

# Notional Defined Contribution (NDC) Pension Schemes and Income Patterns

*Sergio Nisticò and Mirko Bevilacqua*

## Abstract

During the 1990s, some important European countries, particularly Italy and Sweden, have radically transformed their public pension system by adopting defined-contribution rules while retaining a pay-as-you-go financial architecture. This paper inquires into the theoretical properties of these "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 wage growth is equal to, higher than, or lower than average wage growth. The impact of, and the possible remedies to, a possible discontinuity on the replacement rates is finally discussed by means of a sensitivity analysis of the replacement rates with respect to the career length (for a given retirement age), the retirement age, and the conventional rate of return credited on all individual accounts.

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## 1 Introduction

Evaluating whether the pensions provided by a public pension system to its members are ‘adequate’ according to some standard is no easy task. From the viewpoint of the State, the adequacy of pension provisions depends essentially on some fundamental elements, such as financial and social sustainability, fairness and transparency.

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

1. *The extent to which the flows of pensions to be awarded to the individual allow enjoyment of the pre-retirement standard of living for the whole retirement period*; the replacement rate and yearly rate of pension adjustment provide essential information on ‘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 drawn, 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 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 for comparison with both the return on 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 especially important 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 decline in standard of living below the ‘poverty line’. The second dimension is particularly relevant for those who, having been

long employed in hard jobs, need to retire, for purely physical reasons, earlier than other workers. Of course, early retirement age can also be a crucial issue for workers whose need to retire is induced by psychological rather than physical distress. Insofar as some careers are characterized by both low wages and heavy demands, the need emerges for close-to-one replacement rates and early retirement. Finally, the third dimension is becoming particularly relevant in the face of the ever-increasing life expectancy, which forces the individuals and the labor market to accept that the gross wage (income) rate must somehow include a high enough savings rate to finance one or more pension plans covering the expected length of life remaining after retirement.

As is well known, most of the public, pay-as-you-go pension systems are defined-benefit (DB) and of the earnings related sort, in that they promise to pay a stream of pension annuities commensurate with 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. A point that emerges from the reforms enacted in Italy and Sweden in the '90s and, above all, the theoretical works produced both during and after their gestation period<sup>1</sup> is 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 savings<sup>2</sup>. The circumstance of being able to remedy the disparities in individual internal rates of return typical of the earnings-related, DB schemes has definitely increased interest in the Notional Defined Contribution (NDC) model, whose main features 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 are compatible with individually chosen retirement patterns, including flexible and partial retirement as well as

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

<sup>2</sup> 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).

possible supplementation of the individual's account balance with contributions deriving from 'external' sources of revenue such as unemployment allowances and other types of welfare benefits;

3.a Insofar as longevity is managed by addressed with 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) for any given contribution rate.

One could hardly object that individuals would consider adequate, i.e. 'generous enough', a system that ensured a good degree of continuity in the standard of living (as measured by the replacement rate with respect to the last yearly incomes) during the whole retirement period (which is possible only if the adjustment rate is close to average wage growth) for a rather low retirement age and contribution rate. However, financial sustainability requires that in the case of an unfavorable economic and demographic scenario, pension reforms 'hurt' the individuals in one of the three dimensions they care about: (i) the pension level, epitomized by the replacement rate and the pension adjustment; (ii) the ratio between the expected retirement period and the career length (managed essentially through the retirement age); (iii) the contribution rate.

The aim of this paper is to investigate how (i.e. to what extent and for what type of career profiles) the NDC quest for both actuarial fairness and automatic financial stability clashes with the traditional defined-benefit strategy to ensure some degree of 'continuity in the standard of living' for all members of the pension plan, regardless of their career profile; and since the additional key feature of fair and sustainable NDC schemes is to allow for some degree of flexibility as to the choice of retirement age and contribution rate, we will point out some important tradeoffs that a financially stable NDC scheme produces in the face of the inescapable binding constraint whereby more generous replacement rates 'require', *ceteris paribus*, either higher contribution rates or longer working careers or, finally, lower adjustment rates.

In this perspective the next section provides an analytical framework that allows for assessment of the complex interaction between NDC pensions and different career patterns. Section 3 contains a sensitivity analysis that weighs up the impact on the replacement rate of higher contribution rates or working years on

the one hand, and of lower adjustment rates on the other. Finally, the last part of the section is devoted to assessing to what extent the binding constraint mentioned above can be relaxed through possibly higher rates of return on contributions deriving from more favorable economic and/or demographic conditions. Section 4 concludes.<sup>3</sup>

## 2 The NDC Scheme and Interaction between Individual Wage Path and Replacement Rate<sup>4</sup>

With 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 tie the rate of return to be credited each year on workers’ as well as 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 as it stands 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:

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

where  $\pi_i$  is the rate of return to be credited on the account balance in year  $i$  and  $\varphi$  the rate of return anticipated and embedded in the annuity divisors.<sup>5</sup>

The interaction between the NDC rules and each individual’s wage pattern can readily be analyzed starting from the following expression of the account balance

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<sup>3</sup> The results contained in this paper also apply to fully funded defined-contribution schemes.

<sup>4</sup> The argument in this section takes up from Nisticò (2012).

<sup>5</sup> For discussion of the trade-off between the value of  $\varphi$  - hence of the first pension annuity - and the yearly adjustment rate imposed by equation (1), see Gronchi and Nisticò (2008, pp. 135–138) and Section 3.3 below.

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 interest matured on those contributions:

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

where  $a$  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  $\alpha^*$ , 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,

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

where  $\alpha$  is the growth rate of the average wage of the economy registered between period  $i-x$  and period  $i$ , while  $\delta_w$  and  $\delta_\pi$  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:

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

## 2.1 Three Cases

If we assume 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) amounts 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), equals 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 absolute weight in  $AB_R$  independently of their ‘age’, as shown in column (4) of Table 1.<sup>6</sup> 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 corresponding 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%.<sup>7</sup>

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

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<sup>6</sup> Note that equation (4) measures the relative weight of any pair of yearly contributions, whereas the weight referred to in Table 1 measures the future value at retirement of each yearly contribution. In any case, the values contained in Table 1 are consistent with equation (4) and with the assumptions made about the individual wage growth and rate of return.

<sup>7</sup> The first pension annuity for the three cases represented in Table 1 was calculated by assuming a divisor equal to 18 for those retiring at 67, a higher (less generous) value than those presently used in both Italy and Sweden, countries that have taken the decision to anticipate a rather high interest rate  $\varphi$  in the annuity divisors (1,5% in Italy and 1,6% in Sweden). Our choice aims to reflect a hypothetical reformed NDC scheme in which higher divisors, due to lower values of  $\varphi$ , can make room for adjustment rates that can follow, at least in part, real wage growth. Actually, given the present Italian mortality rates, a divisor equal to 18 corresponds to an anticipated interest rate of about 0,6%, which would leave room for a yearly adjustment of about 1% in real terms if productivity grows around 1,6% per year in the coming decades (see equation (1) above and Section 3.3 below). On the other hand, the choice to assume a contribution rate of 30% fits a somewhat 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.

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)
<b>24 years</b>	<b>100,0</b>	<b>30,0</b>	<b>70,30</b>	<b>100,0</b>	<b>30,0</b>	<b>70,30</b>	<b>100,0</b>	<b>30,0</b>	<b>70,30</b>
25	102,0	30,6	70,30	103,0	30,9	70,98	101,0	30,3	69,61
26	104,0	31,2	70,30	106,1	31,8	71,68	102,0	30,6	68,92
27	106,1	31,8	70,30	109,3	32,8	72,38	103,0	30,9	68,25
28	108,2	32,5	70,30	112,6	33,8	73,09	104,1	31,2	67,58
29	110,4	33,1	70,30	115,9	34,8	73,81	105,1	31,5	66,92
30	112,6	33,8	70,30	119,4	35,8	74,53	106,2	31,8	66,26
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...
60	204,0	61,2	70,30	289,8	86,9	99,88	143,1	42,9	49,31
61	208,1	62,4	70,30	298,5	89,6	100,86	144,5	43,4	48,82
62	212,2	63,7	70,30	307,5	92,2	101,84	146,0	43,8	48,34
63	216,5	64,9	70,30	316,7	95,0	102,84	147,4	44,2	47,87
64	220,8	66,2	70,30	326,2	97,9	103,85	148,9	44,7	47,40
65	225,2	67,6	70,30	336,0	100,8	104,87	150,4	45,1	46,94
<b>66</b>	<b>229,7</b>	<b>68,9</b>	<b>70,30</b>	<b>346,1</b>	<b>103,8</b>	<b>105,90</b>	<b>151,9</b>	<b>45,6</b>	<b>46,47</b>
<b>Retirement age: 67 years</b>									
- $AB_R$			3.022,7			3.727,3			2.476,2
- First Pension			<b>167,9</b>			<b>207,6</b>			<b>137,6</b>
- Replacement Rate			<b>73,1%</b>			<b>60,0%</b>			<b>90,6%</b>



## 2.2 Missing Contributions within the NDC Scheme

The last three rows of Table 1 show the values of the account balance at retirement, of the first pension 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 suppose that, for whatever reason, the three individuals whose careers are summarized 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’ careers. The ensuing values for the account balance, the first pension and the replacement rate of the three individuals are set out in *Table 2*.

It is now opportune 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 set out in *Table 3*.

*Table 2: Account balance, first pension and replacement rate for three typical workers with early breaks 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%
<b>Initial Wage</b>	100,0	100,0	100,0
<b>Last Wage</b>	229,7	346,1	151,9
<b>AB<sub>R</sub></b>	2.882,1	3.594,6	2.337,7
<b>First Pension</b>	160,1	199,7	129,9
<b>Replacement Rate</b>	<b>69,7%</b>	<b>57,7%</b>	<b>85,5%</b>

*Table 3: Account balance, first pension and replacement rate for three typical workers with late breaks 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%
<b>Initial Wage</b>	100,0	100,0	100,0
<b>Last Wage</b>	229,7	346,1	151,9
<b>AB<sub>R</sub></b>	2.882,1	3.528,5	2.381,9
<b>First Pension</b>	160,1	196,0	132,3
<b>Replacement Rate</b>	<b>69,7%</b>	<b>56,6%</b>	<b>87,1%</b>

By comparing the three tables (see *Table 4*), it will readily be 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

*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%
<b>1. No career breaks (contribution record: 43 years)</b>			
<b>First Pension</b>	167,9	207,6	137,6
<b>Replacement Rate</b>	<b>73,1%</b>	<b>60,0%</b>	<b>90,6%</b>
<b>2. Early career breaks (contribution record: 41 years)</b>			
<b>First Pension</b>	160,1	199,7	129,9
<b>Replacement Rate</b>	<b>69,7%</b>	<b>57,7%</b>	<b>85,5%</b>
<b>3. Late career breaks (contribution record: 41 years)</b>			
<b>First Pension</b>	160,1	196,0	132,3
<b>Replacement Rate</b>	<b>69,7%</b>	<b>56,6%</b>	<b>87,1%</b>

the same level regardless of whether the two-year gap in the contribution history occurs at the beginning or at the end of the career.<sup>8</sup>

On the other hand, Table 4 shows that for an individual whose wage growth exceeds the average wage growth, early career breaks have less impact on the first pension and replacement rate than late breaks, whereas the reverse applies for an individual with lower-than-average wage growth.

### **3 Social and Financial Sustainability of the NDC Scheme**

It could be argued that the typical careers represented 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 labor market today could accumulate less than 41 full years of contributions before reaching the age of 67; (iii) the 2% real rate of return may exceed the sustainable rate of return .

To answer those possible objections, the following 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 the contribution rate, the lower will be both the first pension annuity and the replacement rate. More precisely, bearing in mind that the first pension annuity is obtained through

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<sup>8</sup> Note 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 average, the percentage drop for each yearly gap in contribution can be lower or higher than the preceding figure according to the exact position of the gap in the career pattern. However, in the case of career breaks 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 by the Swedish Pension Agency (2011, pp.31–32), will be discussed in Section 3.2 below.

division of (2) by the annuity divisor, assuming for simplicity's sake the steady state, the individual replacement rate can be expressed as the following linear function of the contribution rate<sup>9</sup>:

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

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 obtains, i.e. if the retirement savings of all individuals is yearly rewarded with the uniform rate of return  $\pi$ .

It will readily be seen that the slope of (5) depends on the peculiar wage profile ( $w_i/w_n$ ) of each individual.<sup>10</sup> 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  $w_i/w_n$ .

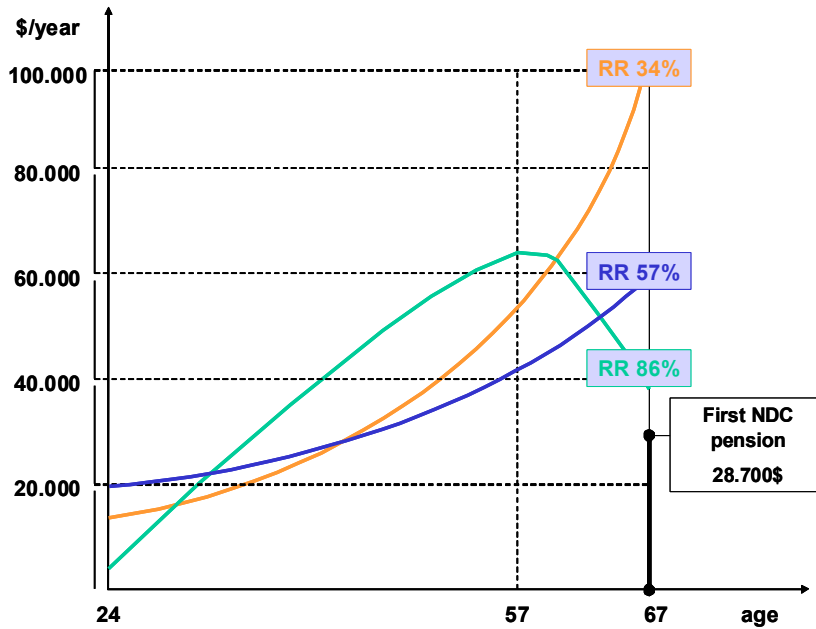
While awarding a uniform yearly rate of return on pension contributions to all individuals, the fact that the NDC scheme yields different replacement rates for different career patterns can clearly be seen in *Figure 1*, which reproduces three income profiles that, under the assumption of a constant rate of return of about 2,5% per year, produce the same account balance at retirement (occurring at the age of 67 for all 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 (28.700\$ per year) for the three individuals with replacement rates ranging from 34% and 57% for the fast-rising and moderately rising income profiles to a high 86% for the reverse u-shaped income profile.

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<sup>9</sup> See also Bevilacqua (2009).

<sup>10</sup> For any given value of the rate of return yearly awarded on all account balances, 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 worth noting that for the ‘benchmark case’ described at the 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

$$(6) \quad \frac{p}{w_n} = (1 + \alpha) \cdot \frac{n}{d} \cdot a.$$

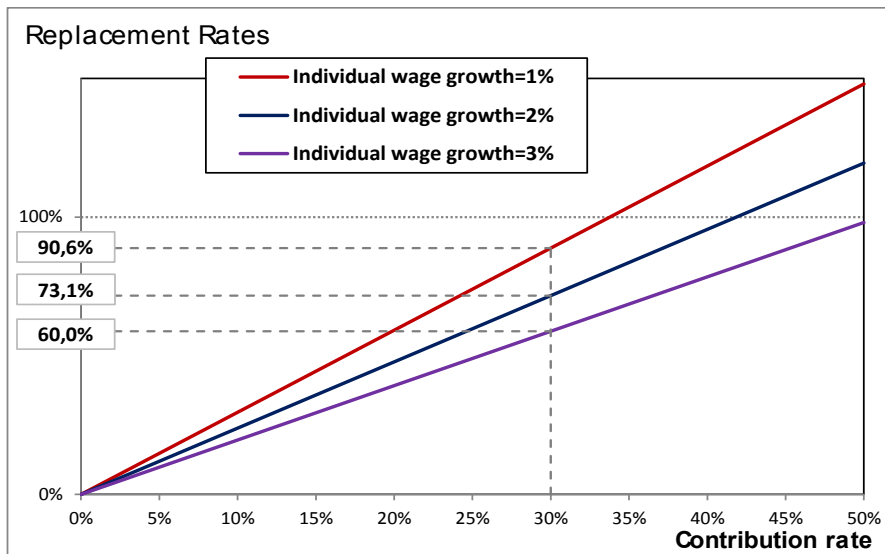
Since the value of  $d$  does not deviate significantly from individual life expectancy, according to (6) the replacement rate awarded by NDC schemes to the ‘benchmark’ individuals is a multiple of the contribution rate, the multiplier  $(n/d) \cdot (1 + \alpha)$  being approximately equal to (only slightly greater than) the ratio between the working and retirement periods. On the other hand, the multiplier (the slope of (5)) is lower than  $(n/d) \cdot (1 + \alpha)$  for those workers whose wage grows more rapidly than the average and *vice versa*. The three linear functions corresponding to the three cases represented 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.<sup>11</sup>

It is to be noted 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 which ensures actuarial fairness precisely by awarding more generous replacement rates to flat-career workers.<sup>12</sup>

The issue of what is the appropriate level of contribution rate to a compulsory, public pension scheme touches upon a political dimension that is definitely beyond the scope of this paper. However, the simulations presented here show that the possible choice to have a robust first pillar based on NDC rules can guarantee at

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



<sup>11</sup> The value of the replacement rate shown in *Figure 2* for the benchmark case (73,1%) can readily be calculated through (6) by assuming  $n=43$ ,  $d=18$ ,  $\alpha=2\%$  and  $a=30\%$  as it is in Table 1. Note that if the assumption is made that the returns on the account balance are credited only up to year  $n-1$ , the slope of (6) simplifies to  $n/d$ .

<sup>12</sup> On this point see also Gronchi and Nisticò (2006 and 2008) and Nisticò (2009).

the same time that: (i) flat-career workers are ensured 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.<sup>13</sup>

### **3.2 The Problems Raised by Short Careers**

On the basis of the analysis contained in Section 2.2 we were able to assess the possible, different impact early or late discontinuity in working careers on the NDC account balances at retirement. However, quite independently from ‘when’ discontinuity occurs, the present sluggishness with which the labour market absorbs both young and older workers will determine a prospective situation in which those who have just entered the labor market could 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 differs according as to whether: (i) ‘marked discontinuity’ is simply a feature of a flexible labor market, wherein the individual worker alternates periods of work with spells of inactivity while earning an average yearly wage comparable to that of the typical workers whose careers are simulated above; (ii) recurrent discontinuity is not offset 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, neither the pension level nor the replacement rate with respect to the average of all yearly earnings<sup>14</sup> that the NDC scheme can ensure its members are affected by career breaks, 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 could actually fall below the poverty line, thus creating a problem of the social sustainability of the pension provisions.

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<sup>13</sup> On the non-tax nature of the contributions paid in an NDC pension scheme see also Feldstein (2002, p.7) and Disney (2004).

<sup>14</sup> 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.31–32).

However, we must bear in mind that: (i) the replacement rate, computed with respect to an average of all earnings, would still be unaffected by career breaks and (ii) frequent career breaks are socially unsustainable for low income workers well 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) career breaks can, possibly, be compensated for by postponement of retirement, which the NDC rules reward more generously than traditional earnings-based DB schemes.

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

$$(7) \quad \frac{\partial(p/w_n)}{\partial n} = (1 + \alpha) \cdot \frac{a}{d} ,$$

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  $d$ ). Note that with reference to the values of  $a$  and  $d$  which were assumed to run the simulations contained in Table 1, each year of contributive history adds 1,7% 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 1,7% 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 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 shorter life expectancy of those who retire later than the age of 67. Actually, to analyze the impact on the replacement rate of postponing retirement, equation (6) should be written as

$$(8) \quad \frac{p}{w_n} = \frac{n}{d(n)} \cdot (1 + \alpha) \cdot a$$

and its partial derivative with respect to  $n$  becomes:



$$(9) \quad \frac{\partial(p/w_n)}{\partial n} = (1+\alpha) \cdot a \cdot \frac{d(n) - \frac{\partial d}{\partial n} \cdot n}{[d(n)]^2} > (1+\alpha) \cdot \frac{a}{d}.$$

Note 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) captures the ‘life-expectancy’ effect, i.e. the positive effect on the pension level due to lower divisors.

Observe, moreover, that if we assume that in the neighborhood of any given value of  $d$ ,  $d(n)$  is the following linear function<sup>15</sup>

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

the right hand side of (9) becomes

$$(11) \quad (1+\alpha) \cdot a \cdot \frac{k}{(k - c \cdot n)^2}$$

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 4,3% to the replacement rate of those workers whose career is represented by the benchmark case, with the life-expectancy effect counting for about 2,6%.<sup>16</sup>

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

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<sup>15</sup> Strictly speaking, the value of the divisors does not depend on the career length  $n$ , but only on life expectancy at retirement and on the rate of return anticipated and embedded in the divisors. See Section 3.3 below.

<sup>16</sup> In fact, according to (10), the divisor at 68 becomes 17,388. Outside the ‘benchmark case’, the first derivatives of the replacement rate with respect to  $n$  depend also on the growth rate of the individual wage ( $\alpha^*$ ), 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.

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
<b>Initial wage</b>	100,0	100,0	100,0
<b>Last wage</b>	225,2	229,7	234,3
<b>AB<sub>R</sub></b>	2.894,5	3.022,7	3.154,9
<b>First Pension</b>	155,5	167,9	181,4
<b>Replacement Rate</b>	<b>69,1%</b>	<b>73,1%</b>	<b>77,4%</b>

### 3.3 Boosting the First Annuity

If the divisor were set equal to life expectancy, when dividing (2) by  $d$ , the account balance at retirement would be virtually split into  $d$  equal ‘balances’, charged with the task to finance the expected pension annuities to be paid from then on; and since all balances will grow, yearly, according to the rate of return credited on all account balances, the pension could be adjusted, yearly, according to the same rate. However, one might prefer to have a first pension greater than  $1/d$  times the account balance. In that case, the  $d$  ‘balances’ charged with the task to finance the future pensions will not be of equal size; the first might be  $1+\varphi$  times greater than the second which, in turn, would be  $1+\varphi$  times greater than the third, and so on, which explains formula (1) for the adjustment rate, i.e. the circumstance that the value of each successive balance that finances the following pension annuity, though growing yearly at the rate  $\pi$ , can ensure an adjustment rate  $\varphi$  percentage points lower than the conventional rate of return  $\pi$ . In any case, the divisors for all possible retirement ages are given by the following function of  $\varphi$  and of life expectancy at retirement ( $m$ ):

$$d(\varphi, m) = \sum_{i=1}^m (1+\varphi)^{1-i} \quad \text{with} \quad \frac{\partial d}{\partial \varphi} < 0, \quad \frac{\partial d}{\partial m} > 0.$$

As we know, Italy has chosen  $\varphi = 0,015$  and Sweden  $\varphi = 0,016$ . Those high values have certainly smoothed out the political process leading to approval of the reform but have, on the other hand, severely narrowed the potential adjustment

rate of the pensions already awarded. With reference to the benchmark case, the positive impact of  $\varphi$  on the replacement rate is measured by the following partial derivative:

$$(12) \quad \frac{\partial(p/w_n)}{\partial\varphi} = - \frac{a \cdot (1+\alpha) \cdot \sum_{i=1}^n \frac{(1+\delta_\pi)^{n-i+1}}{(1+\delta_w)^{n-i}}}{[d(\varphi, m)]^2} \cdot \sum_{j=1}^m (1-i) \cdot (1+\varphi)^{-j} > 0,$$

which shows that the positive impact on the replacement rate of higher values of  $\varphi$  is higher for flat careers characterized by lower values of  $\delta_w$  as well as for higher retirement ages characterized by lower values of the divisor.<sup>17</sup>

On the other hand, according to (1), the negative impact of higher values of  $\varphi$  on the adjustment rate is given by the following partial derivative

$$\frac{\partial\sigma_i}{\partial\varphi} = - \frac{(1+\pi_i)}{(1+\varphi)^2} \cong -1 \quad \forall i$$

which shows that each additional percentage point of  $\varphi$  has a negative impact on the adjustment rate of the same magnitude.

### 3.4 The Impact of 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, we will for the sake of argumentation return to the choice already made in section 2 to express both the individual wage growth and the conventional rate of return in terms of a ‘deviation’ with respect to the growth rate of the average wage of the economy, so that (5) becomes:

$$(13) \quad \frac{p}{w_n} = \frac{a}{d} \cdot (1+\alpha) \cdot \sum_{i=1}^n \frac{(1+\delta_\pi)^{n-i+1}}{(1+\delta_w)^{n-i}}.$$

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<sup>17</sup> Close examination of (12) shows that each additional percentage point of  $\varphi$  generates an increase of around one decimal point in the replacement rate.

With reference to a steady state, in which the sustainable rate of return is the growth rate of the wage bill,  $\alpha$  and  $\delta_\pi$  express, respectively, the economic and demographic components of the awardable return. It is, however, to be noted that  $\delta_\pi$  can also be attributed with a different significance, namely that of a sort of 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 we face the fact that real economic systems hardly exhibit steady-state features.

As we know, Sweden has chosen the latter option, namely to ensure financial stability under all economic and demographic circumstances, thus achieving the important goal of isolating 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  $\delta_\pi$  when the ratio between the assets and the liabilities of the system falls below 1.<sup>18</sup> On the other hand, the former option could, in principle, be adopted to ensure the adequacy, and hence social sustainability, of the pension provisions 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 excessively low replacement rates.<sup>19</sup>

Close examination of (13) shows that:

$$(14) \quad \begin{aligned} \frac{\partial(p/w_n)}{\partial\alpha} &\equiv n \cdot \frac{a}{d} \\ \frac{\partial(p/w_n)}{\partial\delta_\pi} &= \frac{a}{d} \cdot (1+\alpha) \cdot \sum_{i=1}^n \left( \frac{1+\delta_\pi}{1+\delta_w} \right)^{n-i} \cdot (n-i+1) > 0 \end{aligned}$$

or in other words that (i) the individual replacement rates are hardly affected at all by change in the economic component of the rate of return ( $\alpha$ ), since it would affect the account balance at retirement (the first pension) and the last wage in the

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<sup>18</sup> For details on 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.

<sup>19</sup> 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.

same proportion;<sup>20</sup> (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; (iii) flat careers are more sensitive than the dynamic ones to any change in the non-economic component of the rate of return.<sup>21</sup>

#### 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. Moreover, individual replacement rates are particularly generous for flat income profiles. On the other hand, replacement rates are rather insensitive to (the economic component of) the rates of return yearly credited on the account balances.

The rate of return to be credited on the account balance could in principle be set at any constant level that would ensure intergenerational fairness. However, financial sustainability requires the interest to adjust to the varying economic and demographic conditions. Once this is done, the NDC pension scheme becomes a powerful technical tool by means of which all income earners can transform a part of their claims on present GDP into claims on future GDP, being exposed neither to the volatility of the financial markets nor to the varying fortunes of the national

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<sup>20</sup> In fact, as noted in footnote 11 above,  $\partial(p/w_n)/\partial\alpha = 0$  if the assumption is made that the returns on the account balance are credited only up to year  $n-1$ .

<sup>21</sup> In fact, the value of the partial derivative  $\partial(p/w_n)/\partial\delta_\pi$  is lower for higher values of  $\delta_w$  and *vice versa*. Moreover, the circumstance that the sign of the following partial derivative

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

of the replacement rate with respect to the differential  $\delta_w$  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.

fiscal budget. Although a financially stable NDC scheme cannot prevent certain intergenerational disparities, it can eliminate all types of intragenerational, regressive redistribution that characterize the DB, earnings-related schemes.

To be sure that all pensioners will be paid an adequate level of pensions, it suffices that the NDC contribution rate is high enough and that the remaining welfare institutions have adequate resources to do their job, which is effectively to secure all individuals with a decent level of income up to the end of working age.<sup>22</sup> Actually, an essential condition in Swedish implementation of the NDC scheme is that the public pension system, having fixed the contribution rate,<sup>23</sup> 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 expect the pension system to remedy the possible inefficiencies rooted in the economic system but a fair, sustainable and transparent retirement scheme, as was implemented in Sweden, will definitely not interfere with labor market performance.

Within DB pension plans, whether PAYG or funded, an alternative to increasing contribution rates to sustain the cost of generous pension provisions, is to raise the ‘legal’ retirement age. Within the NDC scheme, workers can freely choose their retirement age with the awareness that postponing retirement has a positive impact on the pension level. Our sensitivity analysis has assessed the positive impact of longer careers by distinguishing between the ‘economic effect’ on the account balance (for a given retirement age) and the ‘life-expectancy effect’ on the annuity divisor (for a given career length). On the other hand, we have assessed the negative impact on the adjustment rate of the tempting choice (taken

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<sup>22</sup> 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 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 was hastily put through in a few months in 1995 created a large 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).

<sup>23</sup> 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).

by both Italy and Sweden) to increase the replacement rate by anticipating a significant share of the future interest in the first pension annuity.

Although it is true that postponing retirement age is the most effective strategy to offset the negative impact of increasing life expectancies on the pension level, there can be no denying that, after many years dedicated almost entirely to work and consumption-related activities, with little time for leisure, workers can hardly savour the idea of putting off their retirement<sup>24</sup>. 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 a more balanced distribution of time might be achieved, enhancing individual well-being, and making later retirement more acceptable.<sup>25</sup>

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

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<sup>24</sup> See Eurobarometer (2004).

<sup>25</sup> For a microeconomic analysis of possible positive effects on wellbeing of a more even distribution of time, see Nisticò (2005).

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