Notional Defined Contribution Pensions with Public Reserve Funds in Aging Economies: An Application to Japan

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Abstract

Several developed and developing countries have recently adopted a Notional Defined Contribution (NDC) approach to old-age pension reform. The NDC is essentially a non-pre-funded defined contribution retirement system, in which contributions are credited with a “rate of return” related to aggregate payroll growth, and individual account accruals are maintained in a book-keeping system. Payouts are annuitised based on the expected mortality of each succeeding retiring cohort. NDC plans may be identified with appropriately calibrated Pay-As-You-Go plans in demographic equilibrium, but the two paradigms diverge when demographic shift is introduced. This paper investigates the key actuarial and economic implications of alternative NDC rules, with a particular focus on Japan, the world’s most rapidly aging economy. We examine the potential role for pension reserves in transitioning to an NDC system, and we show these can be used to smooth the impact of demographic transition to an older society. Finally, we show that countries such as Japan could elect to use pension reserves accumulated in the past, if they sought to transition to an NDC system.

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Global population aging is driving reformers in many countries to seek ways to tighten the link between workers’ public pension contributions and their retirement benefits. Often system-wide financial shortfalls have been attributed to the practice of paying retirement benefits which bear no tight relationship to workers’ lifetime payroll taxes or social security contributions. In response, reformers in several nations have sought to tighten the tax-benefit link with a notional defined contribution (NDC) system. This is typically an unfunded defined benefit (DB) scheme where workers’ contribution histories are directly tied to their retirement benefits. Variants of the NDC model have been adopted over the last decade in Sweden, Italy, and Latvia (Holzmann and Palmer 2006). Nevertheless, relatively little analytic work has been conducted to evaluate how such a system might work in the context of a rapidly aging economy.

Our paper focuses on the relevance of an NDC system in Japan, one of the most rapidly aging countries on earth. Japan’s case is of particular interest because this nation is quite vulnerable to the “aging transition,” a direct consequence of rising longevity, a truncated “baby-boom” period, low fertility (currently 1.37 per woman), and Japan’s “lost decade” during which economic growth was nil. Further, its old-age system has come under much scrutiny because its benefit formulas have been de-linked from financing mechanisms.

In what follows, we begin with a brief review of Japan’s public pension system, including the reforms adopted in 2004 greeted as having “solved” the financing problem for the long haul. These reforms assumed a specific financing flow from employee and employer contributions, transfers from general revenue, and transfers of interest as well as principal from the national pension reserve fund. Public pension reserves in Japan are substantial, currently estimated at
about 30% of GDP, of which 137 trillion yen were held in public hands in 2002.¹ Next we characterize the key elements of a Japanese NDC model, and use these to compare projected replacement ratios under current ‘2004 reform’ scenario, with those which would result from an NDC approach having the same financing flows. We highlight the role of the pension reserve by examining how replacement rates might change given alternative investment strategies. Our analysis shows that the transition to an older society in Japan requires that pension fund reserves, or some other supplementary financing source, be made available to generate politically realistic retirement benefits. We also show that an NDC in the Japanese context would be more actuarially fair, and hence more likely to induce prolonged worklives, than the current system.²

The relevance of our work to other aging countries will soon be clear. Analysts are currently debating the introduction of an NDC system to Japan (Fukawa and Yamamoto 2003; Miyazato 2004; Takayama 2006), and the so-called “Swedish model” has been extolled internationally as a reform model of general relevance (Holzmann and Palmer 2006). In parallel, several countries including Norway, Australia, New Zealand, and most recently, Chile, have recently established so-called “future funds,” intended to serve as partial pre-financing for future liabilities associated with the demographic transition. Our work explores how a NDC reform combined with best-practice management of publicly-held retirement assets might produce a more resilient old-age system for Japan. We seek to understand whether an NDC system could

¹ Data available from [http://www.mri.co.jp/REPORT/ECONOMY/2004/er040804.pdf](http://www.mri.co.jp/REPORT/ECONOMY/2004/er040804.pdf) page 4 showing GDP in 2003 was 502 trillion yen. The value of 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 managers.

² Employer-based pensions are available in Japan but most workers rely heavily on the KN and KNH plans for their retirement financing (Clark and Mitchell 2002). Thus government benefits account for 70% of the income of elderly households, and 60% of elderly households depend solely on government benefits in 2004; some 70% of current workers indicate they will rely on the government pension to support themselves in old age (AV2004; p 3).
be implemented in Japan, and also what its consequences might when assessed compared to the goals enunciated in the most recent reform program.

Challenges to Japan’s Public Pension System

As long ago as 1890, defined benefit pay-as-you-go (PAYGO) pensions were established for the Japanese military; later, these were also extended to civil service employees. Currently the two most important retirement systems in Japan are the national basic pension (KN), available to all who make contributions for a vesting period of 25 years; and the employee pension insurance plan (KNH), which is a PAYGO defined benefit plan for most private sector Japanese workers. It is on these two systems that we focus when considering the feasibility of an NDC reform for Japan.

The KN, or basic, pension system was intended to be redistributive; from its inception in 1961, it has been financed both from employee contributions and general revenue. It is targeted at most self-employed workers, students, and the unemployed (sometimes referred to as “Group 1” individuals). By contrast, the KNH or employee pension insurance system covers so-called “Group 2” individuals, mainly wage and salary employees. Spouses of Group 2 contributors, known as “Group 3” members, gain automatic entitlement to the KN benefit without paying any contributions of their own. The provision of benefits for a spouse has been a cornerstone of the Japanese Social Security system, and government analyses accept this feature of the system uncritically. To take a recent example, the Actuarial Affairs Division (2005) analysis of the 2004 reforms use as their basic unit of analysis the so-called “benchmark” couple, in which one spouse (the husband) works full time while his wife does not participate in the paid labor force. Effectively, single workers and married working couples subsidize these benchmark couples.
Initially, the KNH system was intended to be a fully funded DB plan, and during the long period of Japanese growth from the 1960s through the 1980s, large pension reserves were accumulated and invested in a wide range of government projects. But between 1965 and 1973, the replacement ratio was boosted sharply from 40% to 60% of gross wages (Takayama, 2003), rendering reserves insufficient and transforming it into a mostly PAYGO system. In turn, the Japanese government has several times imposed parametric reforms to handle solvency problems. For example, in 1985, eligibility for full KN coverage rose from 25 to 40 years of contribution (with special transitional provisions for those born after 1926 having at least 25 years of coverage). As well, that reform pared down the KNH benefit from 1% of replacement per year of contribution to 0.75% per year, consistent with the increased “full working life” definition (Takayama, 2003). Another wave of old-age system reforms occurred in 1993-94 which raised the retirement age in steps. Under this reform, KNH benefits could be paid between ages 60 and 64 without any reduction, and benefits were henceforth indexed to prices rather than wages. The KN plan imposed a phased-in 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. In 2000, once again national pension reforms were required in the KNH system. Now the eligibility age was increased over time; benefits in payment after the first retirement year were indexed to prices rather than to wages; and the annual benefit factor was further 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). These various reforms were aimed at reducing aggregate pension benefits by 20% by 2025 (Takayama 1999), though overall the system remained strongly redistributive. Takayama (2002) has also argued for further substantive
reforms, pointing out that redistributive pension and healthcare programs would generate considerably higher *per capita* benefits for the aged than for the non-aged population.

For the first time in 2004, labor force decline was formally recognised as a factor exacerbating the burden of the Japanese social security system. Accordingly, a new wave of reforms was implemented to more tightly link contributions and benefits, both at the individual and system-wide levels. Put succinctly, the 2004 package of reforms cuts future public pension benefits and boosts years of service and contribution rates (Fukao and Kaneko, 2005). One way this was implemented was to adopt an adjustment mechanism known as the “Macroeconomic Slide”\(^3\). Formerly, the initial benefit entitlement was indexed only to the wage;\(^4\) now the benefit formula also adjusts for increased longevity and changes in demographic balance. Specifically, this revaluation index equals “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 is also 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 (until that time, the bonus had fallen outside the social security contribution net). This change is said 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 will be again lifted (gradually) 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 these benefit cuts, the 2004 reform also included phased payroll tax increases. Specifically, the KNH contribution rate will rise by 0.354%/year from a base of

\(^{3}\) This links the earnings-related benefits provided under the KNH to each individual’s past wages (Miyazato, 2004).

\(^{4}\) 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).
13.58%, to a capped level of 18.3% in 2017 (Actuarial Valuation Report; hereafter AV2004, Actuarial Affairs Division 2005). Contributions to the KN plan must also rise by 280 yen per month from 2005 until 2017, boosting monthly contributions from 13,300 yen to 16,900 yen over this period. Additional general revenue financing for KN is also required, rising from what had been 33% of the benefit payouts to 50% by 2009. With all of these adjustments, the government predicts that in the long run, an average couple’s benefits will converge to about 50% of the average income of the working generation. (Appendix Table A1 summarizes the most recent policy configurations).

Nevertheless, the Japanese system remains heavily reliant on future contributions and transfers, as it lacks assets sufficient to prefund its promised future benefits. The KNH liabilities of 550 trillion yen (Takayama, 2006) are at least three times larger than the government’s old-age system “reserve fund” of some 179 trillion yen. And while having a reserve fund is better than no fund, some have questioned whether fund earnings are sustainable, inasmuch as a portion of this reserve may be exposed to non-performing loans (Zheng et al., 2005).

Notional Defined Contribution (NDC) Plans

The idea of an NDC system reaches back at least as far as Boskin et al (1988). The classical NDC plan is essentially a non-pre-funded defined contribution system where notional individual accounts accumulate at a notional interest rate linked to system return. Individual

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5 In present value and at the exchange rate of May 2006: ¥1000= USD8.01.
6 AV2004 (Actuarial Affairs Division 2005: 11-12). This is used for the payments to the KN scheme only, and it amounts to 50% of the total KN expenditure; see also Sakamoto (2005).
7 Or about USD$4.7 trillion as of 1/28/06.
8 Or about US$1.5 trillion as of 1/28/06
9 This realization clearly undermines public confidence in the old-age pension system’s integrity, as evidenced by non-payment rates for social security pensions almost doubling, from about 20% to more than 37% in the period 1997-2002 (Takayama, 2003).
10 The idea of a “system return” will become clearer in what follows.
accounts are maintained as a book-keeping system, and benefits are annuitized at retirement based on each cohort’s expected mortality patterns and system returns.\textsuperscript{11}

From the individual worker’s perspective, a well-specified NDC policy looks similar to a funded DC plan with mandatory annuities. That is, the NDC system requires \textit{individual accounts}, where the fundamental unit is the individual, rather than a married couple or family. Every contributor has his own account and makes his own contributions and receives his own annuitized benefit at retirement; there is no \textit{ex ante} redistribution within a cohort. From the government’s viewpoint, however, NDC financing in steady-state is more similar to the PAYG model, as there is a mandatory contribution rate and each birth cohort’s implicit rate of return on contributions is realized only over time. Accordingly, in the NDC plan, each worker builds up a \textit{notional} capital sum in his individual account throughout his working life. In turn, at retirement, this notional accrual is then converted to an annuity, using prevailing estimates of returns and projected mortality patterns.\textsuperscript{12}

To state this more formally, let $A$ be the sum of the worker’s contributions, $\tau$ the contribution rate, $E$ the labor earnings for each cohort at each age, $R$ be the internal rate of return, $s$ the first year of entering labor force, and $S$ the retirement age. Then the worker’s notional accumulation is:

\begin{equation}
A_S^X = \sum_t \tau_{S-t}^X \cdot E_{S-t}^X \cdot \prod_{k=0}^{t} R_{S-k}^X \tag{1}
\end{equation}

\begin{itemize}
\item \textsuperscript{11}Other writers have offered alternative perspectives onto the NDC concept. For instance, Borsch-Supan (2006a: 38) emphasises the accounting aspect of NDC: it “treats the PAYG system like a DC system.” (p 38). Barr (2006: 58) 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.” (p 58). Finally, Lindbeck and Persson (2003: 75) argue that “the ‘property rights’ of pension benefits are more robust politically in NDC systems.” (p 75).
\item \textsuperscript{12}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).
\end{itemize}
In the NDC plan, of course, entitlements depend directly on the worker’s accumulation, so labor force incentives tend to be stronger -- especially at the all-important extensive retirement margin -- than is often the case with traditional PAYG social security systems. The worker is also believed to perceive the accrual value as equivalent to private saving, so some substantial level of saving displacement might be anticipated.

In funded DC plans, of course, workers’ returns on their contributions to their plan are tied to financial market performance. By contrast, NDC benefits are typically tied to the aggregate wage bill or some related magnitude such as the so-called “biological” rate of interest (as in the DB PAYG paradigm). This is what is meant by a NDC system’s implicit return. When the labor force is shrinking, as in many aging 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. For instance, 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:

\[
R_x = \frac{\sum_{y=x+1}^{T} N_{y-x} \cdot E_{y-x}^x}{\sum_{x=1}^{T} N_{y-x} \cdot E_{y-x}^x}
\]  

(2)

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

\[
\beta^x = \frac{A_S^x}{\sum_{i=66}^{T} P_{63}^i \frac{1}{R_{x+5}}} \frac{1}{R_{x+5}}
\]

(3)
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 spelled out in (2). Also, consistent with the NDC approach, deferred annuities could be purchased in tranches throughout the working life, thus diversifying rate of return risk. To our knowledge, no country adopting an NDC plan has explicitly laid out such adjustments \textit{ex ante}, although some (e.g. Sweden) have committed to contingency rules for changing benefits if there are unanticipated increases in longevity (Sunden, 2006).

A canonical unfunded NDC system operates in a manner identical to a DB PAYG system, provided that steady-state assumptions hold. But outcomes diverge between these two systems if the assumptions of demographic equilibrium and balanced growth are violated. Since the classic NDC plan is not pre-funded, period-by-period deficits and surpluses can be recorded at any time. For instance, population growth is often associated with a build-up of reserves, though these are usually dramatically less than the expected present value of pension liabilities. 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 that contributions will not necessarily equal benefits in any given year (Valdes-Prieto 2000). Furthermore, as governments cannot usually change contribution rates with alacrity without transparently incurring future liabilities stemming from augmented notional individual account balances, establishing an NDC plan would seem to require a reserve or contingency fund.

As should be evident, any 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. The NDC plan will therefore be likely to generate low or even negative returns as population aging proceeds, unless adjustments are made such as raising the retirement age to offset labor force reductions.

One poorly-appreciated aspect of a canonical NDC plan is its inability to diversify risks across cohorts. For instance, a cohort that experiences a long term economic depression will pay less money and receive lower retirement benefits than some other cohort with a stronger contribution history. Similarly, a cohort that experiences poor system returns will be disadvantaged relative to a cohort with high system returns. As a consequence, one policy objective of social security, namely cross-cohort risk spreading, is not readily handled in the NDC context. As a result, adopting an NDC may require a separate means-tested safety net to support the poor. More generally, some of the implicit subsidies inherent in a conventional PAYG plan are not present in NDC, and if they are socially desirable, will require separate implementation.

Equations 1-3 provide the key descriptive elements 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 labor 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. But thus far we have ignored the possibility that reserves may be invested and the return used to cushion poor returns

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13 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 internal rate of return shifts given longevity increase. We discuss this and related issues below.
occasioned by declines in the covered wage bill. In an economy with a declining labor force, some source of financing to lift the system return may be deemed necessary. To take account of this, (2) is rewritten as:

\[
R_y = \frac{\sum_{x=1}^{\tau} N^x_{y-x+1} \cdot E^x_{y-x+1}}{\sum_{x=1}^{\tau} N^x_{y-x} \cdot E^x_{y-x}} + \text{buffer return}^{15}
\]

(4)

To date, only a handful of countries have introduced NDC plans, though there are many variants on this schematic model in practice. European and North American studies on NDC models have been mainly descriptive, though there are a few more rigorous economic treatments. Several recent writings on NDC are collected in a conference volume edited by Holzmann and Palmer (2006). We summaries this literature by first reporting what various authors have identified as the crucial aspects of NDC plans, and then highlighting the ways in which individual countries have implemented the NDC approach, each with its own twist.

To recapitulate, there are several advantages of NDC relative to a conventional unfunded PAYG plan. It is a sustainable paradigm in the face of population aging, at least in the medium term, and it is therefore likely to have some political credibility. Clear rules are specified regarding contributions and benefits, and these are cast in a way which should ensure the sustainability of the system in the long term. NDC is also actuarially fairer than many traditional DB plans. And as this type of reform promises an actuarially fair benefit for every participant, some have argued that its political economy appeal could restore public confidence and improve system-wide credibility (Borsch-Supan, 2004). In turn, actuarial fairness implies that the labor

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14 Equally, external sources of finance, such as general tax revenue, may be used to augment returns.
15 Buffer return is the return generated from investment returns from reserves.
16 For example Brooks and Weaver (2004); Disney (1999); Fox and Palmer (2001); Palmer (2006); and Williamson and Williams (2003).
17 For instance Feldstein (2001); Settergren and Mikula (2005); and Valdes-Prieto (2000).
supply incentives confronting households are similar to those which might operate in a
competitive market with prices undistorted by taxes and benefits, and in many cases the NDC
might even induce more labor supply at the extensive retirement margin than a conventional
PAYG system. Finally, because, from an individual perspective, NDC operates much like a
conventional defined Contribution plan, it may be easier to transition to a funded model should
this be seen as a long term policy objective.

At the same time we acknowledge that the NDC also embodies some important
disadvantages. As a stand-alone paradigm, it constrains intergenerational and, more generally,
inter-cohort risk sharing and intra-cohort re-distribution. This may require the introduction of a
separate safety net. It relies on system-wide returns, and thus benefit levels will be poor if the
labor force is shrinking. And finally, as there is no explicit support for fertility, compared to the
traditional PAYG scheme which often pays one spouse to remain at home with children.

The Potential Impact of NDC in Japan

Next we turn to a quantitative assessment of the impact of substituting an NDC pension
system for the existing KN and KNH structures in Japan. We take the current system as our
baseline, along with its evolution as stipulated by AV2004. In particular, we focus on the
benchmark couple, defined under AV2004 as a husband employed full-time at the average wage
for 40 years and his non-working spouse of the same age. Taking this as our point of departure,
we stipulate a unified individual-based NDC plan which replaces both KN and KNH. Our NDC
model is calibrated so that each covered member is charged a 9.15% contribution rate. The
former Group 2 employees would contribute 9.15% for themselves and another 9.15% for their
(non-working) spouses; this generates household contribution flows for the benchmark couple in the NDC approach that are identical to those under the current system.\textsuperscript{18}

Turning to benefits, the benchmark couple under AV2004 jointly is paid benefits amounting to a 50.2% replacement rate. Given projected contribution and benefit flows, the internal rate of return that equates these is 2.41%, for the benchmark couple. We apply this imputed internal rate of return to all NDC contributions made by all members.

It is understandable that without external funds, the current Japanese demographic situation generates a low notional rate of return. If labor shrinks at 0.6% and wages grow at 2.1%, as is assumed in AV2004, then the pure generic NDC return would be 1.49% per annum $\left[=\left(1+2.1\%\right)\times\left(1-0.6\right)-1\right]$. This implies very low benefits for most pensioners. But an NDC in Japan could take advantage of current reserves and government subsidy projections. The notional rate of return could then be bolstered to the system return implicit in AV2004, of 2.41%, delivering a higher replacement rate.

To aggregate NDC outlays and contributions, we use current and projected data on KN and KNH membership from the AV2004. Estimated numbers of beneficiaries are taken from the Demographic Institution of Japan’s population projections and projected from the 2003 SIA report, which estimates 31.37 million social security pensioners in that year (Social Insurance Agency 2005; p.13). Figure 1 charts projected numbers of contributors and pensioners from 2005 to 2100.

\textit{Figure 1 here}

In our NDC experiment, benefits are assumed to be paid for from worker contributions, the government subsidy, and investment returns earned on public pension reserves. These are

\textsuperscript{18} Under AV2004, self-employed workers pay a 2.8% contribution rate, moving to a steady state contribution rate of 3.6% in 2017. Under NDC, they are treated identically with all other individuals.
stipulated in line with AV2004 estimates: the rate of return is set at 3.2%, and the government subsidy is slated to grown from one-third to one-half of the KN benefit budget. Projecting forward, benefit payments exceed the value of revenues from these sources, so reserves are drawn down over time. The AV2004 reserve drawdown left a one year payout residual at 2100, the final year of analysis. This same constraint applies to the NDC specification. The public pension reserve remaining each year is thus determined endogenously in the model, and it becomes the base for the following year’s investment return. Contributions are set, as indicated above, at 9.15% for each contributor.

Next we turn to a discussion of three key dimensions of reform outcome: redistributive impact; labor supply incentives; and financial sustainability.

**Redistributive Impacts.** When considering redistributive impacts of such a reform, these must be seen relative to the benchmark couple, whose circumstances do not change between the two systems. Under NDC, by construction, all contributions are credited with the same 2.41% notional rate of return. Working individuals or two-earner couples will be treated more actuarially fairly under the NDC system. Couples who are both employees contributing under the KNH plan will also be better off in the NDC plan. As seen in Table 1, singles pay a contribution rate of 18.3% under the current system and anticipate a replacement rate of 35.9%. Under NDC, they pay 9.15% and receive 25.1%. (Inasmuch as the singles’ contribution rate has been halved, such an individual might opt to invest privately to increase retirement income.) By contrast, KN beneficiaries would be worse off under NDC compared with AV2004. Under KN, they pay 3.61% and receive a replacement rate of 14%; under NDC they are treated similarly to other individuals. This highlights the cross subsidy implicit in the current system, in favour of non-working spouses and self employed or casual employees.
Labor Supply Incentives. We approach the assessment of labor supply incentives by comparing the benefit formulas with different contribution periods under the two plans. It is frequently claimed that an NDC plan embodies incentives to work longer, because traditional defined benefit social security systems tend to cap or curtail benefit increments after some stipulated contribution period. In Japan, there is currently little incentive for the secondary earner to enter the labor market early in life, because of the heavy subsidy to dependent spouses. However, the current system appears not to discourage the primary earner in the benchmark couple from working longer, since benefit entitlements rise with longer working life, on an approximately actuarially fair basis.

This is clarified in Table 2, which reports replacement rates for different contribution periods for both the benchmark couple and the single worker under the current system, and the equivalent NDC outcome. It shows a person’s replacement rates under contribution periods of 30, 40 and 45 years to age 65, which we simulate by varying the age of commencing employment. The fact that replacement rates are virtually identical for the benchmark couple confirms that the current system has labor supply incentives similar to those of the NDC. By contrast, the impact on singles is ambiguous. The NDC system offers a higher return for an additional year’s work, because the internal rate of return is larger. However, the additional wealth so generated may actually lead to earlier retirement. Additional simulation analysis would be required to resolve this ambiguity.

Financial Sustainability. Finally, it is of interest to track the cash flow implications of introducing an NDC model of the kind described above. For the baseline case, end-of-year
national pension fund assets are reported from 2005 to 2100. We also report 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; this allows direct comparison with AV2004.

Table 3 shows that the targeted minimum replacement rate of 50% for a benchmark couple is achievable while meeting the AV2004 constraint that a minimum reserve ratio of 1 remains in 2100. Indeed, the simulations suggest that an NDC scheme protects reserves slightly better than the current policy described in AV2004, holding other assumptions the same: the reserve ratio will be 1.43 in 2100. This arises because the transfer from general revenue remains unchanged in the NDC scenario, while both contributions and benefits are reduced in aggregate. Contribution rates have increased for KN members, from 3.61% to 9.15%, while their notional return has been set at the standard NDC rate. Contributions for singles and dual-earner couples are halved, while their effective notional returns are boosted.

Table 3 here

The Role of Public Pension Reserves in NDC Plans

Table 4 reports sensitivity analysis of the reserve ratio trajectories under alternative assumptions about the size of the public pension asset and the rate of return earned, but holds all else consistent with AV2004. Column 1 replicates the benchmark NDC case, where in 2100 the reserve is valued at 143% of annual cash outlays. If the reserve had initially been twice the current size, then the same NDC benefit and contribution policy would generate a growing reserve, since the investment return would be more than sufficient to make up the shortfall in

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19 Both the AV2004 projections, and our NDC reserve ratio projections, assume a phased increase of the general revenue transfer to support the KN system, from 1/3 of the KN payout currently to 50% in 2009, in line with current Japanese policy. In the absence of increased transfer, neither system is sustainable in the long run.
20 According to AV2004, the KN pensioner actually has an internal rate of return of 3.5% based on their contribution and benefit payout plan, in our NDC specification, they are credited the same notional rate of return of 2.41%.
revenues (23 times cash outlays; column 2). Column 3 indicates that with half the initial reserve, the system runs out of money by 2050. Alternatively, if the investment return could be improved, this would also generate an accretion of reserves. For example, doubling the assumed return from 3.2% to 6.4% generates a reserve some 300 times the cash payout in 2100. Halving the return would leave the reserve fund exhausted by about 2050.

This enormous asset has already prompted discussion over how these reserves should be managed.21 Some nations have substantial reserves that they invest on the public’s behalf, such as Norway’s Government Petroleum Fund currently worth about 125% of GDP,22 and the Australian and New Zealand “future funds.” Nevertheless, these are non-pension examples of large government investment pools. There is also a growing literature on investment of assets for national and public sector employee pension systems,23 and the World Bank as well as the OECD are developing guidelines for the management of such reserves. Given the importance of wise reserve investment policies, Carmichael and Palacios (2003: 27) stipulate that:

The investment policy should be set by the board of directors or trustees,…fully documented, and should be available in summary form to members of the scheme . . . .(It) should identify all relevant risks and the Board’s approach to measuring, monitoring and managing each of them . . . [and it] 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.

In practice, the governance of pension fund reserves varies across countries, and returns earned tend to fall short of bank deposit rates. For instance Iglesias and Palacios (2000) noted that Japan’s pension fund reserves earned relatively more than many other countries, they remained concerned that all assets were not marked to market and might have lost value. In the

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22 Data from http://www.norges-bank.no/english/petroleum_fund/reports/2006/q1-spu-eng.pdf
past, Japan’s public pension reserves were managed under the Fiscal Investment and Loan Program until 2000; after this time fund management then underwent major reform and a new institution, the Government Pension Investment Fund (GPIF) under the MHLW, was established. 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, though management policy for the reserve fund investment remains under the Ministry of Health, Labor and Welfare (MHLW).

In sum, it is clear that Japan’s social security system remains underfunded, notwithstanding the 2004 reforms, so its accumulated reserves are a consequence of the demographic transition but are insufficient to meet future benefit promises. The AV2004 report contends that the active working generation is expected to support the elderly, so there is no need to reach full funding for all future benefits. Therefore, it is reasonable to suppose 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.

Conclusions

Japan has already been forced to undertake several reforms of its old-age system over the last two decades: to date, contributions were boosted, general revenues added, real benefits cut, and retirement ages raised. But the current system is still not fully funded and is far from actuarially fair. Specifically, the KN program subsidises single KN contributors relative to KNH

24 Specifically, the Ministry states that Japan’s public pension system (the Employees’ Pension Insurance and national Pension) is “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.” It also acknowledges, however, 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 : 99).
workers, while the KNH system subsidises married couples relative to singles. For single workers, working longer and later appears to be penalised by the current PAYG policy, relative to the NDC system. By contrast the benchmark (single earner) couple is closer to an actuarially fair system, in that individual contributions and benefit amounts are now more closely linked. For such a couple, working longer and later up to 40 years is encouraged by the current Japanese PAYG policy, so longer contribution periods for this benchmark couple generates benefits consistent with the system-wide internal rate of return. This may explain why Japan ranks second in the OECD on average retirement ages for males, but female participation is close to average (OECD, 2006).

Our goal is to determine whether a Notional Defined Contribution (NDC) reform combined with best-practice management of publicly-held retirement assets might produce a more resilient old-age system for Japan. To evaluate the answers, we conduct a numerical simulation of the best publicly available data for Japan. Our results, while preliminary, suggest that an NDC approach could offer retirees possibly higher benefits while enhancing system financial sustainability. It could also make more transparent the workings of the national old-age program, possibly reinforcing trust in the program.

Nevertheless, a pure NDC system without any future fund is unlikely to deliver adequate replacement rates given a huge demographic shift toward a substantially older population. For this reason, reserves built up under the Japanese social security system may be deemed the natural source for such additional financing. Accordingly, it is critical to devote careful attention to managing these funds, so as to improve the benefit replacement rate profile over time. What we have shown is that an NDC plan could help resolve the financial challenges confronting a traditional unfunded DB system, in conjunction with a public pension reserve fund intended to
help smooth tax and benefit fluctuations over time. Previous studies have not explicitly linked the design of NDC plans to public pension reserve management.

Future research could take several tacks. More detailed simulation models would be useful, incorporating Japan’s demographic transition along with the structure of labor compensation, occupational pension contributions and entitlements, and social security liabilities by cohort. This would allow analysts to illuminate numerous additional policy-relevant questions including:

- How the old-age system’s indebtedness and future prospects vary with alternative discount and labor earning paths, and with alternative drawdown rules for the reserves.
- How introducing a mandatory individual contributory component influences who gains and loses under a NDC reform.
- How an NDC reform would impact the poor, and how a safety net program could be integrated into the NDC framework.
- How survivor and disability benefits could be handled in this context.
- How an NDC plan and tax policy could be integrated with occupational pensions.

In addition, better microeconomic and demographic data would be invaluable in helping evaluate the potential welfare effects of alternative NDC reforms. Finally, and perhaps most urgently, research into governance and investment of pension fund reserves is needed in the Japanese case.

Those nations which have introduced NDC plans to date recognize the need to specify ex ante what mechanisms will be adopted when the system faces cash-flow shortfalls, namely which combinations of benefit cuts and/or new financing can be implemented. In the Japanese case, an NDC reform could be adopted that would exploit the same financing channels as are currently in place, while making the system more actuarially fair and encouraging continued work.

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25 Borsch-Supan (2006b) argues that the recent German reforms which rely on a points system are in fact very similar to an NDC approach.
References


Figure 1 Projected Pensioners and Contributors: Simulation for Stylized Model of Japan (2005-2100)

Source: Authors’ derivations using AV2004 data.
Table 1: Comparison of Current Policy and NDC Simulated Reform: Contribution and Replacement Rates (all 40 years of contribution, NDC credit rate at 2.41%, other conditions as per AV2004)

<table>
<thead>
<tr>
<th></th>
<th>2004 Reform</th>
<th></th>
<th>NDC Simulation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contribution</td>
<td>Replacement</td>
<td>Contribution</td>
<td>Replacement</td>
</tr>
<tr>
<td></td>
<td>rate</td>
<td>rate</td>
<td>rate</td>
<td>rate</td>
</tr>
<tr>
<td>KNH Plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>18.30%</td>
<td>35.90%</td>
<td>9.15%</td>
<td>25.10%</td>
</tr>
<tr>
<td>Benchmark couple</td>
<td>18.30%</td>
<td>50.20%</td>
<td>18.30%</td>
<td>50.20%</td>
</tr>
<tr>
<td>KN Plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>3.61%</td>
<td>14%</td>
<td>3.61%</td>
<td>9.89%</td>
</tr>
</tbody>
</table>

Source: AV2004 and authors’ calculations

Table 2. Replacement Rates for Retirees at age 65 under alternative contribution periods

<table>
<thead>
<tr>
<th>Working period</th>
<th>AV2004 couple (contribution rate at 18.3%)</th>
<th>AV2004 both working couple</th>
<th>NDC couples (contribute rate 9.15% each)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>37.7</td>
<td>53.9</td>
<td>37.5</td>
</tr>
<tr>
<td>40</td>
<td>50.2</td>
<td>71.8</td>
<td>50.2</td>
</tr>
<tr>
<td>45</td>
<td>53.5</td>
<td>77.6</td>
<td>55.1</td>
</tr>
</tbody>
</table>

(*calculated from the age of 35/35/20 and work till 65 for working period of 30/40/45 years. NDC rate of return at 2.41%. Using wage profile as described in the appendix)

Source: AV2004 and authors’ calculations
Table 3. Comparison of Two Stylized Models: Reserve Ratios under alternative subsidy with 3.2% investment rate of return scenarios

<table>
<thead>
<tr>
<th>Year</th>
<th>With KN Subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AV2004</td>
</tr>
<tr>
<td>2005</td>
<td>4.84</td>
</tr>
<tr>
<td>2030</td>
<td>5.14</td>
</tr>
<tr>
<td>2050</td>
<td>4.29</td>
</tr>
<tr>
<td>2100</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Source: AV2004 and authors’ calculations

Table 4. Impact of Alternative Reserve Ratios Scenarios

<table>
<thead>
<tr>
<th>Year</th>
<th>NDC basic model ratios</th>
<th>Reserve Scenarios</th>
<th>Investment Return Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2XRes</td>
<td>1/2XRes</td>
</tr>
<tr>
<td>2005</td>
<td>4.78</td>
<td>9.42</td>
<td>2.22</td>
</tr>
<tr>
<td>2030</td>
<td>5.56</td>
<td>11.61</td>
<td>2.53</td>
</tr>
<tr>
<td>2050</td>
<td>4.33</td>
<td>12.22</td>
<td>0.38</td>
</tr>
<tr>
<td>2100</td>
<td>1.43</td>
<td>23.34</td>
<td>-9.52</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations
Appendix: Further Detail on the NDC Simulation Model and Data

The model simulates PAYG and NDC policy alternatives for various demographic and economic scenarios similar to those prevailing and expected to prevail in Japan. It generates results for cash flows, replacement rates, and net pension fund assets.

I. The Individual Model

The individual model is to calculate the lifetime contributions and related lifetime benefits, 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: $A = \sum_{t=1}^{\infty} p_x \left( \frac{1 + p}{1 + r} \right)^t$, ($p = CPI$ and $r =$ internal rate of return)

The $p_x$ 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 $p_x$ is the same as the Abridged Life Table of Japan 2004 from MHLW Japan website. The mortality improvement factor is derived from the Australian Life Tables 2000-02 (Australian Government, page 15, Figures 10 and 11). All have been converted to unisex using 2004’s Japan’s labor 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.

II. Aggregate Model

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

1. Number of Contributors:

All 3 current Japan pension groupings are merged into one group now: KN group with the current group 1 and KNH group with the current group 2 and group 3 members. 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).

2. 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 above. 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.

3. NDC model

Using the data above, the NDC 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 part I(g) in two time periods (2025 and 2050, with 2050 target replacement rate, it is already indexed to CPI and target is the result of indexed average of total pensioners’ standard).

iv. Cash out: Number of pensioners times replacement rate times wage, taking account of wage growth, all terms nominal.


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 income of cash in, subsidy and investment profits.

viii. Balance: the balance between Total Cash In and Cash Out.

ix. Simulation period is from 2005 to 2100.
### Appendix Table A1: Stylized Japanese Social Security System Assumptions Used in Simulations

<table>
<thead>
<tr>
<th></th>
<th>Contribution Rate</th>
<th>Replacement Rate</th>
<th>Eligible Age (Male)</th>
<th>Eligible Age (Female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KN</td>
<td>KNH</td>
<td>KN</td>
<td>KNH</td>
</tr>
<tr>
<td>2005</td>
<td>2.8%</td>
<td>13.6%</td>
<td>59.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 (until 2007)</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 (until 2008)</td>
<td>65</td>
</tr>
<tr>
<td>Steady-state</td>
<td>3.6%</td>
<td>18.3%</td>
<td>50.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>65 (from 2017)</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>65 (from 2018)</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: AV2004

### Appendix Table A2: Demographic and Economic Assumptions used in Simulations: AV 2004 and the NDC Model

#### Demographic Assumptions

<table>
<thead>
<tr>
<th>Year</th>
<th>Working Age Population (million)</th>
<th>Retired Population (million)</th>
<th>Total Fertility Rate (per woman)</th>
<th>Life Expectancy at birth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2000</td>
<td>78.9</td>
<td>22.0</td>
<td>1.36</td>
<td>77.64</td>
</tr>
<tr>
<td>2025</td>
<td>66.9</td>
<td>34.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2050</td>
<td>49.8</td>
<td>35.9</td>
<td>1.39</td>
<td>80.95</td>
</tr>
</tbody>
</table>

#### Economic Assumptions

<table>
<thead>
<tr>
<th>Year</th>
<th>Inflation</th>
<th>Real Wage Growth</th>
<th>Real Return on Investment</th>
<th>Labor Force Participation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Male (60-64)</td>
</tr>
<tr>
<td>2005</td>
<td>0.5%</td>
<td>0.8%</td>
<td>1.1%</td>
<td>72.0%</td>
</tr>
<tr>
<td>From</td>
<td>1.0%</td>
<td>1.1%</td>
<td>2.2%</td>
<td>85.0%</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: AV2004