

## Article

Gustavo De Santis\*

# Demography, Economy and Policy Choices: The Three Corners of the Pension Conundrum

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**Abstract:** NDC (notional defined contribution) pension systems are usually considered the best in the PAYGO (pay-as-you-go) category: they mimic funding, seem to be well balanced, and have very limited distortionary effects on the labour market. In this paper, after highlighting a few of their weaknesses, I suggest an alternative solution to the pension problem: IPAYGO, or improved PAYGO. Its guiding principle, “everything is relative”, is applied consistently to both the economic and the demographic part of the problem: this makes the system viable in all possible demographic and economic scenarios. Depending on a few explicit policy (parametric) choices, IPAYGO may take very different shapes, and adapt to national preferences, such as early or late retirement, generous or limited pension benefits, and greater or lesser emphasis on actuarial equity. A properly designed IPAYGO, even in its basic form (the only one discussed here), can tackle issues such as inequities deriving from differential mortality (with the richer living longer), pension-induced low fertility, and quasi-capital gains and losses. While IPAYGO is conceived to be an operative instrument, it can also be used to evaluate existing pension systems, and the phase a population is going through, with a novel measure of the so-called “demographic bonus” (or “malus”).

**Keywords:** PAYGO pension systems; actuarial equity; redistribution; mortality; fertility

## 1 Introduction

Pay-as-you-go (PAYGO) pension systems may be a considerable cause of concern, despite the good intentions with which they were set up, such as smoothing

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**\*Corresponding author: Gustavo De Santis**, Department of Statistics, University of Florence, Firenze, Italy, E-mail: [gustavo.desantis@unifi.it](mailto:gustavo.desantis@unifi.it), <https://orcid.org/0000-0003-2058-2629>

consumption over the life cycle and combating poverty in old age (Kohli and Arza 2011). They may have negative side effects: for instance, they may discourage labour market participation among mature workers (Gruber and Wise 1999), depress saving (Barr 2002), and lower fertility (Fenge and von Weizsäcker 2010). They also raise concerns with regard to redistribution, inter- and intra-generational equity (Holzmann et al. 2017), and gender equity (Bonnet and Geraci 2009; Bonnet, Hourriez and Reeve 2012). Finally, such systems frequently prove unviable when they mature (and population age): costs increase rapidly, outlays tend to exceed revenues, and the relevant demographic and economic variables rarely evolve as policy makers hope or experts foresee.

Despite their nature of “intergenerational compacts”, which would call for rules that change only rarely, if ever, pension systems tend to undergo frequent revisions, under the pressure of economic crises and population ageing (Beetsma et al. 2020; Bonenkamp et al. 2017; Carone et al. 2016; Guardiancich and Guidi 2020; OECD 2019). The formally neutral expression “pension reform” has become a synonym for retrenching in the past few decades, with higher contribution rates, lower benefits, later retirement, or a combination of the three. None of these changes is appreciated by voters, characterized by intergenerational selfishness (i.e. limited interest in the wellbeing of future generations; Boeri et al. 2002) and scarce financial competence. Somewhat greater acceptance of less generous retirement conditions is observed only among the “financially literate”, who are, however, a minority (Boeri and Tabellini 2012; Fornero and Lo Prete 2019). As retrenching pension systems is extremely unpopular, change is usually late and only minimal, or, sometimes, delegated to technocrats who, very conveniently, can later be blamed for harsher retirement conditions.

By mid 1990s, following an influential World Bank (1994) publication and the 1980 Chilean (and Pinochet’s) reform, attempts were made to convert existing PAYGO into pre-funded schemes, but the passage soon proved too costly (Holzmann 2017). Besides, the alleged theoretical superiority of funding can be, and has forcefully been, questioned, because funding does not automatically solve any of the issues listed above: population ageing, financial equilibrium, ... (Barr 2002).

A new wave of enthusiasm emerged in the latter part of the 1990s for the new notional (or non-financial) defined contribution systems NDC, allegedly the best form of PAYGO (see, e.g. Holzmann 2006, 2017), which were actually adopted by a few countries: Sweden, Italy, Latvia, Norway, and Poland.

In this paper, after discussing the pros and cons of this mechanisms, I will present an alternative to NDC, the “improved” PAYGO pension system, IPAYGO, which, as I show below, has all the merits of NDC, but outperforms it in several respects. In so doing however, I will also suggest how pension systems *should* be designed: in such a way that viability is guaranteed and policy choices become

explicit, for instance in the alternative between redistribution and actuarial equity, or in the quest for the best compromise between age at retirement, “generosity” of the system and contribution level.

IPAYGO can be viewed as a theoretical exercise, a sort of standard against which to assess the performance of actual pensions systems. However, it is conceived to be also applicable in practice. Even if not adopted in full, some of its ideas can be used to improve existing systems, including NDC, in several respects, among which, for instance, the dynamic definition of the retirement age.

I will start with a reminder of how NDC pension systems work (Section 2). In Section 3, I introduce IPAYGO and in Section 4, I compare the two. In Section 5, I discuss a few selected issues and some possible variants of IPAYGO, with their pros and cons. In Section 6, I present my conclusions.

## 2 NDC (Notional Defined Contribution) Pension Schemes: A Reminder

NDC pension schemes mimic funded systems. The employed pay their contributions and accumulate a “virtual” capital. Their money is not really stored or invested: as the system is PAYGO, current contributions are used to pay current pensions. However, due note is taken of all contributions, which, after re-evaluation with a “proper” (notional) interest rate, transform into a virtual capital  $K_s$  by the time the employed (now “seniors”, in my terminology and symbols) take their retirement, at age  $\beta$  (e.g. 65 years).

This virtual capital is then converted into an annuity (or yearly pension benefit for each senior,  $P_s$ ) with a formula of the following kind

$$P_s = \frac{K_s}{LE_\beta} \quad (1)$$

where  $LE_\beta$  is life expectancy at retirement, the expected number of remaining years of life of those who retire at age  $\beta$ . Actual formulas are more complicated than (1) (see. e.g. Gurtovaya and Nisticò 2018, 2019), because they take into account additional elements (e.g. interests accruing on the not-yet used part of the virtual capital, survivors’ pensions, floors and ceilings), but these are details that we can ignore here.

NDC pension systems are highly appreciated by economists for four main reasons:

- (a) They introduce flexibility in the retirement age: the later the employed exit the labour market, the more they have contributed (higher virtual capital  $K_s$ ), the shorter their life as retirees (lower  $e_\beta$ ), and the higher their yearly pension  $P_s$ .

This feature constitutes a remarkable progress over once-widespread practices that penalized late retirement and encouraged early labour market exits, sometimes with the unwarranted hope that this would curb youth unemployment (Gruber, Milligan and Wise 2010);

- (b) They emphasize actuarial equity, i.e. a strict correspondence between past contributions and future benefits, again, a notable improvement over several alternative systems, typically very opaque, and sometimes even anti-redistributive, taking from the poor and giving to the rich. Noncompliance with fiscal laws becomes less attractive, because contributions not paid today transform into lower pensions in the future;
- (c) They are (believed to be) viable by definition: if everybody takes back in benefits as much as they have contributed, there cannot be imbalances between revenues and outlays (more on this below);
- (d) They are at least partly protected from “political risks”, i.e. a change of rules that, possibly under the umbrella of “urgency and necessity” (and under the pressure of interested and powerful lobbies), may disrupt the system, favour some groups at the expense of others (e.g. future generations), and undermine people’s trust in the very possibility of a durable intergenerational compact (e.g. Barr 2002).

While NDC pension systems improve over most other theoretical or actually existing PAYGO pension arrangements, they too have their shortcomings. I will mention five of them.

- (A) Revenues and outlays do not match on a yearly basis, and it is far from obvious that they do so in the long run, for four main reasons: (i) quasi-capital gains and losses; (ii) life tables, (iii) (notional) interest rates and (iv) re-evaluation criteria. Let us briefly consider each of them.

- (i) Quasi-capital gains (QCGs) were identified long ago (Lee 1980), but they are frequently forgotten in the pension debate. They are given by the following formula:

$$\text{Quasi capital gain} = P \cdot \Delta \text{age} \cdot \Delta S \quad (2)$$

where  $P$  = average pension,  $\Delta \text{age}$  = difference between two average ages: at receiving benefits and at paying contributions;  $\Delta S$  = change in the number of beneficiaries (seniors), which can be negative in case of population decline and create quasi-capital losses. As  $\Delta \text{age}$  is large (30–40 years), even small demographic variations translate into large QCGs.

- (ii) Life tables are an essential, if underrated, element of the pension conundrum, also in its NDC variant. Those who retire at age  $\beta$  (e.g. 65 years) will survive for several years, about 20 on average, but the exact number is

unknown at the time of retirement, when equation (1) is applied. The correct denominator  $LE_\beta$  must be replaced by an estimate  $\widehat{LE}_\beta$ : if this proves incorrect, imbalances emerge.

- (iii) (Notional) interest rates enter the picture because they concur to the determination and the evolution of the virtual capital  $K_s$ . As this is accumulated over the entire working life of a person (e.g. between 20 and 65 years) and is used little by little after retirement, even small mistakes in the choice of the interest rate may result in an imputed value  $\widehat{K}_s$  that differs significantly from its correct counterpart in equation (1). To avoid yearly recalculation, the value of  $K_{s,\beta}$  at the time of retirement is usually already “inflated”, discounting likely future (notional) increases, but, as the future is unknown, the introduction of mistakes in this phase is unavoidable. Finally, to add confusion, the basis for the calculation of notional interest rates varies by country: growth rate of GDP in Italy; of average wage in Norway and Sweden; of wage bill in Latvia and Poland (De Wouter and Boulhol 2021).
- (iv) Re-evaluation criteria of pensions also matter. Equation (1) is used to determine the *initial* amount of an annuity, but this must be paid for several years. Subsequent instalments are usually calculated as a re-evaluation of the first one. Depending on the criterion (inflation, labour productivity, salary mass, ...), results vary and this too creates imbalances in the system.

A buffer reserve fund for NDC systems is frequently advocated in theory (Holzmann 2017), and may exist in practice (e.g. Sweden). The idea is that when this reserve fund shrinks, some corrective action must be taken to restore equilibrium, for instance a proportional reduction of all pension benefits.

- (B) Actuarial equity is the explicit aim of NDC schemes and it is fairly well approximated in practice, even if points (i) to (iv) above lead not only to imbalances but also to hidden forms of actuarial inequity. However, public pension systems may, and in fact do, pursue also other objectives, including redistribution from the rich to the poor, at least in the form of a minimum pension. The introduction of this facet into NDC pension systems requires ad hoc solutions, not necessarily clear, consistent with the rest of the scheme, financially viable, or resistant to policy interventions (Holzmann 2017).
- (C) A reasonable ratio must exist between the standard of living of the average pensioner and that of the rest of society. This “cross-sectional equity”, as I will call it, is usually measured ex-post, with an indicator known as replacement rate, of which unfortunately several versions exist: e.g.  $P/W_e$  and, in the OECD (2019) version,  $P/y$  (average pension  $P$  divided by average gross labour earning

$W_e$ , or by average per-capita income  $y$ ). For the sake of simplicity, let us consider only the case of an economic downturn, such as the financial crisis of 2008, and let us compare only two groups, the retirees and the adults. A system that protects the old regardless of what happens in the labour market (unemployment, low wages, etc.) is scarcely justifiable, and creates a blatant cross-sectional inequity: the retirees are relatively well off, at the expense of the rest of society. Ad hoc policy measures may be introduced to restore cross-sectional equity, but this is likely to create conflict, may undermine the general logic of the system, and is at odds with the claim that NDC is immune from political risk.

- (D) The rich live longer than the poor. As pension systems transfer resources from the adult to the old years, they favour long-living population subgroups, who are often also better off economically (e.g. Bosworth and Burke 2016). Corrective measures may be advocated: however, their identification and integration into NDC is problematic (Holzmann et al. 2017).
- (E) The standard (or minimum) retirement age  $\beta_t$  is chosen for the starting year  $t$ . However, as mortality changes over time, the question arises of how to adjust  $\beta_t$ . NDC says nothing about this, and various solutions are possible, including *ad hoc* political interventions, not necessarily consistent with the original scheme.

In light of these shortcomings (A to E), it may be worthwhile to consider an alternative: the improved PAYGO pension system (IPAYGO) described below.

### 3 The Improved PAYGO (IPAYGO) Pension System

#### 3.1 An Introduction to the IPAYGO System

In IPAYGO, policy decisions, collective choices intended to maximise social well-being, are in the foreground, in the form of parameters ranging between 0 and 1. In the basic version of the system presented here, there are five of them. Of these, the first two define the *shares* of an average life to be spent in young and old (or senior) ages. The next two specify how generous, on average, the pension system is towards these two groups, young and seniors, respectively. The final parameter specifies the proportion of actuarial equity, as opposed to redistribution, that comes into play in the payment of individual pension benefits.

Laymen and policy makers do not need to understand *why* these choices produce certain effects (e.g. on the contributions rate), just as car drivers do not need to understand why their car accelerates or slows down when they hit the right or the left pedal in front of them. However, just as in the case of car drivers, it is essential that laymen and policy makers *know the effects* that these parameters produce. And

**Table 1:** List and classification of the relevant variables in an IPAYGO pension system.

Step	Policy choices (parameters)	Exogenous variables	Endogenous variables
1	$\gamma^*, S^*$		$A^*$
2		$L_{x,t} (\sum_x L_{x,t} = T_{0,t})$	$a_t, \beta_t$
3		$I_{x,t} (\sum_x I_{x,t} = I_t)$	$\gamma_t, A_t, S_t$
4	$y, s$		$c_t, c^*$
5		$E_t, W_{e,t}$	$e_t, W_{a,t}, N_{a,t}, P_t, B_t$
6	$Q$	$K_{s,t} (\sum_s K_{s,t}/S = K_t)$	$P_{s,t}$

$x$  = age;  $t$  = time. Bold denote vectors. For the meaning of the symbols, see text.

this can be learnt by “trial and error”: once the full set of relevant exogenous variables is available (as in Table 1), stakeholders can try alternative values for these policy parameters (preferably changing them one by one), and appreciate the consequences on the dependent variables of the system: retirement age, contribution rate, average pension, etc.

Independently of these policy choices, the system is and will remain viable, which means that it can last forever, unchanged. This happens for two reasons – but discussing them forces us to open the “black box” and look at the inner mechanism of IPAYGO. The first of these reasons is that all policy decisions are relative: they simply apportion what is, or is going to be, available, be that length of life or labour income. The more the better, of course, but these unknown quantities and their variations will not affect the functioning of the pension system. The second is that the system is built as a combination of automatic adjusting mechanisms, or AAMs. These are nowadays frequently advocated, and occasionally implemented to address specific issues (De Wouter and Boulhol 2021): with IPAYGO, automatic adjustments are generalized and cover all areas, both demographic (survival and population age structure) and economic (employment and labour productivity). AAMs are appreciated in theory; in practice, however, they tend to suffer from two main shortcomings: unforeseen consequences and reliance on forecasts. The latter implies that, in the attempt to prevent possible negative future outcomes (e.g. budget imbalance), unpopular measures (e.g. later retirement) may be introduced even when they are in fact unnecessary. Both types of shortcomings are absent here, because IPAYGO relies only on observed variables and because all the relevant dependent variables are predefined, and the consequences on them are known in advance (see Table 1).

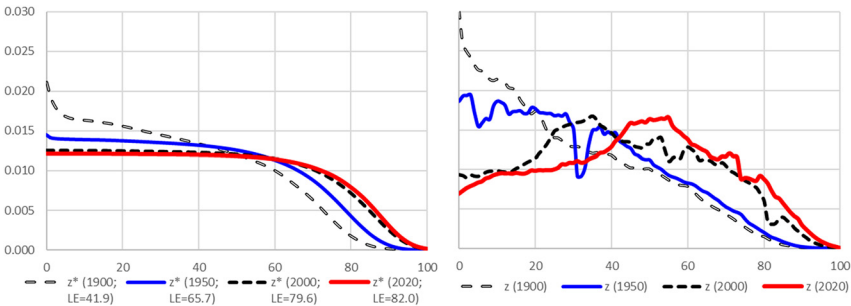
IPAYGO belongs to the family of “risk sharing” pension systems, inspired by the Musgrave (1981) rule of proportionality between pensions and net labour incomes, although with an important difference, discussed in Section 3.3. IPAYGO also belongs to the family of “points systems”: while the average pension benefit is determined by the risk-sharing principle mentioned earlier, some pensions will be higher, and some

lower, depending on past contributions, which may be transformed into “points” (see e.g. Schokkaert et al. 2020). However, differently from other actual or proposed points systems, within IPAYGO, these points are used to assess the *relative* position of each senior in relation to the average senior of that community in that year, and do not translate into absolute claims on future production. Besides, this actuarially fair element is only one of the two determinants of their pension benefit: the so-called *Bismarckian* part, linked to “merit” (meaning past contributions). The second part, the *Beveridgean* one, introduces redistribution, and these two components are treated as explicit relative weights in the calculation of individual pension benefits. In other words, thanks to the policy parameter  $Q$ , IPAYGO is completely transparent as to the relative importance that it attaches to actuarial equity ( $Q$ ) versus redistribution ( $1 - Q$ ) in the calculation of individual pensions. At the same time, all these individual pensions move proportionally up or down each year, to produce the average that each community can afford to pay in that year, given policy preferences and demo-economic conditions.

Although modifications to the IPAYGO initial (parametric) policy decisions are always possible, not *having* to introduce them is a great advantage, and so is the opportunity of getting rid of demo-economic forecasts, because all the relevant variables are observed, not projected. As said, the whole system is about how to “share the pie”, in Takayama’s (2003) words, or total labour output. As all promises and entitlements to this pie are relative and sum up to 100 %, all future claims are by definition consistent with future labour output, even if it is not yet known. Besides, on the *relative* scale of economic wellbeing, on average all claimants (young and seniors) will be exactly where they should be, by explicit policy (parametric) choice on the relative generosity of the system towards them. Indeed, even the definition of who is young or senior is relative to current survival conditions, which permits automatic adjustments of the relevant threshold ages, including retirement age.

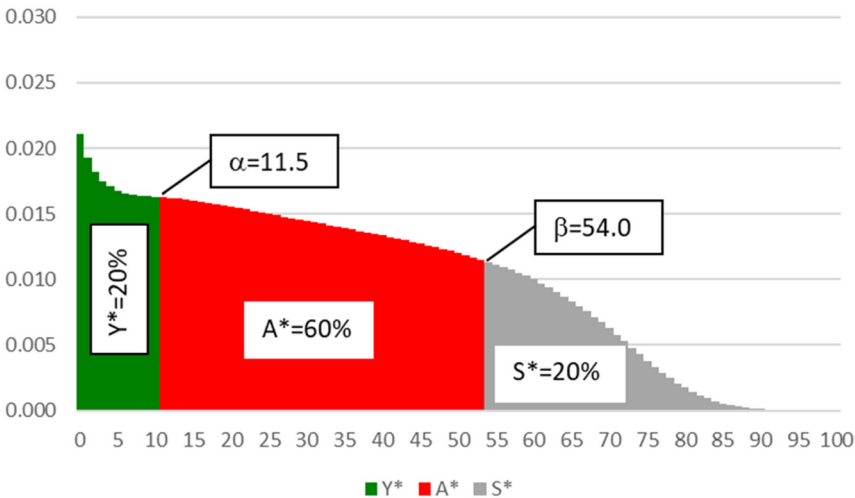
To get a feeling of how the system works, consider the following example. Assume that the average length of life is 80 years, and that 25, 50, and 25 % are collectively deemed to be the best shares of it to be spent as young, adult and senior, respectively. This leads to the identification of the relevant threshold ages: in the simplest possible case of perfect survival homogeneity, these will be 20 years and 60 years, the latter being retirement age (For more realistic calculations, see Figures 1, 2, and 3). Note that this approach provides a rule for the automatic adjustment of these thresholds: for instance, if life expectancy increases to 84 years, these ages will automatically rise to 21 and 63 years, respectively (always assuming a hyper-simplified, rectangular survival curve, for the sake of the argument), maintaining the three shares of life (young, adult and senior) at their preferred values (25, 50 and 25 %, respectively). Every year, once the threshold ages are known, the share of population to be considered young, adult and senior will be identified. In parallel, the



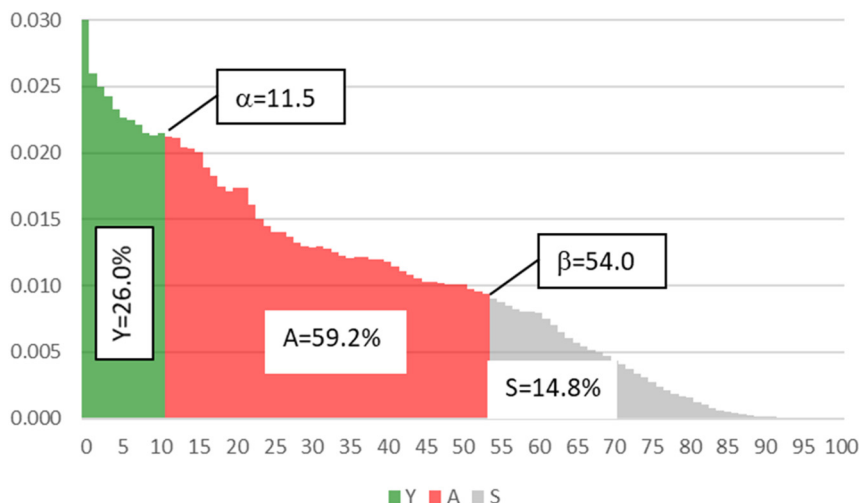


**Figure 1:** Years of life lived and population by age, % distribution, Italy, 1900, 1950, 2000, 2020. Panel (a)  $z^*$  (% distribution of years of life lived), Panel (b):  $z_x$  (% distribution of population by age). Note: LE = life expectancy at birth. Source: HMD and Istat (for 2020).

economic part of the story requires that the average pension (and, if they are introduced, child benefits) be pegged to the economic numeraire of the system at a given, socially preferred relative level. Let us assume, for the sake of the argument that the average pension is set at 70 % of the numeraire, while child benefits are 0 % (i.e. non-existing). The numeraire is the net average labour income of the adults, a novel economic variable that depends positively on employment and labour productivity, and negatively on the contribution rate. Given population shares and



**Figure 2:** Years of life lived, threshold ages  $\alpha$  and  $\beta$ , and average shares of life spent as a young  $Y^*$ , as an adult  $A^*$  and as a senior  $S^*$ . Italy, 1900 (when life expectancy at birth was 41.9 years). Source: HMD and author's calculations (assuming that  $Y^* = S^* = 20\%$  – policy choices).



**Figure 3:** Threshold ages  $\alpha$  and  $\beta$ , and relative weight of the young  $Y$ , adult  $A$  and senior  $S$  population. Italy, 1900 (when life expectancy at birth was 41.9 years). Source: HMD and author's calculations (assuming that  $Y^* = S^* = 20\%$  – policy choices).

relative generosity towards the retirees (70 % in this example), the contribution rate can be computed, and therefore also the net average labour income of the adults (numeraire), and, next, the average pension (70 % of the numeraire). Individual pensions are then treated as deviations from the mean, and these deviations are a weighted average of the two factors mentioned earlier. The former is “merit”, in the form of past contributions to the pension system; the latter is redistribution, from rich to poor pensioners. The weights reflect the relative importance that society explicitly attributes to actuarial equity and redistribution, respectively.

Note that pensions are never re-evaluated, as it usually happens in most, if not all, existing systems, where the initial value is known, and needs to be adapted over time to changing conditions (e.g. inflation). With IPAYGO, all pensions are (automatically) recalculated each year, and are rescaled so that, while “merit” and redistribution preserve their constant, socially preferred weight, the resulting average pension is at the exact level that society has decided to pay (70 % of the numeraire, in this example), and can afford to pay, given the current demo-economic situation.

All this, of course, requires flexibility in several dimensions: for instance, the system is not defined contribution, because future contribution rates will vary from year to year, even if their average value can be determined beforehand. Neither is the system a defined-benefit one: in monetary terms, future pensions will vary from

year to year, each time reflecting the elements that society has defined as important (past contributions, actuarial equity, redistribution) and producing an average which is precisely the desired one (70 % of the numeraire, in this example) and is consistent with the total labour income of the future.

How all this translates into practical arrangements is shown in the next section. More discussion and details can be found in Section 3.3.

### 3.2 How the System Works

The proposed system (IPAYGO: improved pay-as-you-go), of which I will present only the most basic version, distinguishes between three types of variables:

- *Policy choices*, which translate into parameters in the 0–1 range. Five of them are essential, and we will start by imagining them constant, for the sake of simplicity. Changing them is possible, but has its downsides (Section 5).
- *Exogenous variables*, varying over time, of which five are the most important.
- *Endogenous variables*, time-dependent and determined by the joint action of the policy choices and the exogenous variables mentioned above. I will focus on 14 of them.

The five policy variables that must be collectively agreed upon are:

- (1 and 2) The *proportions* of life that the average individual spends as a young  $Y^*$  and as an old person (or senior)  $S^*$ . What remains, of course, is the average proportion of life spent as an adult  $A^* = 1 - Y^* - S^*$ ;
- (3 and 4) The *relative* amount of resources that the system transfers to the young  $y$  (=ratio between average child benefit and average net adult labour earning) and to seniors  $s$  (=ratio between average pension benefit and average net adult labour earning);
- (5) The *relative* importance attributed to actuarial equity ( $Q$ ) and redistribution ( $1 - Q$ ) in the transfer system.

The five exogenous, time-varying variables are:

- (a) Survival conditions. In practice, these are represented by the  $L_{x,t}$  series (years of life lived) of the latest available life table, of which we will consider the relative values  $z_{x,t}^* = \frac{L_{x,t}}{T_{0,t}}$ , (where  $T_{0,t} = \sum_x L_{x,t}$ );
- (b) The population age structure  $z_{x,t} = \frac{I_{x,t}}{I_t}$ , i.e. the relative weight of persons (inhabitants) of age  $x$ ,  $I_{x,t}$ , of whom there are  $I_t$  in total;
- (c) The employed  $E_t$  (absolute number)
- (d) The average gross labour earning of the employed  $W_{e,t}$ ;

- (e) The virtual capital of each of the seniors  $S$ ,  $\mathbf{K}_{s,t}$  (a vector). This is conceptually the same as in equation (1), although in practice it is probably preferable to calculate each senior's virtual capital as a "points system", as suggested, among others, in Schokkaert et al. (2020) (see Appendix C). An important difference, however, is that while in NDC or Schokkaert et al. (2020)'s points system this figure is needed only once, *at* retirement, in IPAYGO all virtual capitals need to be recalculated every year, along with their average  $K_t = \frac{\sum K_{s,t}}{S}$ .

Based on these ( $5 + 5 =$ ) 10 variables, or parameters, all the dependent variables can be determined. Not all of them can be expressed with a formula: four derive from a manipulation of the two series  $z_{x,t}^* = \frac{L_{x,t}}{T_{0,t}}$ , and  $z_{x,t} = \frac{I_{x,t}}{I_t}$ , which form empirically. Figure 1 displays these series in selected years for Italy, one of the first countries to introduce NDC, back in 1996.

For instance, let us assume that the first two policy choices are  $Y^* = 20\%$  (average share of life spent as a young),  $S^* = 20\%$  (average share of life spent as a senior), and therefore  $A^* = 60\%$  (average share of life spent in adulthood), and let us focus on year 1900. Working on the  $L_{x,1900}$  (or, in relative terms,  $z_{x,1990}^*$ ) series (Figure 1a), the threshold ages  $\alpha$  and  $\beta$  (separating, respectively, the young years from the adult ones, and these from the old ones) can be determined in such a way that the proportions  $Y^*$  and  $S^*$  turn out to be exactly the desired ones, as in Figure 2.

These threshold ages  $\alpha_t$  and  $\beta_t$ , derived from the stationary population of year  $t$  ( $t = 1900$  in this case), must then be applied to the *current* age structure of year  $t$ , to derive the shares of young  $Y_t$ , adult  $A_t$  and seniors  $S_t$  in the population, as in Figure 3.

Once the proportions  $Y_t$ ,  $A_t$  and  $S_t$  are known (dependent variables), and policy decisions have been taken on how *relatively* generous the system is towards its seniors (relative value of pension benefits  $s$ ) and its young (relative value of child benefits  $y$ ), two more dependent variables can be computed (see Appendix A for the details). These are the current (time-varying) contribution rate

$$c_t = \frac{s \cdot S_t + y \cdot Y_t}{A_t + s \cdot S_t + y \cdot Y_t} \quad (3)$$

and the *reference* (constant) contribution rate

$$c^* = \frac{s \cdot S^* + y \cdot Y^*}{A^* + s \cdot S^* + y \cdot Y^*} \quad (4)$$

The latter, which can be proven to be the long-term average of  $c_t$  (De Santis and Salinari 2023, 2024), helps policy makers take sensible policy decisions on  $Y^*$ ,  $S^*$ ,  $y$ , and  $s$ . In practice, equation (4) says that policy makers implicitly determine the "normal" (average) level of the contribution rate  $c^*$  when they decide the socially

**Table 2:** Life expectancy at birth, threshold ages and shares of young, adult and senior population if  $Y^* = S^* = 20\%$  and  $A^* = 60\%$  (example referred to Italy, 1900–2020).

	1900	1950	2000	2020
Life expectancy at birth (years)	41.9	65.7	79.6	82.0
$\alpha$ (years)	11.5	14.3	16.0	16.5
$\beta$ (years)	54.0	60.0	65.5	67.0
$Y$	27.1 %	25.4 %	15.3 %	14.4 %
$A$	58.0 %	62.5 %	67.1 %	65.8 %
$S$	14.9 %	12.0 %	17.6 %	19.8 %

Source: HMD, Istat (for 2020) and author’s calculations.

preferred values for  $Y^*$ ,  $S^*$ ,  $y$ , and  $s$ . However, the actual contribution rate, in equation (3), will normally differ from its target value  $c^*$ , because of the irregularities in the population age structure in year  $t$ . By the way, this implies that  $c^*$  can also serve as a benchmark to assess whether the current level of  $c_t$  is relatively high or low, meaning higher or lower than its long-term average. Note that  $c_t$  increases when the population ages because of low fertility, but not when survival improves, because this change is automatically neutralized by an increase in the threshold ages  $\alpha$  and  $\beta$ , if  $Y^*$  and  $S^*$  must remain constant (for an example, see Table 2; for a possible exception, see Section 5.1).

The ratio between the employed  $E_t$  (exogenous variable) and the adults ( $A_t \cdot I_t$ ) (dependent variable, an absolute number) gives the employment rate  $e_t$

$$e_t = \frac{E_t}{A_t \cdot I_t} \tag{5}$$

Although varying over time, this rate is usually not far from 2/3 (e.g. Goodhart and Pradhan 2020). When multiplied by the average gross labour earning of the employed  $W_{e,t}$ , it gives the average gross labour earning of the *adult* population  $W_{a,t}$ , which is not only another dependent variable, but also, to the best of my knowledge, a new concept in this (or any other) field, the utility of which will emerge shortly

$$W_{a,t} = e_t \cdot W_{e,t} \tag{6}$$

As the current contribution rate  $c_t$  is known from equation (3), the net average labour earning of the adult population  $N_{a,t}$  is

$$N_{a,t} = (1 - c_t)W_{a,t} = (1 - c_t)e_t \cdot W_{e,t} \tag{7}$$

This additional dependent variable is the *economic numeraire* of the system, to which the average pension  $P_t$  and the (unique) child benefit  $B_t$  are pegged, through the policy parameters  $s$  and  $y$  respectively

$$P_t = s \cdot N_{a,t} \quad (8)$$

$$B_t = y \cdot N_{a,t} \quad (9)$$

Note that both (8) and (9) define the average value of *all* transfer benefits of year  $t$ , not just those that are *first* paid in year  $t$ . While  $B_t$  is the same for every young person (and can be zero, if  $y = 0$ ), individual pension benefits vary, depending on past contributions, represented by each senior's virtual capital  $K_{s,t}$ , with average  $K_t$ . Individual pensions will be paid according to the following formula

$$P_{s,t} = Q P_t \frac{K_{s,t}}{K_t} + (1 - Q) P_t \quad (10)$$

where  $Q$  is the policy parameter that regulates the relative importance of actuarial equity in the system. This formula satisfies two basic requirements:

- (a) the average of all pensions  $P_{s,t}$  is exactly the quantity  $P_t$  of equation (8), thus granting budget balance in every year  $t$  and system viability in all possible demo-economic scenarios (see Appendix A), and
- (b) individual pensions reflect the exact degree of actuarial equity  $Q$  and redistribution  $(1 - Q)$  that society prefers. When  $Q = 0$ ,  $P_{s,t} = P_t$ : all pensions are the same, regardless of past contributions (so-called *Beveridgean* corner solution). Conversely, when  $Q = 1$ ,  $\frac{P_{s,t}}{P_t} = \frac{K_{s,t}}{K_t}$ : individual pensions are proportional to the *relative* value of individual virtual capitals (full actuarial equity, or *Bismarckian* corner solution). For instance: imagine a senior whose virtual capital, based on past contributions, is twice as high as the average, so that  $K_{s,t}/K_t = 2$ . This senior's pension will be twice as high as the average pension of the time. Intermediate solutions are possible, and arguably preferable: they depend on the policy choice  $Q$  ( $0 < Q < 1$ ), which determines also the minimum pension  $P_{\min,t} = (1 - Q) P_t$ . Imagine for instance that  $Q = 0.75$ . The senior we exemplified before (with  $K_{s,t}/K_t = 2$ ), will now benefit from a pension which is 1.75 times as high as the average, losing something to the advantage of poorer seniors, because of the  $(1 - Q) = 25\%$  redistributive component of the policy mix. The final result is similar to what Holzmann et al. (2017) call two-tier system, but with two main differences: the approach suggested here is simpler and the redistribution that it introduces is not necessarily aimed only at compensating for inequalities in survival between population subgroups.

Table 1 reports and classifies all the variables (or parameters) of the system, highlighting their “nature” (columns) and when (at what “step”, or row) they come into play.

### 3.3 Philosophy of IPAYGO Systems: Separating Viability from Optimization

Understanding the rationale of IPAYGO may not be easy, in part because of the originality of the approach, and in part because, depending on policy choices, it can take very different configurations, with early or late retirement, high or low average benefits, prevalence of redistribution or actuarial equity, inclusion or exclusion of child benefits, etc. The important point, however, is that, regardless of these choices, the system is viable, meaning that it can last forever, in all possible economic or demographic scenarios, without the *need* to change the rules of the game, although the possibility of changing them is always open. It also means that forecasts, either economic or demographic, become superfluous. More precisely: they are helpful for the selection of the best policy parameters, but the system will work as desired (maintaining budget balance at the preferred level of cross-sectional equity, for instance) regardless of what the future holds.

In this paper, I will not discuss the question of how to choose the best set of policy parameters, skipping issues such as optimization and welfare maximisation. This does not mean that they are not important. It simply means that my intent here is to prove that the IPAYGO system is viable, and that optimization should arguably be searched only within this general scheme, or, at least, within a scheme of this type. In the same vein, I will not discuss how to transition from an existing pension arrangement to the preferred version of IPAYGO or how to adjust the set of policy parameters over time, if preferences change.

As mentioned, IPAYGO is all about relative positions (promises, entitlements, and the like), both in demographic and economic terms. This introduces automatic “risk sharing” into the system, of the type suggested by Musgrave (1981) and many more after him (e.g. Gonnot, Keilman, and Prinz 1995; Schokkaert et al. 2020): if things improve, for instance because of higher labour productivity or labour market participation, all relevant actors (young, adults and seniors) are better off, in the same proportion. Vice versa, if things deteriorate, e.g. because of population ageing, everybody is equally worse off. In all cases, the vagaries of the future, either in economic or demographic terms, will not affect only specific subpopulations: they will benefit or harm everybody, in the same proportion.

The relative position on the economic ladder of all relevant actors (young, adults and seniors) is defined in relation to  $N_{a,t}$  (equation (7)), which is the economic point of reference, or numeraire, of the system, because it encompasses all that may possibly affect the economic performance of a society or, more precisely, of the part of it that refers to the labour market.  $N_{a,t}$  is the product of three factors: the employment rate  $e_t$  and the average gross labour earning  $W_{e,t}$  (equation (6)) focus on the economic part

of the story, while the third factor  $(1 - c_t)$  reflects both the demographic situation (population ageing) and policy choices on the generosity of the system towards the age-dependent sub-populations,  $Y$  and  $S$ .

Note that this is similar to, but different from, the rule of intergenerational fairness proposed by Musgrave (1981) and, as far as I know, by all of his epigones. Using my symbols, Musgrave's rule requires constancy in the  $P_t/N_{e,t}$  ratio (average pension over average net labour earning), whereas with IPAYGO what remains constant is  $s = P_t/N_{a,t}$  (average pension over average net labour earning of the adults; eq. (8)). The two are not the same, because  $N_{a,t}/N_{e,t} = e_t$  (employment rate,  $E_t/A_t$ ), which is considerably smaller than 1 (about two thirds) and variable over time. Besides, with IPAYGO the idea of preserving relative economic standing extends to child benefits (eq. (9)).

Nothing can undermine the viability of IPAYGO. Price variations, for instance, inflate all monetary variables in the same proportion, including wages and transfers, and prove neutral. When unemployment and participation rates vary, the employment rate  $e_t$  moves accordingly and timely. Labour productivity and wages may well change over time, but as soon as  $W_{e,t}$  varies, so does  $N_{a,t}$  in the same direction and proportion (eq. (7)).

As for the demographic part of the story, population ageing may have but two causes. One is low fertility or, much less important, emigration of the young, or any combination of the two. This transforms into a higher contribution rate  $c_t$  (eq. (3)) which causes a proportionally identical reduction in both  $N_{a,t}$  and  $P_t$  (and  $B_t$ , if they exist), so that everybody is equally worse off. While not an ideal outcome, this is the spirit of risk sharing, and is arguably better than letting the cost of ageing “from below” fall on just a few selected segments of society.

Conversely, for the part of ageing that depends on longer survival (“from above”, as it is sometimes called), IPAYGO leads to an immediate adjustment of the threshold ages  $\alpha$  and  $\beta$ , leaving all the rest unaffected. In practice, the “everything-is-relative” principle is applied also to the length of life, the future variations of which are unknown, both by amount and direction. Until recently, even the best demographers have systematically underestimated survival progress (Castiglioni, Dalla-Zuanna, and Tanturri 2020); the COVID-19 pandemic and the Russia-Ukraine war, instead, remind us that survival progress is not guaranteed. While we ignore what the future holds, we can agree on certain *proportions* of life to be spent in the three basic, socially defined states envisaged by the system: young, adult and old (senior). This can be done using the latest cross sectional life table (or, better, an average of a few of the latest life tables, to smooth changes) as an approximation of the “normal” duration of life in that context (country and period) (De Santis and Salinari 2023, 2024).



Past age  $\beta$ , or before age  $\alpha$ , working is not prohibited or discouraged: for instance, working seniors will benefit from two sources of income: their labour earning *and* their pension benefit. Note that labour earning is not “taxed” differently depending on age: in all cases, the employed will contribute a fraction  $c_t$  of their gross labour income, and their future pensions will increase correspondingly, along with their individual virtual capital  $K_s$ .

Explicit child benefits are not generally introduced, or even considered, in pension systems, despite the indications of some economists: e.g. Cigno and Werding (2007), Fenge and von Weizsäcker (2010), Fenge and Scheubel (2017). However, they exist in most modern welfare systems and in several cases they are implicit in pension systems, e.g. in the form of extra pension benefits (or earlier retirement) granted to parents (see e.g. Bonnet and Rapoport 2020, for the French case), or special points that can be attributed in points-based pension systems (Schokkaert et al. 2020).

IPAYGO, instead, introduces child benefits explicitly. While these could be set to zero ( $y = 0$ ), there are some good reasons to include them (with  $y > 0$ ) and therefore set up a truly intergenerational transfer system. In no case are these (possible) child benefits intended to substitute other, arguably stronger, pro-natalist policies that governments may want to adopt, financed through general taxation. The possible introduction of child benefits within IPAYGO serves only the purposes of the pension system itself, in five ways: (a) reduction of quasi-capital gains and losses; (b) contrast to the implicit fertility-discouraging effect of all credible pension systems; (c) redistribution; (d) consistency; (e) stabilization of  $c_t$ . Let us briefly examine each of them.

- a. We have already discussed quasi-capital gains and losses (equation (2)). If the system transfers resources also to children, and not only to seniors, the average age at receiving benefits declines, and so do  $\Delta$ age and quasi-capital gains and losses. The economic effects of demographic variations are correspondingly attenuated.
- b. Children are costly, but they are also an asset in one’s old age, and this is one of the reasons that keep fertility high in developing countries (see Rossi and Godard 2019 for a recent application of this old notion). When alternative forms of economic support in old age are available, such as a good pension system, fertility is correspondingly discouraged. Child benefits may therefore be a useful element in a pension system, to counter its own fertility-depressing effects.
- c. Contributions are paid in proportion to labour income, but child benefits are the same for all children, in rich and poor families. In other words, child benefits are redistributive by nature and this feature can be used, together with  $(1 - Q)$ , to fine-tune the degree of redistribution of IPAYGO.
- d. The ultimate reason why pensions exist at all is that there is an age  $\beta$  (e.g. 67 years) beyond which it is considered socially acceptable, or even natural, not to have an occupation, and yet be entitled to some resources. The same logic can

- be applied to the young, who, up to a certain age  $a$  (e.g. 16 years), are not expected to work, but who nonetheless need resources to survive. Looking at things longitudinally (although the system works cross-sectionally), if  $y > 0$ , consumption smoothing in IPAYGO works also “backwards”: the system lends resources to young beneficiaries, who will repay their debt later on, with contributions taken from their future labour earnings.
- e. The equilibrium contribution rate  $c_t$  varies over time. However, its variability is lower when child benefits are present and both terms in the numerator of equation (3) play a role, because they tend to move in opposite directions (when  $S$  increases  $Y$  typically diminishes), which stabilizes  $c_t$ : see Table 3 for an example.

## 4 Comparing NDC to IPAYGO

Several scholars (e.g. Gurtovaya and Nisticò 2018, 2019; Holzmann 2006, 2017) consider notional defined contribution systems the best possible PAYGO pension arrangement, for two main reasons:

- they mimic funded systems, but do not need to accumulate a large capital (strictly speaking, they need no capital at all, as they work on a PAYGO basis), and
- they ensure actuarial fairness, creating a close correspondence between past payments and future benefits, thus reducing the incentive to evade contributions (e.g. working in the underground economy), or retire too early.

An ancillary advantage is that NDC can start paying pensions at various ages, adjusting benefits in such a way as to be actuarially neutral: longer working careers are not discouraged, and individuals are free to retire almost when they please. Finally, NDC is relatively easy to introduce, if a different type of PAYGO pension system is already in existence.

**Table 3:** Reference and actual contribution rate in two scenarios, with different policy choices regarding cross-sectional equity ( $y$  and  $s$ ) (example referred to Italy, 1900–2020).

	1900	1950	2000	2020	Std. dev. of $c_t$
<i>Scenario (A) <math>y = 0</math>; <math>s = 0.8</math></i>					
$c^*$	21.05 %	21.05 %	21.05 %	21.05 %	
$c_t$	17.04 %	13.34 %	17.36 %	19.39 %	2.18 %
<i>Scenario (B) <math>y = 0.2</math>; <math>s = 0.6</math></i>					
$c^*$	21.05 %	21.05 %	21.05 %	21.05 %	
$c_t$	19.83 %	17.02 %	18.51 %	19.74 %	1.14 %

This is a prosecution of the example of Table 2.  $y$ ,  $s$ , relative value of child benefits and pensions, respectively;  $c^*$ , reference contribution rate;  $c_t$ , current contribution rate.

All these advantages apply also to the proposed IPAYGO system, which, on top of this, does not suffer from the four main shortcomings of NDC listed at the end of Section 2. Let us see why.

- (A) With IPAYGO, revenues and outlays are identical, by construction (see eq. A.1 in Appendix A), because the time-varying contribution rate  $c_t$  adapts automatically to the current demographic situation, increasing in line with the share of the “relevant” dependent population (i.e. the old and, if child benefits are included, the young). The effects of these demographic variations on the contribution rate  $c_t$  are discussed in Section 5. As budget balance is always guaranteed on a yearly basis, the system is viable by construction, and never *needs* to be changed, although modifications are possible (see Section 5). Besides:
- (i) Quasi-capital gains and losses can be drastically reduced with the introduction of child benefits and the corresponding reduction of  $\Delta \text{age}$  in equation (2).
  - (ii) Life tables are no longer an issue, together with the never-ending debate on which to use, cross-sectional (readily available, but not necessarily representative of what will happen to cohorts) or longitudinal (which need to be projected, with errors, because the true ones will be known only when the corresponding birth cohorts are extinct). IPAYGO uses only observed, cross-sectional life tables, but updates them every year, each time adjusting threshold ages, and, consequently, population shares and contribution rates.
  - (iii) Interest rates do not need to enter the picture explicitly, because IPAYGO may calculate individual virtual capital  $K_s$  with a “points system” (see Appendix C). Of course, an implicit interest rate is applied (see Appendix C), but the points system method suggested in the appendix makes things simpler and more transparent. The important element, however, is that errors in the choice of the interest rate are possible (and the countries that use NDC adopt different criteria: see e.g. De Wouter and Boulhol 2021). These errors may undermine the budget balance and therefore the long-term viability of NDCs, but they are neutral in IPAYGO, where the average pension  $P$  is calculated *before* individual pensions  $P_s$ . In the worst case, individual pensions will not be exactly as they should be (some being higher and some lower than it would be “fair”), but their predetermined average  $P$  will remain the same.
  - (iv) Re-evaluation criteria (e.g. based on inflation or wages) are never needed. Individual pensions are determined each year  $t$  with equation (8), and not as a modification of the value they had before. Incidentally, this also leads to the disappearance of “vintage” pensions, i.e. pensions originally

sufficient to grant a decent standard of living, but progressively less so, because of inadequate, or non-existent, re-evaluation.

- (B) Apart from the redistributive effects of child benefits, actuarial equity can be perfect (if  $Q = 1$ ), totally absent (if  $Q = 0$ ), or anywhere in between (if  $0 < Q < 1$ ). Within IPAYGO, this policy choice is explicit and fully transparent.
- (C) Cross-sectional equity (i.e. a reasonable and socially accepted ratio between the average incomes of the three age groups: young, adults and seniors) is a relevant socio-economic aspect that no other pension system, to the best of my knowledge, explicitly keeps under control (not *ex ante*, at least). IPAYGO does, with the parameters  $s$  and  $y$  (*relative* benefits accruing to seniors and the young, respectively). Cross-sectional equity will always stay at the socially preferred level, in all economic and demographic scenarios.
- (D) The rich live longer than the poor, and this leads to anti-distributive effects in all pension systems based on pure actuarial equity (see, e.g. Haan, Kemptner and Lüthen 2020; Holzmann et al. 2017; Sanchez-Romero, Lee and Prskawetz 2020). With IPAYGO, however, redistribution can be integrated into the system, and “fine-tuned” to attenuate or even reverse this effect: with  $Q < 1$ ,  $y > 0$  or a combination of the two.
- (E) NDC has nothing to say about the evolution of the standard (or minimum) retirement age  $\beta_t$ , although, of course, *ad-hoc* solutions can be, and actually are, proposed. Conversely, IPAYGO offers a natural solution: it suggests (but does not impose) that both  $\alpha_t$  and  $\beta_t$  evolve in such a way that the policy choices  $Y^*$  and  $S^*$  (and therefore also  $A^*$ ) remain constant over time (more on this in Section 5.1).

## 5 Details and a Few Possible Variants of IPAYGO

### 5.1 On the Evolution of $\alpha$ and $\beta$ (Threshold Ages) over Time

In the basic variant of IPAYGO, the threshold ages  $\alpha_t$  and  $\beta_t$  “follow” survival in such a way that the average shares of life spent in the three states (young, adult and old/senior;  $Y^*$ ,  $A^*$  and  $S^*$ , respectively) remain those preferred by society. For instance, in the case of Italy, assuming that the initial policy choices were  $Y^* = S^* = 20\%$  (and therefore  $A^* = 60\%$ ) and assuming no change in this respect in the past 120 years, threshold ages should have evolved as shown in Table 2:  $\alpha$  from 11.5 to 16.5 years, and  $\beta$  (retirement age) from 54 to 67 years. Admittedly, these are large variations, but they are consistent with the even larger increase in life expectancy in the period, from 41.9 years to 82.0 years.

Note that that nothing is projected, or forecasted, in this table or in the entire IPAYGO system: all its dependent variables ( $\alpha_t$ ,  $\beta_t$ ,  $Y_t$ ,  $A_t$ , and  $S_t$ , in this case) derive

from the interplay of policy choices ( $Y^*$  and  $S^*$ ) and observed independent variables (cross sectional life tables and population by age), and all adjustments are automatic.

Note also that  $Y_t \neq Y^*$ ,  $A_t \neq A^*$  and  $S_t \neq S^*$ . This happens because the reference values, with an asterisk, are constant (and very close to the long-term average of their corresponding current values; De Santis and Salinari 2023, 2024), while the corresponding current variables change every year. The distance between the two increases in turbulent historical periods (demographic transition, very low fertility nowadays, etc.), but it remains relatively small in all cases, and declines once these turbulences are over.

Several objections may be raised at this point. One, for instance, is that relying on a single cross-sectional life table may lead to large “jumps” in the threshold ages. Theoretically correct, this objection is not very compelling in practice, because life tables change very slowly in all developed countries. However, smoothing mechanisms can be introduced, e.g. a moving average of life tables over the past three or five years.

Another possible objection is that there is no need to adjust both  $\alpha_t$  and  $\beta_t$ : it may suffice to let only the latter vary ( $\beta_t$ , the retirement age), which, incidentally, would contribute to reduce its increase, when  $e_0$  improves. While this is a perfectly acceptable alternative policy choice, it is logically weaker and historically inconsistent. Logically, because if the collectively preferred shares of life in the three states ( $Y^*$ ,  $A^*$  and  $S^*$ ) are independent of  $e_0$ , variations in  $e_0$  should not affect them. If, instead, these policy choices depend on  $e_0$ , this relation should be made explicit, and the ensuing rule applied. Historically, this decision appears to be inconsistent because, with the expansion of the average length of life, the young have prolonged their education and delayed their entry into the labour market, and, incidentally, they have done so by much more than the increase in  $\alpha_t$  in Table 2.

Another possible objection is that people dislike uncertainty, while the proposed arrangement apparently introduces a lot of it. For any given senior, for example, pensions  $P_{s,t}$  may vary from year to year, depending on  $N_{a,t}$  and  $K_t$ , even if the senior's personal virtual capital  $K_{s,t}$  has not changed (equations (8) and (10)). Similarly,  $\beta_t$ , the retirement age, evolves over time in a way that individuals are probably incapable to predict. For instance, with reference to Table 2, young workers entering the Italian labour market in 1950 (e.g., at 10 years, which was possible back then) may well plan to retire at 60 years (which was correct, by the standards of 1950), but in fact, when they reach 60 years of age, in 2000, they find that the retirement age has been postponed to  $\beta_{2000} = 65.5$  years.

The objection is, however, miss-directed. Uncertainty is in the nature of things, both in the economic and in the demographic sphere. IPAYGO keeps uncertainty under control as much as possible, with a series of automatic adjusting mechanisms that immediately spread the effects of unforeseen changes to all society. For instance,

it is true that the face value of both  $P_{s,t}$  and  $\beta_t$  changes over time, but it is precisely these formal variations that preserve the substantive sense of the original choices: pensions will move in line with the general economic wellbeing of society, as measured by  $N_{a,t}$ , and the standard retirement age will adapt to the new, and constantly evolving, survival conditions (see also Appendix B).

## 5.2 On the Variability of the Contribution Rate $c_t$

Budget balance is always guaranteed in IPAYGO because the contribution rate adjusts automatically to the demographic situation, preserving the socially preferred cross-sectional equity (constant  $y$  and  $s$ ). It may be objected that this creates uncertainty on the cost of labour, and may therefore negatively affect the functioning of the labour market. While this is true, of course, equation (3) shows that an increase in the contribution rate  $c_t$ , given  $y$  and  $s$  (cross-sectional equity) merely reflects a worsening of the demographic situation, typically population ageing. *This* is what makes society worse off, and if the corresponding costs were not made explicit (through higher  $c_t$ ) they would manifest themselves in other forms, e.g. through greater public debt or higher taxes.

As the contribution rate varies over time, it is theoretically possible to estimate its long-term average (very close to  $c^*$ ; De Santis and Salinari 2023, 2024) and impose that constant contribution rate, instead of the varying one  $c_t$ . This creates a reserve fund that expands in demographically favourable periods and shrinks in others, with surpluses and deficits that should roughly cancel out the long run. This, incidentally, is what happens in almost all actual pension systems, where both the contribution rate and the rules that lead to the formation of pensions benefits are constant – at least as long as the pension debt remains manageable.

As with existing pension systems, this solution (constant  $c^*$  instead of varying  $c_t$ ) has two main downsides. The first is that the real long-term average of  $c_t$  is unknown *a-priori*: it will emerge only several years later, when it is too late to correct past mistakes. The second, and more important, is that even if the exact value for this average is chosen (very close to  $c^*$ ), demographic imbalances may be strong and long lasting, because of demographic inertia. As the sums involved in the pension game are large, even small relative imbalances are sizeable in relation to the GDP of any country, and if these imbalances persist for several decades, as it usually happens, the corresponding debt (or accumulated capital) rapidly becomes unmanageable.

An illustrative example of the variability of the contribution rate is shown in Table 3, where, for the sake of the argument, the case of Table 2 is developed into two possible scenarios of cross-sectional equity. In scenario A, child benefits are excluded ( $y = 0$ ) and transfers towards the elderly are generous ( $s = 0.8$ ). In scenario B, child

benefits are envisaged ( $y = 0.2$ ), but transfers towards the elderly are reduced ( $s = 0.6$ ), so that the reference contribution rate remains the same ( $c^* = 21.05\%$ ). Over time, the actual (equilibrium) contribution rate  $c_t$  varies. In periods of demographic bonus (favourable age structure, with a high share of the adult population),  $c_t$  is below its reference value  $c^*$ , even largely below it (e.g.  $c_{1950} = 13.34\%$  without child benefits;  $c_{1950} = 17.02\%$  with child benefits). Notice that this favourable period has lasted for more than a century, but is practically over nowadays and, according to all demographic forecasts, will be followed by an (almost) equally long period of demographic “malus”, with  $c_t > c^*$ .

This tells us two things. The first is that the comparison between  $c_t$  and  $c^*$  indicates how good (or bad) the demographic phase is, or, in other words, that IPAYGO offers an original metric for measuring the existence and the strength of the “demographic window of opportunity”. The second is that  $c_t$  varies over time, but much less so when child benefits are included: in Table 3, for instance, the standard deviation of  $c_t$  is about half as large in the latter case (1.1 against 2.2). This happens because, while the relative share of the adult population tends to remain approximately constant,  $Y_t$  and  $S_t$  (shares of young and seniors, respectively) may vary considerably, but they typically do so in opposite directions. If non-trivial child benefits are included in the intergenerational transfer system, the variability of the equilibrium contribution rate diminishes substantially.

### 5.3 Varying Policy Choices?

With IPAYGO, well-pondered policy choices may remain unaltered forever: the system is auto regulating, always in equilibrium, with outlays equalling contributions. Besides, it will always preserve its initial, socially preferred characteristics, in terms of shares of life spent in the three states ( $Y^*$ ,  $A^*$  and  $S^*$ ), cross-sectional equity ( $y$  and  $s$ ), and balance between actuarial equity and redistribution (joint action of  $y$  and  $Q$ ). In other words, changes are never needed and the “political risk” (Barr 2002) is minimized.

Change is possible, of course, but it has its downsides, in the sense indicated by Auerbach, Gokhale, and Kotlikoff (1994). Although the system is organized on a PAYGO basis (i.e. it works cross-sectionally), it has cohort implications. Simulations (not shown here) indicate that the IPAYGO system works well also by cohorts: it tends to guarantee intergenerational equity. When this is impossible, because of quasi-capital gains or losses, the system spreads these imbalances across cohorts at least as well (meaning “as much”) as other popular arrangements (e.g. NDC), and markedly better than its alternatives when non-trivial child benefits are introduced.

However, these nice properties are no longer guaranteed when there is a change of rules. Here, intergenerational consequences may be large or small, depending on the extent of the change and on the length of the implementation phase: the slower it is, the more dispersed across several birth cohorts economic gains or losses will be. In all cases, these changes are never neutral, and the typical consequence is that some birth cohorts gain (usually, those who vote now), at the expense of others (usually those who will vote in the future).

In short: changes in pension rules should always be considered with suspicion and introduced with extreme caution. The fact that IPAYGO never *needs* them confers this system a great advantage over its competitors.

#### 5.4 What If Exogenous Variables are in Fact Endogenous, and Is IPAYGO Consistent with Welfare Maximisation?

The proposed definition of exogenous variables is, admittedly, questionable. Pension systems exert their effects on a series of economic and demographic behaviours, and among these are some of the variables classified as independent in Table 1: for instance, earlier or later retirement and propensity to work in the underground sector, evading contributions. Fertility and migration may also be affected by policy decisions, including those that shape the pension system.

These considerations, however, apply to *any* pension system, not just IPAYGO, which, contrary to its alternatives, works just as well in all possible demo-economic scenarios. The real question, therefore, is whether a specific pension system provides the right stimuli to maximize welfare, permitting citizens to choose their preferred balance between work and leisure, ideally also favouring private saving, boosting the efficiency of financial markets, stimulating fertility, etc.

Does IPAYGO pass this test? To answer this question, consider that IPAYGO is not just *one* system: it is a set of infinite possible pension systems, each characterized by its own mix of policy choices. Among these, some are “trivial” (think, for instance of  $y = s = 0$ : the pension system simply disappears), and some are patently absurd and inefficient, for instance combining long periods of retirement (high  $S^*$ ), very generous pensions (high  $s$ ), and scarce relevance of actuarial equity (low  $Q$ ).

How to maximize collective welfare, within the range of the possible choices offered by IPAYGO, is something that I do not discuss here. Aside from technicalities, however, readers may note that the proposed pension system appears to be better equipped than its alternatives for this welfare-maximising exercise, because both the set of policy choices (five parameters, ranging between 0 and 1) and the set of consequences (endogenous variables) is relatively small and clearly defined (Table 1).



## 6 Conclusions

Pension systems are complex objects, but they are also an important element of daily life. Therefore, technical aspects, while important, should not become so complex as to hide the basic mechanism of the transfer game, a social construct that affects all citizens in developed, and increasingly so also in developing, countries (Niño-Zarazúa 2019). Everybody should understand at least the rationale of the problem and of the adopted solutions. The latter (policy choices) should be flexible enough to adapt to the varying demographic and economic circumstances of the future, but their variability should also be limited somehow, to minimize the political risk and the destabilizing effects of too frequent or abrupt changes.

Long-term viability is a major issue, and so is the complex interplay of pension systems with other socio-economic mechanisms: participation in the labour market, migration for work reasons, fertility, saving and accumulation of capital ... Resource redistribution, between and within birth cohorts is another non-secondary aspect to consider.

How to strike the best balance between simplicity and proper functioning of a pension system is still an open question, and various theoretical and practical solutions have been proposed over time. The most recent, and possibly the best thus far, is NDC, the notional defined contribution pension system.

However, a further step may be possible, because the IPAYGO (improved pay-as-you-go) pension system presented here is not worse than NDC in any respect, and better than it in several senses: it guarantees budget balance, incorporates the socially preferred degree of redistribution, does not create “vintage pensions”, brings to the fore and keeps under control the most relevant policy variables (five, among which cross-sectional equity), adjusts automatically to all possible economic and demographic changes, and does not require forecasts (or ad-hoc adjustments, expert committees, etc.) of any kind. On top of that, it is simple (as simple as possible, at least), it circumvents a series of obstacles (interest rates, for instance, are much less an issue here than in NDC) and, perhaps most importantly, redistributes fairly among population subgroups (young, adult and old) all the possible future economic or demographic uncertainties, while at the same time minimizing political risks. With an appropriate parametric set (policy choices), it can encourage “virtuous” behaviours, such as higher fertility and participation in the labour market.

Finally, similarly to NDC, IPAYGO can be adopted in a wide variety of forms, depending on parametric choices: it could even become a standard for EU countries (“United in diversity”), each free to select their preferred national form.

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## Appendix A: How IPAYGO Formulae Are Derived

The budget balance of the system requires that

$$E_t W_{e,t} c_t = I_t S_t P_t + I_t Y_t B_t \quad (\text{A.1})$$

Inflows, on the left, are given by the number of the employed ( $E$ ), multiplied by their average labour earning ( $W_e$ ), multiplied by the contribution rate  $c$ . Outlays, on the right, are given by the number of seniors ( $IS$ ) multiplied by their average pension ( $P$ ). If child benefits exists ( $B$ ), they enter the picture, together with the number of young in the population ( $IY$ ). All the variables are time dependent.

Let us define the average labour earning of the adult population as

$$W_{a,t} = e_t \cdot W_{e,t} \quad (\text{A.2})$$

which incorporates both the average labour earning of the employed  $W_e$  and the employment rate  $e$

$$e_t = \frac{E_t}{I_t A_t} \quad (\text{A.3})$$

Equation (A.1) can be rewritten as

$$I_t A_t W_{a,t} c_t = I_t S_t P_t + I_t Y_t B_t \quad (\text{A.4})$$

Or perhaps more clearly as

$$A W_a c = SP + YB \quad (\text{A.5})$$

dropping the subscript  $t$  for the sake of simplicity and dividing both sides by the total population  $I$ , to transform absolute numbers into proportions.

As both pensions  $P$

$$P = sN_a = sW_a(1 - c) \quad (\text{A.6})$$

and child benefits  $B$

$$B = yN_a = yW_a(1 - c) \quad (\text{A.7})$$

are a fixed proportion of the net labour earnings of the adults  $N_a$ , equation (A.5) becomes

$$A W_a c = S s W_a (1 - c) + Y y W_a (1 - c) \quad (\text{A.8})$$

Simplification and reorganization of terms lead to

$$c_t = \frac{s \cdot S_t + y \cdot Y_t}{A_t + s \cdot S_t + y \cdot Y_t} \quad (\text{A.9})$$

which is eq. (3) in the main text.

Every year, individual pensions are paid as weighted averages of two parts

$$P_{s,t} = Q P_t \frac{K_{s,t}}{K_t} + (1 - Q) P_t \quad (\text{A.10})$$

The part on the right, with weight  $(1 - Q)$ , is a constant  $P$ , with average  $P$  (dropping the subscript  $t$ , for the sake of brevity). The part on the left, with weight  $Q$ , is  $P \frac{K_s}{K}$ , the average of which, over IS seniors, is  $P$  (because  $\sum K_s = ISK$ ). Therefore, the average of  $P_s$  is  $P$ , every year.

## Appendix B: A Note on Private Pension Annuities

The issue of the best balance between public (PAYGO) and private (funded) systems still awaits a solution, and IPAYGO only refers to the former. Let me just note, in passing, that in so doing it favours the development of the latter, because it permits (and implicitly encourages) the purchase of a private annuity to cover the “uncertain years”, those between two retirement ages, the current and the future one. For instance, let us refer to Table 2, and to hypothetical young adults who entered the Italian labour market at age 10 in 1950, and planned to retire at 60 years. They may buy the right to do so privately: they start paying a premium in 1950, or any year after 1950, and acquire the right to receive an annuity when they are aged between 60 and  $\beta$  years.  $\beta_{2000}$  is unknown in 1950, and this is where insurance companies step in: when year 2000 arrives, these workers, now aged 60 years, will start to receive their private annuity, which will expire five or six years later, in 2005 or 2006, when they reach 65/66 years (the retirement age of the time), and start to receive their public pension.

The market for “standard” (i.e. lifelong) private annuity is thin and costly, for several reasons, among which the great uncertainty that surrounds the length of individual lives. This uncertainty is increased by self-selection: it is mainly those who have reasons to believe that they will live longer than average who have an interest in such products (Lambregts and Schut 2020). In the case of IPAYGO, instead, self-

selection plays no role, and uncertainty is greatly limited. The unknown variable, life expectancy at birth, is a collective, not an individual one, and it translates into  $\beta$  (age at retirement) only partially. For instance, in Table 2, between 2000 and 2020, life expectancy increases by 2.4 years, but  $\beta$  increases only by 1.5 years.

This arrangement, incidentally, is the answer to another possible objection to IPAYGO: with NDC, workers can retire when they please (past a minimum age, of course), and their pension will be adjusted in an actuarially fair way, following equation (1). Why not introduce this flexibility also in IPAYGO or, conversely, how can IPAYGO be considered better than NDC if this degree of freedom is lost? A closer look at the problem, however, reveals that nothing gets lost with IPAYGO. Pensions start to be paid at age  $\beta$ , but workers can retire at any age. If they retire before age  $\beta$ , the private arrangement illustrated above will help them cover their needs during the “intermediate” years (between retirement and age  $\beta$ ). If they retire later, for some time (the years between  $\beta$  and their own retirement) they will receive a double income, from the labour market ( $W_{s,t}$  on which they will pay pension contributions, remaining with  $N_{s,t}$ ) and from the pension system ( $P_{s,t}$ ).

## Appendix C: Implicit Rate of Return and Points System

While in NDC the choice of the interest rate is a delicate one, because mistakes will affect the apparent value of individual virtual capitals  $K_s$  and may therefore impair the budget balance of the system, with IPAYGO the consequences are limited: a wrong choice will only affect the relative wellbeing of seniors. Some of them will receive more than their due and some less, but, on average, seniors will still be paid their fair amount  $P = sN_a$  and all the rest of the pension system will be unaffected. Besides, mistakes can be avoided, and calculations simplified, using a points system approach.

For every year  $\tau$  in the past, it is possible to compute the ratios  $R_{s,\tau} (= C_{s,\tau}/C_\tau = W_{s,\tau}/W_\tau)$  between individual and average contribution. In practice, past contributions translate into an index number, or “point”, measuring the “relative effort” of each current senior.  $R_{s,\tau} = 1$  characterizes the average adult of year  $\tau$  and, for instance,  $R_{s,\tau} = 2$  signals contributions twice as high as that year’s average. In this case  $K_{s,t} = \sum_\tau R_{s,\tau}$ : in other words, individual virtual capitals become scores, presumably not far from 40, on average, if 40 is the normal length of the working life.

Readers may note, in passing, that points could be based not only on past contributions, but also on “special merits”, such as heavy/dangerous occupations, having children, assisting sick relatives, and the like, as some scholars suggest (e.g.

Schokkaert et al. 2020). I tend to disagree with this approach, and the rationale behind it, because this is a form of deferred payment: the service is provided in year  $t$ , the beneficiaries of year  $t$  do not pay for it, and the cost is transferred to someone else, several years later. Anyway, a discussion about this and other details would be premature at this stage: the important element here is that *any* choice about how pension points are imputed and accumulated, even if sub-optimal, will not affect the viability of the system, because it will not change the value of the average pension  $P$ .

IPAYGO may be understood and implemented ignoring the issue of the rate of interest that is associated with it. However, those who are interested in these aspects will find that the “natural” rate of interest of IPAYGO is the rate of increase of  $N_a$  (here simply  $N$ ), the average net labour income of the adults.

Let us assume that this rate is  $i$  (constant), and that an average adult (a male, in this example) retires in year 0. In the preceding years, the contributions he paid were  $C_{-1}, C_{-2}, \dots$ , with  $C_{-t} = cW_{-t}$  ( $c$  = contribution rate;  $W$  = gross labour income, or wage). As  $N = W(1 - c)$ , then  $C = Nc/(1 - c)$ . If  $i$  is the rate of increase of  $N$ ,  $N_0 = N_{-t}(1 + i)^t$ , and therefore  $N_{-t} = N_0(1 + i)^{-t}$ . However, the “notional” interest to be applied to those contributions, paid  $t$  years ago, is the very  $i$  that governs the system, so that the current value of those contributions is  ${}^0C_{-t} = c/(1 - c) N_0(1 + i)^t(1 + i)^{-t} = c/(1 - c) N_0$ . This applies to all past contributions which, for an average individual, are paid for a share  $A^*$  of his life. So, the current value of all past contributions is

$$\text{Total credits towards the pension system in year 0 : } c/(1 - c)N_0A^* \quad (\text{C.1})$$

In year 0, the average pensioner receives a pension  $P_0 = sN_0$ . In any of the future years  $t$ , the average pension will be  $P_t = sN_t = sN_0(1 + i)^t$ . However, this future benefit, if evaluated in year 0, must be discounted at a rate  $i$ , to become  ${}^0P_t = sN_0(1 + i)^t(1 + i)^{-t} = sN_0$ . The average individual will receive these payments for a share  $S^*$  of his life, and, globally, the current value of all present and future pensions is

$$\text{Total liabilities towards the pension system in year 0 : } sN_0S^* \quad (\text{C.2})$$

The system is balanced if credits equal liabilities, which implies that

$$c/(1 - c)N_0A^* = sN_0S^* \quad (\text{C.3})$$

Simplification and reorganization of terms leads to

$$c^* = \frac{s \cdot S^*}{A^* + s \cdot S^*} \quad (\text{C.4})$$

Which is formula (4), omitting child benefits (but their inclusion along the same lines is straightforward).

Admittedly, this is a simplified version of the problem, assuming that  $c_t = c^*$  for all  $t$ . In fact  $c_t$  varies over time, which complicates matters, but its average values is (very close to)  $c^*$ , because the average values of  $Y_t$ ,  $A_t$  and  $S_t$  are, respectively,  $Y^*$ ,  $A^*$  and  $S^*$  (De Santis and Salinari 2023, 2024).

In all cases, readers should keep in mind that  $i$ , the natural rate of interest of IPAYGO as we have just seen, applies only to the average individual. Because of the joint action of  $y$  (child benefits) and  $(1 - Q)$ , richer-than-average individuals receive in transfers less than “their due” (in actuarially fair terms), because they lose part of their resources to the benefit of the poor. Therefore, for the rich, the implicit rate of return is lower than  $i$ , while for the poor the reverse is true.

Conversely, longer-living individual will receive pensions for more than  $S^*$  of their life, and will therefore benefit from an implicit rate of return higher than  $i$ , to the disadvantage of those who die early. In short, if “high-class” individuals ( $h$ ) live longer than average ( $i_h > i$ ), but are disadvantaged by the redistributive components of the transfer system ( $i_h < i$ ), it becomes theoretically possible to design the policy parameters  $y$  and  $Q$  in such a way that  $i_h \approx i$ , offsetting the implicit pension advantage of richer and longer living subpopulations.

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