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Financing retirement: A basic economic analysis of the Pay-As-You-Go (PAYG) system and the expected consequences from a transition to a Fully-Funded (FF) scheme.

L.V. Petrides[A] and B.C. Dangerfield[B]
Centre for O.R. and Applied Statistics
University of Salford
Salford M5 4WT
UK

Abstract: *In this paper an attempt is made to illuminate the basic problems that are associated with financing retirement. The currently prevailing, in most developed countries, Pay-As-You-Go (PAYG) system and its deficiencies are analysed initially from a traditional economic perspective and the expected consequences from a transition to a Fully-Funded (FF) scheme are also presented. A System Dynamics model is subsequently described which enables the employment of considerably more realistic assumptions than are commonly employed in economic models, and its results prove to challenge mainstream economic findings. In addition many novel features of PAYG schemes are uncovered.*

Keywords: *social security; pay-as-you-go; economics; system dynamics; simulation*

1. INTRODUCTION

One of the most pressing economic challenges that the overwhelming majority of developed countries have to face is to do with the expected (in some countries) or the already existing (in many others) tremendous gaps between the outlays and inflows of their social security (SS) systems. SS payments encompass all benefits intended to supplement individual or family income, including the provision of funds when sources of income are disrupted (or terminated) or when exceptionally heavy expenditures

[A] E-mail address: lpetrides@cwcom.net
[B] E-mail address: B.C.Dangerfield@salford.ac.uk

have to be incurred. Thus, payments for, say, unemployment, sickness, disability, crop failures, maternity, loss of marital partner, retirement etc. all constitute different examples of SS outlays. The revenues of these systems on the other hand emerge out of taxation. Today's worldwide SS crisis naturally has as much to do with the unrestrainable, as they have developed, outlays of SS systems, as with the inability to keep increasing the already high taxation levels to boost revenue further. At the same time that aging populations promise ever greater SS outlays for the foreseeable future thus, the upper tax limits seem to have been reached setting the very viability of SS systems around the world in doubt.

Despite the fact that in the pages that follow we focus upon only one particular area of SS systems, namely that of pension schemes, the importance of this issue alone cannot be overstated. The magnitude of the pension scheme problem is in fact so great that the majority of economists simply refer to it as the SS problem (see for example Brauninger 1996, Mankiw 1998, Galasso and Profeta 2002). The reason for the intended confusion of the two terms of course is not hard to comprehend. The amounts of money that are involved for pension schemes alone are tremendous. To give an idea it should be noted that:

- To prevent the bankruptcy of their pension schemes, payroll taxes in many countries (for pensions alone) already exceed 25% of wages. (Shipman (2003, p.2))
- Italy's public retirement system already consumes 15% of its gross domestic product and accounts for at least 34% of government expenditures (Eurostat; Boldrin et al (1999 p.293))
- Unless changes are made to Germany's pension system the government will be forced to increase its spending by 9.7% of GDP within the next 30 years (Disney (2000 p.4); OECD (1996) Table 5.3) while by the year 2030 it is estimated that 16.5% of Germany's GDP will be spent on pensions (Disney (ibid); OECD (1998) Table 2.3)
- In most EU countries the implicit debt of unfunded pension programs is two or three times greater than the explicit national debt (OECD 1998 p. 22);

Such is the magnitude of the problem associated with pension schemes thus that its characterisation as 'the SS problem' does not seem unreasonable. In addition, the two diametrically opposed ways of tackling

this problem which will be subsequently explored, have also had their share to play[1].

1.1 The root of the problem

There should be little doubt that the emergence of this problem has occurred for a number of reasons. The most obvious one perhaps is that after the conclusion of the Second World War, SS outlays started to increase at a tremendous pace. The extension of coverage, the widening of the risks covered, and the greater generosity of benefits which at times even exceeded the full replacement of normal earnings (see for example Provopoulos (1987 p.186) as regards the Greek system) describe some of the reasons for this increase. The results of such policies were not surprising. As written in Encyclopaedia Britannica (1994-8) '*While social security spending amounted to less than 10 percent of the gross national product in nearly all countries in 1950, it had risen to 20 to 30 percent or more in many European countries by 1980.*'

Another source of even greater concern though did not have as much to do with the outlays of these systems per se, as with the way a great proportion of these outlays were financed. The way pension schemes were funded in particular was very similar, if not identical, to the way (the illegal) pyramid schemes are financed (see for example Mankiw 1998, Borden 1995). Let us now explore the characteristics of today's national pension schemes in greater detail.

1.2 The five defining characteristics of pension schemes

Provopoulos (ibid p.8) identifies five key issues as regards the principles of organization and operation of pension schemes.

- The schemes can be either mandatory or discretionary
- The institutions that enable the functioning of these schemes can be either public or private
- The schemes can be either PAYG or FF ones

[1] Health care spending should also occupy a prime position in the discussion of SS yet the lack of a clear financing alternative, equivalent to the one that exists when it comes to pension reform, has apparently contributed to its relative marginalization. Different views as to the handling of health care do of course exist (see for example Iriart, Merhy, and Waitzkin 2001) while the magnitudes involved therein also cannot easily be ignored. The President's Council of Economic Advisors (1997) in the US for instance projects that Medicare and Medicaid spending will increase from 2.7% and 1.2% of GDP in 1996 to 8.1% and 4.9% of GDP in 2050 respectively. Bohn (1999) consequently notes that the U.S. SS system is 'almost certainly viable economically as well as politically' if only Medicare expenditure is to be contained.

- The benefits paid out can be calculated either on a Defined-Benefit (DB) or a Defined-Contribution (DC) basis
- The inflows to those systems can result from either (general or special) taxation or from special contributions

Apart from the first of these issues which has long been settled in favour of the mandatory approach, the remaining four are so highly intertwined that they are commonly distinguished under two headings: the prevailing PAYG system on the one hand, and the FF one on the other.

1.2.1 The prevailing PAYG system

PAYG pension systems have prevailed in the overwhelming majority of all developed countries. The essence of these schemes can be summarized as follows: the funds for the pensions that are paid out to *today's* pensioners are all coming out of taxing *today's* working population. If employment suddenly reduced to zero therefore, there would simply be no one to provide for pensions. This scheme is consequently also commonly known as the 'unfunded scheme', since the amount of money that is raised through taxation instead of going into some sort of investment fund, go for the immediate imbursement of pensioners.

PAYG systems are usually[2] connected with the Defined-Benefit approach for estimating the amounts of money that will be paid to pensioners. According to this method this amount will be determined from a formula (different for every country) that takes into account: a) the length of time one has stayed in employment, and b) the wages s/he have been paid during the last few years of their working lives[3]. Since the benefits paid out do not correspond to the contributions made by individuals, the inflows to PAYG systems necessarily emerge out of taxation. Not surprisingly therefore it has been customary for the public sector to provide these services.

1.2.2 FF systems

FF schemes on the other hand are usually[2] characterized by the Defined-Contribution approach for estimating the pensions that are to be paid out to pensioners. The essence of the DC FF scheme is again simple: Pensions are paid out according to the contributions individuals have

[2] It *is* possible for PAYG schemes to feature defined contributions and for FF schemes to feature defined benefits, albeit the latter ones in that case could not be considered pure FF systems. See Espinosa-Vega and Russell (1999 p.4*)

[3] These naturally represent the highest wages they have been receiving in their working lives.

made during their working lives. Throughout employment in other words, a proportion of an employee's (or employer's) monthly income is withheld and directed as a contribution into his/her individual account which has been set up by special investment funds. These funds, which can be managed by private companies, are subsequently allowed to invest these money into bonds, stocks or any other forms of investment that is seen fit by law. At the (happy) time of retirement thus, any particular individual is entitled to the full amount of money that has been accumulating into their personal accounts plus the net accumulated investment gains, minus expenditure. The insured may subsequently decide to make scheduled withdrawals out of his/her account, purchase an annuity, or opt out for a combination of the two.

1.3 The reasons for the prevalence of the PAYG system

The conditions that prevailed from the end of the Second World War up until the first oil crisis in 1973 clearly favoured the establishment of PAYG rather than FF schemes for a number of reasons: PAYG schemes for a start have an immediate impact on senior citizens' finances. At such great times of full employment and high growth rates thus, it only felt right for Governments to try to improve the financial position of those who could not enjoy a share of the riches. Besides, the hardships those generations went through when younger could not be easily forgotten.

Another major reason for the predominance of PAYG schemes is that with the then prevailing and forecasted economic growth rates, the benefits that the then current workers would enjoy when eventually reaching retirement would exceed by far their own past contributions to the system. It should be easy to see thus that PAYG systems offered at the time an unbeatable formula for winning elections. Both senior citizens *and* the working age population, viz. the whole electorate body, would benefit from the scheme. Additional reasons for this pervasiveness also exist, but they are of relative minor importance. Obvious examples would include the intragenerational redistribution of income that takes place which benefits the relatively less well-off, the prevalence of the scheme in most other countries etc.

The major disadvantages of PAYG schemes however also came to the forefront soon after the first oil crisis. The marked reduction in employment and growth rates reduced SS revenue at the same time that major demands were made on the system. From the late 1970s onwards there was consequently talk of a crisis in SS financing.

2. A BASIC ANALYSIS OF THE PAYG SCHEME AND THE NATURE OF THE PENSION CRISIS

2.1 The basic economic principles of PAYG systems

In this section we will attempt to explore the economics of PAYG systems from a somewhat more formal economic approach to demonstrate its properties. The analysis at this point is equivalent as in Disney (2000 p.f14), Gramlich (1999 p. 490-1), and Sebald (2002 p.5-7).

A PAYG pension scheme is in equilibrium when:

$$cwL = pB \quad (1)$$

Where:	c: contribution rate	(1)
	B: number of pensioners	(persons)
	L: number of workers	(persons)
	p: average pension	(£/(persons*time))
	w: average wage	(£/(persons*time))

In plain English, a PAYG system is in equilibrium when the inflows to the system, viz. the contribution rate (c) times the average wages per worker (w) times the number of workers (L), equal the outflows, viz. the average pension per pensioner (p) times the total number of pensioners (B).

Equation (1) can be transformed into:

$$c = (B/L)*(p/w) \quad (2)$$

which shows that for equilibrium to prevail, the contribution rate (c) must be equal to the so-called (old age) dependency ratio, viz. the division of the total number of pensioners (B) by the total number of workers (L), times the replacement rate, defined as the division of pensions (p) by average wages (w). Assuming that governments are not willing to alter either the contribution rates (c) of the working population, or the pensions (p) that are to be paid out, the demographic and macroeconomic shocks that can knock the system out of equilibrium become evident. All demographic alterations that can cause the dependency ratio to increase (decrease) are clearly detrimental (beneficial) for a PAYG system, while positive (negative) growth rates, which are normally associated with higher (lower) wages and increased (decreased) labour force levels, are

beneficial (detrimental). It naturally follows that PAYG schemes can be sustainable even if adverse, say, demographic circumstances prevail, as long as these are counterweighted by improving macroeconomic conditions (or vice-versa). In the face of today's demographic crisis thus (see section 2.2), hopes for the sustainability of PAYG schemes rest on the improvement of growth rates. Sadly however, the macroeconomic outlook does not allow much room for optimism either (section 2.3).

2.2 Demographics

Let us now focus our attention on some real life statistics to illuminate the magnitude of the prevailing problem as that manifests itself through demographics only. As shown in equation (2), this analysis will revolve around the dependency ratio, viz. around the actual numbers of senior citizens[4] (B) as they stand in relation to the numbers of the working age population[5] (L).

Figure 1 shows the dependency ratios in Germany, France, the US, and Japan as they are predicted to evolve until the year 2050.

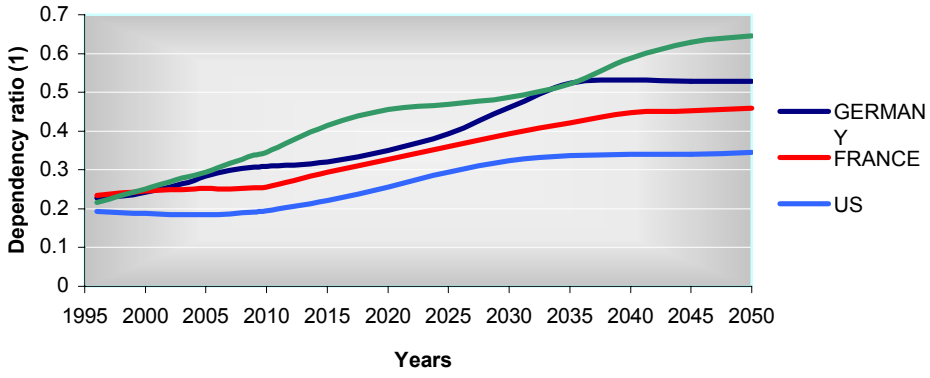

Figure 1 Dependency ratios (Source: US Census Bureau)

All sampled countries as can be seen above (Figure 1) are expected to experience a marked increase in their dependency ratios in the following 50 years or so. Even in the US, the country that is expected to be influenced the least, the dependency ratio will go from a low of approximately 19% which holds today, to over 34% by the end of 2050. At the other extreme of course, we can see Japan whose dependency ratio is expected to reach the 64% levels from the currently prevailing 21%. The corresponding ratios for most remaining developed countries including France and Germany lay somewhere in between the two extremes.

[4] Senior citizens are taken to be all citizens that are 65 years old and over.
[5] The working age population includes all persons between 15 and 64 years of age.

Let us now try to perceive more clearly what those numbers actually mean as regards the viability of PAYG pension schemes. To do so we will first consider the inverse of the dependency ratio, the support ratio, which simply shows the number of workers that are required to sustain one pensioner (Figure 2)

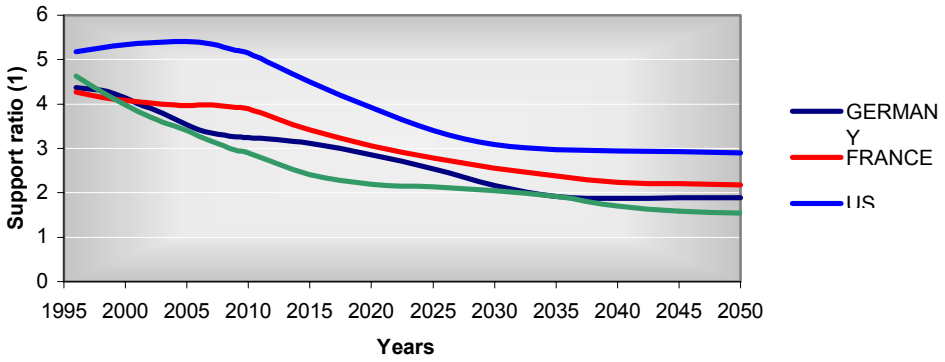

Figure 2 Support ratio (Source: US Census Bureau)

Figure 2 shows that from the approximate 5 workers to 1 pensioner ratio in the sampled countries, we go down to 2.5 to 1 or so, with Japan approaching the 1.5 to 1 ratio. Let us consider the implications of such a change.

Equation (1) is here reproduced for convenience:

$$cwL = pB \quad (1)$$

Where:	c: contribution rate	(1)
	w: average wage	(£/(persons*time))
	L: number of workers	(persons)
	p: average pension	(£/(persons*time))
	B: number of pensioners	(persons)

Portraying average pensions (p) as a percentage replacement rate of wages, we have:

$$p = rw \quad (3)$$

Where:

p: average pension	(£/(persons*time))
r: replacement rate	(1)

w: average wage (£/(persons*time))

Substituting (3) in (1) and after an algebraic manipulation we get:

$$(cwL)/(rwB) = 1 \quad (4)$$

But (L/B) represents the support ratio which we shall call (s). Thus with:

$$s = L/B \quad (5)$$

and substituting (5) in (4) and then simplifying we get:

$$(c/r)*s = 1 \quad (6)$$

which of course equals

$$c = r/s \quad (7)$$

Equation (7) shows that for a PAYG system to remain in equilibrium the contribution rate (c) must equal the division of the replacement rate (r) by the support ratio (s). Let us consequently put some numbers in equation (7) to see how the observant reduction of the support ratio in Figure 2 influences an economy. Table 1 shows the required contribution (tax) rates as a percentage of wages that would keep a PAYG system in equilibrium based on a combination of different replacement rates and support ratios.

Table 1 Contribution rates

Replacement Rate	Support Ratio			
	5	3	2.5	1.5
	10%	17%	20%	33%
	12%	20%	24%	40%
	14%	23%	28%	47%

Contribution Rate

Table 1[6] shows that the reduction in the support ratio in the case of Japan, where public pension benefits replace about 60% of after tax annual earnings (Horioka 1999 p.295), would require taxes (contribution rates) to be raised to the approximate 40% level of wages just to level the pension system. The US on the other hand, with a replacement rate of about 53% (Börsch-Supan 2000 p.29) is much better off. The expected reduction in the support ratio there can be met by increasing taxes up to the approximate 17% levels according to Table 1. It should be noted however that such an increase represents, a rise in taxes of approximately 80%. Politically such changes are very hard to handle.

Trying to locate the reasons for these adverse demographic pressures, we can identify two prime causes (see accordingly for example Cremer and Pestieau (2000 p.977), Bohn (1999 p.9), Joines DH (1999 p.55))

a) low fertility rates
b) increasing life expectancies

Table 2 shows how the fertility rates have developed through the years for the four sampled countries, and how they are expected to grow in the future.

Table 2 Fertility rates

Country	1950	1960	1970	1980	1990	2000	2025*	2050*
Germany		2.36	2.01	1.44	1.56 (1989)	1.35	1.53	1.70
France	2.92	2.73	2.48	1.95	1.78	1.86	1.78	1.70
US	3.02	3.64	2.48	1.84	2.08	2.06	2.18	2.19
Japan	3.64	2.00	2.13	1.75	1.52	1.36	1.53	1.70

(Source: US Census Bureau)

The persistent downward trend in fertility rates can be easily ascertained. After the boost in the number of birth rates that followed the aftermath of the Second World War, and which persisted until the late 60s, a sustaining decline in fertility rates followed. But such a decline puts a

[6] The figures in Table 1 are only indicative of the magnitude of the problem different countries will be facing since they are based only on demographics. The actual numbers differ from those in Table 1 due to a number of important macroeconomic variables which have been assumed away. Some of these variables would include the extent of tax evasion, varying productivity and/or retirement age, a possible tripartite funding of pension schemes, previous mismanagement of PAYG funds etc.

considerable strain on PAYG pension schemes. As the sizeable generations of the 50s and 60s are approaching retirement, the upcoming generations that are required to provide for their pensions are considerably smaller. Hence of course the one of the two reasons for the estimated reduction in the dependency and the support ratios we examined earlier.

The examination of life expectancies in the sampled countries only makes matters worse (Figure 3).

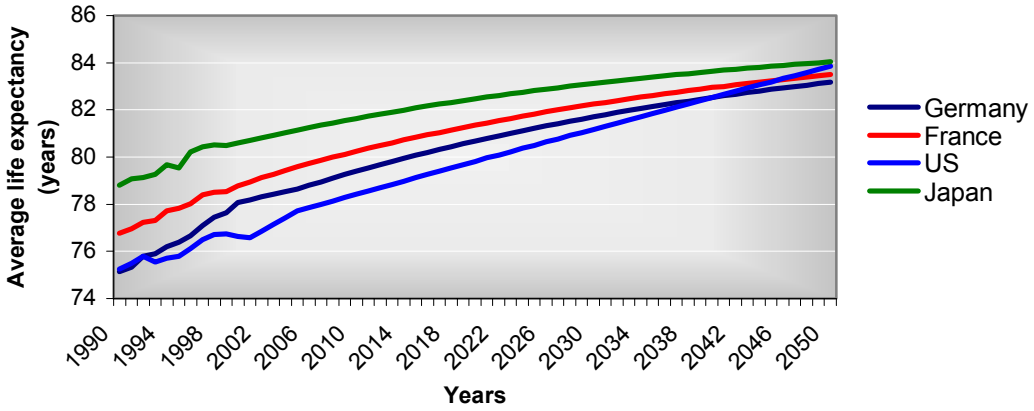

Figure 3 Life expectancy at the age of birth (Source: US Census Bureau)

Figure 3 shows that life expectancies in all sampled countries are expected to continue their considerable rising trend. The consequences of this are simple to understand. Through a prolongation of average life spans, the numbers of senior citizens will inevitably rise and so will the required expenditures of PAYG schemes.

As a result of these two underlying causes, the expected age structures of the selected countries' population for the year 2050 as compared to the ones prevailing today should not seem bewildering (Figure 4).

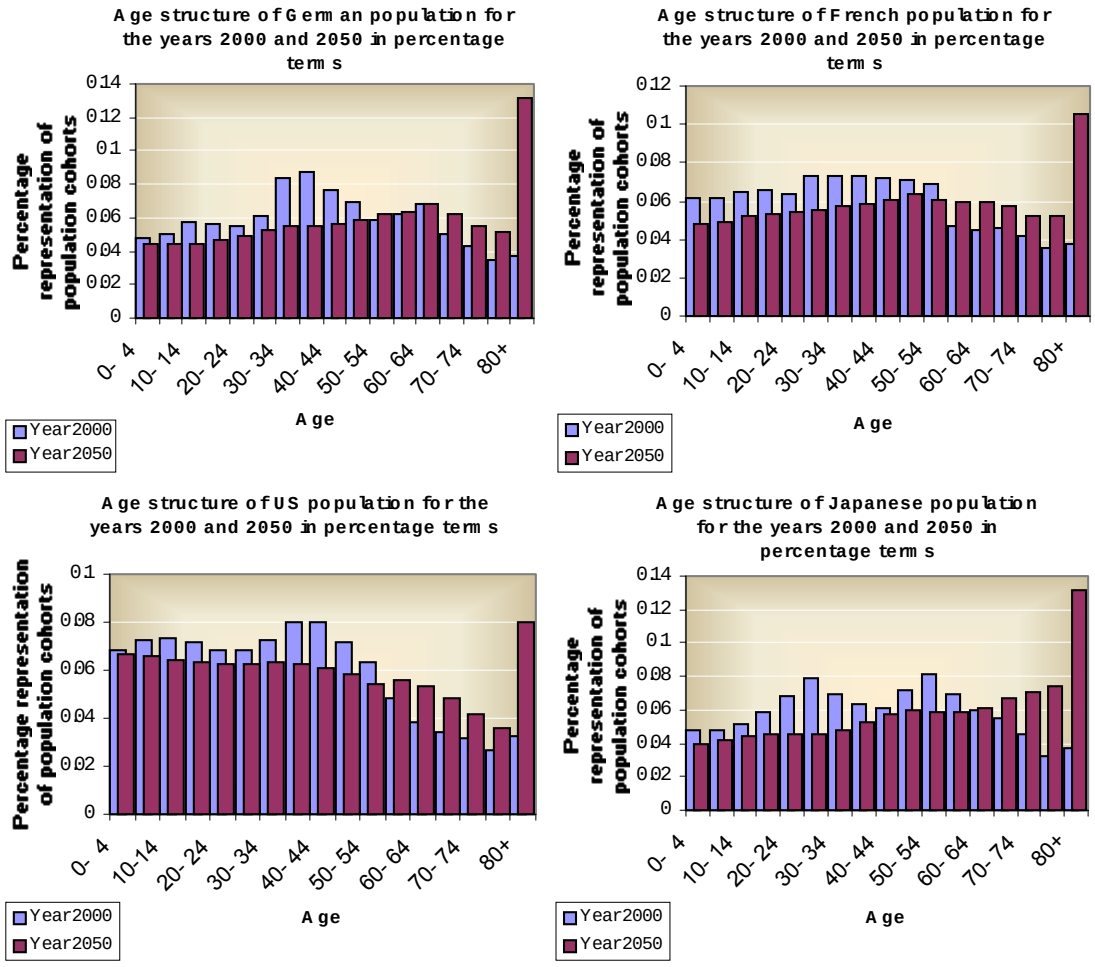

Figure 4 Age structure of the four sampled countries (Source: US Census Bureau)

The picks that appear in Figure 4 for the cohorts between the ages 40 and 55 for the year 2000 (blue bars) in all sampled countries result from the increased fertility rates that were prevalent during the 50s and 60s. The fall in birth-rates thereafter leads to the observed decline in the size of the younger cohorts. The number of senior citizens on the other hand for the year 2000 is not that great, corresponding to only about 4% of the total population in the sampled countries. This state of affairs of course is quite beneficial for the baby-boom generation (the generation born at the 50s and 60s) since their increased size allows for smaller per capita pension contributions. Besides, the number of people they have to sustain is quite small when compared to the size of their own generation.

The emergent pension problem however is also in sight from the data of the year 2000. These large cohorts that are now still in their 40s and 50s are about to retire during the next 20 years or so. How easy will it be for younger generations to finance the baby boomers' retirement given their considerable reduction in size?

By the year 2050 the dire consequences of the previously persistent lower fertility rates and the rise in average life spans are clearly shown. All cohorts between the ages of 1 to about 55 can be seen to be much smaller when compared to their year 2000 equivalents, while the number of senior citizens is set to increase markedly. The size of the over 80s cohort alone is expected to compare and some times even exceed the cumulative size of all persons above 65 for the year 2000. As shown in Figure 4, the over 80s cohort by itself is set to represent the 13% of the total population in some cases (see Germany and Japan regarding the sampled countries). Under such circumstances, the deficiencies of the PAYG scheme become clear. A much-reduced labour force will be called upon to sustain a much-increased number of pensioners.

2.3 Macroeconomic factors

2.3.1 Factors affecting the size of the labour force and the number of pensioners.

Apart from the (adverse) demographic pressures that have been seen to influence the finances of PAYG schemes, there also exist a number of non-demographic factors that exert an important sway. Unemployment provides an obvious case in point.

The dependency and support ratios as examined in the previous section, implicitly assumed that *all* people between the ages of 15 and 64 were employed and contributing towards the pensioners' sustainment. We know for a fact however that this is not the case if only because of unemployment. Unemployment naturally restricts (L), the actual size of the contributing labour force. The significant slow down in most countries' economies that was experienced from the first oil shock in 1973 onwards naturally caused a considerable rise in unemployment rates as Table 3 reveals.

Table 3 Unemployment rates

Country	1959	1970	1980	1990	2000
Germany	2	0.5	2.8	5	8.1
France	1.6	2.5	6.5	9.1	9.4
US	5.5	4.9	7.1	5.6	4
Japan	2.3	1.2	2	2.1	4.8

(Source: US Census Bureau)

The upward trend for all sampled countries but the US is hard to miss (Table 3). And the future is not expected to be markedly different than it is today.

Another factor that influences PAYG funding schemes adversely can be identified in a relatively long standing tradition that has been fostered by many governments across the world: early retirement. '…[S]*ocial security regulations across the world have encouraged early retirement, thus aggravating the imbalance between the number of workers and pensioners in times of population ageing*' writes Börsch-Supan (2000 p.45) concluding his paper (see similarly Gruber and Wise (1999), Blöndal and Scarpetta (1998))). One of the major reasons for these provisions of course was the containment of unemployment in 'acceptable' or, in any case, in the lowest possible levels (Börsch-Supan ibid, von Restorff 2000 p.24).

The results of such incentives can be seen quite clearly in Figure 5.

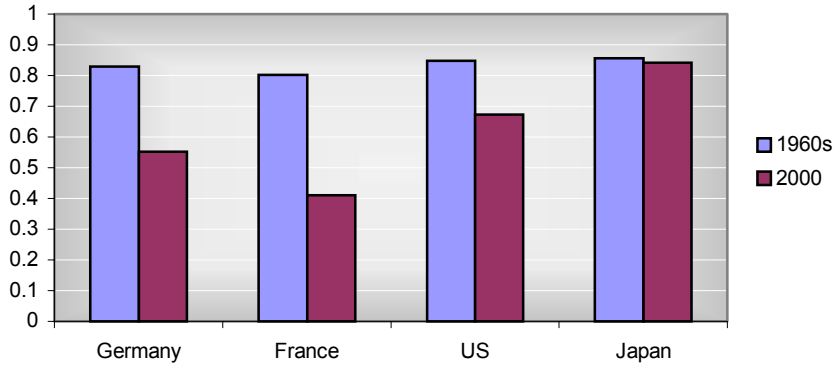

Figure 5 Labour force participation rates of the 55-64 age cohort in 1960 and 2000 (Source: OECD, Labour market statistics; Conde-Ruiz and Galasso 2003)

With the exception of Japan, the tendency to retire early from the labour force has resulted in a marked decrease in the labour force participation rates of the 55-64 years old. Such a decision of course not only contributes to a decrease in the size of the labour force (L), but it also increases the numbers of pensioners (B).

2.3.2 Wages

Let us now examine in greater detail how wages can affect the finances of PAYG schemes. As we have argued earlier on, increased wages can take some of the strain off the shoulders of PAYG schemes. This can be shown mathematically quite easily if we assume a standard two-period overlapping generations (OG) model. OG models are general equilibrium

models and they came to the forefront of economic analysis after Samuelson's (1958) work[7]. They now constitute, as Minford (1998 p.13) explains, '*the way economists model the interaction of private behaviour and government pension policy*'. Their defining characteristic is that people are assumed to be born only once a generation. Not surprisingly, the two-period OG model that we will use in this case makes the assumption that only two generations are alive at any one time t[8], a young one that contributes to the system, and an old one that receives pensions. At time t+1 thus, the previously young generation obviously becomes the old generation, the previously old generation is assumed to have died, and a new young generation has emerged. Under such a scheme, equation (1) must be transformed into:

$$cw_tL = pB \quad (8)$$

Where:	c: contribution rate	(1)
	w_t: average wage *at time t*	(£/(persons*time))
	L: number of workers	(persons)
	p: average pension	(£/(persons*time))
	B: number of pensioners	(persons)

while equation (3) must change into

$$p = rw_{t-1} \quad (9)$$

Where:

p: average pension	(£/(persons*time))
r: replacement rate	(1)
w_{t-1}: average wage *at time t-1*	(£/(persons*time))

Workers in other words are being taxed out of the wages they *currently* earn (at time t), while pensioners receive a percentage replacement of the income they *used* to earn when working, viz. of the wages they earned in the previous time period (t-1).

Assuming that wage rates grow at a rate of (n), we have

[7] The first overlapping models can be found in the appendix of the book of Allais (1947) as Malinvaud (1987) has stressed.
[8] To make some sort of sense, the duration of t must be in the range of 35 years or so.

$$w_t = (1+n)\, w_{t-1} \qquad (10)$$

Where:

w_t: average wage at time *t*	(£/(persons*time))
n: growth rate in wage rates	(1)
w_{t-1}: average wage at time *t-1*	(£/(persons*time))

But from (5), (8), (9) and (10), we ultimately get

$$c = r/(s\,(1+n)) \qquad (11)$$

which shows that an x% increase in wage rates reduces the required contributions (c) by x% as well. Rising wages can consequently have a very beneficial effect on the finances of PAYG schemes.

Let us now explore some data to see whether any potential increases in wages can mitigate the adverse demographic effects previously established. Figure 6 shows how wage rates[9] in all sampled countries have developed through the years, taking as a base (=100) the year 1992.

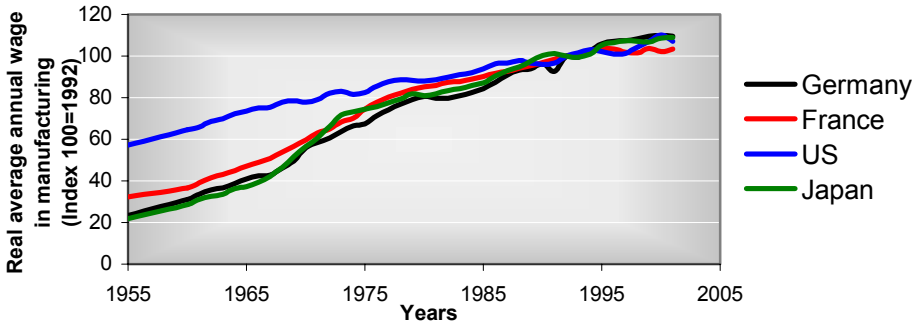

Figure 6 Real wage rates (Source: US Census Bureau)

A significant upward trend in real wages is evident in all countries (Figure 6). Given the very tight association between productivity and wage rates, the significant upward trend found in wages should also be expected to be visible when plotting productivity figures. Indeed, Figure 7[10] verifies this hypothesis.

[9] These figures apply for the manufacturing sector of the selected countries' economies
[10] The figures for the US are available only from 1977 onwards.

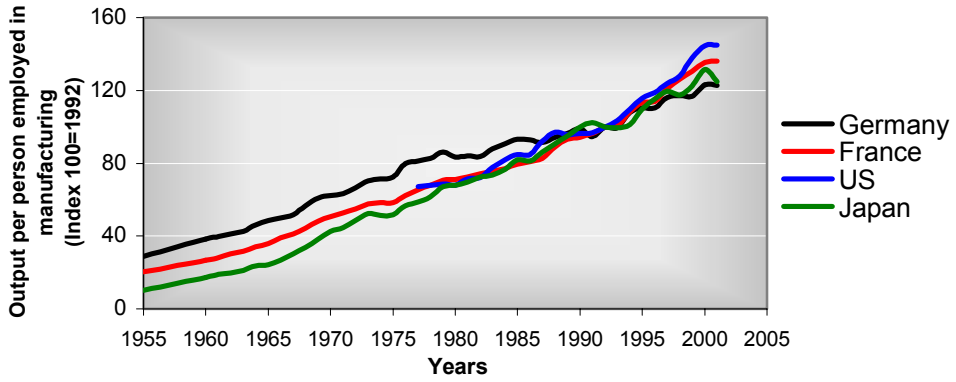

Figure 7 Productivity (Source: US Census Bureau)

Even though these increases seem quite beneficial for PAYG pension schemes, on a closer examination important deficiencies can be uncovered. Figure 8 depicts the ratio of the increase in real wages against productivity gains.

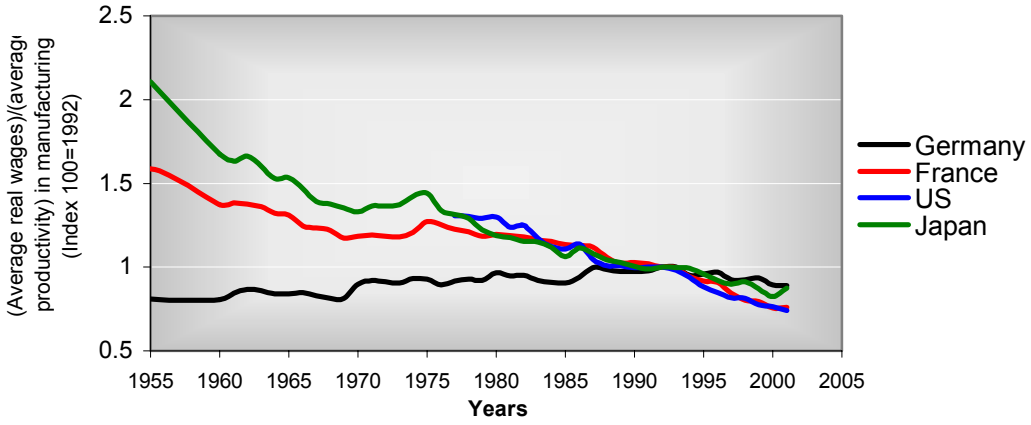

Figure 8 Wages/Productivity (Source: US Census Bureau)

Figure 8 shows that, with the exception of Germany, real wages have not managed to keep pace with the realized productivity gains. In fact a distinct declining trend can be seen to characterize the relationship between the two variables. Given that productivity determines wage rates and not the other way around, it is easy to deduce that even if productivity gains continued strongly into the future, wage rates would be expected to rise on a less than 1 to 1 ratio, unless of course this downward trend changes. For the time being however there do not exist much evidence for such alterations.

Let us now examine how the *rates of growth* of productivity have developed year on year through the years (Figure 9).

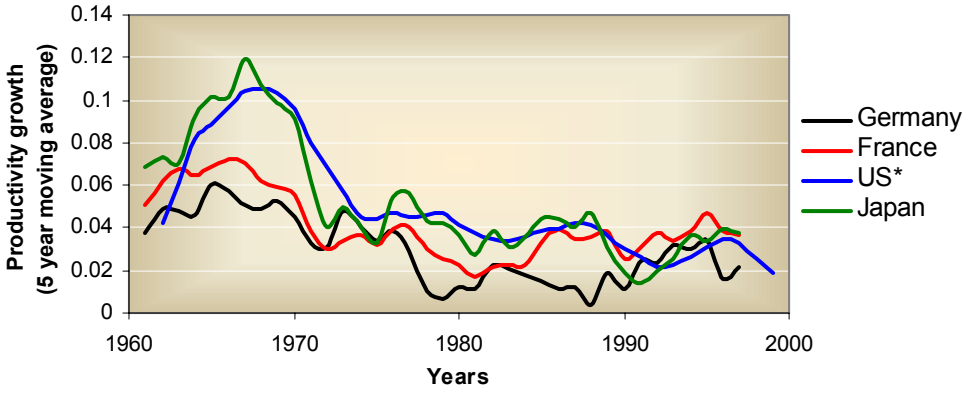

Figure 9 Productivity growth (Source: US Census Bureau)

* US figures represent output per hour in the whole of the business sector

Figure 9 shows that productivity growth has dropped markedly when compared to its past values. This slow down can also be evidenced through the reduction in the growth rates of the sampled countries' GDP (Figure 10).

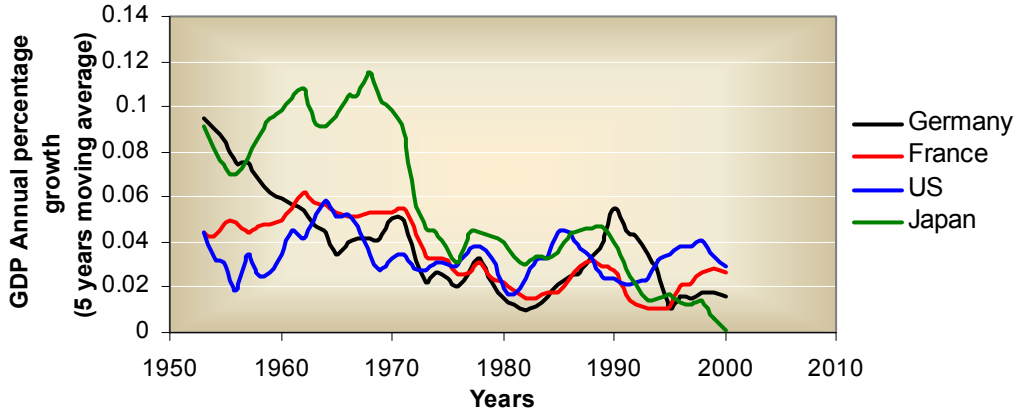

Figure 10 Annual percentage of GDP growth –5 year moving average (Source: US Census Bureau)

It is quite clear from Figure 9 and Figure 10 that after the oil shock in the 70s Western economies never quite managed to regain their momentum. It should be also easy to realize however that if the downward trends captured in Figure 8-Figure 10 continue, and there is no reason to assume that they won't, then wages cannot be expected to even approach the required levels needed to counter the adverse demographic pressures examined in section 2.2.

2.4 The macroeconomic effects of pension schemes according to contemporary economic thought.

PAYG schemes, as Espinosa-Vega and Russell (1999 p.1*) explain, '*have important effects on macroeconomic variables such as national saving, interest rates, investment and growth.*' Indeed, the principal reason for the distinction between PAYG and FF schemes is that these two different systems have markedly different macroeconomic effects (ibid p.7*)[11]. In this section of our analysis then, we will deal with the way these schemes are considered to influence the macroeconomy. The analysis that follows draws on Espinosa-Vega and Russell (ibid).

The easiest way to shed light into the macroeconomic consequences of the two different pension schemes is to conduct a 'thought experiment'. Consider an economy which has no pension scheme in place but which is about to introduce one. Before the introduction of the scheme, the citizens of this economy had to finance their own retirement through private savings. Throughout employment in other words they had to put aside some of their annual income for their old age. After the introduction of a pension scheme (of whichever type) though, active workers will have to start paying taxes (or contributions) in order to receive pensions after they retire. As a result, workers are expected to cut back on their saving rates not only because the government will now provide for them in their old age, but also because they will want to restore consumption in its pre-tax levels (see also Brauninger (1996 p.227)).

Now, the net effect on total savings in such an economy will differ according to the type of pension scheme that will be chosen. If a PAYG scheme is preferred, total savings in the economy are expected to fall. The reasoning is straightforward. The government, after the imposition of taxation on workers, will receive revenue which will be immediately distributed to pensioners[12]. Pensioners on the other hand will naturally spend these money increasing consumption. Given that workers will be cutting back on their saving rates after the system is in place, total savings inevitably reduce (see also Provopoulos ibid p.141-2).

[11] Here should be added that the greater the bequests from one generation to another are, the more the macroeconomic results of PAYG schemes will approach those of FF schemes. See for example Barro (1974)

[12] The first generation of senior citizens obviously gets a free gift.

With a reduction in savings and an increase in consumption, economic theory predicts that growth will be hampered[13]. Following the analysis in Provopoulos (ibid p.165-6)[14], consider the Production Possibility Frontier[15] (PPF) of that hypothetical economy in Figure 11.

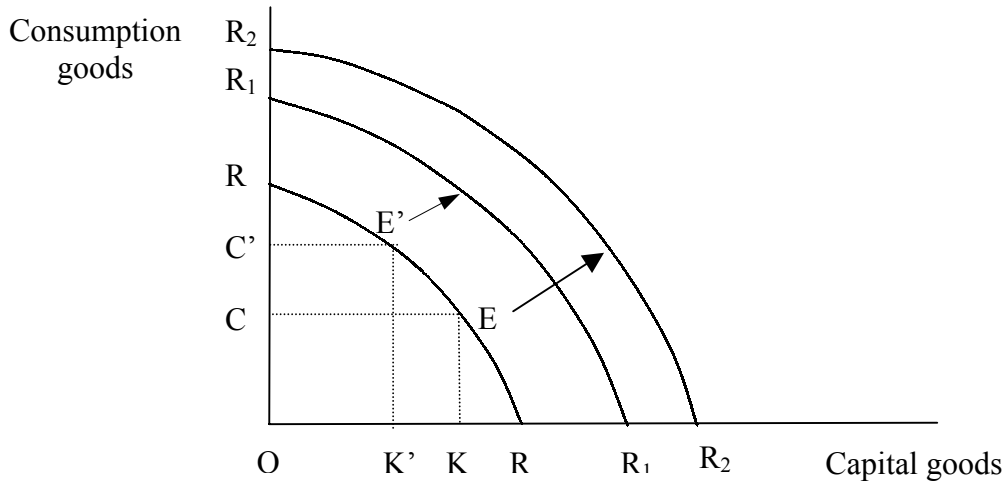

Figure 11 Production Possibility Frontier

Assuming that the x-axis represents the production of capital goods and the y-axis the production of consumption goods, a chosen combination (along the PPF) that favours the greater production of capital goods will enable a greater expansion of the PPF in the future. If we decide to produce OK capital goods and OC consumption goods in other words (point E), the PPF in the future would move outwards from RR to RR_2. If on the other hand we choose to produce more consumption goods selecting the combination E', the PPF in the next period will only move from RR to RR_1. The choice on which combination of Consumption-Capital goods to produce will naturally depend on the consumption habits of the economy's citizens. Only by sacrificing consumption will it be made possible to fund the production of capital goods. It follows, that an increase in consumption will reduce the production of capital goods.

[13] These are naturally the results that are found by the majority of OG models as well. See for example Auerbach and Kotlikoff (1987), Saint-Paul (1992), Wiedmer (1996), Storesletten , Telmer, and Yaron (1999) etc. According to different assumptions however, the results can vary. This can be seen clearly in Kemnitz and Wigger (2000) for example, where the engine of growth of their OG model is taken to be human capital.

[14] See similar analysis in Samuelson and Nordhaus (2001 p.12-3)

[15] The PPF, or else the transformation curve, is according to the Penguin dictionary of economics (1992) *'a graphical representation of the maximum amount of one good or service that an economy can produce* (say consumption goods in our case) *by reducing production of a second good or service* (capital goods) *and transferring the resources saved to the production of the first good*.'

Samuelson and Nordhaus (2001 p.34) summarize this point '*If people are willing to save – to abstain from present consumption and wait for future consumption – society can devote resources to new capital goods. A larger stock of capital helps the economy grow faster by pushing out the PPF.*'

An increase in the production of capital goods of course does not benefit an economy at all times. The beneficial effects occur only if the economy is dynamically efficient, viz. only if the rate of return on marginal capital is relatively high. Since most developed economies are considered to be dynamically efficient (Abel et al 1989) PAYG schemes are generally considered to restrict growth[16] (see also footnote 18).
A reduction in savings also has an adverse effect on interest rates provided that the economy is not completely open[17]. Assuming an investment setting and a closed economy, Figure 12 shows how interest rates equalize the demand for investment funds with the availability of credit – represented by savings.

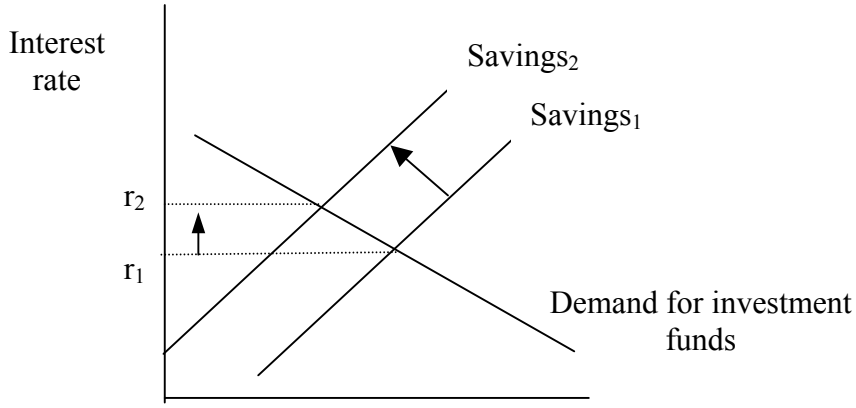

Figure 12 Interest rates as determined from the demand for investment funds and savings

[16] Samuelson (1958) and Aaron (1966) have shown that PAYG schemes can increase welfare when the rate of growth of the population (which implicitly equals the growth rate of the people employed) and the growth rate of real wages (viz. real per capita income) exceed the growth in interest rates. That is the reason why PAYG systems are likened many times to Ponzi schemes. They bear the same characteristics as the schemes of Charles Ponzi, the originator of chain letters to raise money (see Blanchard and Fisher (1989 p.84)).

[17] When considering a fully open economy, interest rates are assumed to be set exogenously and therefore independently of the domestic demand for investment funds or the domestic savings levels. There exist two main reasons however for assuming an endogenously determined rate of interest (Miles 1999 p. 12). Firstly there exist plenty of evidence that domestic investment is financed by domestic savings (Feldstein and Horioka 1980, Obstfeld 1995). And secondly, even if interest rates were dependent upon global savings and investment funds demand, the nature of the SS crisis is such that it affects almost all developed countries and it would consequently affect the relevant global magnitudes anyway.

The reduction in savings naturally causes an upward (leftward) shift of the savings curve (from $savings_1$ to $savings_2$), and interest rates adjust upwards (from r_1 to r_2) to ensure equality between investment funds and savings[18].

Vega and Russell (ibid p8*) consequently conclude: '*a basic prediction of social security theory is that establishing a pay-as-you-go system should cause the amount of saving in an economy to fall and the interest rate in the economy to rise*'.

Now, if the hypothetical economy in question decides to adopt a FF scheme instead, the level of savings, and consequently the level of the interest rates in the economy should remain unchanged. This can be easily deduced. The amount of money that the government would receive from the workers' contributions instead of being distributed to pensioners, they are directed into investment funds. The reduction in private savings that would result from the imposition of the contribution rates on workers would be consequently met exactly by the direct increase in investment funds. The supply schedule in Figure 11 therefore would remain unchanged, and so would the interest rate levels. Consequently Vega and Russell (ibid) write '*a second basic prediction of social security theory is that establishing a fully funded social security system should have little or no effect on the economy. Stated differently, an economy with a fully funded social security system is not much different* [in macroeconomic terms] *from an economy with no social security system.*' They subsequently reason (ibid) '*It follows that switching from a pay-as-you-go system to a fully funded system should cause the total amount of savings to rise, producing a decline in the interest rate.*' On the same line of reasoning explicated above, they add that such a switch would eventually boost investment and consequently growth (ibid p.9*; see similarly James (1998), Orszag and Stiglitz (1999))

The transition from PAYG to FF systems however cannot be achieved painlessly. With a sudden adoption of a FF system, the problem of how to finance the benefits of existing and near-future beneficiaries who have been making contributions to the PAYG system for years emerges. To force existing workers to provide both for their own future retirement as well as for the sustenance of those beneficiaries would simply put too

[18] Increased interest rates are also considered to hamper investment and consequently growth since they increase the cost of capital; see for example Niggle (2000 p.7*,9*) who also presents the counterarguments to this hypothesis (ibid p.9-11*), Bohn (1997)

much strain on them. Such measures would consequently seem unfeasible from either a political or from an economic point of view. As a result Espinosa-Vega and Russell (ibid p.10) note '[*t*]*he transition strategies that seem most likely to be politically feasible would involve spreading the burden of financing the social security benefits due …across a number of future generations of workers.*' And the obvious strategy to accomplish this task would involve the issuance of long-term debt[19], as for example was the case in Chile which was the first country that handled the transition (Williamson (2001), Piñera (1999)). Given mainly the difficulties associated with this transition along with some additional issues some of which will be subsequently touched upon, a heated debate takes place over the potential improvement or deterioration in welfare in the case of a replacement of PAYG systems by FF ones. (See indicatively the World Bank (1994), Feldstein (1995), Shipman (1998), and Kotlikoff (1992) who argue in favour of the transition, and Ball (1997), Boldrin et al (1999), Mueler (1998), and Niggle (2000) who argue against.) It must be added though that in favour of the transition have been set many international financial institutions including the World Bank as we have seen, the IMF, and the Inter-America Development Bank (Williamson 2001 p.296)

3 A SYSTEM DYNAMICS MODEL

It was previously maintained that OG models set the standard in economics when analysing pension policy. OG models however adhering to the neoclassical tradition of economic analysis include many assumptions which are made solely for mathematical convenience rather than realism. The two standard assumptions found in almost all OG models include an optimising behaviour by all parties involved in the model, and an equilibrium concept that reconciles people's decisions with their fellow beings, government policy, and technology (De Nardi et al (2001)). Both of these assumptions however seem quite odd within the context of real economies since the real world is generally fraught with disequilibrium dynamics and genuine uncertainty (in Knight's sense). In fact the invocation of rationalisation within the context of pension economics is twice as striking given the main reason for the obligatory nature of pension schemes around the world. Diamond (1993 p.143) explains '[*A*]*nalysts of social insurance generally recognize that a*

[19] The mere issuance of long-term bonds in itself does not imply that a country is moving away from a PAYG scheme to a FF one. Of vital importance is for that country's government to gradually retire those bonds instead of keep rolling them over indefinitely (Espinosa-Vega and Russell (ibid)).

critical part of the case for having social insurance is the failure of individuals to adequately look ahead and provide for their own retirements.[see similarly De Nardi et al (ibid p.21)] *Thus social insurance analysis is one place where the rationality assumptions of economists are not given a full rein as in most other areas of economic analysis*'

These two assumptions, as far away from reality as they are, are not the only ones that produce discrepancies between real economies and OG modelling. Additional simplifications that can be generally found in many (but not necessarily all) such models include: time being measured in units of generation (Samuelson (1958), Diamond (1965)); zero risk (Pemberton 1999); infinitely-lived people (Weil 1987); constant probability of death in all periods (Blanchard (1985)); unchanging marginal propensities to consume for all generations (Blanchard (ibid), Weil (ibid)); perfect annuities markets viz. elimination of uncertainty about the time of death (Gertler (1999)) etc. The emergent results of OG models therefore can be potentially misleading. A different modelling methodology is consequently adopted herein, which allows for a considerably more realistic approach to modelling and understanding pension economics. The previously described thought experiment is here simulated in an aggregate SD model which enables nevertheless the examination of the basic macroeconomic issues associated with pension economics. The model's results will be shown at times to be quite unintuitive.

3.1 Demographics

Figure 13 depicts the spinal flow of the population sector of this model.

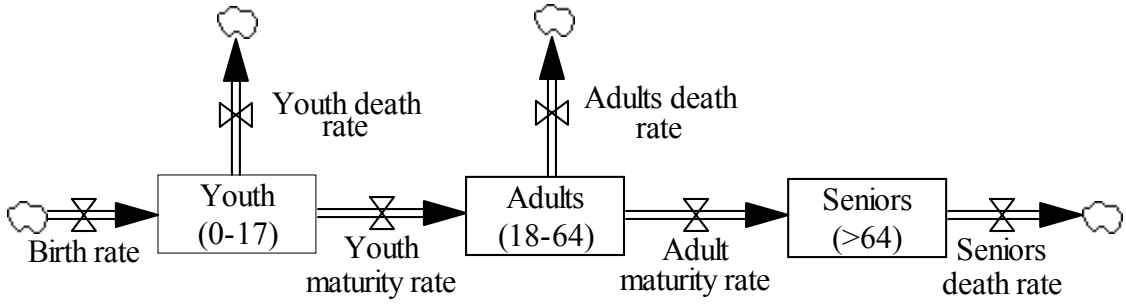

Figure 13 Population sector

As can be seen, total population is separated into three categories according to age: the youth, the adults, and the senior citizens. From the

time people are born until their 18th birthday they are considered to be youths subsequently entering adulthood where they reside until they are 65. From 65 onwards they are transferred into the senior citizens category where they stay until they die. Figure 13 also makes clear that people die not only after they reach seniority, but throughout their lives. Different death probabilities of course are associated with the three identified categories. The youth death fraction in particular equals 0.0025, the equivalent for the adults is 0.0075, and for seniors 0.067 approximately. As one might imagine, different numbers may be tested. Regarding death rates they are evenly spread out throughout the lives of individuals while in the youth and adults categories, whereas when they reach seniority a first order death rate delay applies. The birth rate on the other hand is set exogenously. As is often the case in SD finally, the initial values of the three levels along with the birth and death rates have been chosen to allow for an initial equilibrium. In that way the exploration of different dynamic hypotheses can be carried out more clearly avoiding possible mistakes.

Let us now perform a few tests to see how well this model handles demographics. Figure 14 shows the dynamic behaviour of the three identified levels when the birth rate doubles for only one instance in year 20 through a *pulse* function.

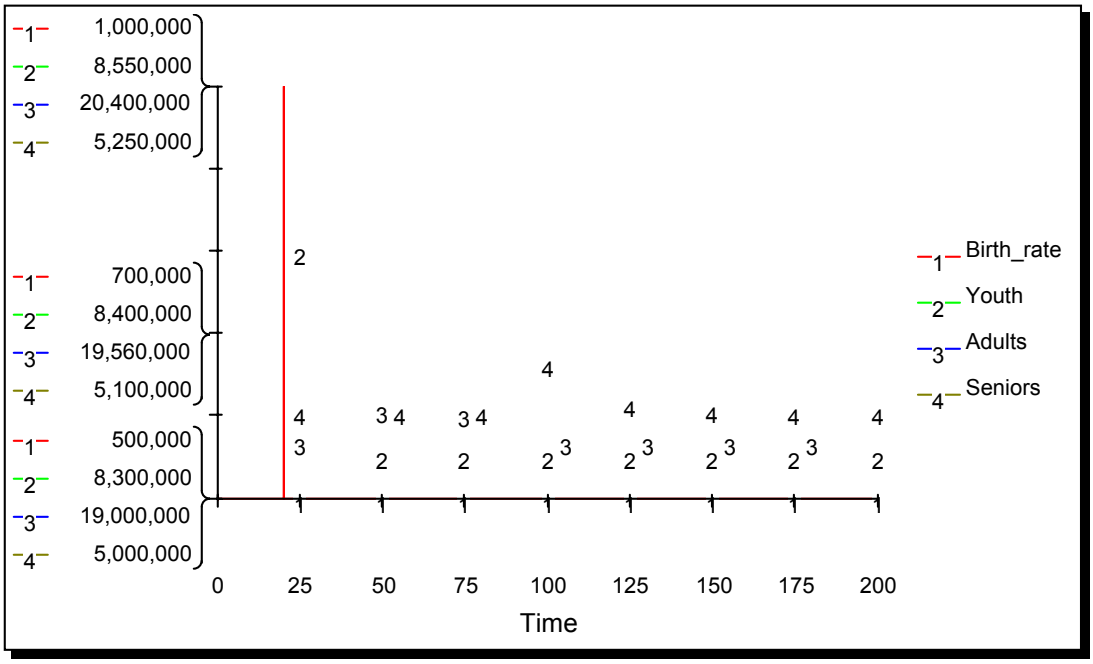

Figure 14 Doubling the birth rate for only one instance through a PULSE function: Plot of birth rate, youth, adults, and senior citizens

Figure 14 above shows that indeed before the doubling of the birth rate in year 20 no dynamics occur since the model is set in equilibrium. After year 20 however youths increase in numbers. A slight uniform reduction in the number of youths as time progresses can be observed which of course signifies the deaths of the youth. After 17 years, viz. at year 37 approximately, a sudden reduction in the youth numbers is observed with an equivalent increase in the number of the adults. As previously, the number of the adults decreases uniformly thereafter until the surviving adults reach seniority (year 84 app.). At that point, again, the number of the adults drops instantaneously and that of the senior citizens increases. The first order delay in the death rates of senior citizens thereafter concentrates the majority of deaths within the first 15 years of their life (years 84-100 app.), while by the year 130 almost all the dynamics produced due to the increase in birth rates 110 years ago, die off.

Let us now explore the consequences of a doubling in the birth rates for a period of 25 years which corresponds approximately to one generation. This augmented generation will be referred to as generation Z for convenience. Two *step* functions are used in this case with the birth rate doubling at year 20, staying at those increased levels for 25 years, and finally returning back to its original levels by year 45. Figure 15 depicts the output.

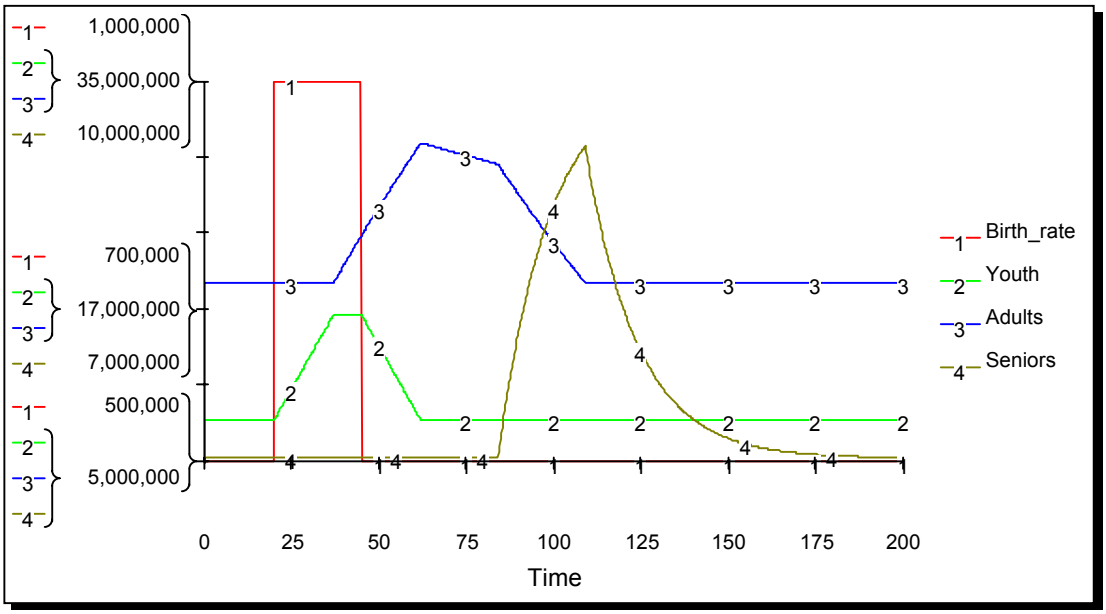

Figure 15 Doubling the birth rate for 25 years: Plot of birth rate, youth, adults and senior citizens

The dynamics in Figure 15 are somewhat more complicated than before. Without going into the details of the stocks and flows[20] relationship we can note that after the step increase in the birth rate, the number of youths increases uniformly as expected[21]. Between years 37 and 45 the number of youths remains unchanged which should be again expected given the equilibrating inflows and outflows of the youth stock. Thereafter the number of youths declines towards its initial value which it eventually reaches by year 62. Evidently, this number emerges from the time the birth rate is re-established back to its original levels (year 45), plus the number of years youths have to wait until they reach maturity (17 years).

The number of the adults on the other hand increases uniformly from year 37 app. (derived from the time the birth rate first doubled (yr 20) plus the number of years it takes for youths to mature (17 years)) until year 62 where the previously increased birth rates cease to exert an influence. The subsequent uniform decrease until year 84 app. takes place due to the increased death rates of generation Z which cannot be compensated by the now reduced youth maturity rates. Once year 84 is reached the reduction in the number of the adults gets more aggravated since generation Z is gradually entering seniority. The senior citizens stock therefore starts to increase until it also falls back into its initial levels after year 155 approximately.

The complexity of the output in Figure 15 probably justifies the presentation of all relevant rates of the population sector which are provided below (Figure 16).

[20]See Sterman (2000 Ch.6-7), Goodman (1980 Ch.2, Ex.2) for greater details.
[21] Here should be reminded that death rates for youths and adults are assumed to take place uniformly throughout their youth and adulthood -see Figure 16.

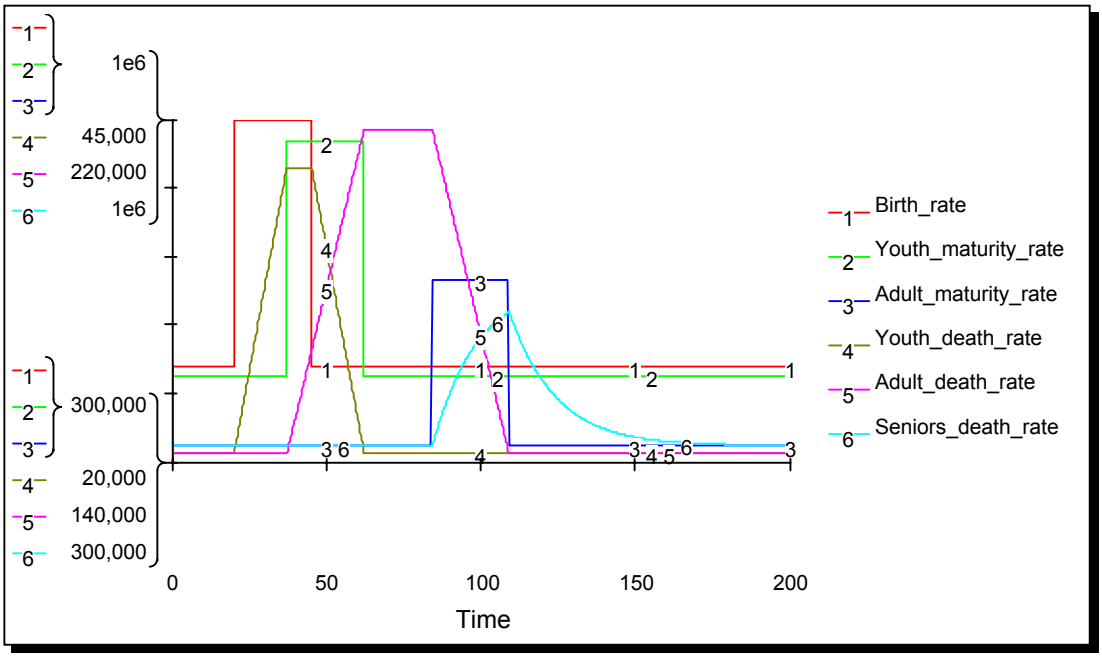

Figure 16 Doubling the birth rate for 25 years: All relevant rates required to explicate the dynamics of Figure 15

The next test that is performed deals with the dynamic effects that would emerge solely from an increase in the average life span of senior citizens. An assumption is made thus that at year 20 of the simulation a 60-year process is initiated that will ultimately increase the average remaining life of senior citizens from 15 to 20 years. This process is evidently gradual and the increase in the average remaining life of senior citizens takes place uniformly throughout the 60 years. Figure 17 shows the results of such an increase.

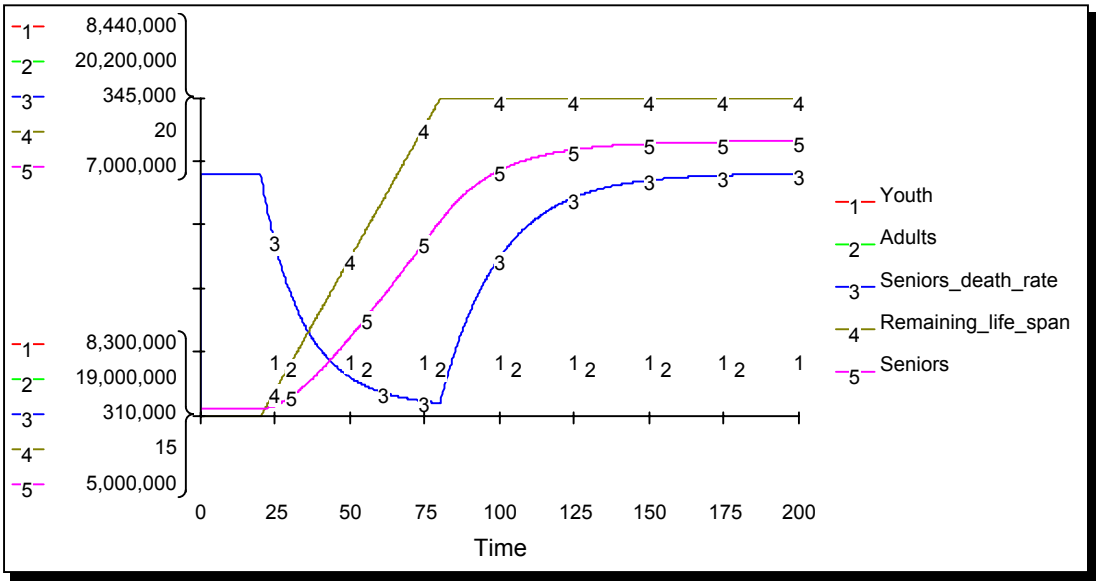

Figure 17 Increasing average lifespan of senior citizens by 5 years: Plot of youth, adults, seniors, seniors' death rate, and the average remaining life span

As expected, both the youth and the adults stocks remain unaltered, while the stock of senior citizens increases. The reason for this increase of course is the reduction in seniors' death rate that can be seen in Figure 17, which of course emerges from the increase in the average remaining life of senior citizens.

Finally, an extreme test is performed with the birth rate reducing to zero at year 20. The output is presented below (Figure 18)

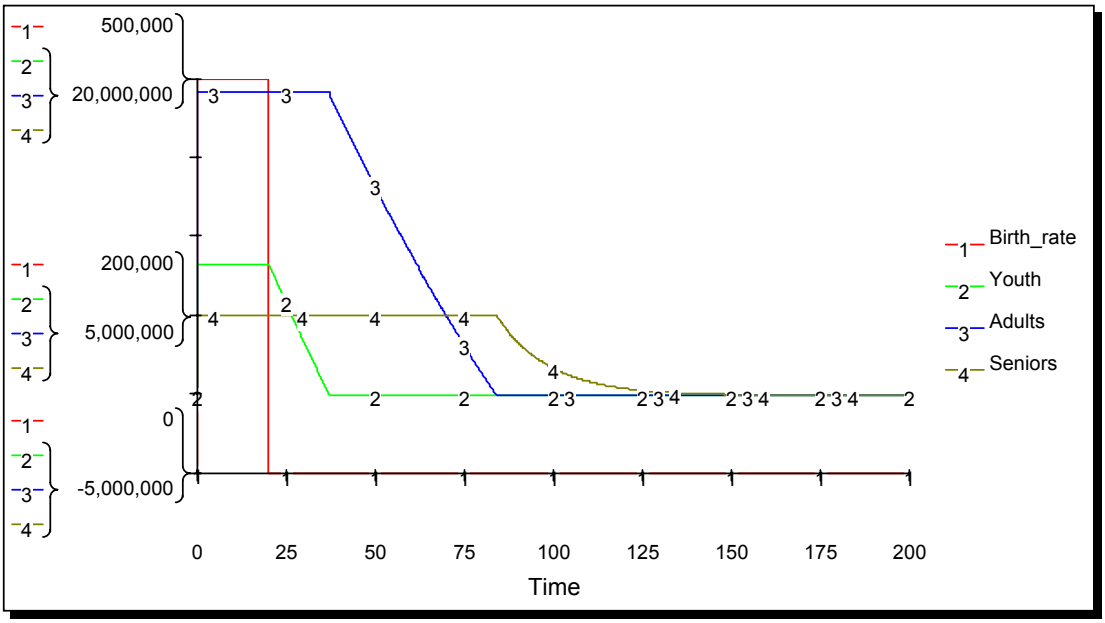

Figure 18 Extreme test with birth rates reducing to zero: Plot of birth rates, youth, adults, and senior citizens

Indeed, all three stocks in the model reach zero at the expected times.

3.2 The economy

Let us now explore the structure of the economy in this aggregated model. The influence diagram in Figure 19 shows some of the main postulated interrelationships.

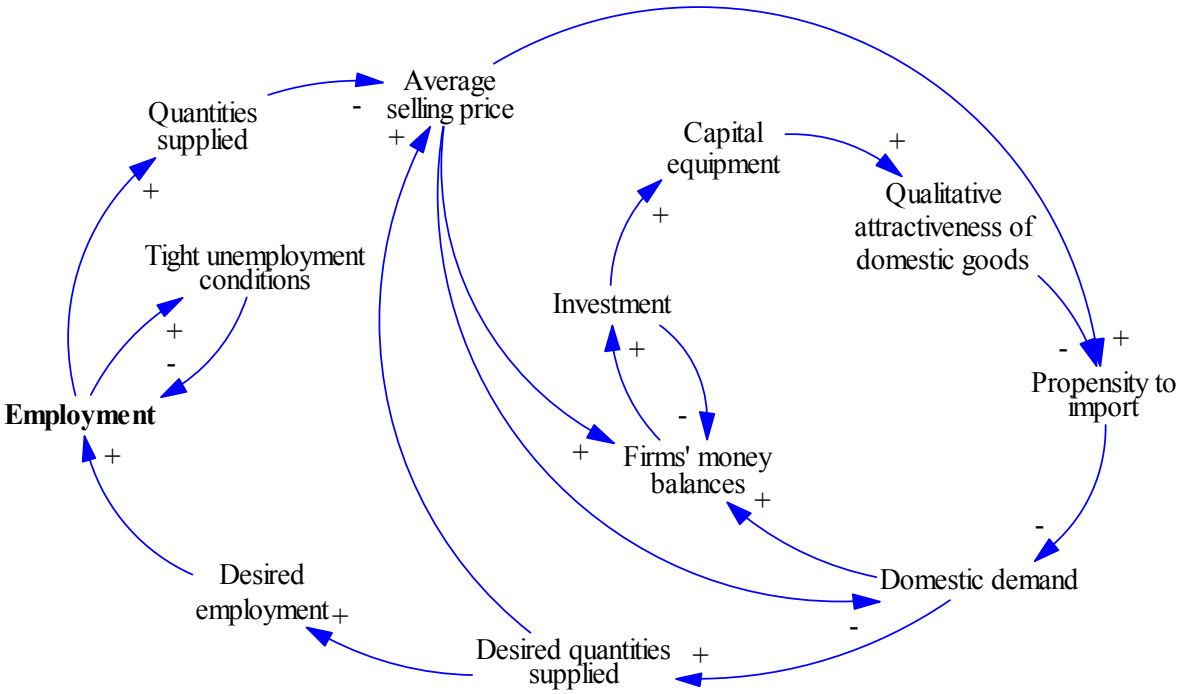

Figure 19 High-level influence diagram of the model

As shown above, employment varies according to its desired levels which in turn depend on the desired quantities of goods and services that the domestic economy would like to supply. Evidently, an increase in the desired quantities supplied of domestic products will result in a wave of new recruits in an attempt to boost employment and consequently supply. Employment however cannot increase unrestrainedly. The less the number of the unemployed within the economy the more difficult it will be to hire new personnel. Such pressures would consequently lead to a rise in wages (Figure 20) since the only way to increase personnel in an economy where almost everybody has a job is simply to hire people who are already working in other firms; but to attract such people more lucrative wages must be offered.

Returning to the analysis in Figure 19, the greater the quantities supplied are the less the average selling prices will be all other things equal. Lowered prices will naturally affect profits and consequently firms' money balances adversely, yet they will also boost domestic demand not only through an income but also through a substitution effect since domestic products will become more competitive internationally. Lower average selling prices thus are assumed to reduce the propensity to import and domestic demand rises even more. Not surprisingly, such raises boost

firms' money balances and they also increase the desired quantities supplied closing a positive feedback loop.

Investment next is considered to depend upon firms' money balances. Naturally, the greater the firms' funds, the greater investment will be. Investment related expenditure of course, like all expenditure, reduce these funds, yet they ultimately allow for a growing base of capital equipment. In this model, such an increase is associated with a betterment of the products' quality and therefore with a greater attractiveness of domestic products both at home and in the international markets. The propensity to import therefore reduces further, exports increase (not shown), and another positive feedback loop is closed.

Figure 20 below shows an aggregate picture of the consumption-related variables included in the model.

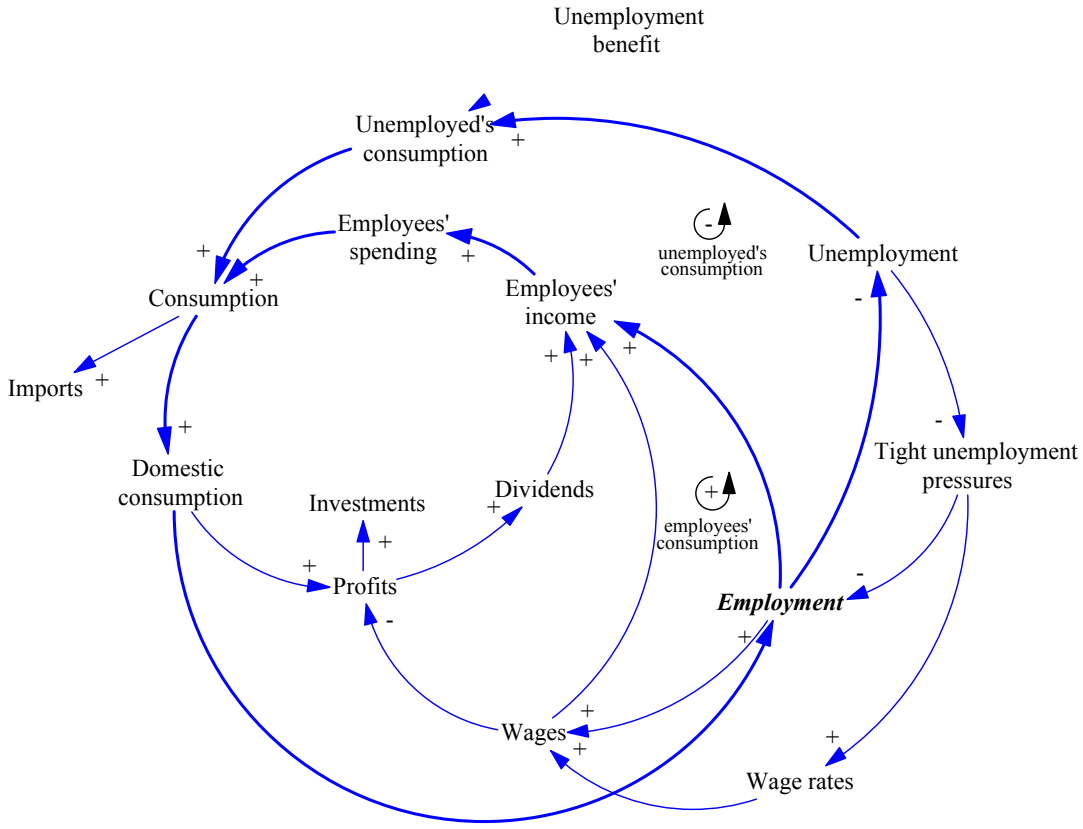

Figure 20 Influence diagram concentrating on consumption-related variables

Tracing the wider arrows in the diagram above two important feedback loops can be distinguished: the positive employees' consumption loop, and the balancing consumption from the unemployed loop. The former of

the two loops shows that the greater employment is, the greater the employees' income will be and consumption subsequently raises leading to even greater employment levels and so on. There exist however two opposing forces that restrain this growth. Firstly it is the gain of the loop which lies well below one, and secondly the consumption from the unemployed loop which acts as an automatic stabilizer. In particular, the less the number of the unemployed in the economy, the fewer unemployment benefits will be paid out by the government, the more the consumption from the unemployed will reduce and total consumption will naturally fall at lower levels than would have otherwise been the case.

Figure 20 finally also depicts the adverse effects that an increase in the wage rates can have on profits providing a third reason for the containment of the positive employees' consumption loop. Although increased wages add to employees' income they also reduce profits which lead, in turn, to reduced dividend payments and thus lower consumption and demand.

3.2.1 Pensioners and the workforce

In most of the runs examined in this paper the workforce and the number of pensioners correspond exactly to the adults and senior citizens levels accordingly. Alternative runs where the retirement age rises thereby expanding the workforce have also been included however (section 3.3.1c). The stock-flow diagram for modelling this expansion is shown below (Figure 21).

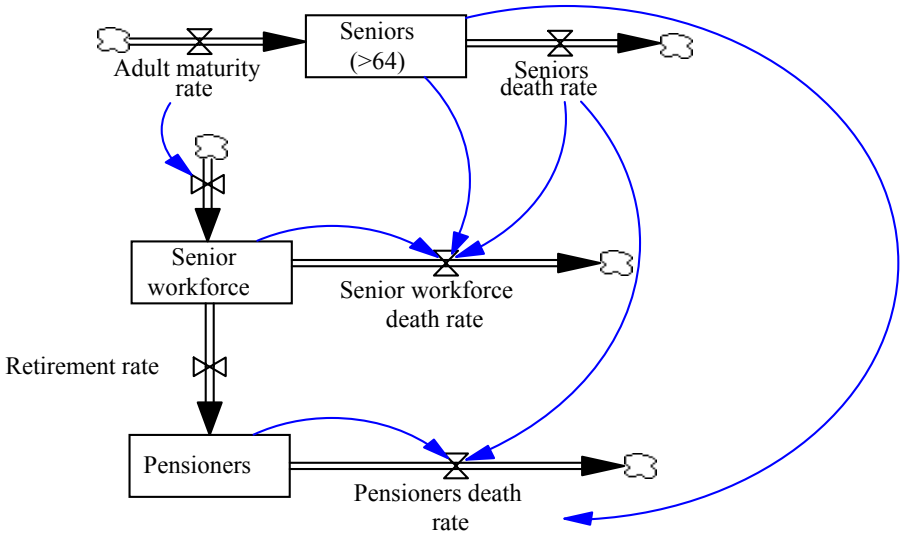

Figure 21 Stock-flow diagram of Expanded Workforce

As can be seen, in this case too most of the dynamics are driven from the population sector (section 3.1). Instead of retiring when reaching seniority however senior citizens join the so-called senior workforce where they remain for a specified length of time before they join the pensioners level.

From the analysis in this section it becomes clear that the number of pensioners itself whether in the expanded or the constant version of the time required for retirement is independent of employment. This deficiency is countered however by the inclusion of the employment rate multiplier which determines the levels of average pensions that are to be paid out according to the average duration people spend in employment (see section 3.2.3)

3.2.2 The flow of money

Depicted in the figure below (Figure 22) is the flow of money of the model.

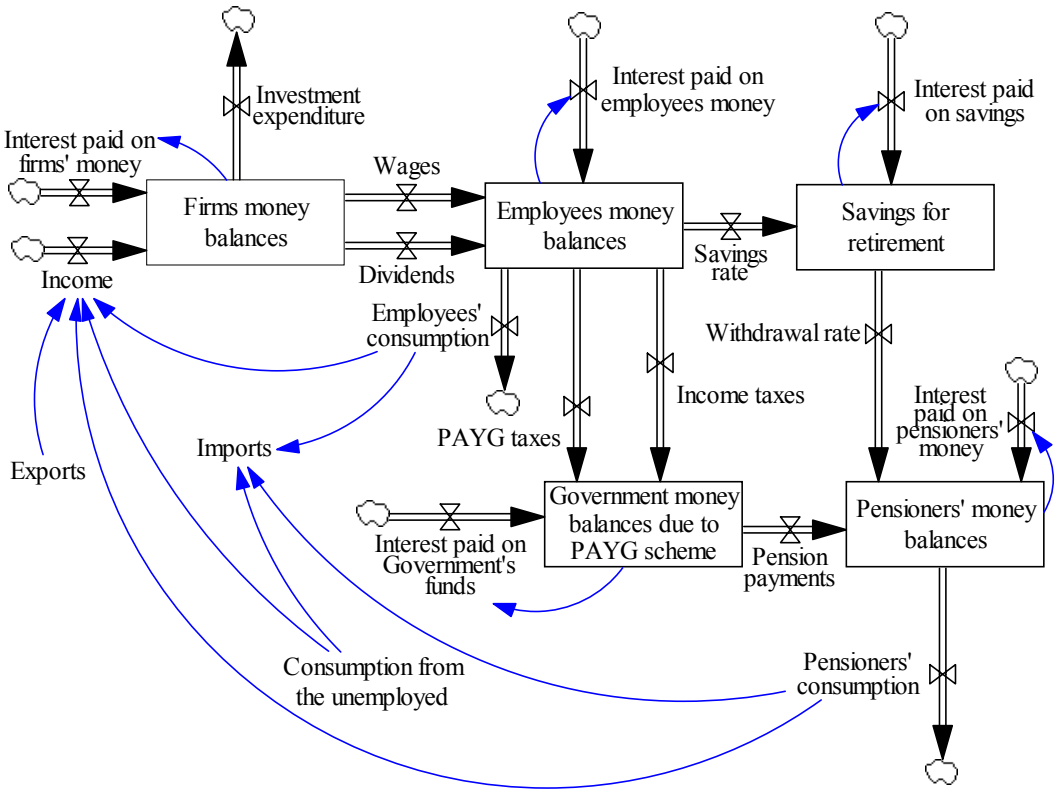

Figure 22 The flow of money

Starting from firms' money balances, we can see that they increase due to four different incoming rates, the consumption from the employed, the

unemployed, the pensioners, and from exports. Assuming positive interest rates firms' money balances, just like all other stocks shown above, also increase when they exceed zero. Firms' outlays on the other hand are constituted by investment expenditure, the wages they have to pay out to their personnel, and dividend payments. The two latter outflows constitute the incoming flows of employees' money balances. The assumption made here therefore is that dividends get paid only to the employed although we could have just as easily assumed that they get equally distributed to all parties including the unemployed and pensioners. Employees subsequently save some of this money for retirement and they consume the rest with a first order delay. Employees' consumption is directed to both imported and domestically produced products according to the propensity to import as has been shown earlier on (section 3.2).
Savings for retirement accumulate throughout the working life of individuals and they are cumulatively withdrawn upon retirement. The withdrawal rate subsequently accumulates in pensioners' money balances which are eventually depleted by pensioners' consumption. As previously, consumption is again directed to both imported and domestically produced products according to the propensity to import.

At some chosen time of the simulation (see section 3.3) next, a PAYG scheme is introduced with the Government starting to collect taxes from the employees and subsequently paying them out to pensioners according to the desired wages replacement rate. Evidently, pension payments also accumulate in pensioners' money balances before they are spent. If government money balances are at some point less than what is required for paying out the pensions (additional) income taxes are instantaneously levied on employees' funds to cover the difference. The instantaneous nature of income taxes although highly unrealistic saves the modellers from augmenting the model unnecessarily.

In the alternative scenario where the PAYG scheme is replaced by a FF one, some adjustments need be made in the flow of money as highlighted in Figure 23.

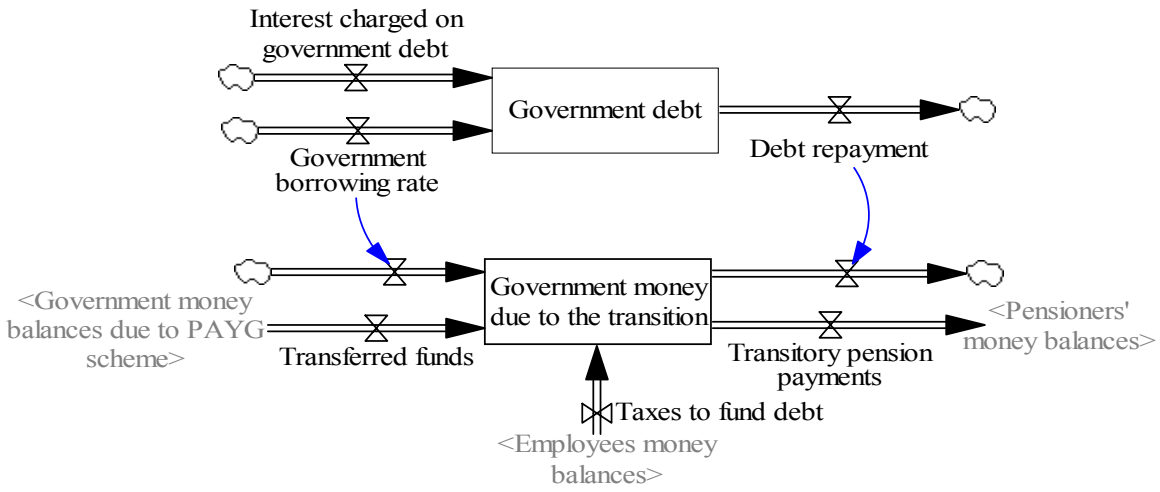

Figure 23 Required adjustments for modelling the transition from a PAYG to a FF scheme

Firstly an additional stock, *government debt*, is introduced. As was the actual case with all countries that attempted the transition, the government in this model is assumed to take up debt in order to finance the required expenditure for the transition. As the model currently stands, this is assumed to be foreign debt in its entirety. Debt naturally increases by government borrowing and the interest surcharges on that money, while debt repayment depletes it. For simplicity, the government is again assumed to borrow money according to the instantaneous needs it has for paying out the transitory pensions. These comprise of the pensions that must be paid to both the current and the future pensioners who have already been making contributions to the SS system under the old (the PAYG) regime which is now dismantled. Debt repayment on the other hand ensures that the borrowed funds along with the interest surcharges are returned in equal instalments within the next 100 years.

Another stock that can be usefully introduced in the analysis is the one identified above as *government money due to the transition*. This stock handles explicitly all the inflows and outflows that are necessary for the transition. As shown above (Figure 23), this level increases by any surplus funds that might have accumulated in the government's coffers as a result of the previously established PAYG scheme as well as by government borrowing and taxation. This latter variable of course signifies the taxes that must be raised domestically to repay for the borrowed funds, and they are all assumed to come out of employees'

funds[22] as can be seen. Transitory pension payments and debt repayment on the other hand deplete the stock as expected. Here should be added that the government is firstly assumed to spend all transferred funds for paying out the transitory pensions before resorting to borrowing.

Additional stocks for modelling the accumulation of funds under the new FF system were not considered necessary for the purposes of the model as it currently stands. These funds simply accumulate undifferentiated in the *savings for retirement* stock shown in Figure 22.

3.2.3 *Further assumptions: initial conditions, constants, table functions, and the capital equipment sector.*
In this simulated economy total population stands at approximately 32 million people with approximately 8 million youths, 19 million adults, and 5 million senior citizens. The annual birth and death rates, which as will be remembered stand in initial equilibrium, equal 500K people.

Employment initially stands at 90% the workforce levels and it is set to adjust to its desired levels with a mean time of three years. The precise relationship that holds between increasing employment and the eventual pressures that arise due to the diminution of the unemployed is presented below (Figure 24).

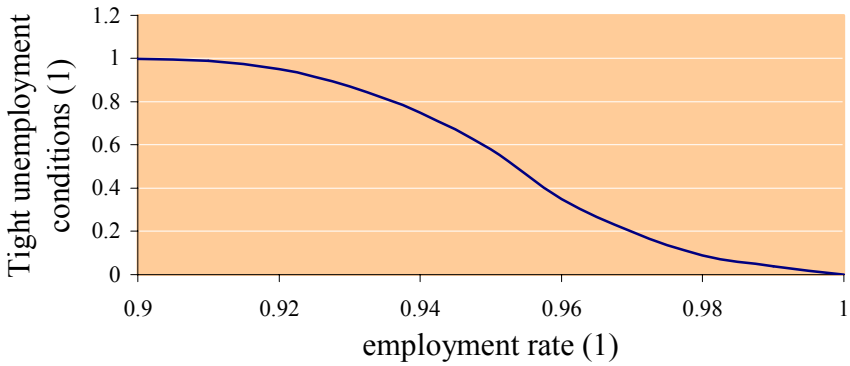

Figure 24 Tight unemployment conditions multiplier

It can be seen from Figure 24 above that at a 90% employment rate no pressures are in place constraining employment. As the employment rate slowly exceeds the initial 90% levels though, pressures due to tight unemployment conditions begin to emerge, initially only in those limited

[22] Evidently, the outflow rate 'PAYG taxes' ceases to deplete employees' money balances once the PAYG scheme is eliminated.

areas of the economy where unemployment is already below the average. Employment pressures are consequently pretty much contained and average hiring rates reduce by only little. If average employment continues to climb however, these pressures become much more widely felt and the restraining pressures on hiring become considerable as shown by the steep fall of the table function shown above (Figure 24). Should the employment rate approach the 96-97% levels the pressures become so great that further increases in employment make only relatively little additional difference given the already very high restraints in hiring. Naturally, in the extreme case where the employment rate reaches 100%, hiring falls to zero.

The average quantities supplied and demanded upon which employment and pricing decisions are made as already seen, are averaged over a mean period of three years, while any discrepancies in the order backlogs are to be desirably eliminated also in three years (mean) time.

Moving on to the money flows, the net of interest firms' money balances initially stand at 100 billion money units, which for simplicity we shall call pounds (£), and they naturally determine the level of dividend payments that are to be paid out. In particular, dividends deplete firms' money balances through a first order material delay with a mean delay time of 5 years.

As regards the annual (average) wage rates, they stand initially at £17000 but they vary according to the levels of the existing workforce and desired employment. If wage rates are set to increase, the increase is assumed to take place relatively quickly, viz. with an average delay time of 2 years; if they are to reduce though a much greater delay time is involved which comes to 16 years. This signifies the great difficulties that employers have to face when cutting back on wages. The annual unemployment benefit rate on the other hand remains constant throughout the simulation at £6300.

Spending delays for the consumption of the yearly income of the workforce is at an average of 3 years while pensioners and the unemployed who are assumed to spend within only one year mean delay time. The cumulative withdrawals that pensioners take out of the savings they had been accumulating while working on the other hand are spent with a first order delay and a mean time that matches their life

expectancy. The propensity to save for retirement equals 0.2 of wage income only although it will vary with different runs.

The propensity to import on the other hand equals 0.3 initially, yet it varies with the domestic average price levels and the attractiveness multiplier according to the figure below (Figure 25)

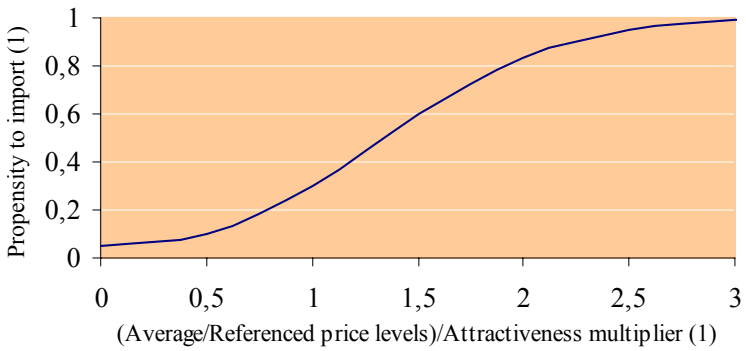

Figure 25 Propensity to import

We can see that even if domestic products were given away for free, there is still assumed to be some demand for imported products. With average selling prices equal to their referenced, viz. their initial –for simplicity- price levels, and with attractiveness equal to one, the propensity to import goes up to 0.3. Thereafter further domestic price increases or declining qualitative product attractiveness increase the propensity to import up to the point where domestic prices triple in respect to their referenced values. At that extreme point all domestic demand is assumed to be diverted away into imported products.

Regarding pension payments, it is assumed that they are provided at an approximately 73% replacement rate of an employee's average wage rate, which is in turn calculated simply as a first order information delay with an average delay time of 15 years. In that way the fact that pension payments are influenced the most from the wages one earns during the last years of his/her employed life (viz. before retirement) is captured in the model. With varying employment levels however the full replacement rate is not necessarily paid out to every pensioner at all times. The employment rate multiplier -depicted in Figure 26- captures the relationship between average employment and the proportion of the full pensions that are to be paid out for all possible employment rate values.

Figure 26 Employment rate multiplier

It is illustrated above (Figure 26) that with average employment standing at 90% the workforce levels, average pension payments reach 94% of their full levels while for full pensions to be paid out the average employment rate need not actually reach unity. This happens due to the fact that in almost all countries full pensions are paid after a particular number of years (normally around 30-35) are spent in employment. Even with some unemployment prevailing thus (3% app.) most people in this model are assumed to manage to complete this period in employment given the substantially greater length of time they belong to the workforce. Following this same reasoning, while average employment stays at relatively high levels the employment rate multiplier also stays quite high. If there is a reduction below the 90% levels though, the average pensions that will be paid out reduce quite drastically. The reason for this reduction is explicated as follows: Low levels of employment usually correspond with low demand and low profitability. Firms at such difficult times usually try to trim down their costs and one of the measures they assume is to fire employees before they are made eligible for the wage increases which are associated with the number of years one stays employed. As a result labour turnover increases. The people who have been recently dismissed however find it harder to get another job because they would cost more to their new employer. It can be understood then that their chances of staying employed for long periods of time diminishes more than proportionately with the increase in unemployment. In any case though different shapes for the employment rate multiplier can be easily tested. The main alternative that is used in this paper simply assumes a 45° straight-line relationship between the multiplier and the employment rate.

As regards capital equipment, they are represented by a stock which increases through the delivery rate of new equipment and depletes through depreciation as shown below (Figure 27).

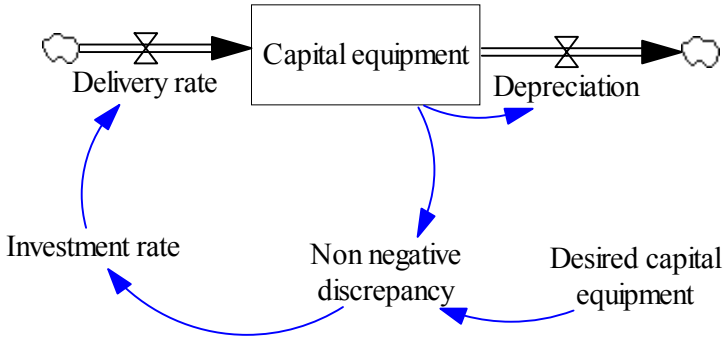

Figure 27 Stock-flow structure of capital equipment

The delivery rate is a first order delay of the investment rate with an average delay time of 3 years, while the investment rate itself depends upon the non-negative discrepancy of the desired minus the actual capital equipment. This discrepancy is to be eliminated in an average time of 4 years. If actual capital equipment exceeds its desired levels on the other hand, the investment rate simply reduces to zero and the stock eventually reduces due to depreciation. The average life of capital equipment equals 15 years and their average unit price equivalent comes up to £5,000.

As previously noted, the attractiveness multiplier of domestic products depends on the levels of capital equipment that exist within the economy. The precise relationship for the base-case scenario is depicted below.

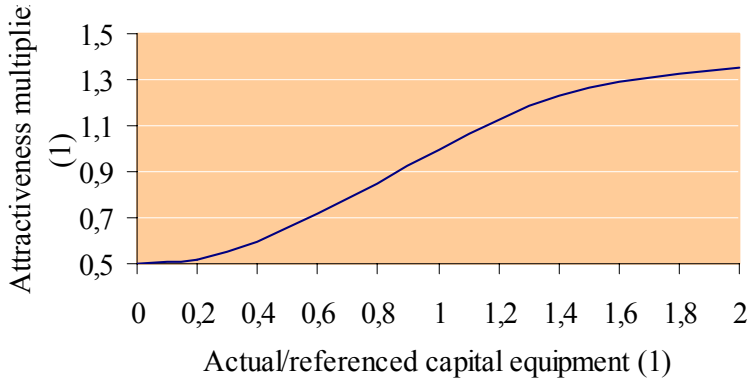

Figure 28 Attractiveness multiplier

With a 20% addition to capital stock thus, the attractiveness multiplier rises by 13% to 1.13, while a 20% reduction leads to a 15% reduction in

the attractiveness multiplier. It is also assumed however that these rates of increase and decrease respectively cannot continue ad infinitum. Specifically it is hypothesised that once the level of the actual stock exceeds the initial (referenced) levels by 40% product quality rises to such levels that its further improvement becomes much more difficult to attain. Increasingly more capital is needed therefore to achieve only modest quality increases and that's captured by the eventual levelling off of the table function in the figure above (Figure 28). Similarly, a continuous reduction in capital stock would reduce the quality of domestic products but only up to a point. It is assumed above that even if the capital base reduced to zero, product quality would fall to only half its initial values.

The remaining numerical assumptions in the model include:

- The level of average domestic selling prices is equal to £10 per unit and the average delay time required to adjust them to their desired levels comes up to 3 years

- Zero interest rates to be paid in according to the accumulated money balances of all identified groups for most runs.

- A 2% surcharge rate per year to be paid back on government debt due to the transition.

- The initial support ratio comes to 3.8 approximately

3.3 Model output and analysis

Multiple scenarios will be tested in this section in order to enhance our understanding of pension economics. Extending the practice that was initially conveyed when exploring the population dynamics of this model, in all scenarios that follow no dynamics develop before some arbitrary year during which time some sort of shock is imposed. In all cases the nature of these shocks and the exact time that they take place will be clearly highlighted. All subsequent dynamics will be occurring endogenously.

3.3.1 Testing the effects of demographic alterations when a PAYG scheme is already in place

In section 2.2 of this paper it was maintained that the currently prevailing demographic pressures have had an important role to play in the

worsening state of PAYG pension finances. In this section of the paper we test our model to see whether our previous analysis corresponds with the model's output. The basic assumptions involved for the runs in this section is that a PAYG scheme is already imposed in the economy and that employees do not find it necessary to save any of their wages for their eventual retirement. In terms of Figure 22 the *savings for retirement* level disappears along with all its inflow and outflow rates. The initial *government money balances due to the PAYG scheme* are arbitrarily set at 10 million pounds. The choice for an initially positive instead of a nil balance is made to enable an easier identification of a possible reduction in its levels. In addition we also assume that the attractiveness multiplier stays constant at one throughout these tests and that the employment rate multiplier (Figure 26) becomes a straight line with a slope of 1. These two assumptions are made in an attempt to minimise any unwanted interference which would force us to divert attention from our intended goal. Both will be relaxed later on.

3.3.1a Testing a 20% step decrease in birth rates

Figure 29 shows how PAYG balances develop after the birth rate suddenly reduces by 20% at the 20th year of the simulation. This reduction is modelled by a step function.

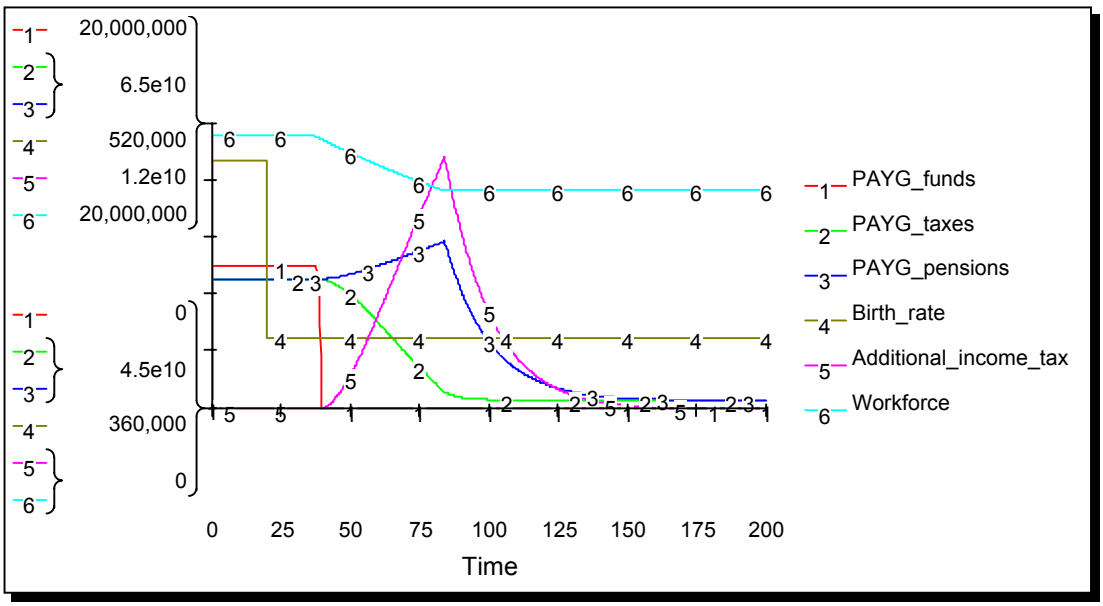

Figure 29 Testing a 20% step decrease in birth rates: Plot of PAYG funds, PAYG taxes, PAYG pensions, birth rates, additional income taxes required, and workforce levels.

As expected, a reduction in birth rates leads to a considerably worsening situation for PAYG finances. 18 years after the reduction in birth rates

workforce levels begin to reduce since the younger cohorts that have now grown and start joining the workforce are smaller in size than the cohorts that preceded them. Employment (portrayed in Figure 30) naturally also declines and incoming (PAYG) taxes drop since there is a reduction in the number of contributors. This reduction alone along with the unchanging (at the time) number of pensioners (Figure 30) would be quite adequate to explain the fall in PAYG balances. Both Figure 29 and Figure 30 show however that pensions instead of staying at their initial levels they follow an upward trend that is initiated at the same time that the reduction in PAYG taxes materialises. This may seem initially quite baffling. Why would a reduction in birth rates cause an increase in pension payments 18 years down the line? The answer becomes clear once we consider the behaviour of the employment rate. As shown below (Figure 30), the employment rate increases at the same time that the reduction in the number of the employed takes place.

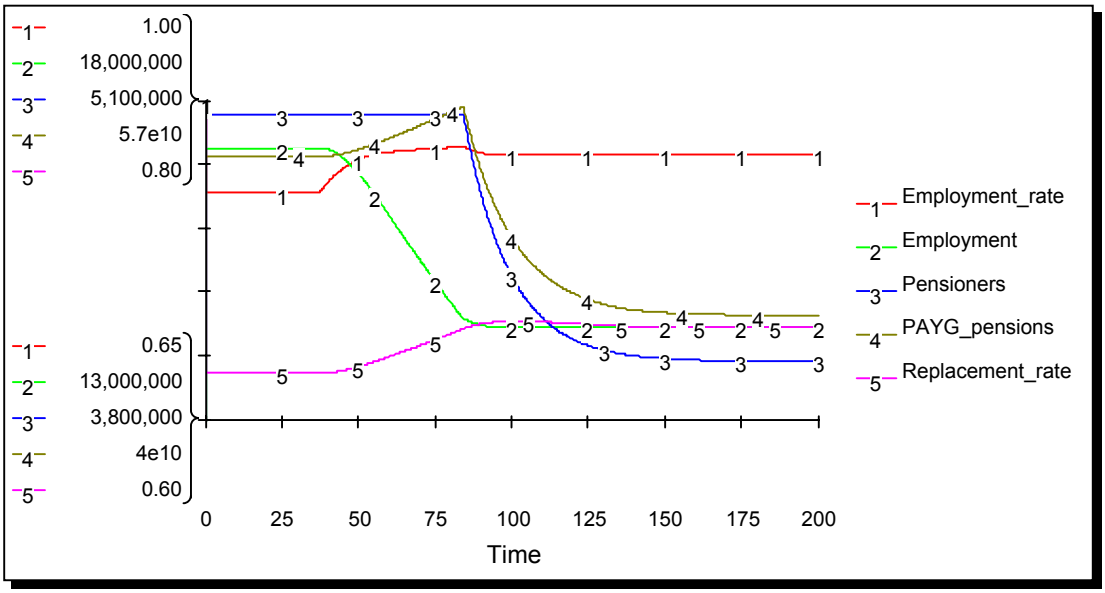

Figure 30 Testing a 20% step decrease in birth rates. Considering the reasons for the short-term increase in pension payments after birth rates reduce: Plot of employment rate, employment, pensioners, PAYG pensions, and replacement rates

The increase in the employment rate occurs exactly because of the reduction in the workforce levels on the one hand and *the less than proportionately* affected total domestic demand on the other. Total domestic demand, should be remembered, is comprised of the demand from the employed, the unemployed, the pensioners, and from exports. The initial decline of the workforce undoubtedly reduces total consumption from the employed and the unemployed since there has been

a reduction in their numbers. Pensioners' consumption however has no apparent reason to drop and so is the case with exports too[23]. With total domestic consumption falling at a lesser pace than the reduction in the workforce levels, the employment rate viz. the ratio of the employed to the workforce, rises. But with a greater employment ratio the replacement rate rises (Figure 30) hence the increase in pension payments.

After the 100th year of the simulation approximately, the behaviour of all variables does not hide any further surprises. Pensioners' numbers begin to decline and by the 150th year approximately all dynamics die off. The consequences for PAYG at the end of the simulation prove to be, as previously noted and according to expectations, disastrous. The transient effects from the permanent reduction in birth rates effectively call for an increase in PAYG taxes until the system returns to its new equilibrium position. Indeed, Figure 30 shows that an increase in taxation does take place in order to keep the PAYG scheme alive.

3.3.1b Increasing pensioners' life spans

In this run we test the model's results for an increase in pensioners' life spans. Three years will be gradually added to the average remaining life of pensioners and, as previously, the process will be gradual. It will initiate at the 20th year of the simulation and it will be completed within 20 years. Figure 31 demonstrates how this alteration affects pensioners' numbers and consequently the support ratio while Figure 32 shows that the results as regards PAYG finances meet our expectations.

[23] Actually if exports are plotted they are seen to eventually drop. Their reduction however is attributed to the increase in domestic prices which emerge as a result of the restriction in the supply of domestic products due to the reduction in employment

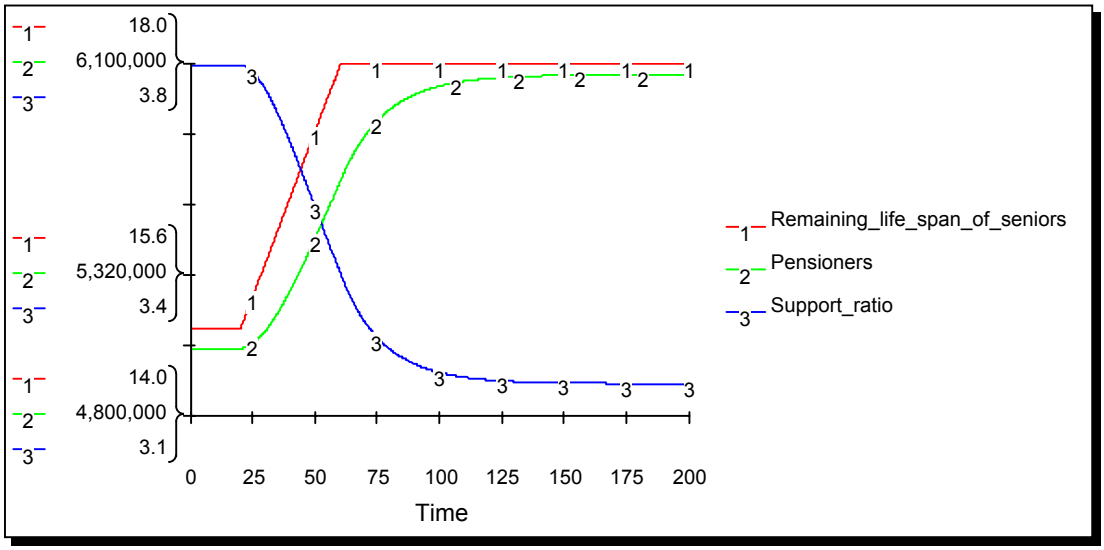

Figure 31 Increasing pensioners' average life spans by 3 years: Plot of average life span of senior citizens, pensioners, and of the support ratio

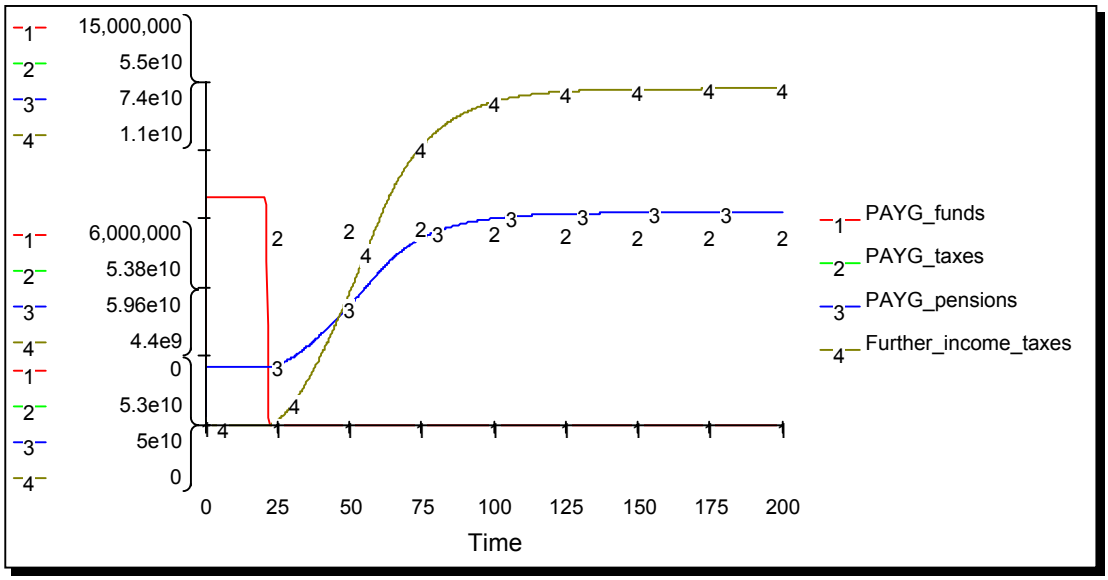

Figure 32 Increasing pensioners' average life spans by 3 years: Plot of PAYG funds, PAYG taxes, PAYG pensions and additional income taxes required to sustain the PAYG scheme

With a permanent worsening in the support ratio, it is clearly indicated in Figure 32 that there is little choice but to increase PAYG taxes to keep the scheme afloat. As was the case in the previous section that is indeed in effect what does take place above since we can see that income taxes are permanently imposed to meet the difference.

3.3.1c Prolonging the duration of employment

In this section we test the implications of extending the number of years people must spend in the workforce before retiring. At the 50th year of the

simulation thus the time required to be spent in employment rises by 3 years taking total working time up to 50 years. (The stock-flow structure for this expansion was presented in Figure 21). Figure 33 shows the relevant dynamics.

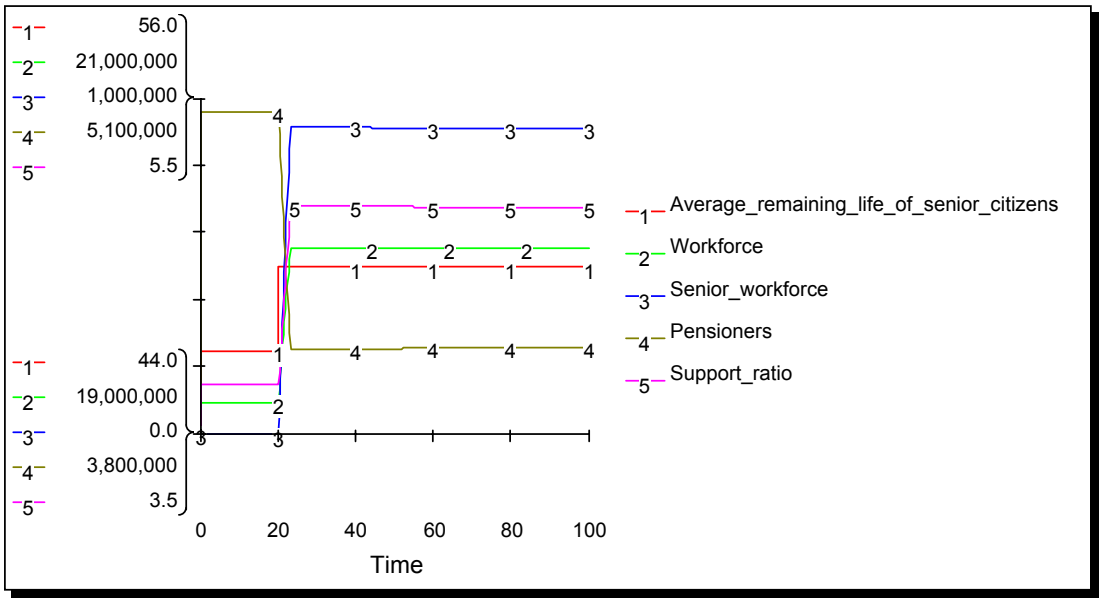

Figure 33 Expanding the duration of employment by 3 years: Plot of time required to stay in the workforce before retiring, workforce, senior workforce, pensioners, support ratio

Indeed Figure 33 shows that at the 50th year of the simulation the senior workforce levels pick up increasing total workforce numbers while the number of pensioners reduces. Naturally, the potential support ratio increases quite markedly. As a result, the dynamics of PAYG finances shown next should not seem bewildering.

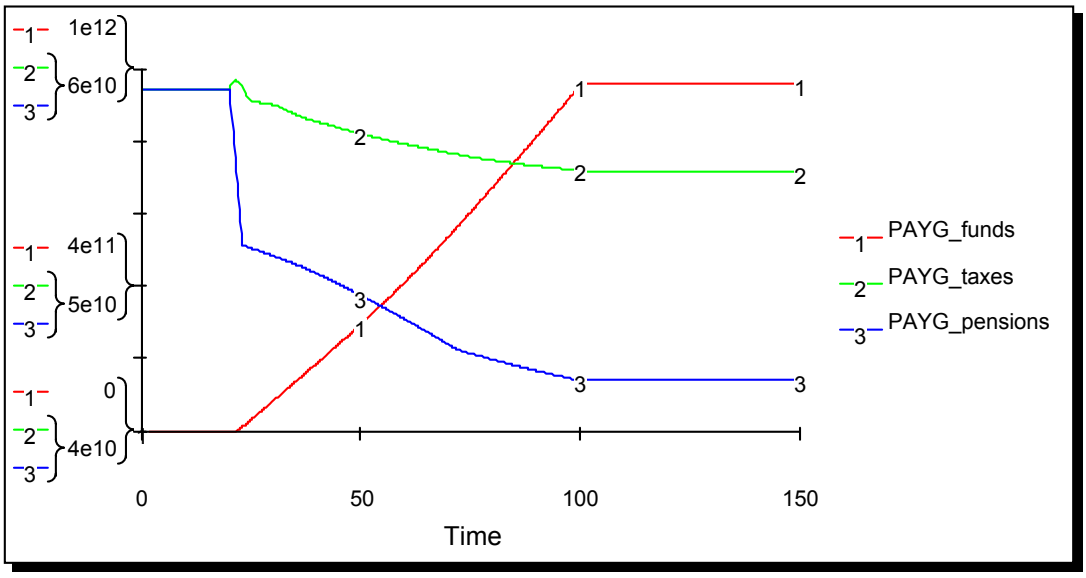

Figure 34 Expanding the duration of employment by 3 years: Plot of PAYG funds, PAYG taxes, and PAYG pensions

With a permanent increase in the support ratio PAYG taxes settle at higher levels than PAYG pensions and PAYG funds increase linearly *ad infinitum* given the unchanging contributions and pension pay out rates. The effects of this policy thus can be seen to work in the opposite direction from those established in the previous section.

The one point that emerges from this run which need not be necessarily evident when referring to an expansion of the duration of employment though, is to do with unemployment. Figure 35 quite eminently depicts that unemployment increases quite markedly as a result of this expansion. This raise however need not be always associated with bad news for the economy for two reasons: Firstly, because in this case more unemployment is not necessarily associated with less employment. The increase in unemployment in other words takes place not because of slack capacity or dim forecasted demand, but because there is an increase in the numbers of the workforce. Evidently, even if employment increased (within certain limits to be sure) unemployment should still be expected to rise. And secondly because, as Figure 35 shows, greater unemployment levels could reduce wage rates enabling firms to increase their profits and consequently their investments.

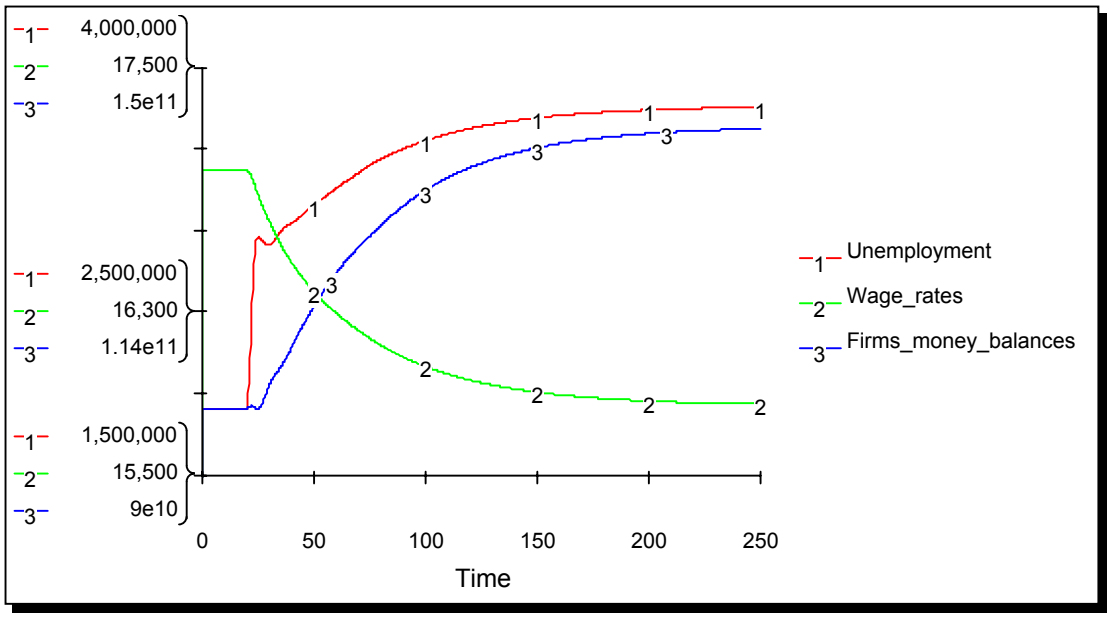

Figure 35 Expanding the duration of employment by 3 years: Plot of unemployment, wage rates, firms' money balances

Such increases could in turn improve the attractiveness of domestic products and consequently lead to greater growth.

3.3.1d Increasing pensioners' life spans as well as prolonging the duration of employment

Before moving on to simulations with markedly different sets of assumptions we test the implications of both increasing pensioners' life spans as well as prolonging the duration of employment in our economy. To enable a finer analysis we assume that both processes are initiated at year 20 and they are both completed within 3 years. Senior citizens again prolong their average lifetimes by three years viz. they gain one extra year of life for every year that goes by after the 20th year of the simulation until year 23 is reached. The ultimate results as regards PAYG funds may seem quite odd at a first glance since they are seen to increase linearly (Figure 36). But no other result should be expected under the circumstances tested in this run.

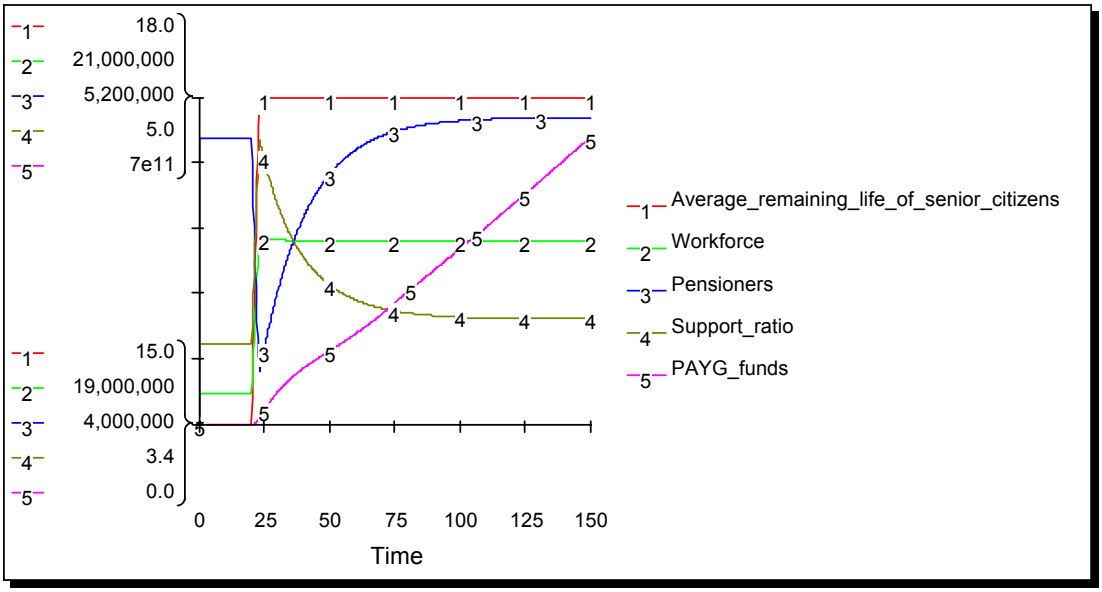

Figure 36 Increasing pensioners' life spans as well as prolonging the duration of employment: Plot of average remaining life span of senior citizens, workforce, pensioners, support ratio, and PAYG funds

An increase in the number of years one must stay in employment that matches the increase in the average lifetime of senior citizens will always result in a permanent increase of the support ratio.

3.3.2 Introducing a PAYG scheme

Let us now proceed to perform the thought experiment previously discussed whereby a PAYG system is introduced in an economy with no previously established pension scheme in place. With the introduction of the PAYG scheme at the 10th year of the simulation a 20% tax on annual

wages is imposed to pay for pensions. Employees on the other hand are assumed to stop saving for retirement completely thereby maintaining their consumption expenditure unchanged (since they voluntarily saved 20% of their wages before the PAYG scheme.) Finally, the employment rate multiplier returns to its original shape (Figure 26).

3.3.2a Constant attractiveness multiplier

For additional simplicity throughout this run we will assume that the attractiveness multiplier stays constant at one. Capital equipment levels in other words are assumed to rise or fall without affecting the quality of domestic products. Figure 37 shows the results for total domestic spending, total savings, and the government's money balances due to the PAYG scheme.

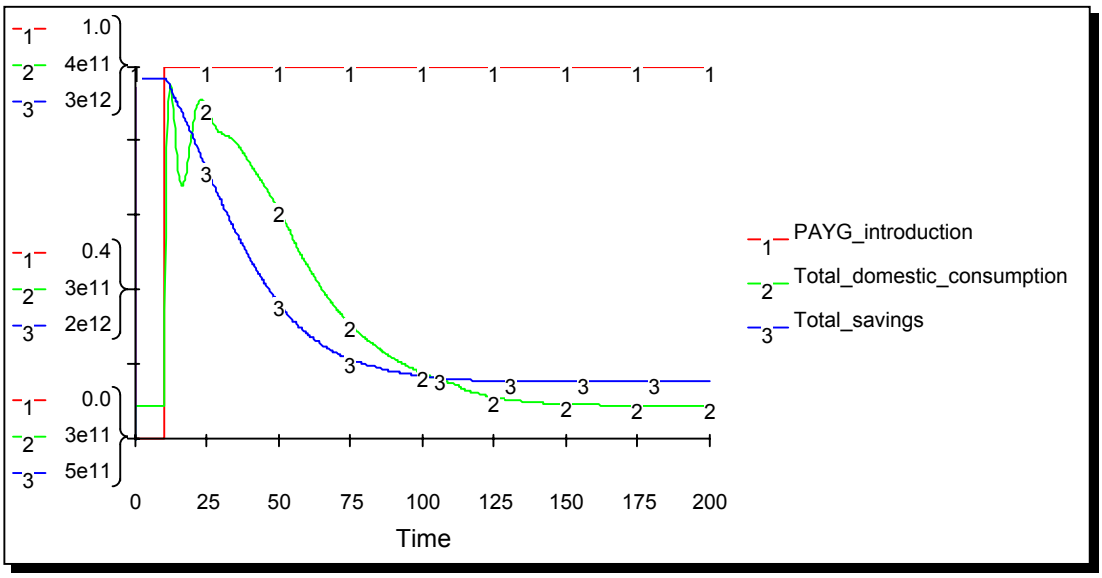

Figure 37 Introducing a PAYG scheme with a constant attractiveness multiplier: Plot of total domestic consumption and total savings

As expected from the conventional macroeconomic analysis (section 2.4), after the introduction of the scheme at year 10, total domestic consumption initially increases while total savings reduce. The reason for the short term increase in consumption of course is attributed to the 'free gift' that pensioners receive by the working generations which enables them to increase their spending. The eventual return of total spending to its original levels is again easily explicated given the one-off nature of the free gift. Once the 'free gift' is spent the economy moves back to where it started. A complete explanation for the permanent reduction in savings

however is somewhat trickier to provide, for the answer entails a solution to the paradoxical result that is shown in Figure 38.

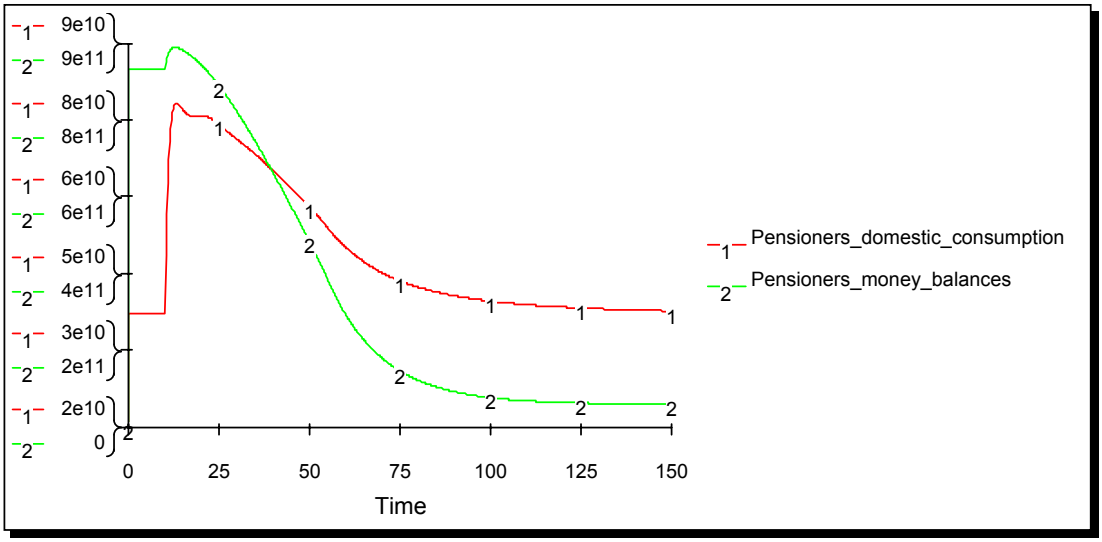

Figure 38 Introducing a PAYG scheme with a constant attractiveness multiplier: Plot of pensioners' domestic consumption and of pensioners' money balances

How can, as clearly shown above, pensioners' consumption ultimately return to its initial levels at the same time that their money balances fall from approximately £900 billion down to approximately £100 billion? The answer is of course ultimately pretty simple. Initially it will be remembered pensioners funded their consumption through the accumulation of funds which they subsequently spent with a delay that matched their lifetime expectancies (viz. 15 years). After the PAYG introduction however they receive a yearly income that gets spent with only a one-year average delay. But smaller time delays reduce the contents of stocks by increasing outflows hence of course the explanation for the dynamics both in Figure 37 and Figure 38.

Let us now explore whether any funds accumulate in government's coffers as a result of the PAYG scheme (Figure 39)

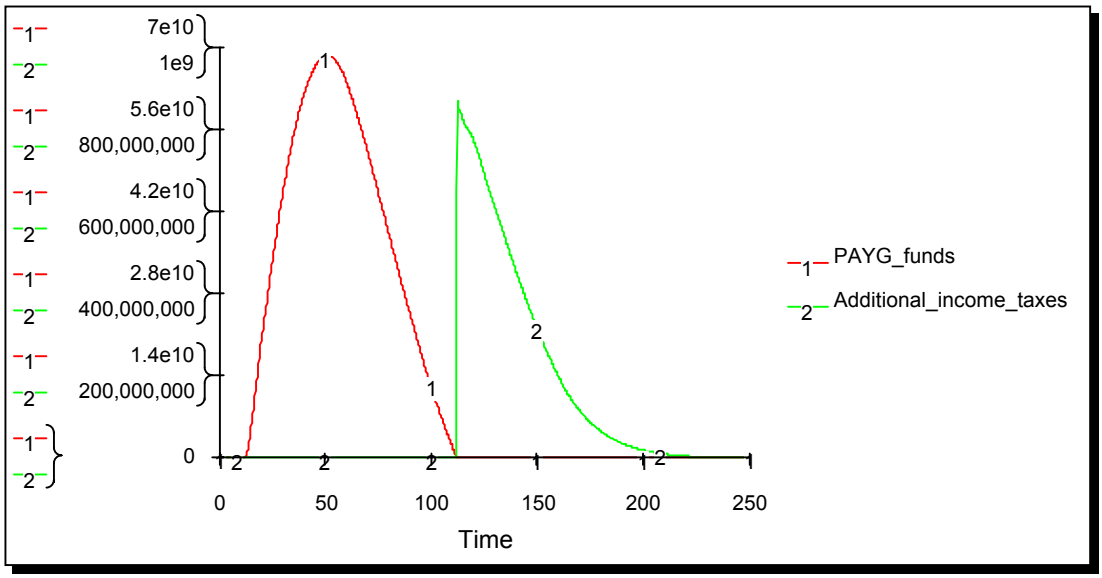

Figure 39 Introducing a PAYG scheme with a constant attractiveness multiplier: Plot of PAYG funds and of the additional income taxes required to keep the scheme in operation

The dynamics that occur in governments' funds due to the PAYG scheme may seem quite odd initially. Not only they increase almost immediately after the imposition of the PAYG scheme reaching a maximum at year 60, but also after year 115 app. the government is seen to be forced to levy extra income taxes on employees to keep the scheme alive. It should be here reminded that this behaviour emerges despite the unchanging population composition and the unchanging per person PAYG taxes (contributions) that have to be paid in. The system in other words moves from affluence to bankruptcy within a hundred years without any policy or any other exogenous alterations. Its design from the very beginning seems to be flawed.

The more obvious reasons for this kind of behaviour are depicted below (Figure 40[24]) (see also section 3.3.2b)

[24] Plotting in Figure 40 starts from time 10 and not form 0 to enable for a finer view of the discrepancies between PAYG taxes and PAYG funds. So is the case also in Figure 44 and Figure 45.

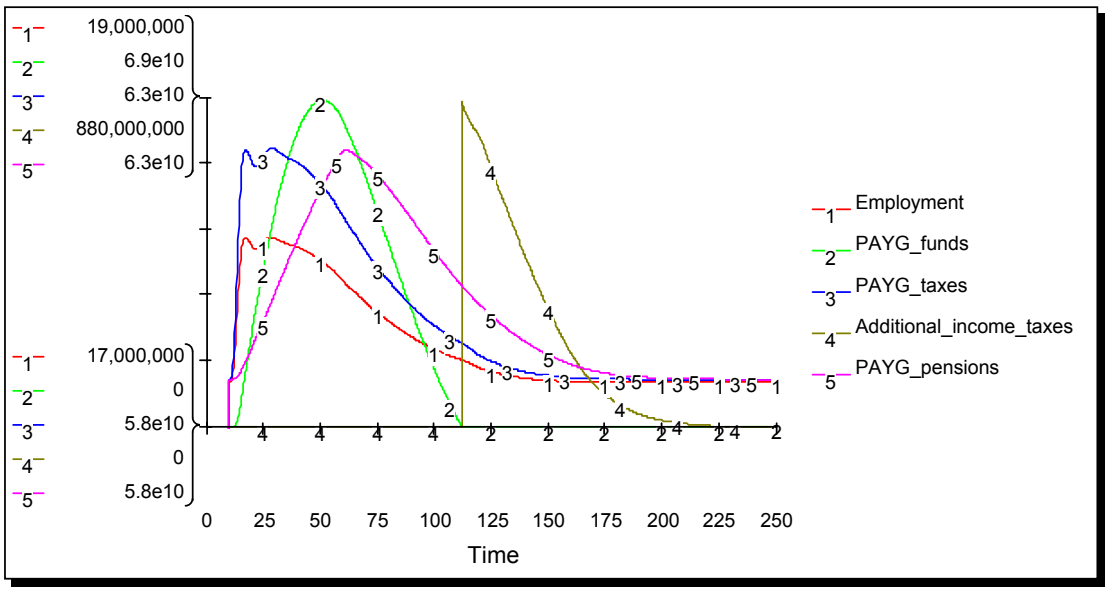

Figure 40 Introducing a PAYG scheme with a constant attractiveness multiplier. Partially explaining the behaviour depicted in Figure 39. Plot of employment PAYG funds, PAYG taxes, additional income taxes, and PAYG pensions

With the initial boost in total domestic consumption (Figure 37) employment increases to meet demand. The increase in employment however brings in the PAYG system more revenue given the unchanging PAYG tax rate since more people are employed and more people are naturally taxed. The pensions that have to be paid to existing pensioners on the other hand remain obviously unchanged. With a greater incoming rate than before and a relatively constant outgoing rate thus, funds accumulate in governments' coffers. As time progresses and total consumption begins to fall however, so does employment. Yet the previously increased employment levels have in the meantime created a higher burden of future liabilities to the system. At the time when increased pensions must be paid out thus, employment is falling and the outflow naturally begins to exceed the inflows to the PAYG scheme subsequently bankrupting the system.

Before moving on to the next section it should be added that the long period that it takes for the system to move from affluence to bankruptcy can create the false impression that the initially accumulated funds constitute permanent net gains from the transition. The temptation to spend this 'extra' money carelessly can prove too great to resist especially given the 4 or 5 five years that any one government spends in power before the next elections.

3.3.2b Variable attractiveness multiplier

In this run the feedback loop that was previously cut off due to the constancy of the attractiveness multiplier is here reactivated according to the table function presented in Figure 28. The PAYG system is again introduced at the 10th year of the simulation. Figure 41 illustrates the dynamic behaviour of total domestic consumption and total savings.

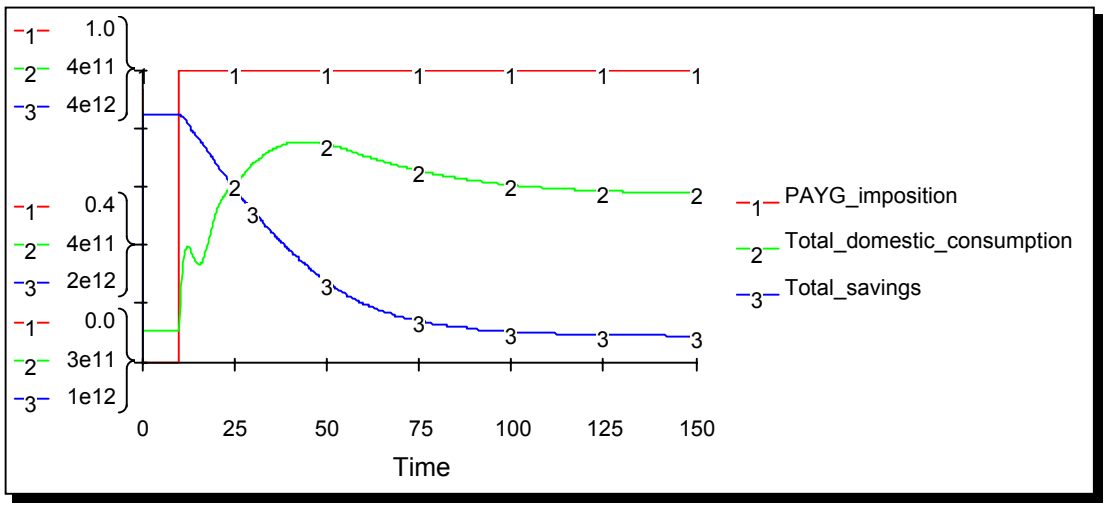

Figure 41 Introducing a PAYG scheme with a variable attractiveness multiplier. Plot of total domestic consumption and savings

Whereas Figure 41 depicts yet again a reduction in total savings, consumption is clearly seen to stabilise in higher levels than before. Figure 42 demonstrates how this outcome comes about.

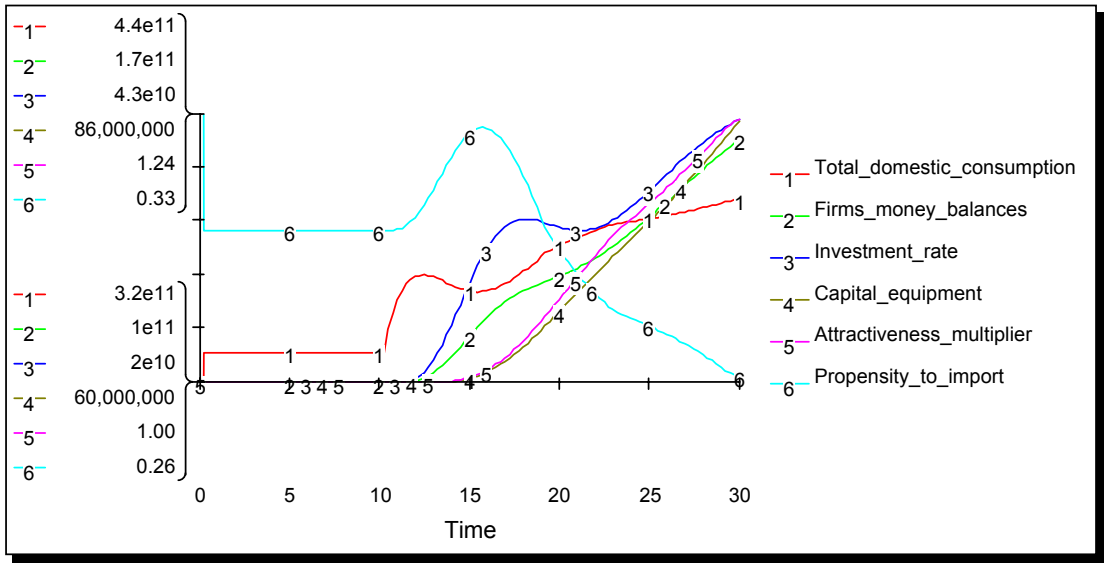

Figure 42 Introducing a PAYG scheme with a variable attractiveness multiplier. Explaining the dynamics depicted in Figure 41. Plot of total domestic consumption, firms' money balances, the investment rate, capital equipment, the attractiveness multiplier and the propensity to import

The initial increase in total domestic consumption naturally boosts firms' money balances and with a full wallet firms increase their investments. Higher investment rates eventually lead to an increase in the capital stock which enables a betterment in the domestic products' quality which, in turn, makes them more attractive. The greater the attractiveness of domestic products the more the demand (captured by the reduction of the propensity to save[25]) and, in turn, the greater the firms' money closing a positive feedback loop which leads the whole economy in the paths of growth (see also Figure 19). Indeed, the positive feedback loop effects that drive the simulation early on become clearly evident when extending the length of the simulation for the previously graphed variables (Figure 43).

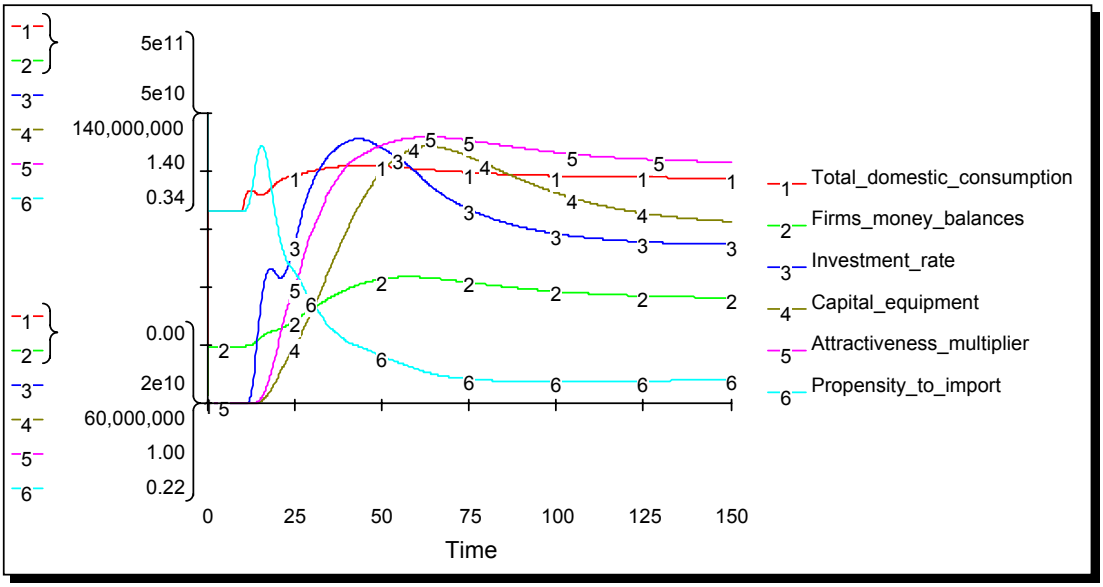

Figure 43 Introducing a PAYG scheme with a variable attractiveness multiplier. Extending the plots of the variables presented in Figure 42. Plot of total domestic consumption, firms' money balances, the investment rate, capital equipment, the attractiveness multiplier and the propensity to import.

Let us now explore the dynamics of the PAYG scheme funds. Figure 44 depicts the results.

[25] The initial upward movement in the propensity to save takes place because of the increase in prices (not shown) that results from the sudden increase in demand. The slight jiggles that can be seen in the domestic consumption plots in many of the previous figures are again caused by these price increases.

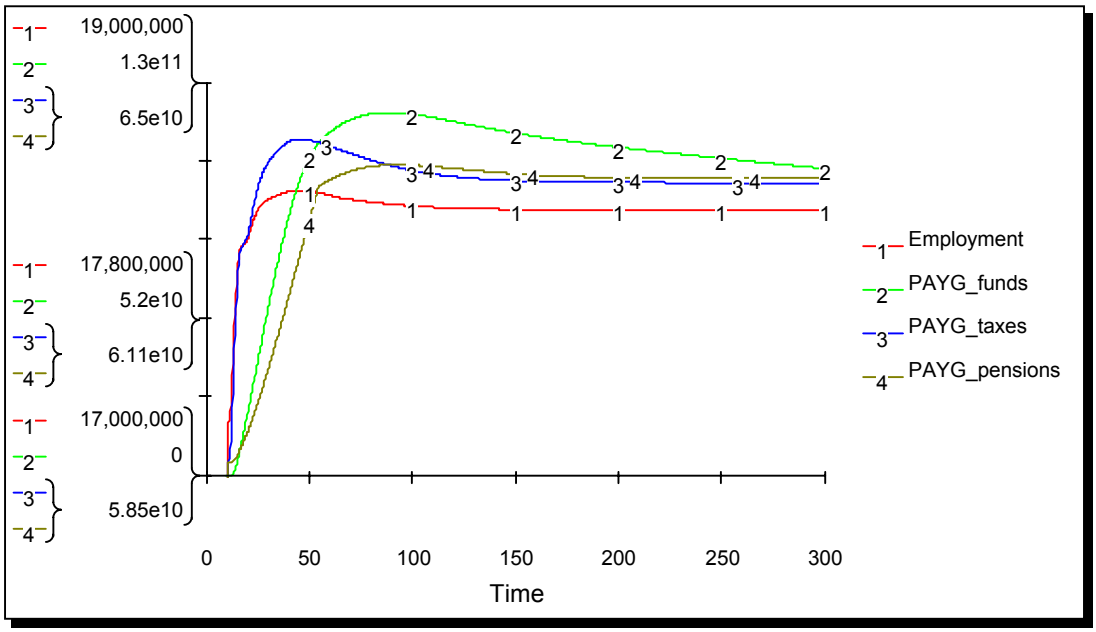

Figure 44 Introducing a PAYG scheme with a variable attractiveness multiplier. Plot of employment, PAYG funds, PAYG taxes, and PAYG pensions

Their behaviour again seems somewhat counterintuitive. Even though PAYG balances initially increase – as expected – from the boost in employment, they subsequently show a definite downward trend despite the settling of employment at permanently higher levels. Indeed incoming (PAYG) taxes remain at permanently lower levels than pension payments and should the simulation be extended PAYG balances would eventually fall to zero while extra taxation would be required thereafter to keep the scheme alive. The employment rate multiplier in Figure 26 of course is responsible for these results. As explicated at that part of the paper and as Figure 26 clearly indicates, for full pensions to be paid out the average employment rate need not equal one. This policy however can cause outflows to exceed inflows when employment settles at permanently higher levels than initially. Here's why: The initial PAYG tax rate is calculated upon the desired replacement wage rate and the ratio of pensioners to employees. Sticking to the initial values chosen for the model, let us say that employment stands at 90% the workforce levels. Pensioners on the other hand are represented by all senior citizens. In addition we know that if employment increases to 94% full pensions are to be paid out (Figure 26). Let us assume for simplicity that employment eventually settles at those levels. Every person who subsequently retires gets paid the full replacement rate. Since employment lies below 100% of the workforce though the ratio of PAYG taxes to pension payments

reduces permanently. Thus the discrepancy previously observed (Figure 44)

Through a slight alteration in the employment rate multiplier which is now assumed to have a slope of one for the interval of 0.9 to 1 of the employment ratio, the different PAYG balances along with its inflow and outflow rates are plotted below (Figure 45)

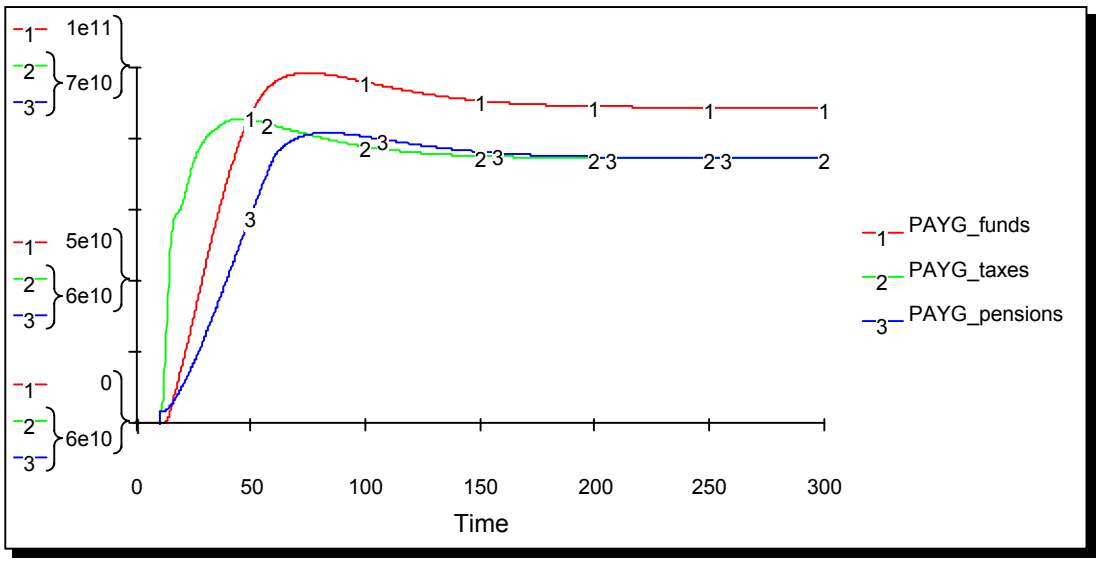

Figure 45 Introducing a PAYG scheme, variable attractiveness multiplier but also assuming a slightly altered employment rate multiplier. Demonstrating a deficiency of PAYG schemes. Plot of PAYG funds, PAYG taxes, and PAYG pensions.

Indeed the results confirm our analysis.

Despite the boom that was initiated in this run because of the introduction of PAYG, some deficiencies in the PAYG system are revealed again. Of course it could always be persuasively argued that a somewhat flawed pension system which enables permanent growth would always be welcome especially if its flaws are very unlikely to be revealed in anything other than simulations.

3.3.2c Positive interest rates, constant attractiveness multiplier

In this section we assume that positive interest rates are paid in according to the accumulated cash balances thereby contributing to the consumption of consumers by boosting their income (see Figure 22). They are set at 2% per year right from the start. In addition, the employment rate multiplier goes back to being a 45° straight line. All remaining assumptions are the same as with the run explored in section 3.3.2a. Let

us explore the consequences of a PAYG scheme introduction in the simulated economy.

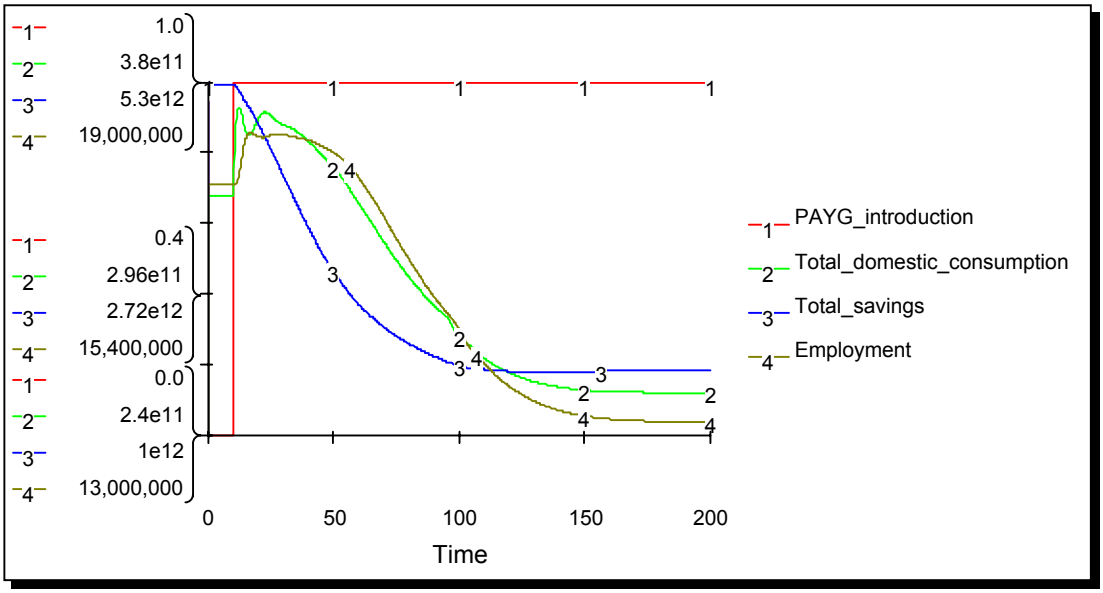

Figure 46 Introducing a PAYG scheme, positive interest rates, and constant attractiveness multiplier. Plot of total domestic consumption, total savings, and employment

Here can be seen that not only total savings end up at much reduced levels than initially but so do both total domestic consumption and employment soon after the introduction of the scheme. The initial adverse effects that the introduction of a PAYG scheme has on savings in combination with the positive feedback loop that is created between interest rates and total savings drives the whole system in decline. Lower savings in particular reduce the total interest paid into the accounts of consumers and consumption reduces. Firms detecting a fall in demand lay off personnel and employees' money balances reduce even more. The income subsequently received from interest rates falls further and so it goes until eventually two negative feedback loops come into play to save the day - or rather what's left of it. The consumption from the unemployed which acts as an automatic stabiliser, and the lower investment expenditure which have no impact on the attractiveness of domestic firms' products in this run.

As regards PAYG finances, they evolve in exactly the same way as in section 3.3.2a (Figure 40) and they do so for the same reasons that were described in that section. Further commentary is consequently omitted.

Before leaving this section it should be perhaps stressed that in traditional economic literature the role of interest rates is not frequently associated with the effects they may have on consumption. From the simulation runs in this section however it is seen that such an omission can be quite crucial.

3.3.3 Transition from a PAYG to a FF system

In the last few runs that are presented we consider the dynamics that emerge by the transition from a PAYG to a FF scheme. A PAYG scheme is assumed in operation from the very beginning of the simulation and the transition takes place at year 10. There are assumed to be zero accumulated funds in the government's treasury as a result of the PAYG scheme although any other (non-negative) number can be chosen instead. The employed are once again considered not to save any of their funds for retirement before the transition takes place while after the transition they are forced to save 20% of their annual wages.

Finally, the different treatment of pension payments that is hypothesised in this model once the transition occurs calls for a separate identification of two distinct pensioner groups. Those who have already retired and are still alive at the time of the transition, viz. the 'old pensioners', and the 'new pensioners' group which comprises of the workforce at the time of the transition who will be retiring in the near future[26]. After the transition, 'old pensioners' are assumed to continue receiving their yearly pension payments as normal (but by the government instead of the workforce). 'New pensioners' on the other hand receive all they are due from the contributions they had been making under the old PAYG scheme at the time of retirement. Different assumptions of course can be tested, yet the ones included in this model are largely based on the actual transition procedures as they took place in Chile (Kritzer 1996 p.47). For determining how much money must be paid to new pensioners upon retirement an inverse countdown is initiated from the time that the transition takes place. The 'new pensioners' who will retire immediately after the transition for example will be receiving full money[27]. The ones who will retire having spent only half of their working lives under the old

[26] A third group also arises yet it needs not be treated in any special way. This final group comprises of all those people who have not made any contributions to the old PAYG scheme either because they were too young to work, or because they weren't born at the time.

[27] Full money should not be confused with full replacement rates. The replacement rates as previously noted are determined from the average employment rate.

scheme will get paid half of what the aforementioned group got and so on.

Figure 47 shows the three main magnitudes that characterise the simulated economy assuming a constant attractiveness multiplier.

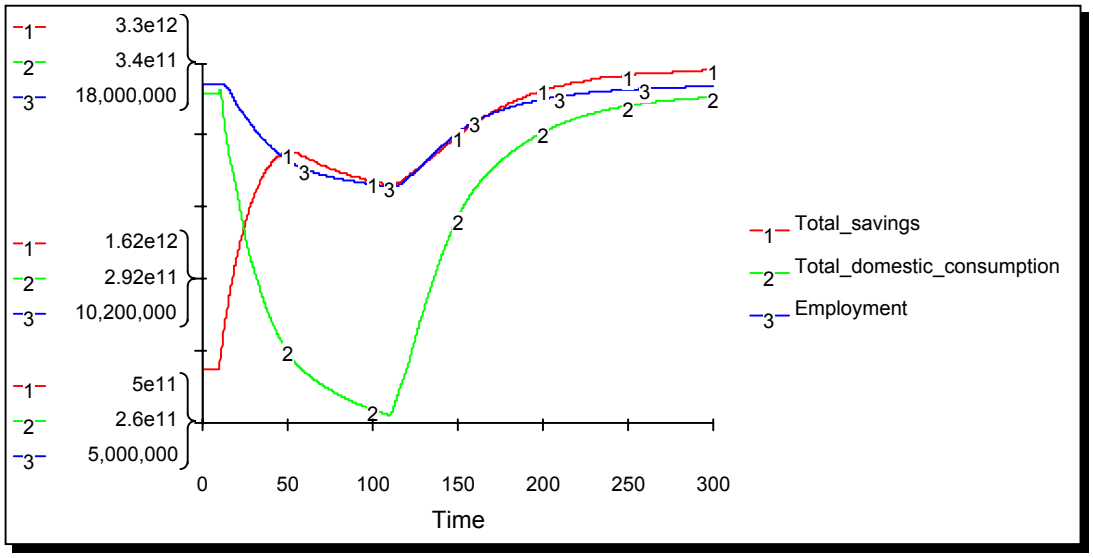

Figure 47 Transition from a PAYG to a FF scheme assuming a constant attractiveness multiplier. Plot of total savings, total domestic consumption, and employment

Not contradicting our previous economic analysis we can see that after the transition a strong increase in savings[28] is initiated while total domestic consumption and employment initially drop. The hardships associated with the transition thus are clearly visible. As the simulation proceeds both employment and domestic consumption return back to their initial levels while savings reach considerably higher levels. Despite the broader agreement of the model's results with traditional economic findings two noteworthy results emerge from Figure 47. Firstly, we can see that savings increase in two distinct steps the first one occurring right after the transition while the second one is initiated at approximately the 110th year of the simulation. With the benefit of hindsight it is quite easy to explain this behaviour.

[28] In the calculation of savings government debt has not been included. Should we consider it as negative savings then total savings initially fall.

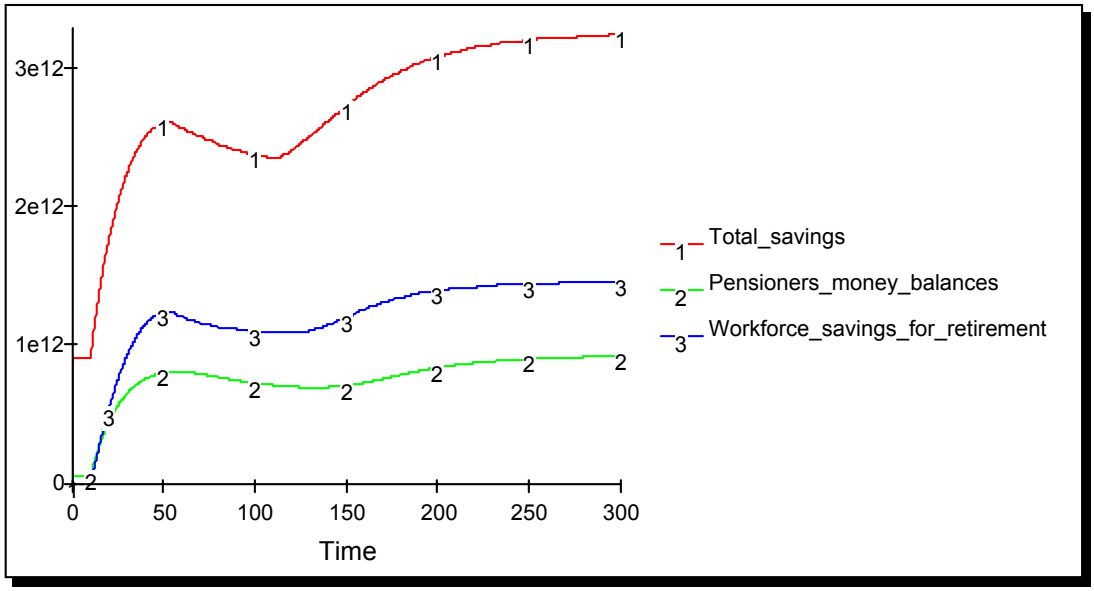

Figure 48 Transition from a PAYG to a FF scheme assuming a constant attractiveness multiplier. Explicating the rise in total savings. Plot of total savings, pensioners' money balances, and workforce's savings for retirement

Figure 48 above shows that immediately after the transition pensioners' money balances along with the money balances intended to fund future retirement rise quite rapidly as expected. Evidently, it is the ascent of both of these variables that is responsible for the initial boost in savings (just like their descent was responsible for the fall in total savings in sections 3.3.2a and 3.3.2b). For the second round of increases however it is employees' money balances (Figure 49) that lead the way. As will be remembered the assumption that has been made earlier on is that debt is to be repaid within 100 years from its inception and that it is to be repaid by taxes levied on employees' income. Now, Figure 49 shows that the need for borrowed funds to manage the transition is greatest immediately after its imposition both because the number of 'old pensioners' is greatest at that time, and because the 'new pensioners' who have just retired get paid full money.

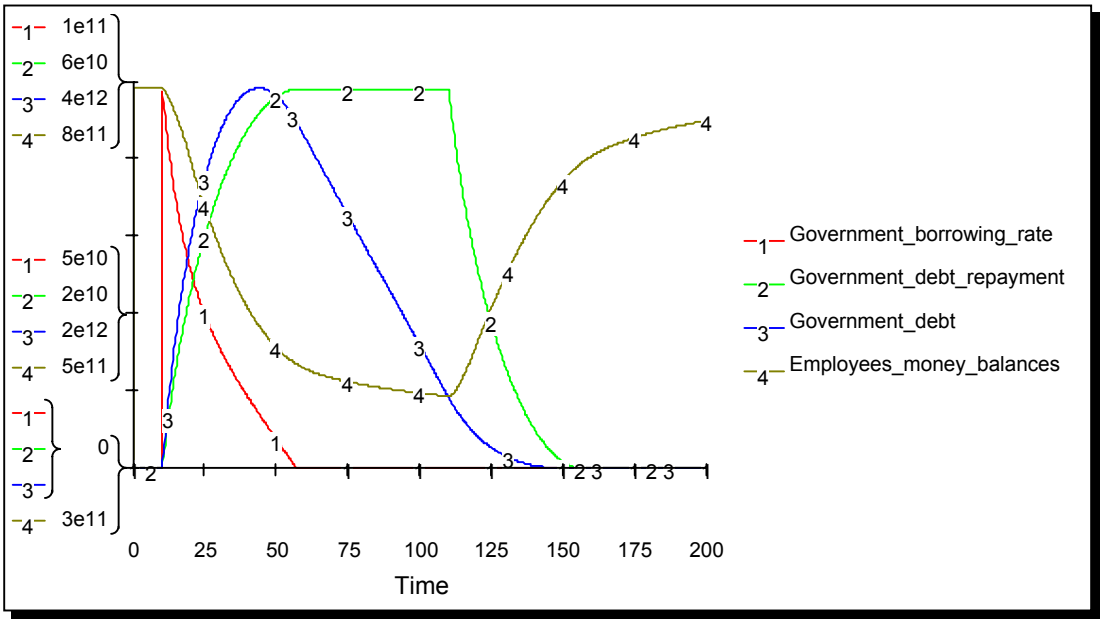

Figure 49 Transition from a PAYG to a FF scheme assuming a constant attractiveness multiplier. Plot of Government borrowing rate, government debt repayment, government debt, and employees' money balances

As borrowing starts and debt accumulates the government imposes income taxes to start paying off the debt. It is clearly seen however that 100 years after the transition date the initially borrowed funds along with interest surcharges are paid back in full with debt repayment starting to drop thereafter. But a fall in debt repayment also implies a cut back on employees' income taxes and hence an increase in their money balances hence of course the second rise in savings (Figure 48).

The second point that emerges from Figure 47 is that the usually identified 'short-term' transition difficulties can last for a pretty long 'short-term' duration. In fact the implication is that the transition difficulties should be expected to match the time it takes the government to repay the debt it has taken to finance the transition and that would only enable the initiation of the recovery process. More time would be required thereafter to match the pre-transitory employment and consumption levels. This is not an unavoidable result however. Assuming a variable attractiveness multiplier as we do in Figure 50 enables a much faster recovery with both employment and total domestic consumption levels exceeding their original levels quite quickly and quite distinctly.

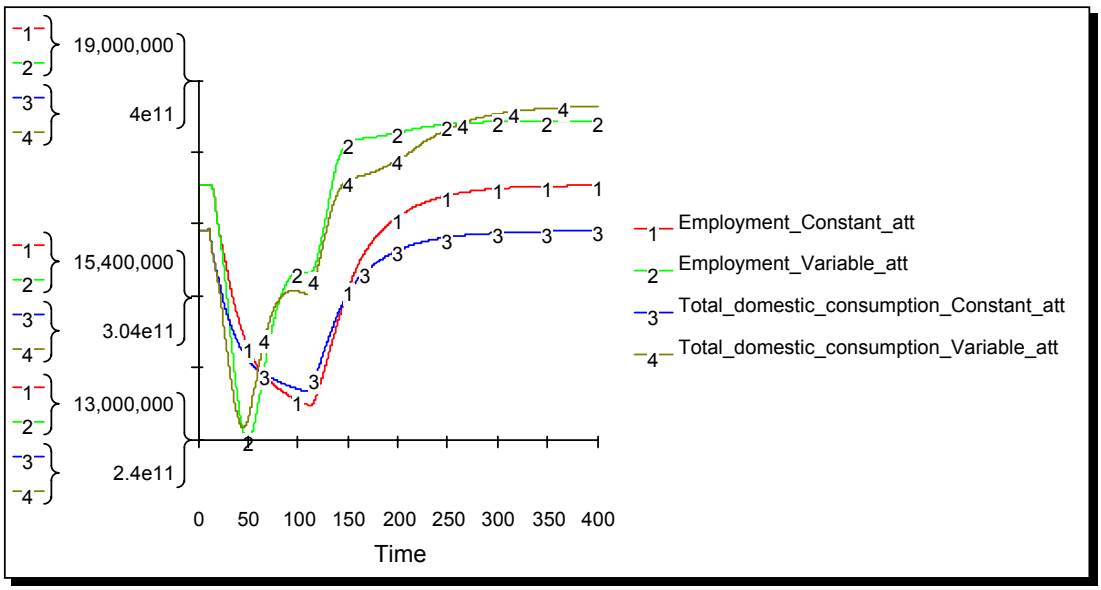

Figure 50 Transition from a PAYG to a FF scheme. Comparison plot demonstrating a quicker recovery process. Plot of employment and total domestic consumption levels under a constant and a variable attractiveness multiplier

This happens of course at the expense of a greater short-term shock to the economy as again clearly illustrated above. The reason for this kind of behaviour can be established by examining firms' cash balances as they develop through time. Figure 51 shows that firms' money balances irrespectively of the shape of the attractiveness multiplier pick up quite quickly after their initial fall and they soon exceed their original levels. This happens because, as shown in Figure 51, a lessening in wage rates occurs (due to increased unemployment levels) which is not reflected back fully through a consumption reduction though since 30% of employees' consumption is directed to imports, but also because total consumption from the unemployed rises when more people become unemployed, and given a reduced cost structure more profits can be realised.

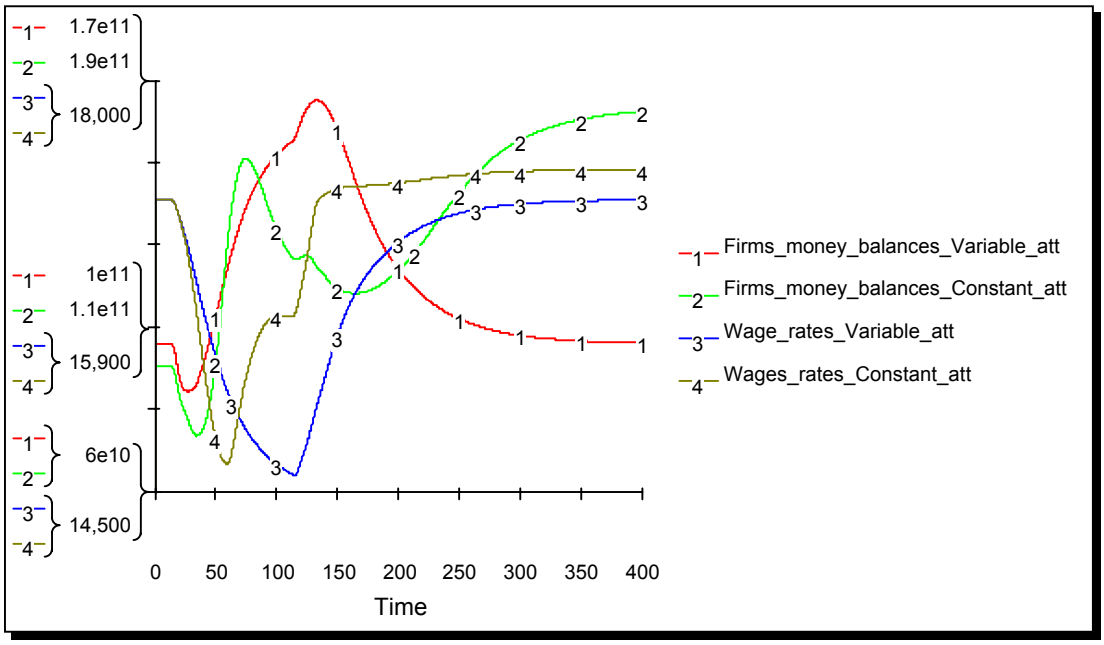

Figure 51 Transition from a PAYG to a FF scheme. Comparison plot. Plot of firms' money balances and wage rates under a constant and a variable attractiveness multiplier

We can see therefore that accepting a cut in wage rates can in principle allow for a faster and stronger recovery later on in the simulation. Indeed, the output depicted in Figure 52 verifies our assertion. Assuming constant wage rates both for the case when the attractiveness multiplier is a straight line and when it is made a variable we can see that the adverse effects in our chosen variable (employment) are much more severely felt.

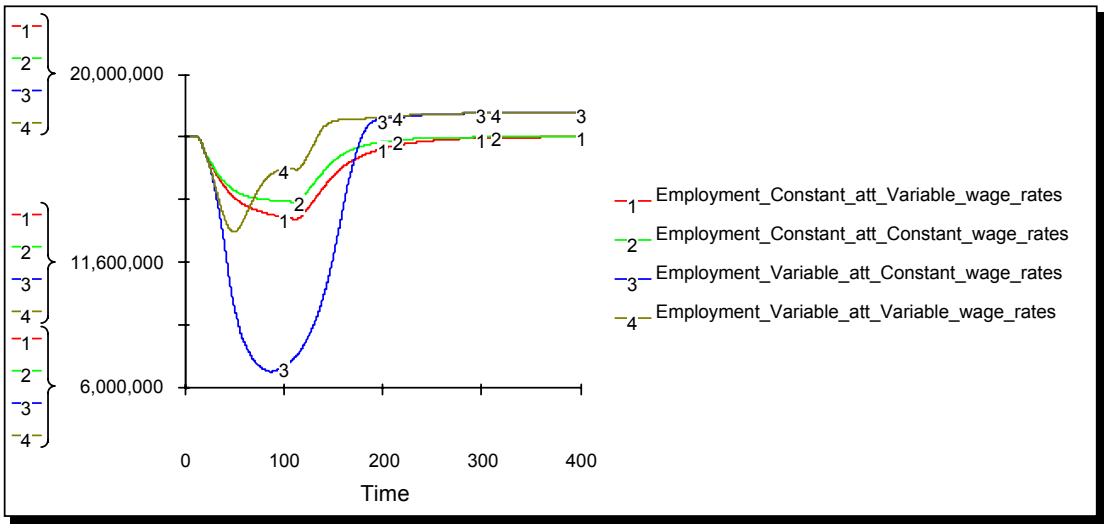

Figure 52 Transition from a PAYG to a FF scheme. Comparison plot demonstrating the importance of wage rates with regard to employment. Plot of employment levels under constant and variable attractiveness multiplier scenarios, and under constant or variable wage rates.

Or are they? Figure 52 makes clear that the previous assertion holds *only if* the extra funds that firms will be making by reducing employees' wages are spent on profitable investments which will enable future growth. If that money is misused instead, both the recovery takes longer to materialise and the transition shock is greater.

With regard to the initial steeper fall of employment and consumption when the attractiveness multiplier is made variable, it should be expected to materialise given the initial lessening of firms' money balances. Such a drop leads unsurprisingly to an early reduction in investment which causes in turn a fall in capital equipment and therefore in the attractiveness of domestic goods as Figure 53 shows, further exacerbating the fall in domestic consumption.

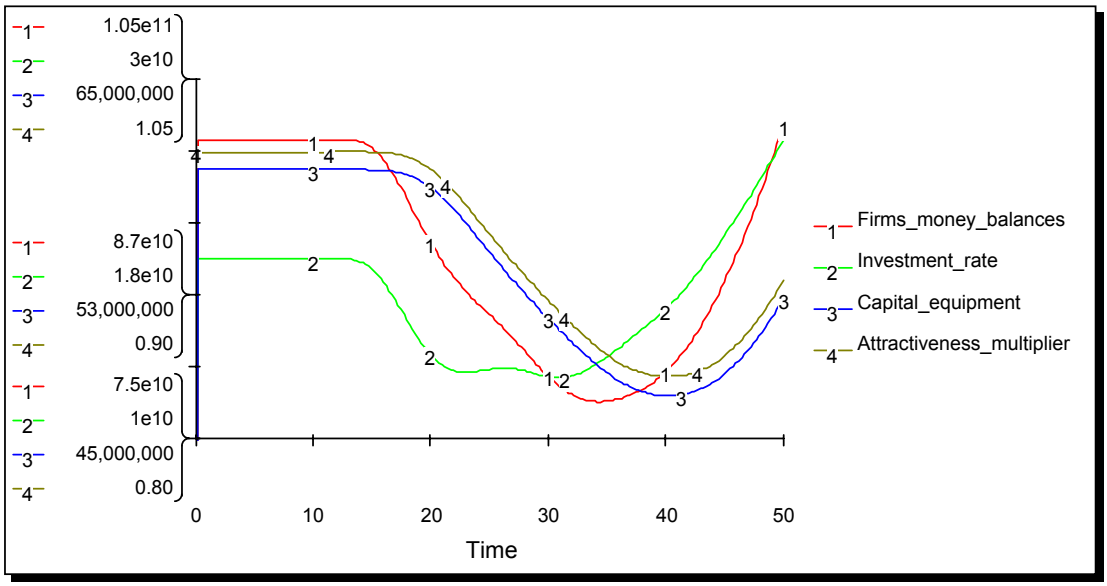

Figure 53 Transition from a PAYG to a FF scheme. Explaining the initial steeper fall of employment and consumption when the attractiveness multiplier varies. Plot of firms' money balances, the investment rate, capital equipment, and of the attractiveness multiplier

Finally, it should be noted that despite the similarities of this model's output with the expectations that emerge from a traditional economic analysis as regards some of the ultimate transition effects, the reasons that explain those results are quite distinct. Growth in neoclassical models is attributed to the accumulation of savings whereas growth in this model ultimately rests upon firms' profits and consumption.

4 RECAP -CONCLUDING REMARKS

In this paper we have attempted to disclose the importance of pension economics, to highlight some of its main problems and to widen our understanding of the issues involved. A system dynamics model was built to allow for a systemic analysis of this issue under realistic assumptions and to enable the exploration of multiple scenarios along with the identification of the main transitory dynamics that would result from different policies. A number of novel findings have been presented and explicated by the model including for example how funds may accumulate or disperse in PAYG schemes despite unchanging policies, and how permanent economic growth can emerge as a result of a PAYG scheme introduction. The importance of three parameters, namely that of the employment rate multiplier, the attractiveness multiplier and the interest rates has also been clearly highlighted. Interest rates in particular have come to the forefront of the analysis not in their usual investment-defining role but rather as consumption determinants demonstrating quite clearly the perils involved if they are not explicitly so considered. Finally the transition from a PAYG to a FF scheme has also been modelled and despite ultimately producing the same effects as those predicted by economic theory different reasons are identified as responsible for bringing them about.

It is important to stress finally that despite the many scenarios that have been tested in this paper the model allows for still more simulation experiments to be made. Productivity increases for example have not been considered at all despite the simplicity with which they could have been introduced in the analysis especially if we assumed them to be exogenous. Interest rates have been assumed not to exert any influence on the decisions of firms to invest whereas we could have easily include them in and so on. Accordingly, many different possible combinations can be made of assumptions that have been considered in this paper but have not been put together. For example the model easily allows for modelling a situation of rising birth rates occurring at the same time that life spans prolong in an economy whose consumption is strongly dependent upon the interest rates they earn on the savings they have etc.
Our initial goal of building a model that can handle all these tests thus appears to have been broadly met.

On a final note it should be reminded that this model simply enables a greater *understanding* of the effects different pension policies may have

upon an economy. The model's highly aggregated structure along with the vast complexity of the real economic system and the inherent unpredictability of people's behaviour cannot allow for any sort of forecasts to be made especially given the time duration involved with pension related manners. The usual practice of many economists to make grossly unrealistic simplifying assumptions in their models' structures and to subsequently attempt to calibrate them as accurately as possible as if it was numerical accuracy that prevented them from perfect forecasts remains a grand mystery to these authors.

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