Last wage	229,72	346,07	151,88
AB_R	2.825,61	3.459,35	2.335,15
First Pension	156,98	192,19	129,73
Replacement Rate	68,3%	55,5%	85,4%

By comparing the three tables (see Table 4), it is easily seen that for the individual whose wage grows in line with the average wage (the conventional return) – so that, according to (4), all yearly contributions have the same final weight in AB_R – it doesn't matter when the gaps in the contribution history occur. In fact, for this individual the first pension and the replacement rate would drop to the same level regardless of whether the two-years gap in the contribution history occurs at the beginning or at the end of the career.⁶

⁶ Notice, that for the average individual the replacement rate drops by 1/43 (2,33%) for each year of missing contribution. For the other individuals with a wage growth higher or lower than the average, the percentage drop for each yearly gap in contribution can be lower or higher than the preceding figure, according to exact position of the gap in the career pattern. However, in the presence of discontinuity the question arises as to whether the replacement rate should be computed with reference to the last wage or to a sort of average of the last or all yearly earnings. This point, touched upon in Swedish Pension Agency (2011, pp.31-2) will be discussed in section 3.2 below.

Table 4. Results of the simulations by comparison*(Average wage growth=2%; contribution rate=30%; Retirement age: 67 years)*

	Individual wage growth = average wage growth	Individual wage growth = average wage growth +1%	Individual wage growth = average wage growth -1%
1. No discontinuity in contribution history <i>(contribution record: 43 years)</i>			
First Pension	164,6	203,6	134,9
Replacement Rate	71,7%	58,8%	88,8%
2. Early discontinuity in contribution history <i>(contribution record: 41 years)</i>			
First Pension	156,98	195,86	127,25
Replacement Rate	68,3%	56,6%	83,8%
3. Late discontinuity in contribution history <i>(contribution record: 41 years)</i>			
First Pension	156,98	192,19	129,73
Replacement Rate	68,3%	55,5%	85,4%

On the other hand, the table 4 shows that for an individual whose wage growth exceeds the average wage growth, early discontinuity has a smaller impact than late discontinuity on the first pension and the replacement rate, whereas the reverse applies for an individual with a lower—than—average wage growth.

3 Social and financial sustainability of the NDC scheme

One could argue that the typical careers reported in **Table 1**, together with the assumptions made to run the simulations, might overestimate the actual performance of the NDC in that: (i) the 30% contribution rate is abnormally high; (ii) even if two years of discontinuity are allowed for, still many young workers entering the labourmarket today, could gather less than 41 full years of contributions before reaching the age of 67; (iii) the 2% real rate of return will possibly exceed the sustainable rate of return .

To answer those possible objections, the next sections contain a ‘sensitivity analysis’ of the NDC pensions with respect to the contribution rate, the career length and the conventional rate of return yearly credited on all pension accounts

3.1 The contribution rate and the replacement rate

In most countries, the contribution rate to the public compulsory pension scheme is normally set at a much lower level than 30% and the lower is the contribution rate, the lower will be both the first pension annuity and the replacement rate. More precisely, if one considers that the first pension annuity is obtained through division of (2) by the annuity

divisor, assuming for simplicity the steady state, the individual replacement rate can be expressed as the following linear function of the contribution rate⁷:

$$(5) \quad \frac{p}{w_n} = \frac{\sum_{i=1}^n \frac{w_i}{w_n} \cdot (1 + \pi)^{n-i}}{d} \cdot a,$$

where the ratio on the right hand side, i.e. the slope of the function, measures by how much the replacement rate must decline (increase) for a unit fall (rise) in the contribution rate if actuarial fairness obtain, i.e. if the retirement savings of all individuals is yearly rewarded with the uniform rate of return π .

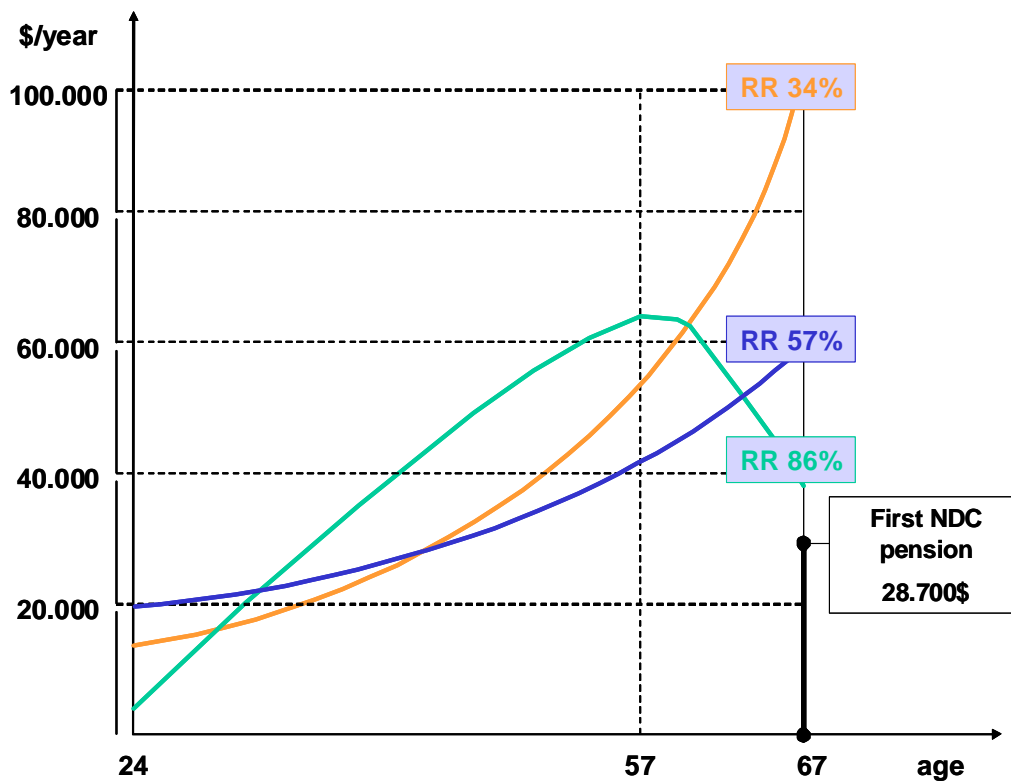
It is easily seen that the slope of (5) depends on the peculiar wage profile (w_i/w_n) of each individual.⁸ In particular, for a given contribution rate, the replacement rate will be higher (lower) for flat career patterns characterized by higher (lower) values of all ratios w_i/w_n .

The circumstance that awarding a uniform yearly rate of return on pension contributions to all individuals, the NDC scheme produces different replacement rates for different career patterns is clearly visible from Figure 1 that reproduces three income profiles that, under the assumption of a constant rate of return of about 2,5% per year, produce the same account balance at retirement (occurring at the age of 67 for all the three individuals). Given the uniform retirement age (annuity divisor) and the uniform account balance at retirement, the NDC rules produce the same first pension annuity (28700\$ per year) for the three individuals with replacement rates ranging from 34% and 57% for the fast-rising and moderate rising income profiles to a high 86% for the reverse u-shaped income profile.

⁷ See also Bevilacqua (2009). Notice that in (5), the assumption has been made that the returns on the account balance are credited only up to year $n-1$.

⁸ Assuming that the rate of return yearly awarded on all account balances is the sustainable one, equation (5) expresses a trade off between the available wage (net of pension contributions) and the replacement rate. The extent to which the slope of all individual functions (5) depends also on the rate of return yearly awarded will be discussed in section 3.3 below.

Figure 1: Three different NDC replacement rates for the same account balance at retirement



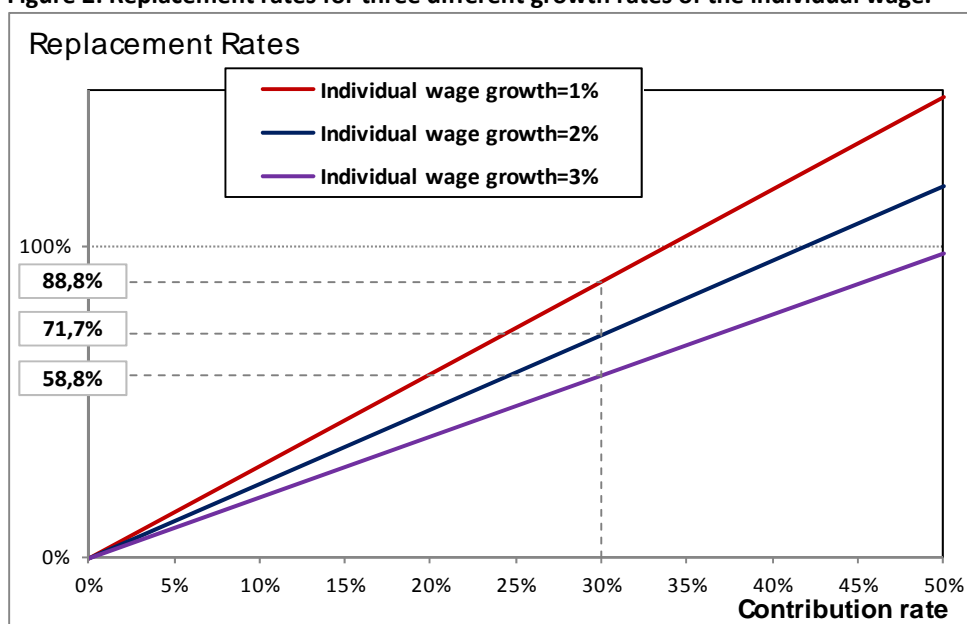
It is interesting to note that for the 'benchmark case' described at beginning of section 2.1, i.e., for the typical worker whose wage grows in line with the average wage growth when the conventional rate of return is supposed to equal the average wage growth, (5) becomes

$$(6) \quad \frac{p}{w_n} = \frac{n}{d} \cdot a .$$

Since the value of d does not deviate significantly from individual life expectancy, according to (6) the replacement rate awarded by NDC schemes to the 'benchmark' individuals is a multiple of the contribution rate, the multiplier being the ratio between the working and the retirement period. On the other hand, the multiplier (the slope of (5)) is lower than n/d that for those workers whose wage grows more rapidly than the average and *vice versa*. The three linear functions corresponding to the three cases reported in **Table 1** are plotted in **Figure 2** wherein the benchmark case is represented by the central, blue line. The steeper, red line represents the case of a worker whose wage grows yearly by 1% less than the average,

whereas the flatter, purple line represents the opposite case of a worker whose wage grows by 1% more than the average.⁹

Figure 2: Replacement rates for three different growth rates of the individual wage.



One should remark that this different degree of responsiveness of the replacement rate to the contribution rate according to the individual's career pattern is one of the key features of the NDC scheme that ensures actuarial fairness precisely by awarding more generous replacement rates to flat-career workers.¹⁰

The issue of what is the appropriate level of the contribution rate to a compulsory, public pension scheme touches upon a political dimension that is definitely beyond the limits of this note. However, the simulations here presented show that the possible choice to have a robust first pillar based on NDC rules, can guarantee at the same time that: (i) flat-career workers are ensured with a very high replacement rate; (ii) the lower replacement rates awarded to the 'steeper' careers leave room for a second, possibly funded, pillar intended to top up those lower replacement rates; (iii) the sustainability and actuarial fairness characterizing the system ensure that the (constant) contribution rate will not be perceived as a tax but rather as a compulsory savings rate rewarded with a fair and uniform rate of return.¹¹

⁹ The value of the replacement rate shown in Figure 2 for the benchmark case (71,7%) can be easily calculated through (6) by assuming $n=43$, $d=18$ and $a=30\%$ as it is in **Table 1**.

¹⁰ On this point see also Gronchi and Nisticò (2006 and 2008) and Nisticò (2009).

¹¹ On the non-tax nature of the contributions paid in an NDC pension scheme see also Feldstein (2002, p.7).

3.2 The problems raised by short careers

The analysis contained in section 2.2 has allowed to assess the possible, different impact of early or late discontinuity in working careers on the NDC account balances at retirement. However, quite independently from ‘when’ discontinuity happens, the present sluggishness with which the labour market absorbs both young and older workers, will determine a perspective situation in which those who have just entered the labor market might reach the age of 67 with working careers much shorter than those imagined so far, say with a record of contributions to the pension system of around 30-35 years. The relevance of these possible cases is different according to whether: (i) ‘strong discontinuity’ is just a feature of a flexible labor market, wherein the individual worker goes back and forth from work, while earning an average yearly wage comparable to the typical workers whose careers have been simulated above; (ii) recurrent discontinuity is not compensated by an extra-wage during working years, so that the average yearly wage approaches, or even falls below, a sort of subsistence threshold.

In the former case, both the pension level and the replacement rate with respect to the average of the last yearly earnings¹² that the NDC scheme can ensure to its members are not affected by discontinuity, i.e. they do not differ from those awarded to ‘continuous’ careers with the same average yearly wage.

In the latter case, the pension level might actually fall below the poverty line, thus creating a problem of social sustainability of the pension provisions. However, one should consider that: (i) the replacement rate, computed with respect to an average of the last earnings would still be unaffected by discontinuity and (ii) strong discontinuity is socially unsustainable for low income workers quite before they reach retirement age; (iii) if some other welfare institution is able to fill the gaps, by providing income support gross of pension contributions, the NDC scheme will, in turn, ensure a decent pension level; (iv) discontinuity can, possibly, be compensated by a postponement of retirement that the NDC rules reward more generously than traditional earnings-based DB schemes.

¹² For an interesting discussion of the notion of replacement- or compensation rate in the face of different income profiles, see Swedish Pension Agency (2011, pp.31-2).

The impact on the replacement rates determined by the length of the working careers is easily analyzed with reference to the benchmark case. In fact, according to (6) the replacement rate increases with n and, given that

$$(7) \quad \frac{\partial(p/w_n)}{\partial n} = \frac{a}{d},$$

the impact on the replacement rate of one extra year of contributive seniority is greater for those schemes characterized by a high contribution rate and is lower for low retirement ages (higher values of d). Notice that with reference to the values of a and d that have been assumed to run the simulations contained in **Table 1**, each year of contributive history adds 1,67% to the replacement rate of those who retire at 67. On the other hand, for those workers with a career path different from the one represented by the benchmark case, the impact on the replacement rate of each working year will be (slightly) higher or lower than 1,67% according to the ‘position’ of that year within the career. It is worth pointing out that the impact measured by (7) holds for a given retirement age, i.e. for a given value of d .

However, one of the key features of the NDC scheme is the free choice of the retirement age and hence the possibility to postpone retirement, thus determining, in equation (6), both an increase of n and a reduction of d due to the lower life expectancy of those who retire later than 67. Actually, to analyze the impact on the replacement rate of postponing retirement, equation (6) should be written as

$$(8) \quad \frac{p}{w_n} = \frac{n}{d(n)} \cdot a$$

and its partial derivative with respect to n becomes:

$$(9) \quad \frac{\partial(p/w_n)}{\partial n} = a \cdot \frac{d(n) - d'(n) \cdot n}{[d(n)]^2} > \frac{a}{d}.$$

Notice that, whereas (7) measures the ‘economic’ effect of postponing retirement, i.e. the positive effect on the account balance of one extra-year of work, the positive difference between (9) and (7) catches the ‘life-expectancy’ effect, i.e. the positive effect on the pension level due to lower divisors.

Notice, moreover, that if one assumes that in the neighborhood of any given value of d , $d(n)$ is the following linear function

$$(10) \quad d(n) = k - c \cdot n, \text{ with } k, c > 0,$$

the right hand side of (9) becomes

$$(11) \quad a \cdot \frac{k}{[k - c \cdot n]^2}$$

and considering that in the neighborhood of $d=18$ the table of the recently updated Italian divisors is characterized by $c \cong 0,612$, and that, with $n=43$, $d=18$ obtains for $k \cong 44,316$, according to (11), postponing retirement by one year from 67 to 68 adds about **4,1%** to the replacement rate of those workers whose career is represented by the benchmark case, with the life-expectancy effect counting, therefore, for about 2,4%.¹³

The impact on the pension benefit of postponing retirement from 66 to 68 is summarized in Table 5.

Table 5. Account balance, first pension and replacement rates for three different retirement ages
(Individual average wage growth=2%; contribution rate=30%)

	Retirement age		
	66 years	67 years	68 years
Initial wage	100,0	100,0	100,0
Last wage	225,2	229,7	234,3
AB _R	2.837,8	2.963,4	3.093,0
First Pension	152,5	164,6	177,9
Replacement Rate	67,7%	71,7%	75,9%

3.3 The assumption about the rate of return

In order to discuss the adequacy of the pensions that the NDC scheme awards according to the possible different levels of the rate of returns yearly credited on the individual account balances, it is convenient to resume the choice, already made in section 2, to express both the individual wage growth and the conventional rate of return in terms of a

¹³Outside the 'benchmark case', the first derivatives of the replacement rate with respect to n depend also on the growth rate of the individual wage (α) which, if greater than the average wage growth, reduces the 'economic effect' since the impact on the last wage outweighs the impact on the account balance. The reverse applies for those workers whose end-of-career wage grows less than the average. In the general case, the first derivative of (5) is

$$\frac{\partial (w_n/p)}{\partial n} = \frac{a}{d} \cdot \sum_{i=1}^n \left(\frac{1+\pi}{1+\alpha^i} \right)^{n-i} \cdot \ln \left[\sum_{i=1}^n \left(\frac{1+\pi}{1+\alpha^i} \right)^{n-i} \right],$$

which is necessarily positive.

‘deviation’ with respect to the growth rate of the average wage of the economy, so that (5) becomes:

$$(12) \quad \frac{p}{w_n} = \frac{1}{d} \cdot \sum_{i=1}^n \left[\frac{(1+\alpha) \cdot (1+\delta_\pi)}{(1+\alpha) \cdot (1+\delta_w)} \right]^{n-i} \cdot a = \frac{1}{d} \cdot \sum_{i=1}^n \left(\frac{1+\delta_\pi}{1+\delta_w} \right)^{n-i} \cdot a .$$

With reference to a steady state, in which the sustainable rate of return is the growth rate of the wage bill, α and δ_π express, respectively, the economic and demographic components of the awardable return. One should notice, however, that δ_π can be given also a different meaning, namely that of a sort of an arbitrary differential with respect to the average wage growth, which the manager of the pension scheme can maneuver in order to achieve social or financial sustainability, especially if one admits that real economic systems hardly exhibit steady-state features.

As it is well known, Sweden has chosen the latter option, namely to ensure financial stability under all economic and demographic circumstances, thus achieving the important goal to isolate the pension system from the varying needs of the governmental budget. The Swedish Automatic Balance Mechanism (*A.B.M.*) operates by attributing a negative value to δ_π when the ratio between the assets and the liabilities of the system falls below 1.¹⁴ On the other hand, the former option could, in principle, be used to ensure the adequacy of the pension provisions, and hence social sustainability, by awarding an extra rate of return financed by the general tax revenue, whenever the combination between the chosen contribution rate and the sustainable rate of return generates too low replacement rates.¹⁵

Close examination of (12) shows that: (i) the individual replacement rates are insensitive to a change in the economic component of the rate of return (α), since it would affect the account balance at retirement (the first pension) and the last wage in the same

¹⁴ For the details about the working of the Swedish ABM, see Settergren and Mikula (2006) and Vidal-Meliá, Boado-Penas and Settergren (2009). For an analysis of the welfare properties of the Swedish ABM, see Auerbach and Lee (2011). Awarding a rate of return not greater than the average wage growth, when the balance ratio is greater than 1, ensures also substantial intergenerational fairness.

¹⁵ Actually, awarding extra rates of return amounts to increasing the slope of all individual functions (5) thus ensuring higher replacement rates for each given contribution rate. Notice that the slope of the functions does not change in the face of a shift in the economic component of the rate of return.

proportion;¹⁶ (ii) the individual replacement rates are positively (negatively) affected by any rise (fall) in the non economic component of the rate of return, since it would affect the account balance at retirement but not the value of the last wage;¹⁷ (iii) flat careers are more sensitive than the dynamic ones to any change in the non economic component of the rate of return.¹⁸

4 Conclusions: what a pension system can do and what it cannot do

Within the NDC scheme, the level of pensions for a given retirement age is positively related to the contribution rate and to the vector of the yearly interest rates with which the system rewards individual compulsory savings. On the other hand, replacement rates are rather insensitive to the (economic component of) the rates of return yearly credited on the account balances. Moreover, individual replacement rates are a linear function of the chosen contribution rate and are particularly generous for flat income profiles. Therefore, the contribution rate to an NDC pension scheme can be set in order to ensure predefined levels of replacement rates for a series of individual income profiles.

Also the virtual interest rate to be credited on the account balance could in principle be set at whatever constant level so as to achieve intergenerational fairness. However, financial sustainability requires the interest to adapt to the varying economic and demographic conditions. Once this is done, the NDC pension scheme becomes a powerful technical tool through which all income earners can transform a part of their claims on present GDP into claims on future GDP; and to be sure that all pensioners will be paid a

¹⁶In fact, since α does not even show up in (12), $\partial(p/w_n)/\partial\alpha = 0$. Actually, $\partial(p/w_n)/\partial\alpha$ becomes (slightly) positive when the account balance is capitalized up to year n .

¹⁷In fact,

$$\frac{\partial(p/w_n)}{\partial\delta_\pi} = \frac{1}{d} \cdot \sum_{i=1}^n (n-i) \cdot \left(\frac{1+\delta_\pi}{1+\delta_w} \right)^{n-i-1} \cdot a > 0$$

¹⁸In fact, the value of the partial derivative $\partial(p/w_n)/\partial\delta_\pi$ is lower for higher values of δ_π and *vice versa*.

Moreover, the circumstance that the sign of the following partial derivative

$$\frac{\partial(p/w_n)}{\partial\delta_w} = \frac{a}{d} \cdot \sum_{i=1}^n (n-i) \cdot \left(\frac{1+\delta_\pi}{1+\delta_w} \right)^{n-i-1} \cdot \left(-\frac{1+\delta_\pi}{(1+\delta_w)^2} \right)$$

of the replacement rate with respect to the differential δ_w between the individual wage growth and the average wage growth rate is negative, confirms the results of the analysis carried out in section 2.1 above.

decent level of pensions, it suffices that the remaining welfare institutions have enough resources to do their job: namely that of securing all individuals with a decent level of income up to the end of working age.¹⁹

Actually, an essential aspect of the Swedish implementation of the NDC scheme is that the public pension system, having fixed the contribution rate,²⁰ be accompanied by a variety of other welfare benefits for the young that *should include pension contributions* actually paid to the pension agency, thus forcing all costs of social security to show up. These and other welfare benefits for the elderly (such as a minimum guaranteed pension) would be paid for out of tax revenue. One cannot ask the pension system to remedy the possible inefficiencies rooted in the economic system but a fair, sustainable and transparent retirement scheme, as it was implemented in Sweden, will definitely not interfere with the performance of the labour market.

Within DB pension plans, whether PAYG or funded, an obvious alternative to increasing contribution rates to sustain the cost of more generous pension provisions, is to raise the 'normal' or 'legal' retirement age. But, after many years dedicated almost entirely to work and consumption-related activities, with little time for leisure, few Europeans like the idea of putting off their retirement²¹.

In fact, one of the key issues aging societies will soon have to face is the need for a redistribution of the rigid time spans individuals dedicate to education, consumption, work, and leisure during the life-cycle. Many changes are possible: more work for young people in parallel with their education, more leisure and education instead of work (and consumption) for the middle-aged, some continued work and education for elderly people – on top of leisure. These are just a few examples of how it might be possible to achieve a more balanced

¹⁹ This clear-cut separation between the roles of the pension agency on the one hand and the rest of social security, on the other, has been implemented only by Sweden, whose reform went into effect in 1998 after a long and careful discussion of the many details implied by the new scheme. On the other hand, the rather messy way in which the Italian pension reform has been hastily implemented in a few months in 1995 created a big gap between the potential of its design and its actual functioning. For a detailed comparison of the Italian and Swedish implementations see Gronchi and Nisticò (2006).

²⁰ Within Europe, different countries still have different preferences for rates of contribution to compulsory pay-as-you-go public pension schemes. For a detailed analysis of the potentialities of a European pension system, and of obstacles to implementation see Holzmann (2006).

²¹ See Eurobarometer (2004).

distribution of time, enhancing individual well-being, and making later retirement more acceptable.²²

The NDC pension system, in that it allows individuals to choose their preferred retirement age and to go through partial retirement, constitutes an appropriate legal framework in which individuals can 'easily' move back and forth between leisure, education and work by feeling that they have a range of options and that the decisions they take are not irreversible.

²² For a microeconomic analysis of possible positive effects on wellbeing of a more even distribution of time, see Nisticò (2005).

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