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CAPP*aper* n. 164
giugno 2018

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Is the Italian NDC pension system really sustainable? Parameters' design and consistency.

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Abstract

Using a multiperiod OLG model we study the theoretical financial, adequacy and distributive characteristics of various NDC systems. The main aim of the paper is to compare the Italian current setting of policy parameters with choices made in other countries that adopted a similar philosophy for the accrual of pension benefits. All countries studied present solutions that are inferior both from a financial point of view and from a distributive one, with respect to a "well designed" system. Among them the Italian NDC system is the one that produces the highest financial imbalance in the long run. Moreover it also relinquished to use the indexation rate of pension benefits, one of the policy parameters that can be used to adjust the pension expenditure dynamics and to correct intergenerational inequities. Looking at situation that are out of the steady state solution of the model it appears that an NDC system, as all PAYGO arrangements, produces complex path of expenditure, where even simple and temporary demographic and economic shocks request decades in order to be absorbed. All these results call for a quick intervention in order to make the system more transparent and more suited to face the real evolution of macro variables, without compromising its financial short and medium term position.

Jel codes: H55, H68

1. *Introduction*

In year 1995 the Italian Parliament approved the gradual substitution of a defined benefit (DB) formula with a defined contribution (DC) one in the public pension system, maintaining at the same time the PAYGO financing method. Once the transition from the old to the new formula will be completely phased-in, pension expenditure in Italy will still be financed by current social security contributions, but at the same time a salary based formula for the computation of individual pension benefits will be replaced with a (quasi) actuarial one. Such kind of arrangement, that has been adopted in other countries in the last two decades, among them Sweden, Poland, Latvia and Norway, has been called Notional Defined Contribution (NDC). A lively debate on pros and cons of NDC systems followed its development. In particular its ability in contributing to the financial stability of public pension systems during the demographic transition that will interest developed economies in the future, was analyzed and discussed both theoretically and from an institutional point of view[1] (Holzman and Palmer, 2006; Holzman, Palmer and Robalino, 2012).

In spite of the considerable weight of the public pension expenditure in the Italian public budget, policy makers have taken only partially advantage of advices and suggestions coming from this debate[2]. The slow transition from the defined benefit (DB) to the NDC formula designed by the Italian Parliament in 1995 and only lately amended in 2011, could explain this lack of interest: the political decision to guarantee "older" workers (i.e. those with more than 18 years of seniority at work in 1995) the possibility to retire with the more generous DB formula and to apply the NDC one on a pro rata principle for younger workers, implied that the share of pension benefits computed and actually paid under the NDC regime was low during the years after the 1995's reform. Two decades later however this share is starting to be quantitatively important. Old age pension benefits paid for the first time in 2016 and computed completely under the NDC formula were equal to 19%, those computed under the mixed NDC/DB formula were equal to 67% and those computed only under the DB formula were equal to 14%. In 2012, the last year of available data in the public INPS archive, shares were respectively 10%, 40% and 50%[3].

It is therefore time for Italian policymakers to consider more seriously the consistency of the Italian pension system with principles of a well-functioning NDC system, the potential instability that would derive from economic and demographic shocks and the opportunity to use all parameters that allow an NDC system to be protected against risks of financial instability. In the next subsection I will first discuss principles of NDC systems. Section 3 presents results of a steady state OLG model, where the theoretical Aaron-Samuelson solution for a PAYGO pension is compared with the Italian, the Swedish

[1] The effects of the adoption of the NDC principle on the adequacy, the decision to retire were other important topics that have been discussed in the literature.

[2] The notable exception is the recent improvement in neutralizing negative financial effects of longevity risk on the pension expenditure. On the other hand it is worth noting that in the years following the NDC reform's approval, a series of rigidities were introduced in the system, which moved the Italian pension system away from principles of a well designed NDC systems. Among them it is worth remembering the abolition of the flexibility in the retirement age from 2004 to 2011 and the introduction, in 2009 of the indexation of retirement age to lifetime expectation at 65. In 2011 a series of constraints on the possibility to retire have been introduced, namely having an accrued pension benefit of at least 2.8 times the minimum pension in the case of an "anticipated" pension and of at least 1.5 times the minimum pension when the "legal" retirement age is reached. Also in the same year all eligibility conditions to retire have been indexed to lifetime expectations.

[3] Looking at the stock of old age pension benefits in 2016 the share of DB is still equal to 85%, while 11% of benefits are computed under the mixed DB/NDC rule and 4% are computed under the NDC rule.

and the Polish systems. Section 4 looks at the financial effects of transitory 10 years shocks in the development of employment and in per capita growth of wages. Section 5 concludes.

2. The NDC's principles

The basic idea of NDC schemes is to mimic DC funded pension plans without setting aside reserves[4]. Each worker who belongs to the system is credited a "notional" account where all social security contributions paid during working years are registered. Since the systems is not funded and contributions are not invested into the financial market, they earn a rate of return that is exogenously defined in the pension law. At each point of his/her active lifetime the value of the worker's account is determined by the sum of past contributions and accrued yields. When the retirement age is reached, a pension benefit is computed in such a way that the present value of all future expected pension benefits are equal to the accrued value of the notional capital. The first year pension benefit depends on the amount of the "notional" capital, on the individual's expected lifetime and on the difference between the discount rate and the indexation rule for pension benefits.

Assuming that time is discrete, that social security contributions and pensions are both paid at the beginning of each period, considering an individual who lives with certainty T years[5] and works L years[6], equation (1) and (2) below describe how the notional pension wealth (NPW) and the present value of the stream of pension benefits (PVP) are determined in a generic NDC system, at the age L.

$$NPW_L = a \sum_{i=0}^{L-1} W_i \prod_{j=i+1}^{L} \left(1 + r_j\right) \quad (1)$$

and

$$PVP_L = P_L \left[1 + \sum_{i=L+1}^{T-1} \prod_{j=L+1}^{i} \frac{(1+z_j)}{(1+s_j)}\right] \quad (2)$$

where:

NPW_L: notional pension wealth at age L

PVP_L: present value of pension benefits at age L

a: (constant) rate of contribution

W_i: gross wage at age (i)

P_L: pension benefit at age (L)

L: number of years in work

[4] In fact a country that adopts an NDC formula might have reserves that allow the system to cushion demographic and economic shocks. This is not the case of Italy, where the degree of funding of the public pension system is equal to zero.
[5] In the case of uncertainty on the duration of lifetime after retirement the term T-1 in the equation (2) can be substituted by the cohort based expected lifetime.
[6] Uncertainties on survival can influence also the accumulation phase. Some countries (Sweden for example) foresee a mechanism to redistribute accrued capital of deceased workers among workers of the same cohort. Other countries, like Italy, allow the creation of a survival pension through the old age pension scheme.

T: total number of years (work + retirement)

r_j: rate of return of contributions at age (i)

z_i: rate of indexation of the pension benefit at age (i)

s_i: rate of discount of pension benefits at age (i)

The pension benefit in the first year of retirement P_L is determined from the condition $NPW_L = PVP_L$ implying that the notional pension wealth NPW_L is converted into an annuities flow multiplying the net pension wealth by a conversion coefficient k_L that depends on the expected remaining life at retirement and on the difference between the discount and the indexation rate during the retirement period. Accordingly the first year pension benefit is defined as:

$$P_L = \; k_L \, NPW_L \qquad (3)$$

where k_L is defined as:

$$k_L = \frac{1}{1 + \sum_{i=L+1}^{T-1} \prod_{j=L+1}^{i} \frac{(1+z_j)}{(1+s_j)}} \qquad (4)$$

According to Palmer (2006) an NDC scheme can be designed in such a way that it assures long term financial stability to the pension system, if return parameters (r, s and z) are defined in a way that is consistent with the wage mass dynamic. Advocates of NDC systems (Settergreen 2001; Palmer 2006; Gronchi and Nisticò 2008) sustain that this arrangement allows a better control of the political risk in the pension system, since most of the parameters' adjustments to exogenous demographic as well as to economic shocks occur automatically and do not necessarily require ad-hoc interventions. Moreover the term "a" in the equation (1) is fixed: any decision to increase it to finance current pension expenditure would also automatically make clear that future pension expenditure will increase. Looking at an NDC system in a steady state economy the idea can be summarized saying that, by properly choosing values for terms "r", "s" and "z" in equation (1) and (2), the pension expenditure and social security contributions will grow at the same rate. Resorting to the well known Samuelson-Aaron theorem about the determination of the internal rate of return of a PAYGO system, Gronchi and Nisticò (2008) show that a generic NDC system in a steady state equilibrium will assure financial stability in the long term as long as the internal rate of return of the program is equal to the rate of growth of the wage bill. Intuitively in a steady state economy and for a given contribution rate, the pension expenditure is equal to social security contributions when the return guaranteed to pension benefits in payment is equal to the growth rate of the (tax) base over which social security contributions are computed. This result is guaranteed because, under this particular situation, the horizontal and the intertemporal dimension of the relation between contributions and pensions are coincident.

However once the steady state condition is leaved apart and more realistic situations are examined, the equilibrium between current expenditures and current revenues is not more automatically guaranteed and two opposite positions emerged in the economic literature. On one side advocates of the NDC philosophy maintain that the scheme can be designed in such a way that it is financially stable at least in the long run. Moreover deviations that brings the system out of the long run equilibrium are considered only temporary (Gronchi and Nisticò 2008). The main task for policy makers of countries that adopt an NDC system would be that of measuring deviations from the long term equilibrium and introducing an automatic adjustment mechanisms, that allow to properly modify parameters of the pension system in response to external shock (Palmer 2006). According to Holzman, Palmer and Robalino (2012) the adjustment in NDC parameters that determine the current and future level of pension benefits should occur whenever assets of the system are not sufficient to balance liabilities.

On the other side those who express a more critical position against NDC schemes claim that they are not inherently different from other forms of PAYGO systems (Chicon 1999). More importantly NDC schemes would not be able to deliver financial stability when the economy is out of the steady state. In particular they would not be able to assure short-run stability defined as a situation where asset reductions and/or new debt formation is avoided (Valdes-Prieto 2000). Long-run stability would be however meaningless for two reasons: i) the difficulty to distinguish between transitory and permanent shocks is risky as errors may induce delays in the adjustment process that may in turn threaten the stability of the system itself; ii) since PAYGO systems are mandatory and under the political control, the critical time unit that would ensure the success of automatic adjustments would be a period of one-two years and in any case a shorter time lapse than the political cycle (Valdes-Prieto 2000). Another point of criticism is more empirically based: results of exercises obtained both with certainty and stochastic forecasting simulation models, indicate that an NDC system may produce situations of under or over accumulation of (implicit) assets (Auerbach and Lee 2006; Chlon-Dominczak, Franco and Palmer 2008; Robalino and Bodor 2008). Also the welfare of generations involved in the system and therefore the intergenerational equity of the system might be influenced (Auerbach and Lee 2009).

The debate about the financial stability of the Italian NDC pension scheme was aware of most of the features above described. Bosi (1995), Gronchi and Nisticò (2008), Franco and Sartor (2008) and Dominczak, Franco and Palmer (2008) and more recently (Andrle, Kangur and Raissi 2018) for example highlighted that the choice of parameters for the Italian NDC formula was not consistent with a well-designed theoretical model, while Bosi (2001) and Dominczak, Franco and Palmer (2008) studied the financial implications of deviation of growth rate in wages and employment from their long time trends. It is therefore somehow surprising that, until now, most of the sources of potential instability embedded in the Italian NDC system have not been seriously discussed at a political level, an exception being the automatic adjustment in the conversion coefficient of equation (3) envisaged to take into account changes in mortality rates of successive cohorts of (future) pensioners.

In what follows we will proceed in two directions. First we will look at sources of instability that characterize the Italian pension system with respect to a generic NDC system in a steady state equilibrium. Subsequently we will study instabilities that bring the system out of the steady state as a consequence of shocks in the employment rate and in the wages' dynamic.

3. Ndc pension systems in steady state

In order to better analyze characteristics of the Italian NDC scheme we resort to the formulation proposed in Bosi (1995). Differently from his presentation we consider hwever a larger set of situations. Firstly we allow the indexation rate of pension benefits "z" to be different from zero, secondly we compare the theoretical A-S situation with three stylized cases which aim at representing the Italian, the Swedish and the Polish Ndc systems. Finally we measure the amount of the pension liabilities associated to each of these systems and we model accurately the implications of temporary deviations from the steady state equilibrium.

The population is composed by T cohorts. Every individual works for L years and is retired for R years, with L + R = T. Consequently in every period (t) there are L cohorts of workers and R cohorts of pensioners. There is no uncertainty. At the beginning of each period individuals receive a wage W_t if employed or a pension P_t if retired. W_t is age independent, while P_t depends on past wages and on the indexation rule.

The financial features of the pension system are analyzed in a period of time (t) when the system is fully mature[7]. The system is in steady state. Defining with letters *m, r, s, z, n* respectively the (constant) growth rate of wages, the rate of return attributed to the notional capital, the rate of discount used for the computation of the pension benefit, the rate of indexation for pension benefits during retirement and the growth rate of the employed population, the notional pension wealth at time (t-R) for a workers born at time (t-T) can be written as:

$$NPW_{t-R}^{t-T} = a\, W_{t-T}^{t-T}\ A \qquad (5)$$

where

$$A = \ (1+r)^L \left[\frac{(1-c)^L}{(1-c)}\right] \text{ and } c = \frac{(1+m)}{(1+r)} \text{ if } r \neq m \quad (6a)$$

and

$$A = L \quad \text{if } r = m \quad (6b)$$

The amount of the pension benefit at time (t-R), computed according to the NDC principle, and paid to the same worker is equal to:

$$P_{t-R}^{t-T} = a\, A\, B\, W_{t-T}^{t-T} \quad (7)$$

where:

$$B = \frac{(1+s)^{R-1}(s-z)}{(1+s)^R - (1+z)^R} \quad if\ \ s \neq z \quad (8a)$$

and

$$B = \frac{1}{R}\ if\ s = z \quad (8b)$$

Terms A and B in equations (6a), (6b), (8a) and (8b) represent respectively the compound capitalization factor for the determination of the notional capital and the conversion factor of equations (1) and (3). At time (t) the total yearly pension expenditure, AP_t, can be calculated by summing up the pension expenditure of the whole retired generations from the generation born in year (t-T) to the generation born in year (t-T+R). Taking into account population and wages growth factors, we have:

[7] This condition is satisfied after (T+L) period.

$$AP_t = P_{t-R}^{t-T} N^{t-T} C \qquad (8)$$

where:

$$C = (1+z)^{R-1} \frac{1-d^R}{1-d} \; if \; g \neq z \qquad (9a)$$

with

$$d = \frac{(1+m)(1+n)}{1+z}$$

$$C = R \; if \; (n + m + n * m) = z \qquad (9b)$$

The wage mass in year (t) is defined by the sum of all wages earned by workers of the L active generations in that year:

$$AW_t = W_{t-T}^{t-T} \, N^{t-T} D \qquad (10)$$

where:

$$D = (1+m)^{T-1}(1+n)^R \frac{((1+n)^L - 1)}{n} \qquad if \; n \neq 0 \quad (11a)$$

and

$$D = L \; if \; n = 0 \qquad (11b)$$

It is immediate to note that, given the steady state characteristics of the economy and the fact that A, B, C and D are constant over time, the ratio between the pension expenditure (AP_t) and the wage bill (AW_t) is also constant through time and equal to:

$$E_t = \frac{AP_t}{AW_t} = \frac{aABC}{D} \qquad (12)$$

For the same reason the difference between current pension expenditure and social security contributions is constant through time and therefore we can write that:

$$F_t = \frac{AP_t - aA \quad t}{aAW_t} = \frac{ABC - D}{D} \qquad (13)$$

When the wage mass is a constant share of GDP, a reasonable hypothesis in steady state, equation (12) implies that also the ratio between pension expenditure and GDP is constant over time. Defining γ as the share of the wage mass over GDP we will have that:

$$S_t = \frac{AP_t}{GDP_t} = \frac{\gamma aABC}{D} \qquad (14)$$

We define finally pension (implicit) liabilities. In a PAYGO system liabilities can be defined as the difference between the present value of pension benefits expected by current pensioners and workers and the present value of contributions that current workers expect to pay until they reach the retirement age. Since the system we are analyzing is of the NDC type we can exploit its actuarial equivalence property. Accordingly pension liabilities of the system are equivalent to the sum of the present value of pension benefits expected by current pensioners and the amount of accrued notional pension wealth for current workers. We will have that pension liabilities in a period (t) are equal to:

$$PL_t = N^{t-L-R}PVP_t^{t-L-R} + \cdots + N^{t-L+1}PVP_t^{t-L+1} + N^{t-L}NPW_t^{t-L} + \cdots + N^{t-1}NPW_t^{t-1} \quad (15)$$

In order to verify the sustainability of the implicit pension debt it is sufficient to check its dynamic from time (t) to time (t+1). Observing the amount of pension liabilities one period late:

$$PL_{t+1} = N^{t-L-R+1}PVP_{t+1}^{t-L-R+1} +..+ N^{t-L+2}PVP_{t+1}^{t-L+2} + N^{t-L+1}NPW_{t+1}^{t-L+1} +..+ N^{t}NPW_{t+1}^{t} \quad (15b)$$

we note that each term in equation (15b) is higher than the correspondent term in equation (15a) by a factor (1+n) which resembles the demographic growth of the population and by a factor (1+m) which resembles the growth in per capita income. Consequently the growth in pension liabilities between two periods is equal to the rate of growth in the wage mass. When the share of wages over GDP is constant this implies that pension liabilities is also a constant share of GDP.

Given the general structure described by equations (1) to (15) the actual values of institutional, economic and demographic parameters determine the financial and distributive steady states' features of an NDC system. Table 1 below reports four different combinations of policy parameters which represent the Aaron-Samuelson rule (AS) and simplified versions of the Italian, the Swedish and the Polish NDC systems. In the AS case both the rate of return during the accumulation phase and the discount rate during the decumulation one are equal to the wage mass growth. The Italian case, fixing the rate of return during the accumulation phase to the GDP growth and the discount rate at a valure of 1.5%, fulfils the AS conditions only when the share of the labour national income over GDP is constant and when both grow at a rate of 1.5%. As for the Swedish case the return during the accumulation phase is related to the growth in the per-capita labour income. Interest credited at the time of retirement is fixed exogenously at 1.6%. The Polish case fulfil the AS conditions in the accumulation phase, while the discount rate is set at zero.

Interestingly the term z, which measures the rate of annual real indexation of the pension benefit after the first year of retirement, plays a different role in each of the above four cases. Under the AS z can be used to determine, without having effects on the financial position of the system, the path of pension benefits during retirement as well as the relative position of old with respect to new pension benefits. Under the Italian case the rate of indexation z is tided at 0, meaning that pension benefits remain constant in real terms during an individuals' retirement period. The term z is used to automatically adjust the real growth of pension benefits under the Swedish case and finally z can be used discretionally by policy makers in the Polish Ndc system.

Table 1
Policy parameters of different NDC systems

	NDC	ITALY	SWEDEN	POLAND
r	m+n+m*n	m+n+m*n	m	m+n+m*n
s	m+n+m*n	1.5%	1.6%	0%
z	any value	0	m – 1.6%	α*m

Under a common set of hypotheses concerning the long term evolution of the demographic, economic and institutional variables, the steady state financial and distributive performances of NDC systems in the four cases are computed and presented in Table 2. In order to make results comparable we set the tax rate for social security contributions at 33% of gross wages, as for the main scheme in the Italian public pension system. Per capita wages and employment growth rates are consistent with values chosen in the AWG long term pension expenditure projections for the Italian economy, respectively at 1.2% and 0.1% on a yearly base. Employment and retirement periods are known with certainty and are equal respectively to L = 40 years and R = 20 years.

The first part of the table reports policy variables (r, s and z) as well as the individual internal rate of return of the program computed over a representative individual. The central part of the table reports three measures of the replacement rate, respectively the ratio between the first, the average and the last year of an individual pension benefits to the average wage. The comparison between these three replacement rates helps in evaluating both the adequacy and the cohorts relative position of each NDC setting. In particular a higher dispersion of the replacement rates in a column can be interpreted as a sign that pension benefits lose real value over the lifecycle of an individual, meaning that the relative position of older pensioners worsen with respect both to younger pensioners and to workers. The last part of the table finally reports the ratio between the aggregate pension expenditure and the wage mass, the ratio between the aggregate pension expenditure and GDP, computed with the hypothesis that the aggregate labour income is equal to 56% of GDP, and the current balance of the pension system expressed as a percentage of the GDP. A measure of the pension liabilities over GDP is also reported in the last row of the table.

Table 2
Adequacy and sustainability indicators of different possible setting of policy parameters in a NDC system in steady state.

Variable	A-S	ITA	SWE	POL
Return on notional capital	1.30%	1.30%	1.20%	1.30%
Discount rate	1.30%	1.50%	1.60%	0.00%
Indexation of benefits	0.00%	0.00%	-0.40%	0.00%
Internal Rate of Return	1.30%	1.37%	1.20%	0.89%
First year pension / Av. Wage	76.9%	78.3%	77.3%	68.1%
Last year pension / Av. Wage	61.3%	62.3%	57.1%	54.3%
Average pension / Av. wage	68.0%	69.2%	66.0%	60.3%
Pension exp. / Wage Mass	33.0%	33.6%	32.0%	29.2%
Pension expenditure / GDP	18.5%	18.8%	17.9%	16.4%
Current balance / GDP	0.0%	-0.3%	0.5%	2.1%
Pension liabilities / GDP	548%	563%	522%	455%

a = 33%, m = 1.2% and n = 0.1%

In the Aaron-Samuelson solution the equilibrium tax rate is equal to the value of the contribution rate and the current balance of the pension system is in equilibrium. The ratio of the pension expenditure and of the pension debt to GDP are equal respectively to 18.5% and 548%. The ratio between pension benefit and the average wage ranges from a maximum value of 76.9% in the first year of retirement to a value of 61.3% in the last. Taking the AS solution as the benchmark, the Italian parameters choice appears as the most expensive for the pension system's finance and also the less manageable among the three national solutions. As for financial indicators it is only under the Italian case that the system has a negative balance. This can be explained by the fact that the discount rate is higher than the growth rate of the wage mass. It is interesting to notice the different way that the Swedish set of parameters works with respect to the Italian case. The indexation rate of pension benefits here is used to adjust a similar unbalanced configuration of the discount rate. In fact real indexation of pension benefit is negative under the Swedish case, meaning a real decreasing path of them over time. As a result the Swedish case turns out to be less expensive, even if at the cost of lowering the average value of the pension benefits and also the relative position of older pensioners with respect to younger ones. In the Polish case the choice to fix the discount rate at zero leaves the system with the higher positive balance with respect to the GDP. Consequently replacement rates are always in the lowest position.

A common feature of the setting of parameters presented in table 2 regards the path of pension benefits during the retirement period. Having fixed at zero (and at a negative rate in the Swedish case) the term "z", which defines in the model the indexation rule of pension benefits, a clear distributive problem as well as an adequacy one for older pensioners emerge. This can be appreciated looking at the ratio between pension benefit and the average wage at the beginning and at the end of the retirement period, which ranges around 15% and 20% in all cases.

In order to check the sensitivity of the four cases to a change in the term "z", table 3 reports same indicators of table 1 computed when the indexation of pension benefits is increased by a factor equal to 50% of the wage mass growth. Some interesting results derive from this exercise. First, as expected, the option to increase the indexation of pension benefits contributes to a better situation as for the adequacy in the final part of the lifecycle. However it is only under the AS case that this policy can be accomplished without affecting the financial conditions of the pension system. Indeed in the AS case imposing a higher indexation means also lowering the level of pension benefits at the beginning of the retirement period[8]. In the other three cases a change in the term "z" increases the relative position of older pensioners with respect to younger ones and to employee, but at the cost of reducing the net financial position in the current budget of the pension system. The same result emerges if one compares the internal rate of return for the representative individual and the wage mass growth.

So a first result that emerges looking at results reported in table 3 is that policy makers cannot modify the indexation rule of pension benefits without changing also the term that determines the return in the notional capital or the discount of the pension benefit if they do not want to affect the financial stability. A second important point is that the initial setting of parameters in the Italian case appears as the more unbalanced in the potential creation of deficits in the current balance of the pension system or equally in the creation of a higher pension debt. The use of the parameter z is in practice not a feasible policy in the Italian Ndc system, as even a policy of partial indexation would bring the deficit at a value of 1.5% of the GDP.

Table 3
Sensitivity to a change in "z"

Variable		A-S	ITA	SWE	POL
Return on notional capital	**r**	1.30%	1.30%	1.20%	1.30%
Discount rate	**s**	1.30%	1.50%	1.60%	0.00%
Indexation of benefits	**z**	0.65%	0.65%	0.25%	0.65%
Internal Rate of Return	**Irr**	1.30%	1.56%	1.39%	1.10%
First year pension / Av. Wage	P_t/W_{t-1}	72.4%	78.3%	77.3%	68.1%
Last year pension / Av. Wage		65.3%	70.5%	64.6%	64.0%
Av. pension / Av. wage	**AP / AW**	68.0%	73.5%	70.0%	61.5%
Equilibrium tax rate	**E**	33.0%	35.6%	33.9%	31.1%
Pension expenditure / GDP	**MP / GDP**	18.5%	19.9%	19.0%	17.4%
Balance / GDP	**F / GDP**	0.0%	-1.5%	-0.5%	1.1%
Debt / GDP		550%	619%	574%	504%

[8] The AS case is the only one, among those considered in this paper where the indexation rate "z" is used in the formula for the computation of the conversion coefficient.

As a further exercise we test the sensitivity of the four NDC equilibria to changes in terms “m” and “n”, namely a reduction of 0.5% in the growth of the per capita labour income and of the employed population.

A permanent reduction in the growth of per capita income does not have any effect on the financial stability in the AS and in the Swedish case. In fact in the Swedish case the indexation rule is constructed in a way that makes the system completely unaffected from changes in “m”. While in the Polish setting the financial situation worsens as a consequence of the new value of “m” it is the Italian case that presents the most worrying scenario. Again the system appears to be less able to react to changes in exogenous variables.

Table 4
Sensitivity to changes in “m”

Variable		A-S	ITA	SWE	POL
Return on notional capital	**r**	0.80%	0.80%	0.70%	0.80%
Discount rate	**s**	0.80%	1.50%	1.60%	0.00%
Indexation of benefits	**z**	0.00%	0.00%	-0.40%	0.00%
Internal Rate of Return	**Irr**	0.80%	1.01%	0.69%	0.54%
First year pension / Av. Wage	P_t/W_{t-1}	73.1%	77.9%	77.0%	67.8%
Last year pension / Av. Wage		64.0%	68.1%	56.8%	59.4%
Av. pension / Av. wage	**AP / AW**	68.0%	72.4%	66.0%	63.1%
Equilibrium tax rate	**E**	33.0%	35.1%	32.0%	30.6%
Pension expenditure / GDP	**MP / GDP**	18.5%	19.6%	17.9%	17.1%
Balance / GDP	**F / GDP**	0.0%	-1.2%	0.5%	1.3%
Debt / GDP		552.9%	605.7%	522.4%	492.5%

On the other hand a permanent reduction in the growth rate of the employed population affects the financial condition more under the Swedish case, where both the return on notional capital and the indexation of benefits are computed independently from what happens in the population growth. In the Italian case there is a reduction in the return on national capital, but again the erogeneity of both the discount rate and of the indexation of pension benefits represent a rigidity for the system financial viability.

Table 5
Sensitivity to changes in "n"

Variable		A-S	ITA	SWE	POL
Return on notional capital	**r**	0.80%	0.80%	1.20%	0.80%
Discount rate	**s**	0.80%	1.50%	1.60%	0.00%
Indexation of benefits	**z**	0.00%	0.00%	-0.40%	0.00%
Internal Rate of Return	**Irr**	0.80%	1.01%	1.20%	0.54%
First year pension / Av. Wage	P_t/W_{t-1}	66.3%	70.6%	77.3%	61.5%
Last year pension / Av. Wage		58.5%	62.4%	65.8%	54.4%
Av. pension / Av. wage	**AP / AW**	52.8%	56.3%	57.1%	49.0%
Equilibrium tax rate	**E**	33.0%	35.1%	37.1%	30.6%
Pension expenditure / GDP	**MP / GDP**	18.5%	19.6%	20.7%	17.1%
Balance / GDP	**F / GDP**	0.0%	-1.2%	-2.0%	1.2%
Debt / GDP		539%	593%	639%	480%

Summarizing and looking at peculiarities and rigidities of the Italian case, some important points emerge from exercises presented in this subsection. Firstly it is only under the AS configuration that the financial stability of the pension system is ensured for any value of z, the indexation rate. As a consequence the indexation rate can be used to determine the relative position of pension benefits among the population of retired without implications for the financial stability of the system.
Among national cases, even a non realistic steady state situation does not necessarily implies the absence of financial disequilibrium. In particular, looking at the three possible configurations, the choice of the discount rate seems to be the one that mostly differentiates national solutions. While the Swedish and in the Polish parameters are set in such a way that the indexation of pension benefits can be used to correct financial imbalances or excessive disadvantage for older pensioners, the Italian configuration of policy parameters makes the use in the term "z" more difficult. With respect to the Swedish case the Italian one shares the choice of a relatively high discount rate, but in the Swedish case the indexation rate counteracts automatically in order to take into account at least the effects of changes in "m". With respect to the Polish case the Italian one shares the choice of having a low value in the indexation of pension benefits, but the Polish case, having chosen also a low value for the discount rate, has more flexibility in the choice of the indexation.
Finally results of the above presented exercises make clear that even in steady state moderate deviations of economic or demographic parameters can generate non negligible deficits and/or surpluses in the pension budget.

3.2 Ndc pension systems out of the steady state

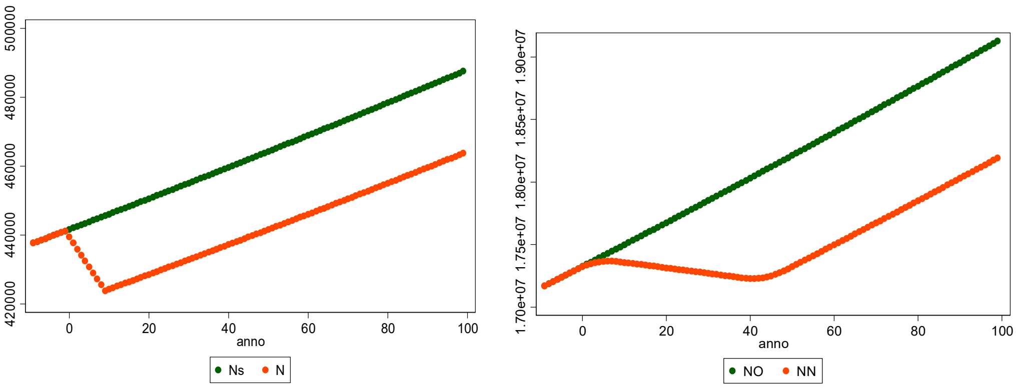
While the steady state represents a useful device to study theoretical long term features of an NDC system, it is much less helpful when the researcher and the policy maker want to consider more realistic situations. As a matter of fact an economy and a population are always out the steady state. This has important consequences on the financial short and medium term position of a pension system and can be synthesized saying that the cross sectional growth of the wage mass is normally not perfectly aligned with the ex ante longitudinal internal rate of return implicit in the pension rule[9], unless policy parameters (r, s and z) are continuously modified in order to achieve this condition. It is however the growth path of the wage mass that, in a situation where the contribution rate is fixed, determines resources available to finance pension expenditure. Accordingly when pension benefits in payment are not completely and automatically tided to changes in the wage mass path, a deficit (or a surplus) can emerge in the current budget of the pension system. This may be for example the consequence of shocks in economic or demographic variables or the effect of a modification in the distribution of the retirement age within the employed population. In order to check the policy relevance of this point it is then important to measure both the size of the misalignment of the pension expenditure with respect to the wage mass and the amount of time that it is required to the system in order to absorb the financial effects of the shock itself, without external intervention. In order to check these dimensions we will then start from a steady state solution of the model and we will describe the dynamic of the sustainability indicators E of equation (12), in cases of temporary shocks that bring the per capita income and the employed population out of their long term steady state path.

A shock in the growth of employment: starting from the steady state condition described in the subsection 2, we bring down by an amount of 1%, the growth rate in the number of new individuals that enter in the employed population for a period of ten years. After ten years the rate of growth of the employed population returns immediately to its original path. Implications of such a shock on the number of individuals belonging to the youngest generation and on the total employed population is showed in the next graph[10], where the number of new and total workers are represented respectively in the left and in the right side.

[9] Considering the internal rate of return measurement of a PAYGO system for example Settergreen and Mikula (2005) show that its computation under the AS conditions is not a complete representation of what usually happens in real pension systems. This happens for example when exogenous variables like m or n in the model deviate from their long term equilibrium values or when the lifetime income profile change its shape or finally when individuals modify their retirement age or improve their lifetime expectations. In all these situations the authors show that the traditional internal rate of return has to be completed with the rate f growth of what they define the "turnover duration".

[10] We calibrate population's parameters in such a way that, in the first year of the shock the number of new workers is comparable with the one that characterizes the Italian current population.

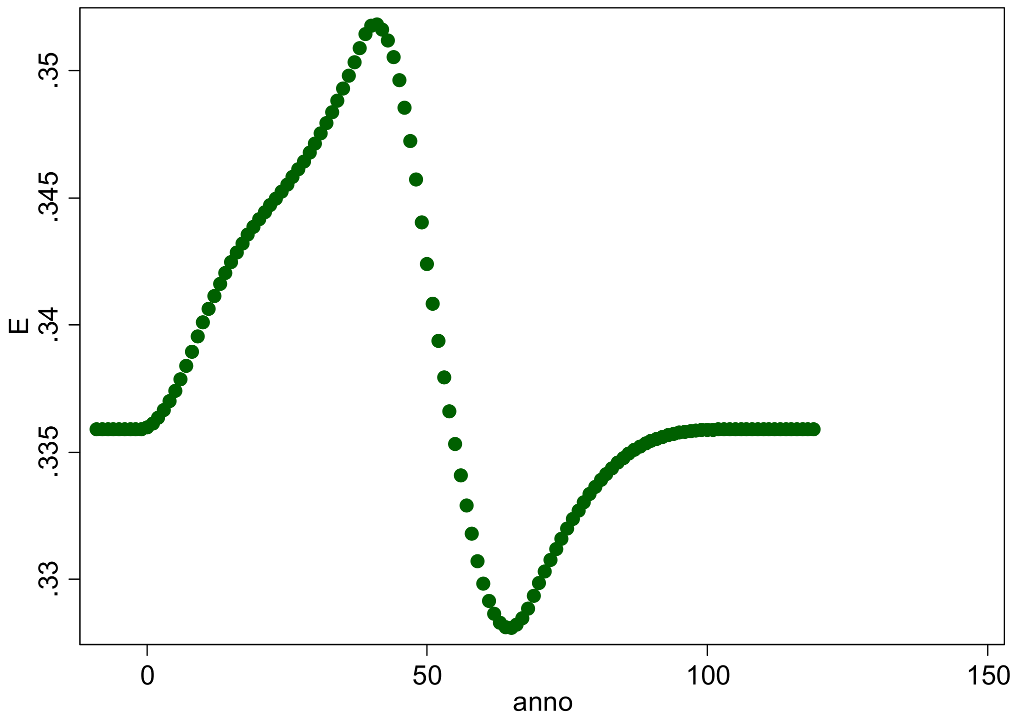
Figure 1
Effect of a 10 years demographic shock on the number of new workers (left) and on the number of total workers (right).



In the next figure we report the effect of the above described shock on the ratio between pension expenditure and social security contribution E described in the equation (12), when model's parameters for the computation of pension benefits are set as in the Italian case.

Figure 2:

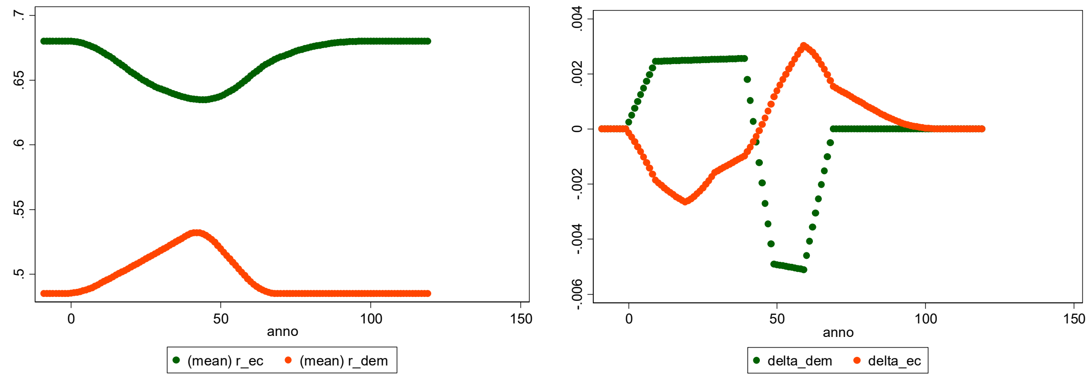
Effects on the term E of the transitory demographic shock



The shock in the employment growth brings the value of E away from a stable value for quite a long period of time, namely 106 years. A period of more than 50 years where the term E is above the initial value, is followed by a period where E lies below it. Starting from a steady state value of 33.6% at its maximum the value of E reaches 35.8%. While in the long term the "algebraic" sum of deficits and surplus is zero, the sequence of deficits in the first part of the simulation determines an accumulated value of deficits equal to 9% of GDP in the year when the term E reaches its maximum.

In order to better understand what drives the path of the term E it is useful to decompose it in the product of the ratio between average pension benefits and average wage and the ratio between the number of pensioners and the number of employed, as the two figures below reports.

Figure 3
Time path for the economic and the demographic ratios (left) and percentage changes in the ratios (right)

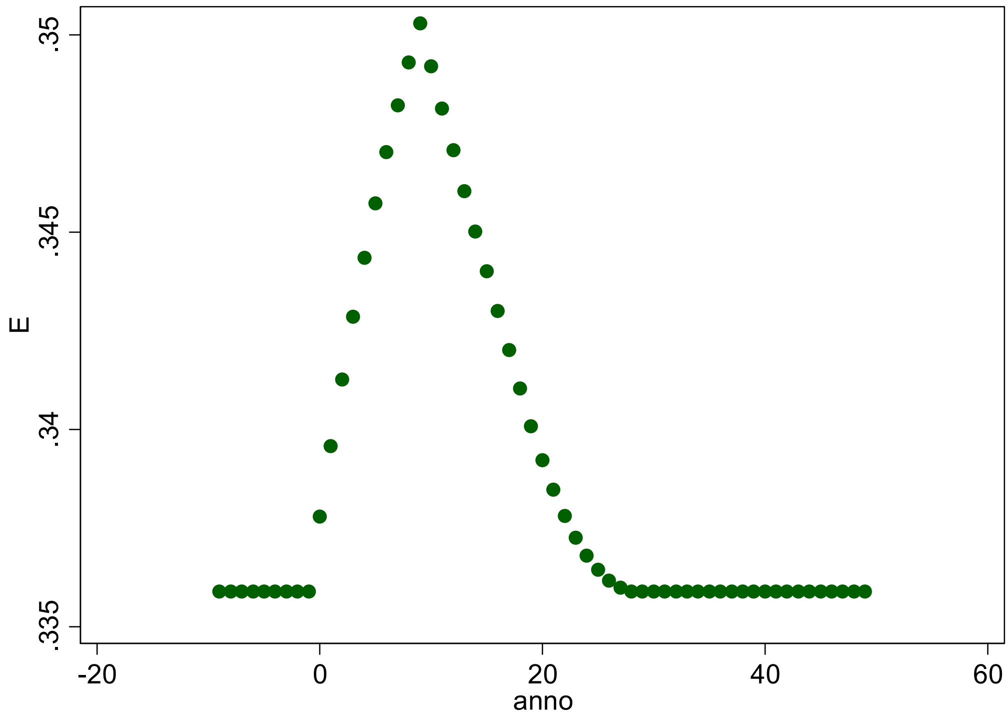


For a period of 68 years the demographic ratio is above its long term equilibrium value. This is explained by the transition of the ten cohorts interested by the fertility shock through different phases of their lifetime and by the number of years that individuals are employed and retired[11]. In order to maintain at a constant level the term E in each period of the transition an equal path, but opposite in sign, in the economic ratio would be necessary. The right part of the figure shows that, without interventions in the parameters of the NDC system the adjustment in the value of pension benefits with respect to wages, that would allow to counterbalance the negative effects of the demographic ratio on the term E, occurs but only with some delay. In order to understand the reason of the delay in the reaction in the economic ratio it is useful to remember that the worsening in the demographic ratio does impact immediately on the amount of disposable contributions, but it modifies only the pension benefits of those that reach retirement after the shock. For a period of (R-1) years however aggregate pension expenditure will in part be composed by benefits belonging to individuals who retired before the shock and who have their pension computed with an implicit internal rate of return which is not any more compatible with the "new" growth in the contribution base.

A shock that halves the growth rate of per capita wages for a period of ten years. Differently from the previous case changes in the term E here are only determined by modifications in the economic ratio, as the number of pensioners with respect to employed is not affected by the shock.

[11] In the case here considered employment growth is below its long term equilibrium path for 48 years. The growth of pensioners is below its long term equilibrium value for a period of 38 years. The two periods partially overlaps from time 40 to time 48.

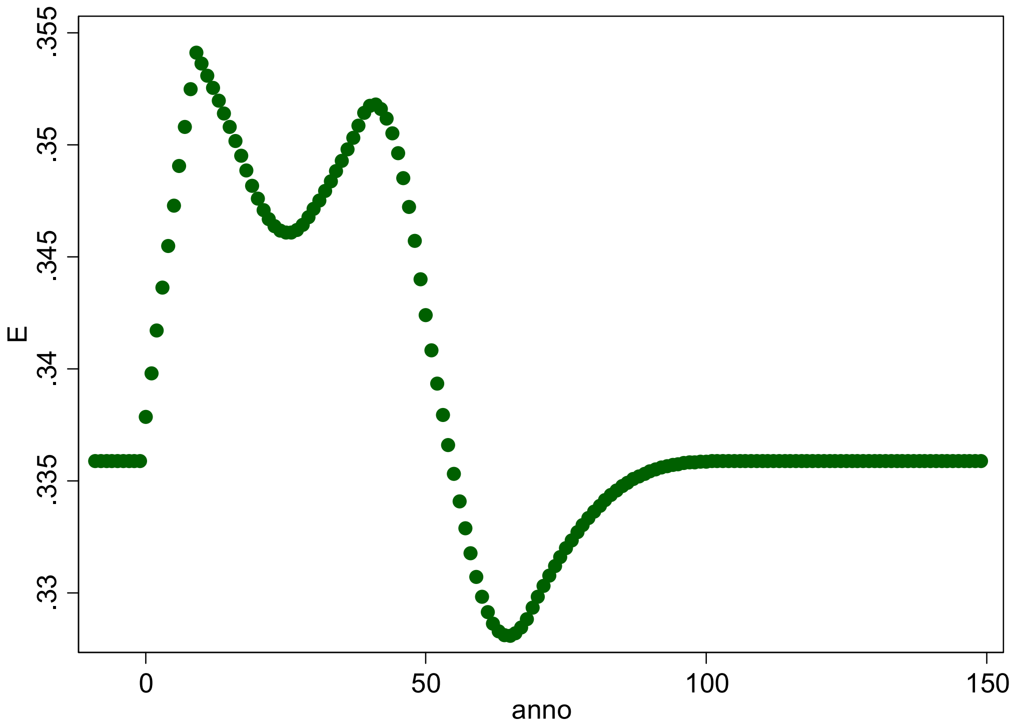
Figure 4
Effects on the term E of the transitory economic shock



Starting from its equilibrium value the term E quickly increases to a maximum of 35.2% and decreases again to the original equilibrium value, which is reached after a period of 30 years. Again it is the different intensity of the effect of changes in the term "m" on the wage mass and on pension expenditure that explains the dynamic of E. In particular as "m" decreases its impact on the wage mass is initially much larger than the effect on pension expenditure. Only new paid pensions partially incorporate the reduction in the growth of procapita wages in their amount. Conversely, ten years after the shock, "m" grows at the original value while pensions already paid incorporate a lower rate of return, which explains why the term E reverses its slope and turns to its original equilibrium value.

Finally the last figure put toghether the two shocks above described. Approximately the macroeconomic effects of this last shock resembles what happened to the Italian economy in the ten years after the 2008 financial crisis. First of all it is interesting to notice that the term E result above its equilibrium vale for more than a percentage point (more than 34.5%) for around 5 decades. Secondly it is not more true that the positive and the negative phases cancel out each ther in the long run. Finally the sum of the deficit generated by the shock are equal to 20% of GDP.

Figure 5
Effects on the term E of the transitory demographic + economic shocks



4. Conclusions

An NDC formula has been, albeit very slowly, introduced in the Italian PAYGO system in 1995. Probably, also because of the very slow transition path to the new formula, Italian policy makers do not seem completely aware of the complexity of the system and of the necessity to introduce automatic procedures free from discectional political interventions that allow the system to produce transparent financial and distributive effects and control unexpected demographic and economic shocks. Looking at the mechanism that determine both indivdual benefits and macro financial indicators in an OLG model where individuals live with certainty for a period of T = 60 years, work for L = 40 years and are retired for a period of R = 20 years, we were able to analyse both the theoretical feature of a system that follows either the prescriptions of the Aaron-Samuelson rule and the application of the NDC system decided in Italy, Sweden and Poland. While all national solutions produce inferior results with respect to the theoretical prediction, the Italian one distinguishes among the other two because in fact it renounces to use the indexation rate of pension benefits, one of the three policy paramters that, toghether with the rate of return recognized during the accumulation phase and the discount rate used in the computation of the conversion coefficient, can be used to regulate distributive and financial features of the system. This choice can be brought back to 1995, when the Italian Parliament decided to choose the highest first year replacement rate, compatible with the constraint that the present value of contribution must be equal to the present value of pension at an individual level. It is however also clear that the choice prevents the use of the indexation of pension benefit to contrast the effects of unexpected shocks in the dempgraphy and or in the dynamic of per capita wages. Having fixed at zero the indexation rate opens also a problem of relative position of old pensions with respect to new ones, that is obvious also in the other two national cases.

Even looking at unrealistic steady state situations the Italian choice of policy paramteres appears inadequate. In particular after having set demographic and economic parameters of the model in a way that is consistent with the most recent European Commision's Ageing Working Group projections, we show that the Ndc Italian systme would produce a constant deficit in the budget, the highest value of the pension debt, the highest value of the internal rate of return, but at the same time a not desirable intergenerational distribution among pensioners, especially when compared both with the Aaron-Samuelson case and the other national cases. In a case of zero growth, as the macro scenario experimented in Italy during last ten years, the steady state solution of the Italian setting of paramters for the Ndc system would produce a constant deficit of 2.7% of GDP.

Finally looking at what could happen out of the steady state we simulate the financial effects of a temporary demographic and economic shock. Result of these excercises show that even modest short term shocks can have prolonged and non negligible effect on one of the sustaibnability indicators used in this paper, namely the ratio between the pension expenditure and the wage mass. Instability of the system is magnified when demographic and economic shocks occour at the same time.

All these results call to a more self conscius use by Italian policymakers of the NDC rule. In particular it is necessary to modify the value of the discount rate used for the computation of the first year pension benefit as it incorporates unrealistic growth rate for the economy, and to modify the way in which the indexation rule is used unless the policy makers decide that this will not be any more a policy variable of the system. Finally it is urgent to define a rule that allow the Italian pension system to respond to effects of demographic and economic shock on the financial short and medium term position of the pension budget.

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