Notional Defined Contribution Pensions and Public Reserve Funds in Ageing Economies

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Abstract

In recent years, many developed and some developing countries have adopted a Notional Defined Contribution (NDC) approach to old-age pension reform. This paper reviews existing studies explaining the rationale for and approach to NDC plans around the world. We also investigate the key actuarial and economic implications of alternative NDC rules, devoting particular focus to an ageing economy similar in key respects to Japan. Next we investigate alternative approaches to managing public fund reserves, which we show can be used to smooth the impact of demographic transition to an older society. Such reserves are implied, and indeed essential for, a well-specified NDC system. Finally, we show that countries such as Japan could elect to use accumulated reserves under an old defined benefit system, if they sought to transition to an NDC system.

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Notional Defined Contribution Pensions and Public Reserve Funds in Ageing Economies

Global population ageing is driving public pension reformers in many countries to seek ways to tighten the link between workers' public pension contributions and pension benefits paid in retirement. Indeed, in many nations, massive unfunded retirement system liabilities are partly attributable to the practice of paying defined benefit (DB) pensions which bear no tight relationship to workers' lifetime payroll taxes or social security contributions. This tax-benefit link can be strengthened in a notional defined contribution (NDC) system, where workers' contribution histories are directly related to the value of benefits promised in retirement. While several countries have adopted variants of the NDC model in the last decade, relatively little analytic work has been conducted to evaluate how such a system might work in the context of an ageing economy. Accordingly, in this paper, we examine alternative structures for NDC plans to assess whether and when they may help resolve the financial challenges confronting traditional unfunded DB systems. Further, we seek to assess how NDC plans might benefit from being paired with a system-wide public pension reserve fund to help smooth tax and benefit fluctuations over time, as a nation experiences overall population ageing. To the best of our knowledge, no previous study has explicitly linked the design of NDC plans to pension fund reserve management.

This paper begins by outlining a stylized NDC pension system, relating it to the traditional pay-as-you-go (PAYG) consumption loan model as well as to a funded defined contribution (DC) paradigm. Next, we provide a brief literature review on NDC plans, followed by simulation results which illustrate key features of an operational NDC system under alternative demographic and wage growth scenarios. This is followed by an overview of international

experience of NDC implementation. We then turn to a more detailed analysis of how a NDC system might operate in an ageing economy with elements similar to modern-day Japan, where the labor force is declining and the population is projected to age dramatically over the next few decades. After investigating the actuarial and economic implications of alternative NDC rules, we go on to examine the implications of an NDC system for national debt. This analysis is undertaken to demonstrate how an NDC policy might work in an economy with aggregate parameters similar to those of Japan.

The results of our analysis indicate that the transition to an older society requires pension fund reserves, or a supplementary financing source, to provide what generally-agreed on "politically realistic" retirement benefits. Indeed, such reserves would appear to be essential if a country undergoing demographic transition seeks to adopt a fully-specified NDC system. In particular, the rate of return earned on pension fund reserves may be very important in helping deliver adequate replacement rates while avoiding high deficits. We therefore consider alternative approaches to managing demographic reserves in countries which have them, and we also explore the role of these returns in NDC reforms. In countries such as Japan that have accumulated substantial reserves under a previous unfunded social security system, these reserves could be used to transition to an NDC system.

The international relevance of this project is clear, particularly for ageing economies. In Japan, for instance, a handful of analysts is currently debating the introduction of an NDC system (Fukawa and Yamamoto 2003; Miyazato 2004). Other countries, such as Italy, Sweden, Latvia, and Poland, have already adopted a NDC pension approach. Even without an NDC reform, several nations (Norway, Australia, New Zealand, and most recently Chile), have established so-called "future funds," intended as pre-financing for a portion of the future

liabilities associated with demographic transition. Of course, there is a wide array of protocols concerning investment and use of these funds, and in what follows we identify protocols most likely to allow reserves that would be consistent with a resilient NDC system.

The Notional Defined Contribution (NDC) Paradigm

To explore what an NDC system does, we consider an overlapping generations framework in which all individuals are born and live for two periods. In the first period, individuals work and in the second they are retired. We initially assume that the economy is in steady-state, with demographic equilibrium and balanced growth. Under these assumptions, prior studies have shown that each working generation can be taxed to pay a pension benefit to retirees, in a self-financing system that can be isolated (in accounting terms) from other government activity. This arrangement is essentially the Samuelson (1958) consumption loan model as elaborated by Aaron (1966), in which the system-wide rate of return to contributions is provided by population and wage growth. For convenience, in what follows, we will label this arrangement the PAYG paradigm.

From an individual worker's perspective, a well-specified NDC policy looks most like a funded DC plan. From the government's viewpoint, the financing in steady-state is more similar to the PAYG model, as there is a mandatory contribution rate, and each birth cohort's rate of return is revealed as it is determined over time. Accordingly, in the NDC plan, each worker builds up a notional capital sum throughout his working life. In turn, at retirement, this notional accrual is then annuitised using prevailing estimates of returns and projected mortality patterns. Various life payout patterns could be specified; an NDC annuity is usually price-indexed, but it

may also include escalation clauses to take account of rising community standards over time (e.g. an average of price and wage indexation is sometimes used).

To state this more formally, let A be the worker's accumulated contributions, τ be the contribution rate, E the earnings at each age, R be the internal rate of return, s the first year entering labor force, and S is the retirement age. Then Equation 1 defines the worker's accumulation as follows:

Equation 1: $$A^{X}_{\bar{S}} = \sum_{t}^{\bar{S}} \tau^{X}_{\bar{S}-t+1} \cdot E^{X}_{\bar{S}-t+1} \cdot \prod_{k=0}^{t} R_{\bar{S}-k}$$

In the NDC plan, of course, entitlements depend directly on the worker's accumulation, so labor force incentives are far stronger than is often the case with traditional PAYG social security systems, especially at the all-important extensive retirement margin. Similarly, the worker is likely to perceive the accrual value as equivalent to private saving, so some substantial level of saving displacement might be anticipated.

In funded DC plan, workers' returns on their contributions to the plan are related to financial market performance. By contrast, NDC returns are typically tied to the aggregate wage bill or some related magnitude such as the so-called "biological" rate of interest (as in the PAYG paradigm). When the labor force is shrinking, as in many ageing economies including Japan, then returns are diminished and may even fall below zero. Whether the entire wage bill itself shrinks ultimately depends on empirical parameters. Thus as labor becomes scarcer, wage rates would be expected to rise relative to other prices; furthermore, technical progress might be anticipated to enhance labor productivity. These positive influences could outweigh labor force shrinkage. In any event, the biological rate of return for an individual NDC account is given by:

Equation 2: $$R_y = \frac{\sum_{x=1}^{\bar{T}} N^x_{y-x+1} \cdot E^x_{y-x+1}}{\sum_{x=1}^{\bar{T}} N^x_{y-x} \cdot E^x_{y-x}}$$

At retirement, each worker's accumulation is converted to a pension annuity using a standard annuity conversion factor. Specifically, the annual benefit is given by:

Equation 3: $$\beta^X = A^X_{\bar{S}} \Big/ \sum_{t=66}^{\bar{T}} {}_t p^x_{65} \frac{1}{R_{X+\bar{S}}{}^t}$$

Notional account annuities could, and perhaps should, vary with evolving mortality experience, and the benefit computations could be based, instead of on financial market returns, on the rate of return implied by Equation 2. Also, consistent with the NDC approach, the annuity could be purchased in tranches on a deferred basis throughout the working life, thus diversifying rate of return risk. To our knowledge, no country that has adopted an NDC plan has explicitly laid out such adjustments *ex ante*, although some (e.g. Sweden) have committed to contingency rules if there are unanticipated increases in longevity.

An NDC system will operate in a manner identical to the PAYG system, provided that steady-state assumptions hold. But outcomes will diverge between these two systems if the assumptions of demographic equilibrium and balanced growth are violated. Since the NDC plan is not pre-funded, period-by-period deficits and surpluses will be recorded at any point in time. For instance, population growth is often associated with a build-up of reserves, though these are dramatically less than the expected present value of pension liabilities. And then later, when population growth rates fall, deficits will be recorded. As a result, an NDC plan will often be out of cash-flow financial balance, in the sense of contributions equaling benefits in any given year (Valdes-Prieto 2000). Furthermore, as governments cannot frequently change contribution rates

to cover current liabilities without transparently incurring future liabilities stemming from an augmented notional individual account balance, committing to an NDC plan requires a reserve or contingency fund.

An NDC plan which is rigorously followed despite demographic disequilibrium or macroeconomic fluctuations will inevitably confront year-by-year deficits and surpluses. That is, an NDC structure can accommodate predictable adjustments attributable to increased cohort longevity and macroeconomic fluctuations impacting the time path of aggregate contributions. But it does not remedy the fundamental concern facing those charged with resourcing retirement in times of demographic transition: namely, that there are fewer workers producing goods and services, relative to the nonworking retiree population. If an NDC plan is rigorously followed, it will likely generate low or even negative returns as population ageing proceeds, unless adjustments are made such as raising the retirement age to offset labor force reductions. It is interesting that NDC plans are often advocated in shrinking economies, but they would be likely to work better when reserves exist to bolster the underlying biological rate of return. If such reserves are not available, NDC plans are unlikely to be implemented, and are less likely to be seen as successful if they are implemented.

Another poorly appreciated aspect of NDC plans is their inability to diversify risks across cohorts. That is, a cohort with a poor contribution history due to having reached working age in a depression, for instance, will suffer lower retirement benefits relative to some other cohort with a stronger contribution history. Similarly, a cohort which experiences poor system returns will be disadvantaged relative to a cohort in which system returns are high. As a consequence, one policy objective of social security, namely cross-cohort risk spreading, is not readily

incorporated in the NDC setting. As a result, an NDC is often tied to a separate means-tested safety net to support the poor.

Equations 1 - 3 provide the key elements descriptive of an NDC system. In particular, they take account of demographic change and macroeconomic fluctuations, because at every point, the rate of return in Equation 2 is based upon actual labour force experience. The notional return is what is credited to the notional account, and no uncovered promises are made. The model also captures the implications of longevity change via the annuity factor.[1] But thus far we have ignored the possibility that reserves may be invested, and the return used to cushion poor returns occasioned by the decline in the covered wage bill. To take account of this buffer, Equation 2 is rewritten as

$$\text{Equation 2a: } R_y = \frac{\sum_{x=1}^{\bar{T}} N^x_{y-x+1} \cdot E^x_{y-x+1}}{\sum_{x=1}^{\bar{T}} N^x_{y-x} \cdot E^x_{y-x}} + \text{buffer return}$$

To illustrate how countries which have introduced NDC plans have followed, or departed from, this schematic model, we turn to a review of existing literature on NDC programs and the policy experience thus far.

Prior Studies and Policy Experience

While the NDC paradigm has been implemented in a several countries, there is relatively little economic analysis of the structure. European and North American studies on NDC models have been mainly descriptive (Brooks and Weaver 2004; Disney 1999; Fox and Palmer 2001; Palmer 2006; Williamson and Williams 2003), though a handful of more rigorous economic

[1] The implications of increasing longevity are explored in an interesting way by Settergren and Mikula (2005), who develop the concept of "turnover duration" to help explain IRR shifts under longevity increase. We discuss this and related issues below.

treatments exist (e.g., Feldstein 2001; Settergren and Mikula 2005; Valdes-Prieto 2000). In Asia the NDC model has been little contemplated, though Japanese writers have begun to discuss the possibilities (e.g., Takayama 2003, Miyazato 2004). The most recent writings on NDC are collected in a conference volume edited by Holzmann and Palmer (2006). We summarise this literature by first reporting what various authors have identified as the crucial aspects of NDC plans, and then we highlight the ways in which individual countries have implemented the NDC approach, each with its own twist.

Definitions and Perspectives: The idea of an NDC system reaches back at least as far as Boskin et al (1988), and probably before that. Palmer (2006) tries to capture its essence:

> "An NDC scheme is a defined contribution, pay-as-you-go (PAYG) pension scheme. Contributions are defined in terms of a fixed contribution rate on individual earnings. These contributions are noted on an individual account. As opposed to a financial defined contribution (FDC) scheme, the contributions of participants noted on individual accounts are not 'funded'. More specifically, individual account money is not invested in financial market instruments. . . .In the generic NDC scheme, the rate of return is the internal rate of return. The NDC benefit is a life annuity. It can be claimed at any time from the minimum retirement age. The generic NDC annuity embodies a rate of return based on the same internal rate of return that is credited accounts during the accumulation phase and, importantly, cohort life expectancy at the time the annuity is claimed. Since newly granted annuities reflect life expectancy, in principle, NDC is an actuarially fair pension system."(p 18).

That is, an NDC plan is a defined contribution system with notional individual accounts accumulated at a notional interest rate tied to system return, and annuitised based on the expected mortalities of the retired cohorts, again using the system return.

Other writers bring alternative perspectives to the NDC concept. Borsch-Supan (2006), for example, emphasises the accounting aspect of NDC: it "treats the PAYG system like a DC

system" (p 38). Barr (2006) stresses the separation of the actuarial and redistributive functions of traditional PAYG plans: "The basic idea of NDC pensions is to separate the state pay-as-you-go (PAYG) scheme into two components: a strictly actuarial element (the NDC pension), operating on a PAYG basis but mimicking a funded defined contribution scheme; and a redistributive element financed from general taxation." (p58). Finally, Lindbeck and Persson (2003) emphasise that "the 'property rights' of pension benefits are more robust politically in NDC systems" (p 75).

Country Practice: Specific Design Features. The generic or canonical NDC plan outlined above can be varied in several ways. The three most important have to do with (i) the basis for the rate of return; (ii) the annuity specifications; and (iii) arrangements for transition Most of the countries which have actually introduced NDC plans – Sweden, Italy, Latvia and Poland – depart from the pure NDC along one or more of these dimensions.

The most widely reported NDC system is that of Sweden, which has become a kind of exemplar for other countries contemplating NDC reform.[2] The Swedish model departs from the canonical NDC formulation in using the change in the covered wage rate, rather than the taxable wage bill, to calculate the notional rate of return. This ensures that pension entitlements keep pace with community living standards; further, this wage indexation is approximately carried forward into pension indexation (Konberg et al. 2006). The problem, of course, is that if the labour force declines, the system fall into cash-flow deficit. To take account of this possibility, the system has a contingency plan: benefits will be adjusted downward when a "balance ratio" drops below some threshold. This "balance ratio" is quite complicated to compute: see Settergren (2002) for details, but in short, it depends on the expected present value of contributions falling short of the expected present value of benefits, plus a buffer fund, to ensure asset liability balance. The Swedish buffer fund amounts to about four times the annual system payout, and it

[2] For an example of Japan's interest in the Swedish model, see Miyazato (2004).

was originally generated under the previous PAYG social security system. A second way in which the Swedish model departs from the canonical NDC framework concerns the computation of the annuity factor. As that country uses unisex mortality tables, it does not maintain actuarial fairness for men and women system members. In practice, it turns about that unisex tables are quite common in real-world NDC arrangements, and it operates as an *ex ante* redistribution to older women.

Italy enacted its NDC reform in 1995, at which time the country elected to use nominal GDP growth to compute the notional rate of return. This is, again, a departure from the generic NDC structure, though it does implicitly take account of labour force decline, thereby reducing the need for reserves. The Italian reform also indexes pension benefits to price inflation, rather than wage growth. It is interesting that the transition process from the old PAYGO system to the new NDC is very long: workers with 18 years of contribution experience in 1998 remain fully under the old system, which will therefore not be phased out for many years. In addition, the Italian reform completely exempts 40% of existing workers, compared with only 7% in Sweden (Gronchi and Nistico 2006).

Latvia and Poland have also adopted NDC systems; both of these nations use the growth of the wage bill as the basis for assigning a notional rate of return. In this regard, therefore, they are consistent with the canonical model. Both expect to reduce contribution rates in the future due to population aging: Latvia from 38% to 33%, and Poland from 24% to 18% (Valdes-Prieto 2000).

NDC Outcomes and the Demographic Shift: Illustrative Simulations

In this section, we explore key features of an NDC system under alternative scenarios and using numerical examples. We begin with the canonical NDC formula where the notional rate of return is tied to the wage bill, and we base the replacement rate simulations on various labor force and longevity change scenarios. We also introduce a buffer fund to bolster the replacement rate under the condition to meet system balance.

These examples assume an 80 year time horizon, simulated in decade-long tranches. The model is launched with four "live" cohorts per decade. Once the system is "mature" (after four operating periods), eight simultaneous cohorts are either working or retired. More complex formulations could be created, but this model is sufficiently tractable to work through the impacts of alternative policy and practice changes. Each representative consumer works full-time for 40 years from 25-64, at average wages, and retires at 65 with lump sum withdrawal of the pension accumulation, annuitised in the commercial market.[3]

Two broad demographic scenarios are analysed: steady growth in the contribution base from labour force and wage growth; and a static contribution base (labour force decline just balanced by growth in the wage bill). Inflation is assumed to be zero throughout. For each of these simulations we also introduce longevity increase of 0.3% per year. An NDC system is introduced in the first period, with a contribution rate of 18.3%. It pays actuarially fair benefits which are indexed to the current wage level In the early periods of the model's operation, therefore, when new retirees have contributed for less than the whole of their working lives, the replacement rate generated by the NDC policy is low. (The Appendix provides tabular information with detailes of the assumptions for the above scenarios.)

[3] More detail on mortality tables and the model appear in the Appendix.

Figure 1 illustrates the time profile of replacement rates in a simulation with a constant labor force. Wage growth is set at 1% annually. In Scenario 1a, mortality is held constant; Scenario 1b adds the longevity improvement at 0.3% per year. As expected, the replacement rate is constant through time under Scenario 1a; longevity increase implies a downward drift in replacement rates for successive cohorts.

Figure 2 elaborates on Scenario 1b. First, we assume a labour force decline of 1% per year (Scenario 2a), while retaining the assumption of 1% wage growth. The initial replacement rate falls from 48.5% (in Scenario 1b) to 35.2%. In order to explore the impact of invested reserves, we assume a buffer fund equal in magnitude to the first year payout, invested at 2%, and use the investment return to bolster the replacement rate, which increases to 45.1%. More importantly, as we point out below, the balance sheet becomes positive in year 2115 if the capital in such a fund is preserved.

Figure 3 reports the system balance sheet under various assumptions. The asset balance profile under Scenario 2b is constant at zero. When labour force growth is zero (Scenario 1a), we find that if the notional accounts are credited with a positive rate of return consistent with the rate of wage bill growth, this will generate a negative asset balance which persists while wage bill growth continues. This is independent of longevity increase, which in our simulations is balanced by reduced replacement rates.

If, however, the labour force is declining, as in scenario 2b, the buffer fund, if preserved in real terms, can eventually affect a positive asset balance in the system. In our simulation, this occurs after 70 years. This is because the covered population is declining through time, so that the *per capita* value of the return on the buffer fund gradually increases.

Figure 1-3 here

Understanding Japan's Pension Reforms to Date

Before evaluating the possibility of an NDC plan for Japan, it is useful to review the major social security reforms that have occurred in that nation over the last two decades. This assessment serves to inform a more detailed simulation of the possible impact of introducing an NDC policy in Japan. As long ago as 1890, pensions had been established for the Japanese military, and later these were extended to the civil service. Currently, five different social security programs are in operation covering various sectors of the economy. The two most important systems are the employee pension insurance plan (KNH), which is a PAYG defined benefit plan for most private sector Japanese workers established in 1942; and the national basic pension (KN) introduced in 1961, which is available to all who make contributions for a vesting period of 25 years. It is on these two systems that we focus when considering the feasibility of an NDC reform for Japan (Takayama 2003 pp 186-187).

Initially, the KNH system was intended to be a defined benefit which was fully-funded. During the long period of wage bill expansion in Japan of the 1960s, 70s and 80s, large pension reserves were accumulated. These reserves were invested in a wide range of government projects. Nevertheless, over time, sharp increase of replacement ratio from 40% to 60% of gross wage from 1965 and 1973 (Takayama 2003 pp 186) made the system's reserves became insufficient to finance all future benefits, so it gradually became a PAYG system. The KN system was introduced as a redistributive program; it is partly financed from contributions and partly from transfers from general revenue, and it has a strong welfare mission.

The 1985/86 Reform: Several national pension reforms have been undertaken in Japan, generally aimed at curtailing the value of benefits promised.. The KN, as the national pension

scheme, requires a very small contribution and is targeted at most self-employed workers, students, and the unemployed, sometimes referred to as “Group 1” individuals. The KNH is the employee pension plan, covering so-called “Group 2” individuals. Finally, Group 3 includes spouses of Group 2 workers who pay employee contributions; thus spouses of contributing workers gain automatic entitlement to the KN benefit without paying any contributions of their own. The 1985 reform increased the number of years of contribution required for full coverage by KN from 25 to 40 years, with special transitional provisions for those born after 1926 having at least 25 years of coverage. As well, the reform phased the KNH benefit down from 1.0% of replacement rate per year of contribution to 0.75% per year, consistent with the increased full working life definition (Takayama 2003 p188).

1993/94 Reform: Another wave of Japanese old-age system reforms was enacted in 1993-94, and it included steps to raise the retirement age. In the KNH plan, legislation specified that benefits could be paid between ages 60 and 64 without any reduction, and benefits were to be indexed to prices rather than wages. Under the KN plan, there was a phased increase in the eligibility age from 60 to 65 for men (by 2013) and for women (by 2018). Further, the KN benefit was indexed to net wages instead of the gross wage..

The 2000 Reform: The 2000 reform again focused on the KNH system. Now the eligibility age was to be increased over time; benefits in payment were to be indexed to prices rather than to wages; and the accrual factor was again reduced from 0.75% to 0.7125%. This reform also formally recognised the need to subsidise the KN from general tax revenue (Fukawa and Yamamoto (2003 p 7).

The 2004 Reform: In 2004, labour force decline was formally recognised as a factor which would exacerbate the social burden of the social security system. Accordingly, these reforms

sought to establishing tighter links between contributions and benefits, at both the individual and system-wide levels.

One way this was implemented was to develop an adjustment mechanism known as the "Macroeconomic Slide", which links the earnings-related benefits provided under the KNH to each individual's past wages (Miyazato, 2004). Formerly, benefits were indexed to the wage rate;[4] now the benefit formula adjusts for increased longevity and changes in demographic balance. Specifically, the revaluation index is set to equal "the wage growth rate minus the demographic factor change rate", where "the demographic change rate (is equal to) the declining rate of workers (plus) the longevity rate of increase" (Miyazato, 2004; p 14). The benefit factor will be reduced from 0.7125% to 0.5481% per standard contribution year at the average wage level. This latter change was, in effect, an adjustment for the expansion of the taxable wage base which was extended to include the traditional Japanese bonus (at that time, the bonus had fallen outside the social security contribution net). This change is thought to have no effect on real benefits for a worker on average wages and in receipt of a standard bonus. Further, the retirement eligibility age is also gradually rising to 65 for both men and women, although early retirement, at ages 60-64, will still be possible with a penalty under the KNH.

In addition to benefit cuts, the reform also included phased payroll tax increases. The KNH contribution rate is to be raised by 0.354% per year, from October 2004 onward, from the present 13.58% to a capped level of 18.3% in 2017, according to the Actuarial Valuation Report for 2004 (hereafter AV2004; Actuarial Affairs Division 2005). Contributions to the KN plan must also be raised by 280 yen per month from April 2005 until 2017, boosting monthly contributions from 13,300 yen to 16,900 yen over this period. General revenue financing for KN will also be

[4] Before 1994, the benefit was adjusted to gross wage, then to the net wage. In the 2004 reform, it is adjusted to net take home pay but could be changed if demographic circumstances change. (Takayama 2003 p 188)

required, rising from the current 1/3 of its benefit payouts to 50% by 2009.[5] With all of these adjustments, the actuaries predict that an average couple's benefits will total more than 50% of the average income of the working generation. Appendix Table 1 summarises these changes.

In sum, this sequence of reforms reduces future benefits and increases years of service and contribution rates (Fukao and Kaneko 2005). This is the result of rising longevity, low fertility (currently 1.37 per woman), and Japan's "lost decade," as well as benefit formulas which were de-linked from financing mechanisms. Though Japan does have many employer-based pension plans (Clark and Mitchell 2002), most workers will still rely heavily on the KN and KNH plans for their retirement financing. According to AV2004, government benefits account for 70% of the income of elderly households, and 60% of elderly households depend solely on government benefits. Furthermore, 70% of current workers plan to depend on the government pension to support themselves in old age (AV2004, p 3).

It seems clear that Japan's "automatic" mechanism for adjusting benefits and contributions might entail further benefit cuts and tax hikes. Perhaps as a result, public confidence in the government's ability to carry out its promises appears to have been eroded. Between 1997 and 2002, for example, non-payment rates for social security pensions nearly doubled, from about 20% to more than 37% (Takayama 2003). This dynamic will surely exacerbate social security financing difficulties in the future, as it compounds the shrinkage of the contribution base.

Japan's 2004 reform brings the KNH closer to an actuarially fair system, by linking individual contributions and benefit amounts, but the reality is that it remains a PAYG system facing huge unfunded liabilities. The KNH program, for example, has been estimated to have liabilities of 550 trillion yen [6] in 2005 (Takayama 2006). It is worth noting that the

[5] AV2004 page 11-12, this is used for the payment of KN scheme only, and is 50% of the total KN expenditure .
[6] Or about USD$4.7 trillion as of 1/28/06.

government's old-age system reserve fund amounted to 179 trillion yen[7] in 2004, though a portion of this reserve might be heavily exposed to non-performing loans that threaten its future returns (Zheng et al., 2005). This may well have further impact on public confidence in the integrity of the social security system.

The Feasibility of NDC for an Ageing Economy: The Case of Japan

Next we turn to a discussion of the pros and cons of introducing a Notional Defined Contribution system to an ageing economy such as Japan's. Inasmuch as such a reform promises an actuarially fair benefit for every participant, some have argued that its political economy appeal could help restore public confidence and improve the system's credibility (Borsch-Supan, 2004). We approach the question by adopting the same assumptions and projections used in AV2004, so our simulation results can be directly compared with those projections.

An NDC system is an individual-account system, where the fundamental unit is the individual, rather than a married couple or a family. For this reason, every contributor has his or her own account and makes his or her own contribution. There is no *ex ante* redistribution in this simple variant of the NDC proposal (later we return to the issue of a safety net). Accordingly, the different population groupings identified under the current Japanese pension systems would effectively disappear under the envisioned NDC model, and the KN and KNH would be merged into one NDC system. The contribution rate required for an individual is about half that of today's standard worker level, as the current systems are designed to support a retired couple. By contrast, in a NDC world, single individuals may make additional contributions to an occupational pension plan which could be managed by private investment institutions. Self-

[7] Or about US$1.5 trillion as of 1/28/06

employed workers, as well as those out of the labour market or in the informal labour force, would need to pay contributions to the NDC plan, in order to get a benefit.

The pensioner numbers used in our NDC simulation are calculated from the Demographic Institution of Japan's population projections.[8] This is based on the number of pensioners reported in the 2003 SIA report (Social Insurance Agency 2005, p.13) which was 31.37 million in total and is very close to the total population for 60 and up. Figure 4 charts projected numbers of contributors and pensioners from 2005 to 2100.

Figure 4 here

In what follows, we first present computations for a simple NDC plan, and then we go on to discuss possible variants. Appendix Table 2 summarizes the demographic and economic assumptions used in combination with the model based on Equations 1, 2a and 3, presented above.[9]

Table 1 presents the pension parameters used in AV2004, and the outcomes from the NDC, for comparative purposes. In all cases, we use the AV2004 standard consumer unit, which is a husband employed full-time on average wages for 40 years, with a non-working spouse of the same age. This we term a "benchmark couple".

Table 1 here

Consistent with our findings in the schematic simulations above, this system is not sustainable in the absence of some form of subsidy. The rate of return implied by wage bill growth is 1.1%. In order to reach our 25% per person replacement rate target, a 2.2% rate of

[8] The 2004 number was derived using data from:総務省統計局『国勢調査報告』，国立社会保障・人口問題研究所『日本の将来推計人口(平成14年1月推計)による，the detailed projection of the future pensioners as per Appendix.

[9] Additional model and data details appear in Appendix 1.

return is required. This is financed by current contributions, the same government subsidy that is used for the AV2004 proposal, and investment returns from pension funds reserves.

Table 2 reports the cash flow implications of introducing an alternative NDC approach into this simulated framework. With a stipulated rate of return of 2.2%, end-of-year assets are reported from 2005 to 2100, along with the "reserve ratio", which is defined as the ratio of the value of assets at the end of any year to the value of payouts in that year.

Table 2 here

Under these contribution assumptions, the targeted minimum replacement rate of 50% for a benchmark couple is achievable. Singles, who receive only 25% replacement, can supplement this by contributing to a funded DC plan.

The NDC simulations show that this policy protects reserves better, in the long term, as compared to the current policy described in AV2004. During the last 30 years of this century, there will be a much more rapid drawdown of reserves than would be necessary with the NDC system (under our assumptions).

In the context of population ageing (or more accurately, system participation ageing), an NDC plan will necessarily offer low rates of return. So a large and well-invested reserve is useful and indeed essential to make the reform feasible given political economy constraints. The size of Japan's current pension reserves suggests that if they were properly invested, such a reform would be feasible.

Another point to note is that the NDC system sketched here can deliver the target minimum 50% replacement rate for couples, while retaining robust reserves in the long term, but still higher rates of return would naturally render higher replacement rates feasible. Table 3 relates the rate of return on reserves to the associated increment to notional account returns that this will

finance, and reports the achievable replacement rates. AV2004 returns are in bold. Again following AV2004, we impose the constraint that the reserve ratio in 2100 is greater than unity. The results indicate that the current reserve amount is just sufficient to achieve reasonable replacement rates, given our demographic projections. With significantly lower reserves, even with very high assumed rates of return, satisfactory replacement rates cannot be financed. On the other hand, a higher reserve would allow a fully funded system to be partially implemented. In the long run, the government might consider whether to continue the NDC or gradually switch to a fully funded DC system.

Table 3 here

NDC simulations of this sort also permit us to assess the "actuarial fairness" of the AV2004 proposal, using assumptions which are actuarially consistent with the target benchmark couple benefit. Under the current PAYG system and assuming our simulation conditions, if a member pays 40 years of contribution to the KNH system, he should expect about a 50% replacement rate with a notional rate of return at 2.2%. But a single person receives only a 35% replacement rate. A lesser implicit transfer occurs for KN contributors: they would receive only a 14% replacement rate under the NDC policy, compared with the AV2004 of 16%. This provides some measure of the extent to which the current system departs from the "actuarially fair" outcome.

Such departures impact especially on labour supply incentives. Strong incentives to work longer are one of the strengths of an NDC system, and we find this to be supported in simulations using our model, particularly for singles and working couples. Replacement rates can increase dramatically – from 45% to 72% - for singles or working couples who postpones retirement and work for five years longer. Differences of this magnitude might be expected to

significantly alter behavior. For instance, relative to the current system, full-time work would likely be substituted for part-time work by households of these types. These changes themselves will exacerbate the fiscal burden of financing the ageing population.

In summary, two important but related points emerge from these results. First, the current KN system subsidises single KN contributors relative to KNH workers. The KNH system subsidises married couples relative to singles. As a result, the existing system appears to depart substantially from actuarially fair outcomes. Second, working longer and later is penalised by the current Japanese PAYG policy, relative to a NDC system such as that sketched here.

The NDC system outlined here appears to be able to pay higher benefits with better financial sustainability than the existing system. It also other advantages, compared to the current PAYG system:

1. It offers a more transparent system, in that contributions are linked more tightly to benefits. This can aid in restoring trust in the system, and it may reduce the extent of non-payment of contributions.
2. It combines the current system's three population subgroups into a single cohort with individual accounts, so that recordkeeping is much simplified.
3. It eliminates the housewives' survival benefit of 75% of the husband's KNH benefit if the husband dies before the wife. The NDC proposal sketched here raises the value of the wife's benefit from the current 16% to about 25% of average take home pay, so the survivor benefit is less necessary on equity grounds.
4. Contributors face labour market incentives which are more likely to lead them to work longer, which helps achieve a higher notional accumulation and a higher replacement rate.

Issues Pertinent to Managing Social Security Reserves

Even in an unfunded social security system, significant reserves will accumulate through a period of demographic transition. When the covered population is increasing, contributions will exceed entitlements, and the surpluses will aggregate over time. In Japan's case, this is very important – public pension reserves are currently estimated at 170 trillion yen, about 30% of GDP,[10] of which 137 trillion yen lay in public hands in 2002.[11] This naturally leads to the question of how these reserves should be managed. This discussion is therefore related to issues arising in the management of other publicly-held reserves, but it is distinct in that pension fund reserves are publicly-managed yet privately owned. Norway's Government Petroleum Fund, currently worth about 60% of GDP,[12] and the Australian and New Zealand "future funds," constitute non-pension examples.

A separate literature has evolved on ways to manage public reserves in national social security systems (Iglesias and Palacios 2000; Palacios 2002; Settergren 2002, 2004) and US public employee pensions (Mitchell and Hsin 1998; Wall Street Journal 2005). Both the World Bank and the OECD have developed guidelines for the management of such reserves, and Japan has addressed this problem.[13]. The World Bank published a series of literatures concerning the public pension fund management. Carmichael and Palacios's (2003) principles serve as useful guidelines or checklists for policy designs in this field. Their recommendations include the following:

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[10] Data available from http://www.mri.co.jp/REPORT/ECONOMY/2004/er040804.pdf page 4 showing GDP in 2003 was 502trillion yen.

[11] 137 trillion yen is the amount held by the government (the SIA or the Pension Sub-account of the Special Account of the Social Insurance). However some companies can contract out, and then hold reserves in their employee pension funds, which they themselves manage, so while reserves total about 170 trillion yen, only 137 trillion yen is in the hands of public management.

[12] Data from http://www.statsbudsjettet.dep.no/2004/pdf/budget2004.pdf.

[13] See www.mhlw.gov.jp/english/org/policy/dl/p36-37d5.pdf

- *Clear Structures, Objectives* – there should be clarity of roles and responsibilities within the pension fund, and it should not be in conflict with any other government or political purposes;
- *Transparent Manner* – The operation of the fund shall be as transparent as possible and disclosure procedures shall be defined.
- *Accountable Management* – The operators of the schemes should be accountable to its members and an appraisal system should be installed to penalize/reward relevant performance.

With respect to the investment of these reserves, Carmichael and Palacios (2003) stipulate important guidelines:

> "The investment policy should be set by the board of directors or trustees, should be fully documented, and should be available in summary form to members of the scheme . . . .
> should identify all relevant risks and the Board's approach to measuring, monitoring and managing each of them . . . [they] should clearly delineate the role of managers and, where relevant, the criteria for selection and the retention of external parties. These criteria should be based on objective benchmarks that are provided regularly to the Board in a form that can be understood." (Pages 27-30)

In practice, the governance of pension fund reserves varies across countries; in general, returns fall short of bank deposit rates. Figure 5, from Iglesias and Palacios (2000), provides a guide to country by country performance. It is notable that Japan's pension fund reserves perform best of all countries shown.

Figure 5 here

Until 2000, the Japanese public pension fund was managed under the Fiscal Investment and Loan Program. After the reform, management underwent major reform and a new institution, the Government Pension Investment Fund (GPIF) under the MHLW, was established to manage the

reserves. As a result of this reform, governance of the Japanese public pension reserve fund became independent from other publicly held reserves and the reserves were formally dedicated to cover pension benefits. The overall policy for the management of the reserve fund is determined by the Minister of Health, Labor and Welfare (MHLW), which consults with professional investment institutions to enable prudent fund management.

The policy document that accompanies the 2004 reform makes clear that Japan's social security system is unfunded, and its accumulated reserves are a consequence of the demographic transition. The document goes on to state that the active working generation is expected to support the elderly, and there is no intent to reach full funding for all future benefits.[14] Therefore, it is reasonable to imagine that the reserve fund already accumulated could be consistent with an NDC reform of the type evaluated here, in the context of the broad objectives of Japan's social security system.

Legacy Costs and Funding: an Alternative Perspective

An alternative approach to social security reform would separate – and presumably finance – the legacy costs from the old system, from those associated with a new, reformed, and presumably fully financed new system. Modeling such an approach for Japan would require much more detailed demographic, financial, and labor force data than is widely available. Nevertheless, in what follows we undertake a simplified exercise using available statistics.

[14] "Japan's public pension system (the Employees' Pension Insurance and national Pension) is operated based on the concept that the active worker generation supports the elderly generation. Therefore, there is no intent to reserve necessary funds for pension benefit payments. However, Japan is facing an intensified ageing society with fewer children, meaning that the future generation's burden will inevitably increase sharply to cover the pension benefit payment by the active worker generation. In order to avoid a sharp and excessive increase in the future generation's premium burden, and to make the burden lighter, a certain amount of the reserve fund is maintained and its investment profit is utilized." (www.mhlw.gov.jp/english/org/policy/dl/p36-37d5.pdf Page101).

We begin with the assets and liabilities, or the "balance sheet" of the current system. Takayama (2006) has calculated the liabilities under the KNH system, and he also has provided to us KN liability estimates.[15] In total, it is estimated that prior to the 2004 reforms, the KNH system faced 740 trillion yen in liabilities, and the KN system 50 trillion yen.[16] The 2004 reforms reduced existing liabilities to the point where they can be financed with existing reserves, pre-specified future contributions, and currently-committed transfers from general revenue.

This is achieved by holding benefits below those which could be realised if contributions were invested in the capital market. To obtain a sense of the magnitudes involved, we have amended the illustrative model outlined above to evaluate what would happen under a stylized Japanese stand-alone DC plan, using the contribution rate of 18.3% from AV2004. The system starts in 2005, and workers are assumed to earn average wages throughout their 40 year working life, retiring at 65. Their accumulations are then annuitised using prevailing life expectancies according to assumptions described earlier. Wage growth is set at 2.1% nominal a year and the labor force declines at 0.6% annually, consistent with AV2004.

Assuming that benefits are only paid to contributors and the reserve is invested in the financial market with a return at 3.2%, the replacement rate is estimated to rise to about 73% (given all the same assumptions in AV2004). The current AV2004 provides only about 50% of the net take-home pay replacement rate. Furthermore, the system would be judged to be sustainable in terms of asset and liability balance.[17]

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[15] Private correspondence, November 2005.

[16] This estimate is calculated using the AV2004 investment return of 3.2% as a discount rate. Whether this is the most appropriate rate is questionable.

[17] Whether this is the correct investment return to use is subject to debate. Geanakoplos et al. (1998, 1999) show that simulations of social security investment accounts should use risk-adjusted real returns for at least that portion of the covered workforce that already has access to capital markets; higher rates may be justifiable for those who lack such access.

Conclusions and Possible Extensions

NDC plans have been seen by many as a means to enhance actuarial fairness of PAYG social security systems around the world, particularly when nations confront the unpleasant consequences of system insolvency due to population aging. To evaluate the possible implications of NDC reform in Japan, we have reviewed the limited literature on the topic and carried out a simple numerical simulation based on the 2004 Japanese Actuarial Valuation of Social Security. We also explore the use of existing reserves and pre-specified general revenue transfers as means of buttressing the replacement rates implied by a "pure" NDC system.

Japan has already implemented several old-age system reforms in the last two decades, which have boosted contributions, reduced the real value of benefits, and raised retirement ages. Our analysis shows that the current system is still far from actuarially fair: specifically, the KN program subsidises single KN contributors relative to KNH workers; while the KNH system subsidises married couples relative to singles. Furthermore, working longer and later appears to be penalised by the current PAYG policy, relative to the NDC system.

Using a simulation model, we show that an NDC system such as that outlined here could pay higher benefits with better financial sustainability than the current system. It also has the potential to make more transparent the workings of the system, which could reinforce trust in the national program. But a pure NDC system is unlikely to deliver adequate replacement rates for participants in the face of a demographic shift toward a substantially older population. For this reason, additional sources of financing are likely to be required. In the Japanese case, reserves built up for the existing social security system are a natural candidate for this financing. Accordingly, how these assets are managed becomes critical. While Japan's pension fund management performance has been relatively strong by international norms, we also indicate

ways to improve future performance. Our analysis also briefly examines the feasibility of transitioning to a fully funded system in Japan. While the investigation is preliminary, the results suggest that such a policy alternative should be further evaluated.

Our research effort has been constrained by data availability; thus it would be of great interest to construct a more realistic demographically-based simulation model, in which the detail of demographic transition in Japan could be incorporated, as well as the structure of labour compensation, occupational pension contributions and entitlements, and liabilities by cohort. While such an undertaking is beyond the scope of this paper, work in this direction would illuminate additional policy-relevant questions. These might include evaluation of:

- A more comprehensive analysis of the current indebtedness and future prospects of the social security system under various reform options, with sensitivity analysis for discount and earning paths, and with more complete consideration of alternative drawdown rules for the reserves.
- A more comprehensive analysis of the possibilities for introducing a mandatory pre-funded element into the suite of retirement finance policies under NDC reform.
- The impact of NDC reform on the poor. Traditional PAYG plans usually involve redistribution to the less well off, so adoption of an NDC paradigm raises the question of whether a safety net program should be integrated.
- The specification and cost of providing survivor benefits in an NDC option.
- How an NDC plan might be integrated with occupational pensions and personal wealth. Issues such as tax neutrality could be considered.

The international relevance of the topic is clear, particularly for ageing societies such as Japan. Where demographic transition is underway, countries which have introduced NDC plans

specify mechanisms for reducing benefits at a later date, or identify possible channels for external funding. Several countries including Italy, Sweden, Latvia, and Poland, have already adopted a NDC pension approach, and others including Norway, Australia, New Zealand, and Chile, have established so-called “future funds,” intended as pre-financing for a portion of the future liabilities associated with demographic transition. Additional work will be required to further specify what features are most consistent with a resilient NDC system, and to examine the redistributive implications of such a reform.

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Figure 1: NDC Replacement Rates with a Constant Labour Force (Notional return rate as wage bill)

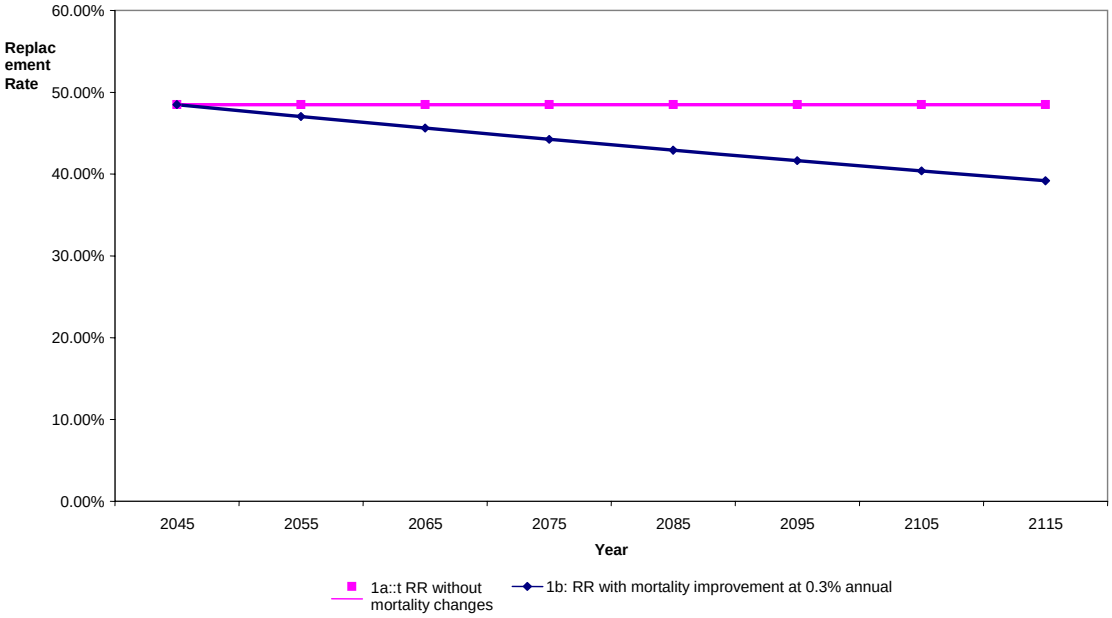


Figure 2. NDC Replacement Rates with Changing Labour Force

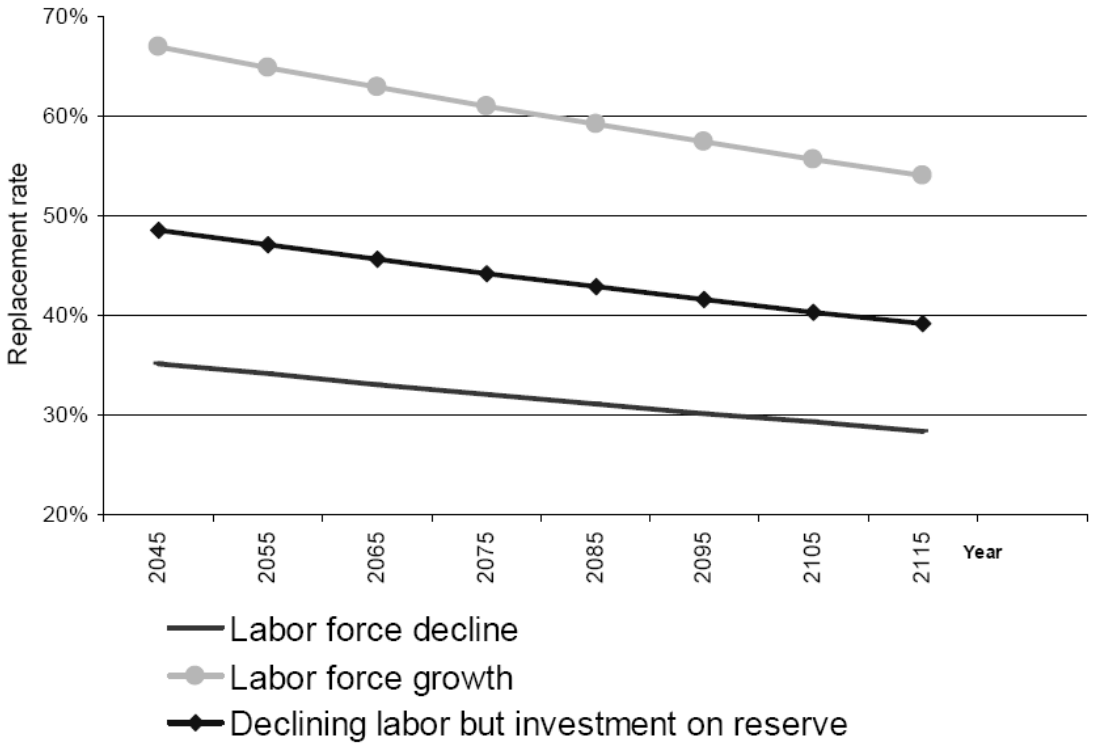


Figure 3: The NDC System Balance Sheet under Alternative Labour Force Scenarios

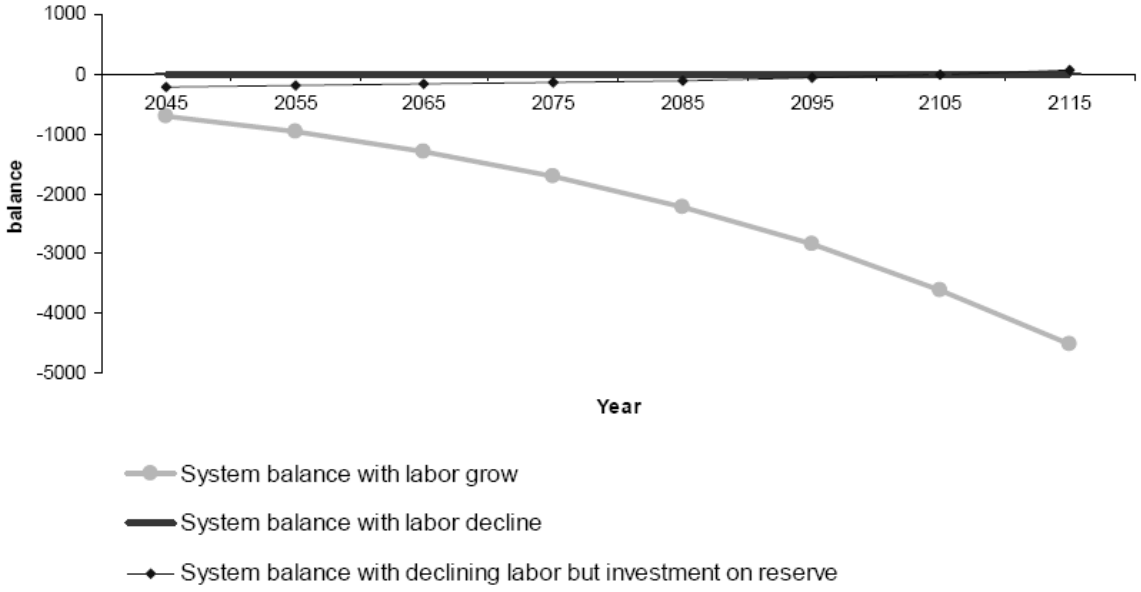


Figure 4: Projected Number of Pensioners and Contributors: Simulation for Stylized Japan Model, 2005-2100

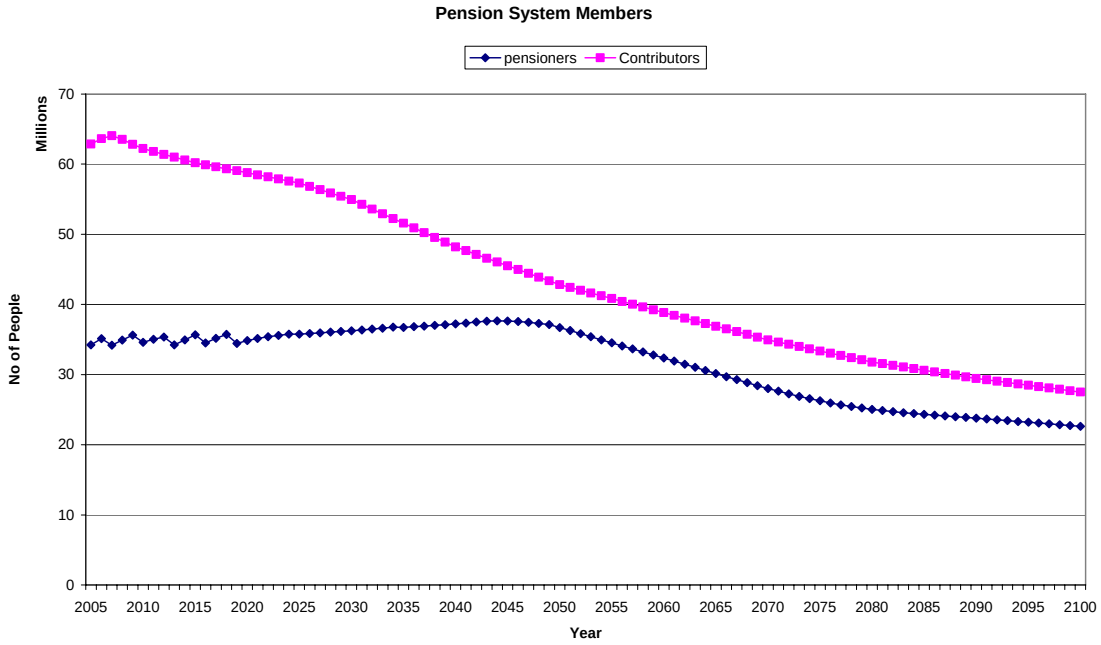
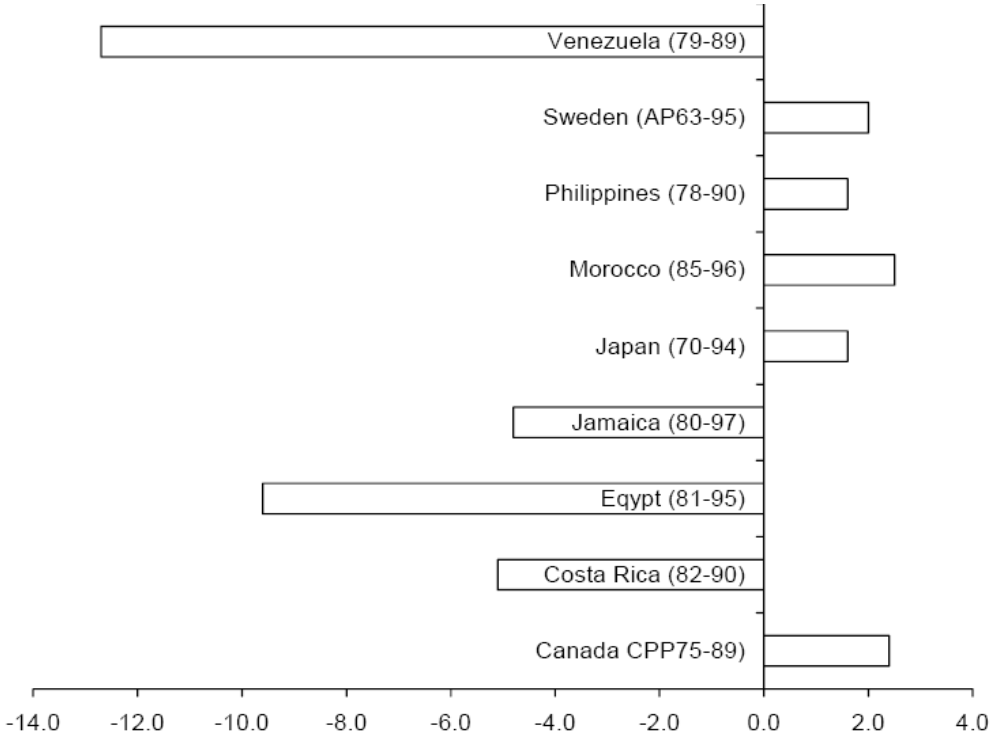


Figure 5: Annual real investment return of pension fund in various time period of different countries:



Iglesias and Palacios (1999)

Table 1: Comparison of Current Policy and NDC Simulated Reform

	2004 Reform		NDC Simulation	
	Contribution rate	**Replacement rate**	**Contribution rate**	**Replacement rate**
Single	18.3%	36.4%	9.15%	25%
Benchmark couple	18.3%	50%	18.3%	50%

Notes:
Long-term economic assumptions (from FY2009) are as follows (AV2004):

Wage growth rate	2.1%
Price inflation	1.0%
Rate of investment return	3.2%
Disposable income growth rate	2.1%

Table 2 Comparison of Two Stylized Models: End-of-Year Assets and Reserve Ratios

		Current Policy		NDC	
	(trillion yen)	End of year asset value	Reserve ratio	End of year asset value	Reserve ratio
2005		175	4.84	178	4.70
2010		167	3.92	182	4.38
2015		176	3.73	200	4.31
2020		204	4.11	233	4.73
2025		246	4.69	270	4.93
2030		296	5.14	307	5.09
2040		369	5.02	359	4.91
2050		377	4.29	368	4.33
2060		456	4.67	378	4.10
2070		324	3.02	416	4.23
2080		273	2.32	496	4.58
2090		207	1.6	577	4.56
2100		137	0.95	622	4.20

Note: authors' calculations based on actuarial report (2005) and Japan NDC model. All other assumptions the same as in tables 2 and 3.Contributors numbers as per Actuarial Report 2005 Japanese version and pensioners number as per NDC model derived from 2004 mortality and longevity growth projection in Australia in 2000 for 2005-2100

Table 3: Replacement Rates for the Simulated NDC Model Under Alternative Investment Return Assumptions

Assumed Investment Return	2%	**3.20% ***	6%
RR for Single Retiree in 2050	23%	**25%**	29%
NDC Crediting Rate	2.0%	**2.2%**	2.8%

Note: Based on the condition that the final year 2100 balance is not less than the projected 2100 outlays.
* AV2004 rate of return and target replacement rate.

Data Appendix: Specification of the NDC Simulation Models

This model was designed to simulate the PAYG and NDC policy systems alterative demographic and economic scenarios. It generates results of cash flow, replacement rate, and net assets. The purpose of the simulation is to illustrate in broad terms the behavior of these outcomes variables under alternative economic-demographic scenarios.

The Individual Model

The individual model is to calculate the individual life time contribution and his related life time benefit level based on different assumptions. Parameters include the following:

a. Wage growth: nominal wage growth for the next 100 years, assumed constant.
b. CPI index: constant.
c. Internal rate of return: same both for nominal rate of return under the proposed NDC system and the actual investment return for its current reserve.
d. Contribution rate: constant
e. Annuity factor: $A = \sum_{t=1}^{\infty} {}_t p_x \left(\frac{1+p}{1+r} \right)^t$, ($p$ = CPI and r = internal rate of return)

The ${}_tP_x$ is set for 2005 and is adjusted for mortality improvement until 2050. The 2050 annuity factor is used to set the target replacement rate in the NDC model. The 2005 ${}_tP_x$ is the same as the Abridged Life Table of Japan 2004 from MHLW Japan website. The mortality improvement factor is borrowed from the Mortality Improvement factor. It is derived from the Australia Life Tables for 105 years trend (Australian Life Tables 2000-02, Australian Government, page 15, Figures 10 and 11). All have been converted to unisex using 2004's Japan's labour force gender ratio.

f. Wage profile: calculated from data provided at www.mhlw.go.jp/english/, annualised by the authors.
g. Replacement Rate: Steps a – f allow the calculation of contributions and benefits through the life cycle. Based on the set wage growth and CPI data, together with the internal rate of return assumption, we can simulate a typical person joining the work force at age 20 in 2005 and retiring at 2050 at age 65 with 45 years of contribution at the set contribution rate and with the corresponding annuity factor. The associated replacement rate, defined as benefit divided by the average wage in the retirement year, can then be computed. This is used as an input into the aggregate model.

1. Illustrative Framework

At the commencement of execution, the model specifies 5 cohorts for each life cycle – 4 working cohorts and one retired cohorts, which may be thought of as representing decades of life between 25 and 64, with retirement at age 65 and withdrawal in lump sum of all the pension accumulation and annuitised in the commercial market. For convenience, the years represented can be assumed to be 2005-2115. The NDC system implemented is actuarially fair, in the sense that benefits paid are related to contribution and earning history. The first beneficiaries therefore receive only a low benefit, because they have contributed for only one period. The system should be regarded as mature only in year 2045 when the first age group 25 in year 2005 retires. In what follows, we specify policy input parameters, demographic and economic scenario assumptions, and outcome measures.

Policy Design Parameter Inputs

Notional rate of return (NRR): the rate calculated for the return on accumulations in the notional account. This can be set to any rate chosen by the user. The default is the wage bill growth rate. This return can be augmented to subsidise low notional returns, at the expense of more rapid reserve drawdowns.

Pension rate of return (PRR): the rate of investment return used in annuitising notional accumulations at retirement. As with the NRR, it can be defined as any fixed terms or fixed numbers. In our simulations, we have used the same rate as that specified for accumulations.

Pension Index: the indexation for benefit payment. This may be set to either the Consumer Price Index or the Wage Growth index. We have specified wage growth in our simulations.

Contribution rate: the proportion of wage that is set aside as a contribution to the pension system. Any constant rate between 0 and 1 may be chosen. We have chosen 18.3%.

Demographic Projections

Labor cohort growth: the labor force growth rate. All labor decline and growth happens in the first entry cohort of the year and no death rate from 25-64 is assumed.

Mortality Improvement Factor (MIF): the rate of mortality improvement in the retired cohorts. This reduces the death rate by the specified proportion each year. In our longevity improvement simulations, we have assumed an MIF of 0.5% (it sometimes refers to as the longevity improvement rate, they may differ in real world, for convenience sake, we use the same rate here).

Age Wage Profile: the average wage in each age group comparing to the average total wage. Any vector of values may be chosen, provided the average is 1.

Economic Assumptions

Wage Growth: the nominal rate for average individual wage growth at 1%.

CPI: Consumer Price Index. Default rate is 0%.

The average wage for the first period of model execution is set at 1; this effectively operates as a numeraire for the model.

Formulas

Contribution Asset: contribution rate x wage

End-of-year asset with NRR: contribution asset x (1+NRR)

Total asset: total contribution asset and End with NRR asset for all contribution age groups.

Annuity Factor: $$a_f = \sum_{t=1}^{4} kPt\left[(1+PRR)/(1+CPI\right]^{4-t}$$

LS (lump sum) withdrawal at age 65: all aggregated contributions of the cohort.

Book Value: Cash balance previous year + Current year total contribution asset – Current year total Pension LS withdrawal

Liability – all the aggregated accumulations assets of the contributors up to date.

Net Asset: booked value – liability

RR (Replacement Rate): pension asset / current wage /annuity factor, the simulation is linked with the individual model using same set of parameter settings.

2. Simulations for Stylized Japan Case

The Stylized Japanese case comprises two components: an individual model, which tracks a typical worker through his working life and retirement; and an aggregate model, which uses some outputs from the individual mode, especially the implied NDC replacement rate, to combine individuals of different ages together in an overlapping framework. We consider each in turn.

Individual model

Same as per the above individual model

Aggregate Model

To aggregate the individual profiles into a system-wide mode, data are required on demographics and system contributors and pensioners.

a. Number of Contributors:
   All 3 current Japan pension groupings are combined. The projection of numbers of contributors from 2005-2100 are in line with the Outline of 2004 Actuarial Valuation on Employees' Pension Insurance and National Pension in Japan (2005) with linear interpretation (pages 223-225).

b. Number of Pensioners:
   According to the "Social Security Report 2003" (Feb, 2005 by Social Insurance Agency in Japan), the number of pensioners in 2003 was 31.37million and was very close to the population number of the aged (60 and above). Therefore, the number of pensioners was inferred from the age structure of our model using 2004 pensioner numbers calculated from the projection given by Demographic Institution Japan (総務省統計局『国勢調査報告』，国立社会保障・人口問題研究所『日本の将来推計人口(平成 14 年 1 月推計)による』). Projected pensioner numbers are estimated using our population and mortality estimates (assuming all aged people are covered as pensioners and the mortality and mortality improvement are as explained in Document Individual (e). The computation of total pensioner numbers takes account of the gradual increase of preservation age from 60 in 2005 to 65 in 2025, using a stepwise linear adjustment at 3 year intervals. The implied estimate of pensioner numbers in 2100 is somewhat higher than the population projection presented in the Actuarial Valuation Report (2005), because we have used a less conservative longevity increase projection. This is, of course, a more conservative projection in terms of liability of the pension fund.

c. NDC model

Using the data above, the NDC model is parameterised in a manner analogous to the illustrative model outlined in the Illustrative model (see Part 1 of this appendix). The input parameters include: contribution rate, wage growth, CPI, internal rate of return, the first NDC retirement cohort target replacement rate in 2025 and the "mature" (all-cohort) target replacement rate in 2050. (These are derived from the individual model with the same contribution rate: the initial benefit rate as the 2025 target and the average benefit replacement rate as the final 2050 target).

i. Contribution Rate: this is taken from the Actuarial Report (2005) (from 7.14% to 9.15% in 2020 as half of the current policy specification for adjusting Japan's contribution rate.)
ii. Cash in: number of contributors times contribution rate. (As the contributor number has already excluded inactive contributors, the projection assumes full active members only). All these values are nominal, and take account of projected wage growth.
iii. Replacement Rate (RR): RR is linearly declining to the targeted level explained in 4(a) in two time periods.
iv. Cash out: Number of pensioners times replacement rate times wage, taking account of wage growth, all terms nominal.
v. Subsidy: Government subsidy as set in Actuarial Report 2005 by MHLW, Actuarial Division.
vi. Investment Profit: Investment profit refers to the profit made from the reserves of the pension fund with data from the Actuarial Report (2005) for 2004; the on-going profit is based on the assumed rate of return. The default rate is 3.2%.
vii. Total In: the total of income contributions, subsidy and investment profits.
viii. Balance: the balance between Total In and Cash out.
ix. Simulation year is from 2005 to 2100.

Assumptions for AV2004

Table 1: Stylized Japanese Social Security System Assumptions Used in Illustrative Simulations

	Contribution Rate		Replacement Rate	Eligible Age (Male)		Eligible Age (Female)	
	KN	KNH		KN	KNH	KN	KNH
2005	3.5%	13.58%	59.2%	60 (until 2007)	65	60 (until 2008)	65
Steady-state	4.5%	18.3%	50.2%	65 (2017)	65	65 (2018)	65

Source: Outline of 2004 actuarial valuation for Employee' Pension Insurance and National Pension in Japan.

Table 2: Demographic and Economic Assumptions used in Illustrative Simulations: Actuarial Valuation 2004 and the NDC Model

Demographic Assumptions

Year	Working Age Population (million)	Retired Population (million)	Total Fertility Rate (per woman)	Life Expectancy at birth	
				Male	Female
2000	78.9	22	1.36	77.64	84.62
2025	66.9	34.7			
2050	49.8	35.9	1.39	80.95	89.22

Economic Assumptions

Year	Inflation	Real Wage Growth	Real Return on Investment	Labor Force Participation Rate	
				Male (60-64)	Female (30-34)
2005	0.5%	0.8%	1.1%	72%	59%
From 2009	1.0%	1.1%	2.2%	85%	65%

Source: Outline of 2004 actuarial valuation for Employee' Pension Insurance and National Pension in Japan