emographic changes and unfunded pension systems: Financial aspects

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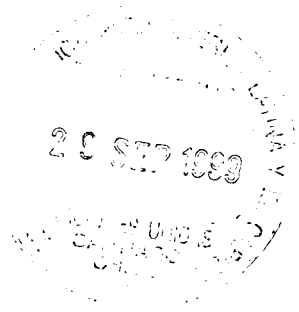

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1. Introduction

The operation and organization of social security systems is being redefined and restructured in many Latin American countries. This process is inscribed in the larger one of the revision of the role of the State, including its economic size and direct responsibility regarding income redistribution. In the particular case of social security systems in the region, the reform movement is also fueled by the current financial problems which, at least in some countries, do not appear to be easily solvable within existing institutional settings.

Two types of policy and technical issues that arise in the discussion of pension systems reform alternatives are the distributive aspects and the financial ones. Distributive issues in the context of unfunded systems have been studied through inter-generational differences in internal rates of return by Keyfitz (1985, 1990), Lapkoff (1985, 1991), Auerbach and Kotlikoff (1987) and others; Rofman (1993) has analyzed intra-generational effects of mortality differentials in greater detail. While most of the empirical applications have referred to U.S. data, there are a few studies of Latin American countries, like those of Arrau (1990, 1991), who has used general equilibrium life-cycle models to study macroeconomic and distributive effects in Mexico and Chile.

This paper focuses on the financial aspects, which are of prime importance for the government agencies which run the systems; financial solvency is a crucial consideration for the viability of the system in the medium to long term, and it is also important in the short run in many Latin American countries where reducing the fiscal deficit and the related objective of macroeconomic stabilization receive high priority. However, little is known about the financial implications of national demographic trends and

related policy interventions. For example, how large an impact will the current and projected population aging have on the system's balance of specific countries in the near future? Can these trends be compensated or reversed by the anticipated variations in labor force participation, or by policy changes, such as increasing the required number of contributing years or the minimum retirement age? Can the systems be financially viable in the long term or are they doomed to insolvency?

These questions are addressed in this paper in the context of unfunded (i.e., "pay-as-you-go" type) systems,[1] in the following order. First, we present the basic notation to be used henceforth. Then analytical derivations are carried out and are used to make estimates of the financial impact of changes in selected variables of interest, such as retirement age, number of contributing years and projected population ageing, using data for selected Latin American countries. Finally, some implications of demographic stationarity are briefly discussed.

2. The model

Unfunded transfer pension systems, where most or all pension tax receipts in each year are used to pay the annual pension bill, are the norm in the Latin American region, and probably worldwide.

Analyses of demographic factors in the context of such schemes generally assume an equilibrium of the system's income (or 'contributions') with respect to expenditures ('pensions'). In reality, this is rarely the case since imbalances occur due to economic fluctuations, changes in minimum pensions, in other

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[1] Possible future extensions of the framework could allow for the consideration of partially or fully funded systems or to allow for the integration of financial and distributive aspects (see Arrau, 1990, 1991, and Blanchet and Kessler, 1991, for two approaches in that regard).

legislation related to the system, or due to changing demographic profiles. In Latin America, some systems originate in early this century and are therefore relatively mature, whereas in other countries they are incipient; even if all systems were actuarially balanced (which is certainly not the case), the systems would show temporary surpluses or deficits depending on their degree of maturity. Therefore, in our set-up, we admit the possibility of temporary financial imbalances.

Let $p_{x,t}$ = labor force participation rate of those aged x at time t, and $N_{x,t}$ = number of people aged x at t. For the present purposes, it will be convenient to write the number of economically active aged x at t as $v_{x,t} = p_{x,t}N_{x,t}$, and to denote the economically inactive as $u_{x,t} = (1-p_{x,t})N_{x,t}$.

Denote $y_{x,t}$ = labor earnings of workers aged x at time t, $\tau_{x,t}$ = their pension tax, and $b_{x,t}$ = the benefit (or pension) of retirees aged x at t. Call total pension taxes collected T_t and the total value of pensions paid B_t, and assume that no one can receive a pension before the age of **z**, the minimum legal retirement age. Then the balance (F_t) of the system, expressed as a fraction of total taxes is:

$$F_t = \frac{T_t - B_t}{T_t} = 1 - \frac{\int_z^\infty b_{x,t}u_{x,t}dx}{\int_0^\infty \tau_{x,t}y_{x,t}v_{x,t}dx}. \qquad (1)$$

Most existing studies incorporate the equilibrium condition; either fixed pensions or fixed tax rates are assumed, letting the remaining variable adjust to balance contributions with benefits. In this paper I try to take into account some of the features of real-world Latin American systems and, accordingly, make the following assumptions, which differ somewhat from the usual framework.

Since tax rates are generally the same for workers of all ages, and are normally fixed by law, I set $\tau_{x,t} = \tau$ for all x,t. The value of pensions is also subject to some legal norms, but is rarely fixed in absolute terms; in most cases, pensions are determined in proportion to the individual's "base salary" (IDB, 1991, 234-281), which is calculated as the average of earnings over the last 2, 3, 5 or more years. For this reason, I set the replacement rate (i.e., the ratio of pensions to the base salary) **r** to be constant over time. Denoting the mean pension at time t by b_t and the mean base salary of retirees by s_t, then the assumption is that $b_t = rs_t$. Under these conditions, the system's balance can be written as:

$$F_t = 1-\frac{rs_t}{\tau y_t}R_t = 1-\rho_t R_t$$

$$\text{where } \rho_t=\frac{rs_t}{\tau y_t}, \text{ and } R_t=\frac{\int_z^\infty u_{x,t}dx}{\int_0^\infty v_{x,t}dx} \qquad (2)$$

is the ratio of the (eligible) retired population to the labor force in the system and y_t is the mean value of earnings per worker. Since **R** and **y** are functions of the labor force participation rates, population age structure and retirement age, this equation constitutes a starting point to examine how changes in them affect the financial balance of the system, and the relative effectiveness of different types of policy interventions regarding these variables.

Before proceeding to analyze said derivations, it will be useful to examine some basic properties of equation (2). Public discussions often concentrate on -and exaggerate- the negative effect that aging has on **R** and through it, on the system's financial disequilibriums, while dismissing or downplaying other factors. All too frequently, this misleads to the conclusion that aging, being an exogenous and largely inevitable process, will inexorably lead

to "bankruptcy" and to the system's collapse. Equation (2) clearly shows that three other important factors are the legal retirement age (z), the ratio of the base salary to mean wages (s/y), and (r/τ), the ratio of the system's replacement rate to the pension tax rate[2]. s/y is basically a function of productivity and wage growth across cohorts and other factors that affect the age distribution of earnings in the population. In many Latin American countries, this ratio tends to vary near unity.

Figure 1 shows different combinations of r and τ, including iso-ratio lines and the specific position of some Latin American countries, the majority of which are located within a r/τ range from 1 to 5. All other things the same, people participating in systems with larger r/τ ratios are getting a better return in terms of replacement rate points per percentage tax rate paid. On the other hand, the system as a whole is subject to more stringent financial requirements. Also, even when r/τ is large, some people may not be receiving benefits sufficient for basic subsistence expenditures; for example, even though in Colombia (which has an r/τ near 2) people would seem to be getting a better deal from the system than in Argentina, which has a r/τ ratio near 1.2, many low-income colombian retirees may not be able to finance their basic needs with a pension which is less than one half the value of their base salary.

Figure 2 illustrates the relationship between r/τ, the dependency ratio and the system's balance. Of course, countries with high Rs and r/τ ratios will tend to display deficits, and vice-versa. This figure also shows that, at least in principle, even countries with very high dependency burdens can equilibrate their systems or even

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[2] s/y, r/τ and the legal retirement age are also important determining factors of the system's internal rate of return (i.e., the economic yield of participating in the system, when viewed as a lifetime investment project)

produce surpluses as long as they fix their r/τ ratios at moderate levels; in fact, the three countries which I have selected for more detailed study (Argentina, Colombia and Paraguay) are fairly far from the break-even line that assumes $s/y=1$. In this regard, one general conclusion that will be drawn in this paper is that only under very extreme conditions, which are not presently observed in any Latin American, will a system such as the one described by the above assumptions face the danger or reality of insolvency. Why is it then that some systems are already under serious financial strain or even showing sizeable deficits? The answer lies simply in all the factors that are not incorporated in our model, such as the fact that social security taxes are used to pay many other benefits aside from pensions, that the system's coverage of the labor force was significantly reduced during the recessionary 1980s, that under-declaration and mora have been endemic in some countries, that investments from temporary reserve funds have often yielded negative returns, and many other factors that have been studied in detail elsewhere, specially by Carmelo Mesa-Lago (1985, 1990, 1991a, 1991b, 1993).

I believe it is useful to abstract, at least in a first instance, from all those other aspects which are not intrinsic to the system's design, in order to attain a sharper focus on the way in which demographic factors, or more specifically, the age-related variables of the system, affect its financial position and viability. The remaining of the analysis is carried out accordingly.

3. Effect of a change in contributing years

In Latin America and elsewhere, eligibility to receive pension benefits normally contemplates both a minimum number of [active] contributing years and a minimum legal age at retirement. The

number of compulsory contributing years can be a binding restriction in most Latin American countries for a significant fraction of workers. Up until recently, minimum contributing years typically ranged from 10 to 15 years (Inter-American Development Bank, 1991, 234-281), which is far less than what most people work over their lifetimes. But recent legislation in an increasing number of countries is tightening eligibility requirements, including raising contributing years to 20 or 30 years in some countries.

If the number of person-years in economic activity in the population, denoted by L_t, increases either spontaneously (e.g., as a result of greater female labor force participation) or in response to legal requirements, the ratio of the retired to the active population will fall and the financial balance will improve. Due to the lack of complete data on cohort profiles, in what follows L_t will be measured as the expected number of working years by the synthetic cohort subject to participation rates $p_{x,t}$ and to survivorship rates $l_{x,t}$.

In order to quantify this and other effects, I will make use of functional differentials (see Arthur, 1984), which prove to be very useful in this context. The effect of the change of any age-distributed variable a_x, δa, on some variable of interest (call it $H(a_x)$) is denoted by $\delta H[\delta a]$. Let $l_{x,t}$ be the life table survivorship function. Since

$$L_t = \int_0^\infty l_{x,t}\, p_{x,t} dx \quad and$$
$$\delta L_t = \int_0^\infty l_{x,t} \delta p \, dx, \tag{3}$$

there are infinitely many possible ways in which the age schedule of labor force participation rates may accommodate a given change in L, and the specific manner of adjustment of the p_xs to the new

policy requirements regarding L will carry different financial implications. The effect on the financial balance may be expressed as:

$$\delta F[\delta p] = \rho \left(R \frac{\delta y[\delta p]}{y} - \delta R[\delta p] \right) \qquad (4)$$

where all the time subscripts have been dropped. There are basically two effects on the system's balance, one that acts through the value of y and the other (and main one) that operates via R. The first effect may be positive or negative, depending on whether p increases in ages where earnings are above or below average, while the second one is by necessity positive. However, the magnitude of this last positive effect will vary depending on the precise type of behavioral response to the policy change.

Figure 3 shows four special cases, which encompass most likely responses. In the first panel, two rather extreme cases are represented. In case 1, a one year increase in L is obtained by increases in labor force participation only at ages younger than z, while case 4 represents increases only at ages above z. This last case is rather unlikely to take place spontaneously, but might conceivably be induced by policy that raises the age at retirement, which will be discussed more specifically later. Case 1 is perhaps more unlikely since it goes against the historical trend of youths spending more time in the educational system and delaying their entrance to the labor force. Cases 2 and 3, displayed in the bottom panel are judged to be somewhat more realistic: case 2 represents an increase of the p_xs in the same proportion at all ages, while case 3 shows the effect of delaying the timing of retirement uniformly at all ages, which implies a shift of the p_x schedule to the right.

Results in table 1 show that the positive effect of increasing the number of contributing years is always greater when labor force

participation rates increase in post-retirement ages. Under this setup, contributions will increase but also a sizeable saving in terms of pensions not paid to all those who postponed their retirement will be registered. In reality, such saving may not be as large inasmuch as individuals who continue to work beyond the legal retirement age may nonetheless receive partial or even full benefits.

In all cases, increasing labor force participation proportionately at all ages (and therefore mostly in main working ages in absolute terms) such as in case 2, has a larger positive financial effect than either earlier entrance to the labor force (case 1) or uniformly postponing the timing of retirement (case 3). A proportional increase of labor force participation at all ages may also come about exogenously with respect to the pension system; for example, may well represent the kind of effect that increased female labor force participation can have on global rates.

The differences across countries seem to be comparatively small, although the effect of uniformly postponing retirement appears to be somewhat smaller when it takes places in countries with younger population age structures (e.g., Colombia and Paraguay) than those with older populations, such as that of Argentina.

4. Effect of a change in the minimum retirement age

Some Latin American countries have recently enacted legislation for increasing the legal minimum retirement age, and in many more countries there have been unsuccessful proposals to that effect. This is perhaps the most common way, sometimes in combination with changes in contributing years, through which authorities have attempted to deal with the system's financial problems.

What is the effectiveness of these kinds of measures as compared to those regarding contributing years and to the effects of population aging? Note that, unlike in the previous case, mean earnings y are not directly affected by changes in **z**, so that **F** is affected trough **R** only. Re-writing **R** as:

$$R_t = \frac{\int_z^\infty u_x dx}{\int_0^\infty v_x dx} = \frac{\int_o^\infty u_x dx - \int_0^z u_x dx}{\int_0^\infty v_x dx}, \qquad (5)$$

it can be shown that

$$\delta F[\delta z] = \rho \frac{u_z}{\int_0^\infty v_x dx} \delta z. \qquad (6)$$

As illustrated by the examples given in table 1, a one year increase in the legal age at retirement tends to have a larger effect by comparison to a one year change in contributing years in countries close to stationarity like Argentina, except for the case where participation increases only in ages past the legal minimum. The result tends to reverse itself the younger the population age structure, as the cases of Colombia and Paraguay illustrate. It is important to note that this is, in reality, the <u>minimum</u> expected effect, since in equation 6 it is implicitly assumed that all other variables, including participation rates, remain constant. A larger improvement of the system's balance is expected because it is likely that if **z** is raised, at least some people will continue to work until they reach the new minimum age in order to qualify for full benefits, which will add an extra positive effect.

5. Effect of population ageing

A general expression for the change in **F** induced by a variation in the population age structure is given by

$$\delta F[\delta N] = \rho\left(R\frac{\delta y[\delta N]}{y} - \delta R[\delta N]\right). \qquad (7)$$

As in the case of a change in contributing years, there are two main effects, one operating via **y** and the other through **R**. Likewise, the effect via **y** may be positive or negative, depending on whether the particular shape of aging of the population distribution considered weighs more heavily those ages at which income is above or below the average value, but the effect via **R** is always negative.

As it turns out, the income effect is, in all cases, very small and never sufficiently large to outweigh the main negative **R**-effect. This is to be expected, given that the earnings schedule by age is normally increasing, bending downwards only slightly at older ages. The first row of table 2 provides estimates for the total effect that population aging has on the financial balance of the system over a 30-year projection period (1990-2020), on the assumption that all the other parameters (i.e., labor force participation, social security tax, ratio of pensions to wages, etc.) remain at their 1990 levels. The effect is much larger in Colombia, where aging is proceeding at a faster pace than in Argentina or Paraguay, which are at an advanced and at an early stage of their demographic transition, respectively. In Paraguay, aging effects are projected to begin to be perceptible around 2010, while in Argentina they will continue to be relatively mild throughout the projection period and beyond, unless significant perturbations with respect to the current population projection take place.

The above relations can be used to integrate the analysis of two or more of the previous changes. Of particular interest in this context is to estimate how much would the legal age at retirement have to increase to compensate for the projected population aging.

Analytically, the answer is obtained by setting the expressions of equations 6 and 7 to be equal, from which it is easily found that $\delta z = \delta F[\delta N]/\delta F[\delta z]$. In terms of figure 4, this involves finding the horizontal distance between the two (F,z) curves for some given initial point on the vertical axis.

The second row of table 2 reports the results. The 30-year projection is consistent with the results of the first row of the table, in that it shows that the compensatory change in z is larger in countries in the intermediate stages of their demographic transition than those in the extremes of the process. It seems that the required increase of 1.8 years towards 2020 in Argentina would be quite feasible, considering that there have been proposals to raise it by 5 years, from 60 to 65 years for both men and women. It appears to be conceivable, although more difficult, that the retirement age in Paraguay could be raised from 55 to 63. Since the paraguayan system is relatively incipient and still operates with significant annual surpluses, an increase in retirement age does not seem necessary in the short run, although some form of adjustment, either in the replacement rate or in the retirement age, may eventually be required to continue to sustain positive balances. In Colombia, by contrast, the needed raise in the legal retirement age, from 60 to 71, appears to be simply inviable.

6. Toward the stationary state: is insolvency inevitable?

The last consideration I would like to make regards the long term state of the type of system presently discussed, and thus return to one of the initial preoccupations expressed at the beginning of the paper: If population aging hasn't at present drawn the Latin American pension systems down to insolvency, is it just a matter of time before it does? Or can the systems be financially solvent even if (and when) they reach population stationarity? Under what

conditions can they be viable? I will not answer these questions here in full, but will attempt to provide some key elements of the answers.

Firstly, it is important to note that neither Colombia nor Paraguay are expected to reach population stationarity within the next 60 years. Argentina, one of the countries most advanced in the demographic transition in the region, is currently projected to attain zero population growth rate (not full stationarity) around 2040. It is very difficult to predict with some certainty which particular age structure will the populations of the three countries considered have if and when they reach the stationary state, so some (necessarily arbitrary) assumptions need to be made to measure the final effects on the system's balance.

Just as two plausible reference patterns, I estimated the effects associated with two possible stationary age structures: the life table L_x function of Argentina's population projections for the year 2000, which has a life expectancy at birth (e_0) near 74 years, and that for the year 2045, with $e_0 = 80$ (CELADE, 1994). Figure 5 shows the estimated values of the financial balance under present conditions and under the two hypothesized stationary age structures, holding all other factors as they are at present. Both the argentinian and the paraguayan systems seem to be capable of sustaining non-negative balances even under the rather distant possibility of stationarity. However, under the stationary age distribution with $e_0 = 80$, Paraguay is right by the limit, meaning that if life expectancy eventually reaches values significantly higher than 80, the system could well be subject to permanent deficits. Colombia is a clear-cut case in this regard, showing negative balances even with the "younger" $e_0 = 74$ distribution. This conclusion is broadly consistent with more pessimistic projections (Ayala, 1990), which conclude that the functioning of

the current scheme is unsustainable and that a major reform to the system is inevitable.[3] The only way to avoid future reductions in the benefit to contribution ratio within the colombian system, would seem be to expand the coverage to the non-contributing workers, which currently account for more than half of the labor force. Due to a number of structural problems, however, this presents serious difficulties.

Even though it is true that these and other problems do exist in Colombia and elsewhere, they should not lead to loose sight of the fact that the high r/τ ratio is the fundamental reason why the colombian system is projected to be insolvent in the long run. It is not population aging per se the principal cause of its eventual insolvency nor other factors intrinsic to the system's design. The argentinian and paraguayan set of parameters, for example, constitute two alternative solvent solutions: the first with high tax rates and high replacement rate; the second buying a low replacement rate in exchange for a low tax rate.

In reality, political considerations are of paramount importance in how disequilibriums are perceived and dealt with. For example, in many european countries, generous benefits provided by the social security systems as well as, in part, much more aged populations are producing sizeable disequilibriums, but governments have decided to maintain the systems and to finance the deficits through other means, based on social equity considerations. It is unclear, however, whether that deficit financing can be sustained indefinitely. In many Latin American countries, on the other hand, the neoliberal policies which emphasize privatization are inducing reforms in those directions even in countries, such as Paraguay,

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[3] In Colombia, as in Argentina and Paraguay, the type of reform more strongly advanced is a change of regime to one based on individual private capitalization, along the lines of the Chilean 1981 reform.

where deficits are not expected to manifest themselves for a long time.

An important topic not studied here which merits attention are the welfare implications of this particular model (fixed contribution and fixed benefit) as compared to the more widely studied fixed contribution or fixed benefit variants. The specific model used here may be more or less apt to smooth out inter-generational inequities than the other (i.e., "equilibrium") alternatives depending on how imbalances are dealt with and financed.

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Appendix: Data Sources

- Population estimates, projections and life table measures: CELADE (1994), cited under references.
- Labor force participation rates: CELADE (1992) Latin America: Economically Active Population, 1970-2000. Demographic Bulletin Year XXV, No. 49. Santiago, Chile.
- Replacement rate **r**: C. Mesa-Lago (1991a), cited under references. Table 21, p. 75 (data are for 1985).
- Total contribution (or tax) rate τ: Mesa-Lago (1991a), table 4, p.12. Total contribution includes taxes paid by the insured worker, the employer and the state, as a percent of wages (data are for 1987-88).
- Legal retirement age **z**: Mesa-Lago (1991a), table 20, p.73 (data are for men in 1980-85)
- Per-worker earnings by age y_x: Argentina: Encuesta Permanente de Hogares (Capital and 19 urban sections of the province of Buenos Aires), october 1991; Colombia: Encuesta Nacional de Hogares - Fuerza de Trabajo (8 principal cities), september 1991; Paraguay: Encuesta de Hogares - Mano de Obra of the metropolitan area of Asunción, october and november 1991.

Table 1. Financial impact of raising the number of contributing years and the legal retirement age

Per cent change in the financial balance of the system*

	case1	case2	case3	case4	$\delta z = 1$
Argentina	1.3	1.5	1.3	4.2	1.8
Colombia	1.3	1.7	0.9	4.2	1.8
Paraguay	1.0	1.5	0.8	3.2	1.0

* Notes: [i] The estimates are based on equations 4 and 6; [ii] The balance is measured as a fraction of income (see equation 1 and related text); [iii] Data sources are given in the appendix; [iv] In case 1, a one year increase in L is obtained by increases in labor force participation only at ages younger than z; case 2 represents an increase of the p_xs in the same proportion at all ages, while case 3 shows the effect of delaying the timing of retirement uniformily at all ages; case 4 represents increases only at ages above z.

Table 2. Financial consequences of population aging and needed compensatory changes

	Argentina			Colombia			Paraguay		
	2000	2010	2020	2000	2010	2020	2000	2010	2020
Per cent change (w/r to 1990) in the financial balance induced by projected population aging	-0.4	-0.8	-3.1	-0.3	-5.6	-20.0	0.4	-2.9	-8.5
Required change (w/r to 1990) in retirement age to compensate for population aging	0.3	0.5	1.8	0.2	3.2	11.0	-0.4	2.8	8.2

Figure 1: Replacement rate and tax rate

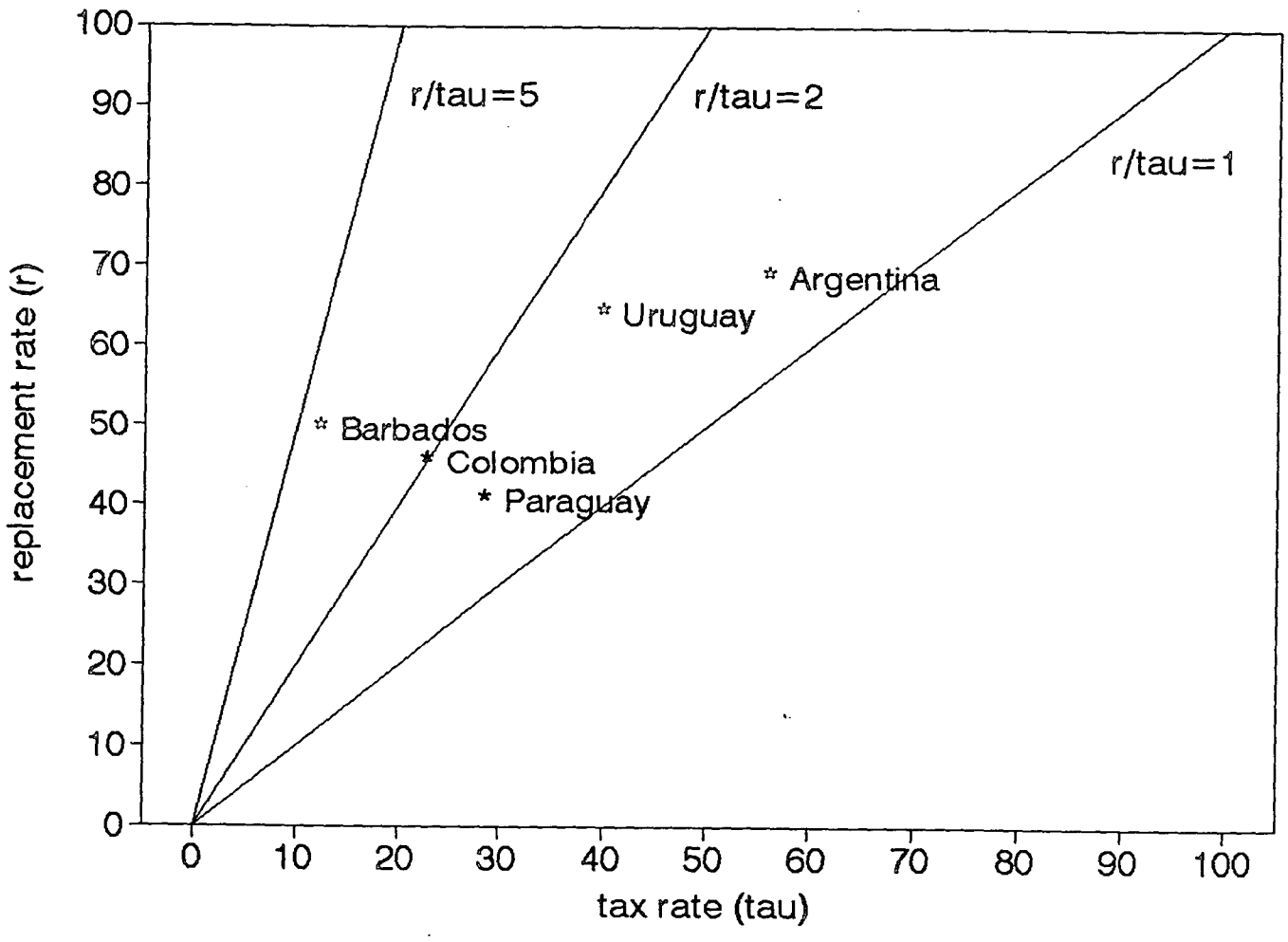


Figure 2: Balanced budget dependency ratio (with s/y=1)

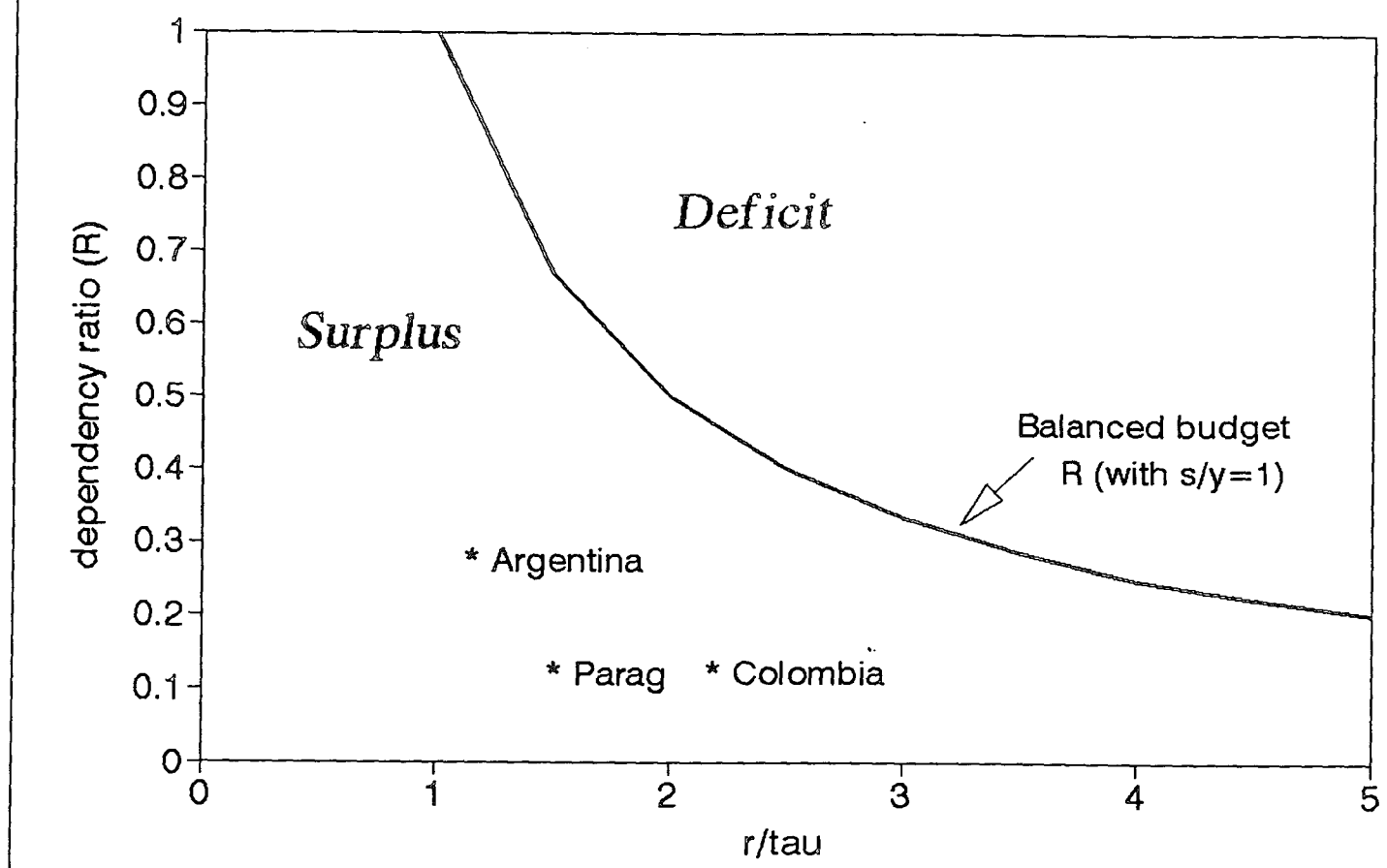
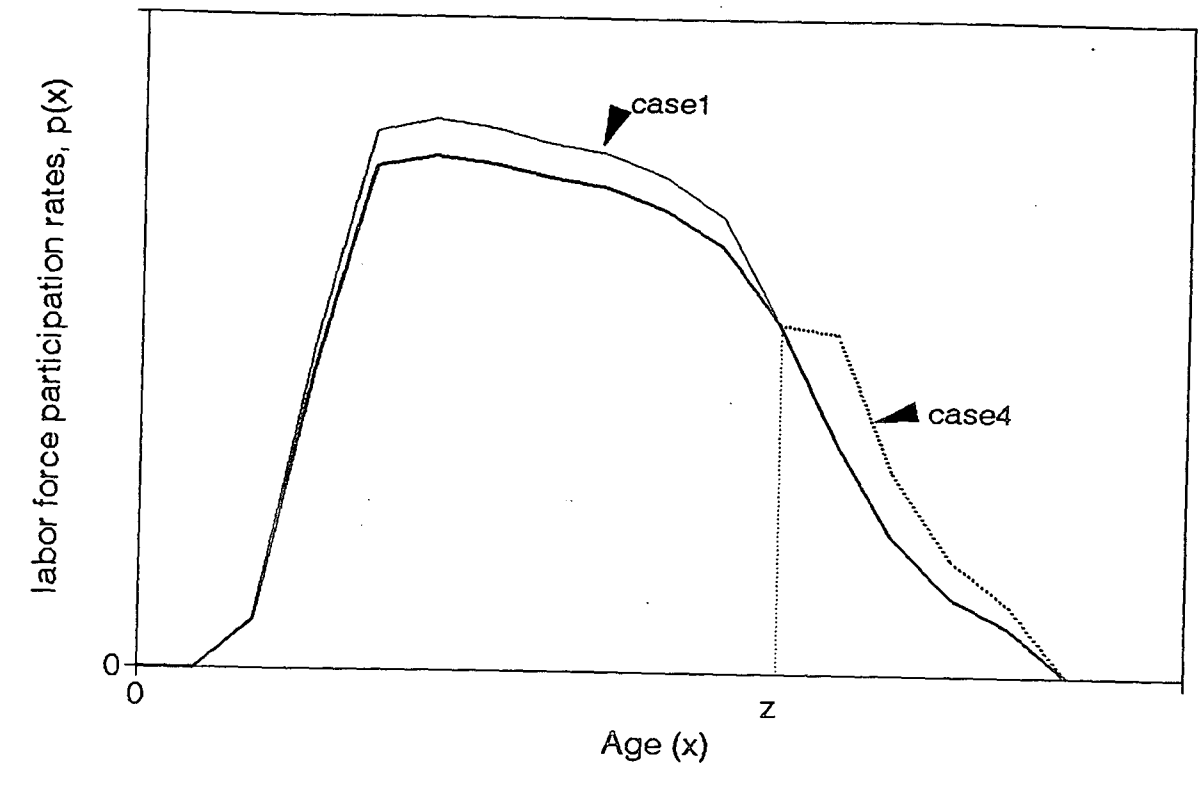


Figure 3: Some possible reactions to policy that raises contributing years



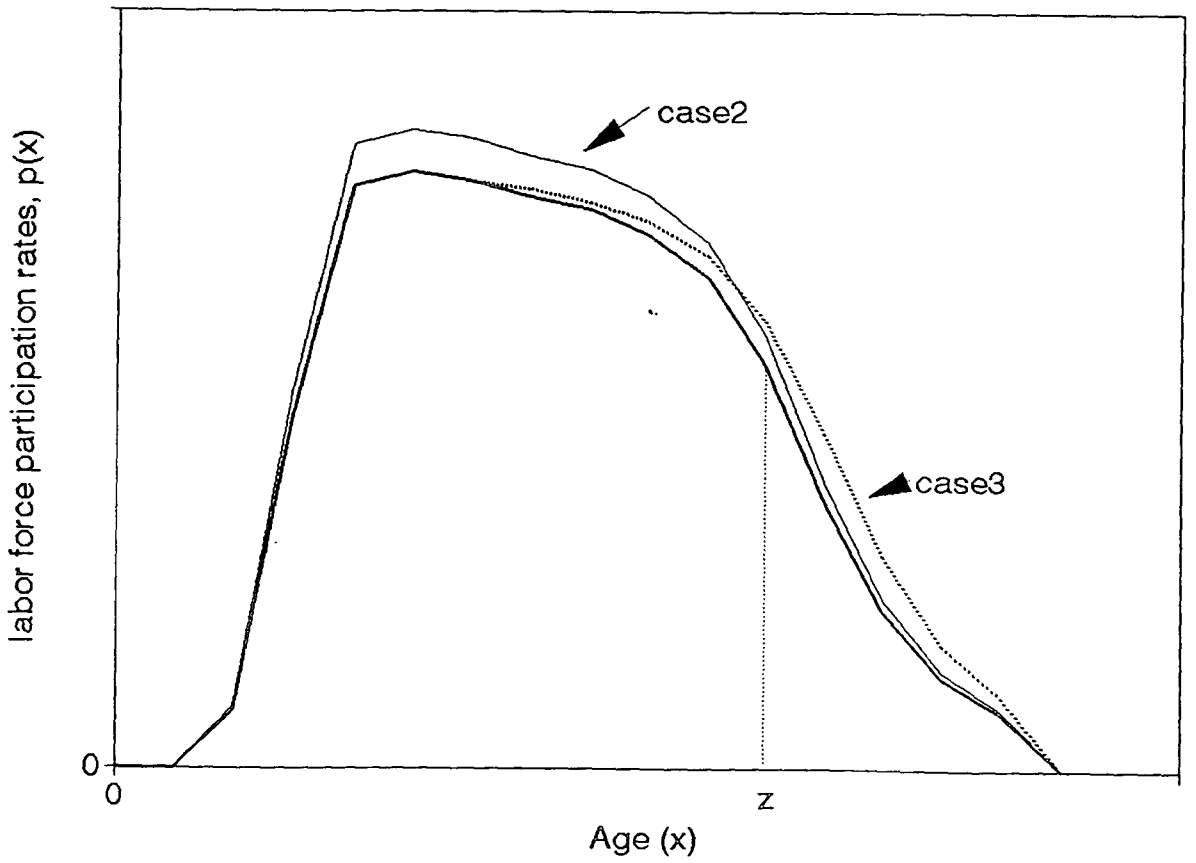


Figure 4: Financial balance as a function of aging and retirement age

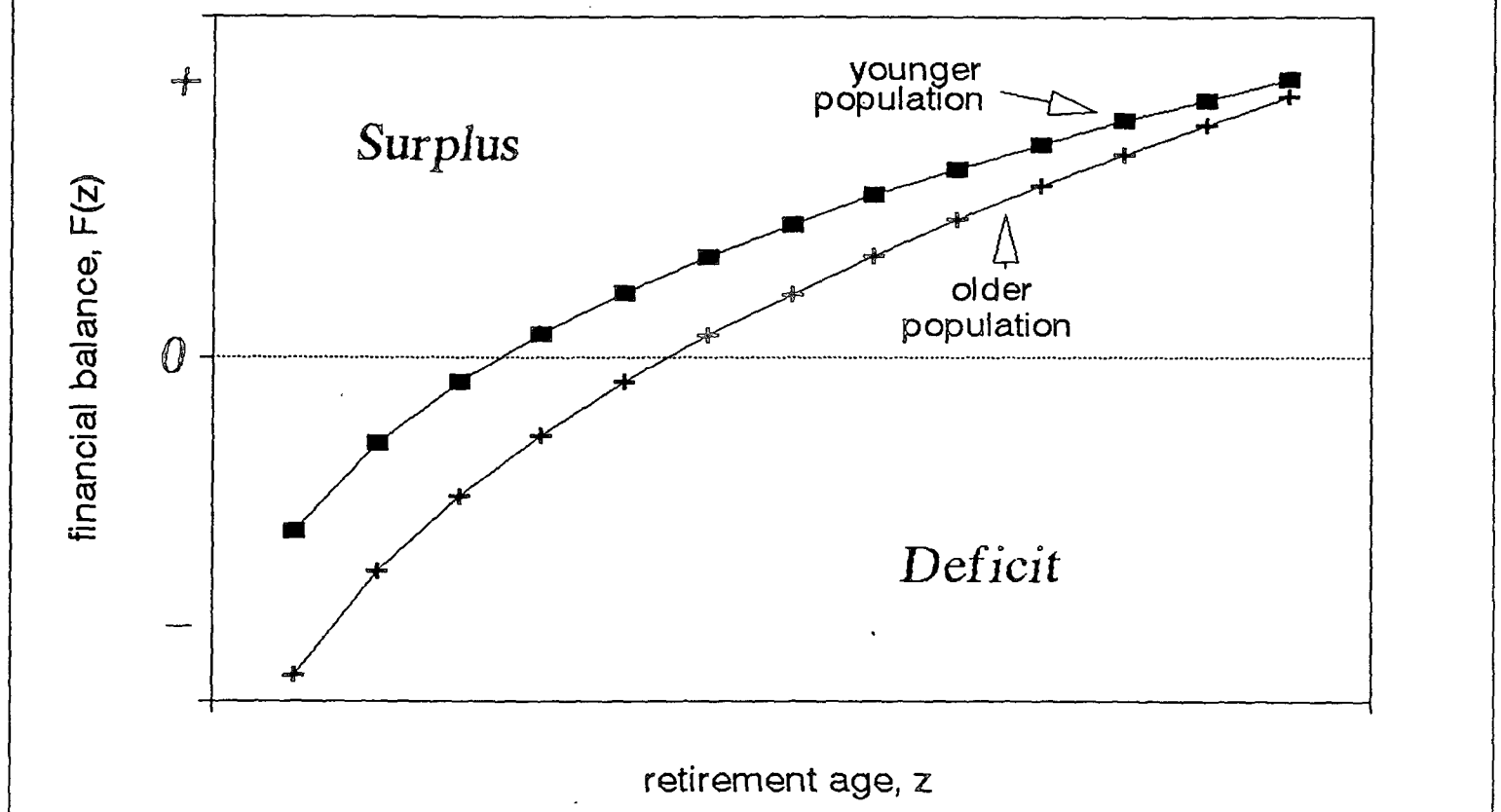


Figure 5: Financial balance under population stationarity