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An Old-Age Social Security Program for Bangladesh

by

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I. Introduction

The purpose of this paper is to describe a possible Old-Age Social Security Program for Bangladesh, with financial projections through the year 2025. The United Nations sponsored report (Kabir, 1994) has as its number one recommendation: "Government should give serious consideration to introducing a national welfare pension programme to ensure income security for the elderly. Such an effort will contribute significantly to removing the great resistance to family planning arising mainly from the fear of old age income insecurity. Efforts should be made to institutionalize income security in old age." (loc. cit., p. 49). Actuarial projections for the cost of a national social security program are needed to justify the inauguration and maintenance of such a financial protection system. The reference (Andrews-Beekman, 1987) discusses such projections. This paper and proposed program relate to old-age income protection, and not to a survivor, and disability social insurance program. Recently Cecil J. Nesbitt and others have developed models to calculate reserve funds for a social insurance program (Nesbitt, 1991; Nesbitt, Messner, Robertson, 1993; Nesbitt, Cohen, Gallers, Houghton, Myler, Weiss, 1994; Nesbitt, Rosenberg, Berger, Levinsky, Nerdrum, O'Donnell, Samaniego, Trendel, 1995; Nesbitt, Nerdrum, Clark, 1996). Those models will prove helpful in our development.

II. Notation and Functions

Assume that each citizen of Bangladesh aged 60 and higher will receive x units of money at the beginning of each month that he (she) is alive. The present value of the cost to provide that benefit for the year k would be (approximately) $\sum_{y=60}^{\infty} {}^{k}L_y \; 12\,x\,\ddot{a}^{(12)}_{\overline{1}|i_k}$, where the demographic function

$$ {}^{k}L_y = \int_0^1 {}^{k}\ell_{y+t}\,dt $$

$$ \doteq {}^{k}\ell_{y+\frac{1}{2}} $$

= Average number of recipients (aged y last birthday) of monthly benefits during the year k; and the annuity function of x per month for one year

$$ 12x\,\ddot{a}^{(12)}_{\overline{1}|i_k} = x[1 + v_k^{\frac{1}{12}} + v_k^{\frac{2}{12}} + \ldots + v_k^{\frac{11}{12}}], \text{ where} $$

$$ v_k = (1+i_k)^{-1} $$

for an effective annual rate of interest i_k for the year (k, k+1).

In the notation of (Nesbitt et al, 1995; Nesbitt, Nerdrum, Clark, 1996),

$$ O_k = \sum_{y=60}^{\infty} {}^{k}L_y \; 12\,x\,\ddot{a}^{(12)}_{\overline{1}|i_k} \; . \qquad (2.1) $$

Thus, O_k represents the present value (as of the beginning of year k) of the projected monetary outgo for the year k.

Assume that through a combination of employee, employer, and national government contributions, for each citizen of Bangladesh aged 20 through 59, θx units of money, $0 < \theta < 1$, will be deposited at the beginning of each month that he (she) is alive. The present value of the contributions during the year k would be (approximately)

$$\sum_{y=20}^{59} {}^{k}L_{y} \; 12\theta x \; \ddot{a}^{(12)}_{\overline{1}|i_k} .$$

Let us now use the notation and ideas of the last two cited papers. If ${}_nI_k$ is the required income in year k, excluding interest, to maintain n-year roll-forward reserves, and it is elected to maintain one-year roll-forward reserves, then

$$ {}_1I_k = \sum_{y=20}^{59} {}^{k}L_{y} \; 12({}_1\theta x)\ddot{a}^{(12)}_{\overline{1}|i_k} . \qquad (2.2)$$

By Figure 2 and explanation of (Nesbitt, Nerdrum, Clark, 1996),

$$ {}_1I_k = O_{k+1} (1 + i_k)^{-1} . \qquad (2.3)$$

Therefore, the contribution rate for one-year roll-forward reserves

$$ {}_1\theta = \frac{(1 + i_k)^{-1} \sum_{y=60}^{\infty} {}^{k+1}L_{y} \; \ddot{a}^{(12)}_{\overline{1}|i_{k+1}}}{\sum_{y=20}^{59} {}^{k}L_{y} \; \ddot{a}^{(12)}_{\overline{1}|i_k}} . \qquad (2.4)$$

From Section 4 of (Nesbitt, Nerdrum, Clark, 1996),

${}_nA_k$ = Amount of reserve fund required at the beginning of calendar year k under n-year roll-forward reserves.

Thus, the one year roll-forward reserves

$$A_{1k} = O_k \tag{2.5}$$

and the two year roll-forward reserves

$$A_{2k} = O_k + O_{k+1}(1+i_k)^{-1}. \tag{2.6}$$

The required income in year k would be

$$I_{2k} = O_{k+2}(1+i_k)^{-1}(1+i_{k+1})^{-1}. \tag{2.7}$$

To maintain two year roll-forward reserves, the contribution rate

$$\theta_2 = \frac{(1+i_k)^{-1}(1+i_{k+1})^{-1}\sum_{y=60}^{\infty} L_y^{k+2}\, a^{(12)}_{\overline{1}|i_{k+2}}}{\sum_{y=20}^{59} L_y^{k}\, a^{(12)}_{\overline{1}|i_k}}. \tag{2.8}$$

III. Contribution Rates To Provide One and Two Year Roll-Forward Reserves for Years 2000 Through 2025

In this section we will develop roll-forward reserves for the years 2000 through 2025, under certain assumptions.

Our population projections were developed by Dr. Ataharul Islam (see Acknowledgement). In particular, we will be using the projections and the related ratios of Table 1.

TABLE 1

Calendar Year k	$\sum_{y=60}^{\infty} L_y^k$	$\sum_{y=20}^{59} L_y^k$	$\sum_{y=60}^{\infty} L_y^{k+1} / \sum_{y=20}^{59} L_y^k$	$\sum_{y=60}^{\infty} L_y^{k+2} / \sum_{y=20}^{59} L_y^k$
1998	6,482,696	54,873,620	0.120835	0.123820
1999	6,630,643	56,746,183	0.119735	0.122911
2000	6,794,479	58,830,229	0.118557	0.121839
2001	6,974,717	61,106,193	0.117301	0.120594
2002	7,167,813	63,550,037	0.115956	0.119218
2003	7,369,033	66,125,741	0.114575	0.117769
2004	7,576,331	68,797,409	0.113195	0.116383
2005	7,787,546	71,535,763	0.111928	0.115186
2006	8,006,836	74,308,184	0.110888	0.114401
2007	8,239,906	77,061,497	0.110314	0.114249
2008	8,500,942	79,739,294	0.110412	0.114816
2009	8,804,202	82,289,108	0.111259	0.116033
2010	9,155,382	84,639,341	0.112811	0.117742
2011	9,548,288	86,722,981	0.114913	0.119736
2012	9,965,602	88,481,323	0.117357	0.121926
2013	10,383,865	89,860,176	0.120055	0.124315
2014	10,788,140	90,726,788	0.123127	0.127212
2015	11,170,933	92,010,618	0.125437	0.129571
2016	11,541,499	93,354,342	0.127706	0.132211
2017	11,921,875	94,721,102	0.130304	0.135383
2018	12,342,497	96,077,023	0.133473	0.139139
2019	12,823,666	97,403,067	0.137245	0.143367
2020	13,368,058	98,698,482	0.141486	0.147938
2021	13,964,426	99,974,380	0.146050	0.152654
2022	14,601,245	101,239,745	0.150746	0.157351
2023	15,261,512	102,507,035	0.155406	0.162035
2024	15,930,174	103,783,021	0.160043	
2025	16,609,719	105,051,940		

To the extent that the future actual populations deviate from these projections, the reserves will also be different.

For our calculations, assumptions must be made about future interest rates. We will use the following assumed rates:

TABLE 2

Calendar Year k	i_k	Year		i_k
1998	0.05	2002	through	0.045
1999	0.05	2011		
2000	0.05	2012	through	
2001	0.05	2025		0.04

These rates have been chosen to be conservative. To the extent that the actual rates earned are better, the reserves should be greater.

For the one year roll-forward reserves, formula (2.1) was used to calculate the projected outgoes. Formula (2.5) then gives the required reserves. The required income was computed from (2.3). The contribution rate θ_1 was determined from (2.4).

A specific value for x was not chosen. The U.S. Social Security employee contributions, employer contributions, and income payments to retirees have changed many times since the inception of the system in 1935. It is expected that a Bangladesh system would also have many changes. Our general value x allows for future changes.

The assumed rates in Table 2 were used in obtaining the following needed financial functions:

TABLE 3

Calendar Year k	$\ddot{a}^{(12)}_{\overline{1}\rvert i_k}$	$\dfrac{\ddot{a}^{(12)}_{\overline{1}\rvert i_{k+1}}}{(1+i_k)\,\ddot{a}^{(12)}_{\overline{1}\rvert i_k}}$	$\dfrac{\ddot{a}^{(12)}_{\overline{1}\rvert i_{k+2}}}{(1+i_k)(1+i_{k+1})\,\ddot{a}^{(12)}_{\overline{1}\rvert i_k}}$
1998	0.978001	0.952381	0.907029
1999	0.978001	"	0.907029
2000	0.978001	"	0.908946
2001	0.978001	0.954394	0.913296
2002	0.980068	0.956938	0.915730
2003 through	0.980068	0.956938	0.915730
2009	"	"	"
2010	0.980068	0.956938	0.917729
2011	0.980068	0.959027	0.922142
2012 through	0.982208	0.961538	0.924556
2025	"	"	"

TABLE 4

Projections If a One-Year Roll-Forward Reserve Is To Be Maintained
(all multiples of 12x, except for ${}_1\theta$)

Calendar Year k	Outgo O_k	Fund At Beginning of Year k+1 ${}_1A_{k+1}$	Income Required in Year k ${}_1I_k$	Contribution Rate ${}_1\theta$
1999	-------	6,645,007	6,328,578	0.114033
2000	6,645,007	6,821,280	6,496,457	0.112911
2001	6,821,280	7,024,944	6,722,434	0.111951
2002	7,024,944	7,222,153	6,911,151	0.110963
2003	7,222,153	7,425,320	7,105,569	0.109641
2004	7,425,320	7,632,325	7,303,660	0.108321
2005	7,632,325	7,847,244	7,509,324	0.107108
2006	7,847,244	8,075,668	7,727,912	0.106113
2007	8,075,668	8,331,501	7,972,728	0.105564
2008	8,331,501	8,628,717	8,257,145	0.105657
2009	8,628,717	8,972,897	8,586,504	0.106468
2010	8,972,897	9,378,405	8,974,550	0.107953
2011	9,378,405	9,788,294	9,411,821	0.110205
2012	9,788,294	10,199,115	9,806,841	0.112843
2013	10,199,115	10,596,197	10,188,651	0.115437
2014	10,596,197	10,972,180	10,550,173	0.118391
2015	10,972,180	11,336,153	10,900,147	0.120612
2016	11,336,153	11,709,761	11,259,386	0.122794
2017	11,709,761	12,122,899	11,656,634	0.125292
2018	12,122,899	12,595,507	12,111,064	0.128339
2019	12,595,507	13,130,214	12,625,206	0.131966
2020	13,130,214	13,715,971	13,188,434	0.136044
2021	13,715,971	14,341,460	13,789,865	0.140433
2022	14,341,460	14,989,979	14,413,441	0.144948
2023	14,989,979	15,646,744	15,044,946	0.149429
2024	15,646,744	16,314,199	15,686,730	0.153887
2025	16,314,199			

For the two year roll-forward reserves, formulas (2.1), (2.6), (2.7), and (2.8), and Tables 1, 2, and 3 were used.

TABLE 5

Projections If a Two-Year Roll-Forward Reserve Is To Be Maintained

(all multiples of 12x, except for ${}_2\theta$)

Calendar Year k	Outgo O_k	Fund At Beginning of Year k+1 ${}_2A_{k+1}$	Income Required in Year k ${}_2I_k$	Contribution Rate ${}_2\theta$
1998		6,328,578	6,027,217	0.112308
1999		13,141,464	6,187,102	0.111484
2000	6,645,007	13,543,714	6,402,319	0.110745
2001	6,821,280	13,936,095	6,613,542	0.110138
2002	7,024,944	14,327,722	6,799,588	0.109171
2003	7,222,153	14,728,980	6,989,149	0.107845
2004	7,425,320	15,141,649	7,185,956	0.106575
2005	7,632,325	15,575,156	7,395,131	0.105479
2006	7,847,244	16,048,396	7,629,405	0.104760
2007	8,075,668	16,588,646	7,901,575	0.104621
2008	8,331,501	17,215,221	8,216,751	0.105140
2009	8,628,717	17,947,447	8,588,086	0.106255
2010	8,972,897	18,790,226	9,006,527	0.108055
2011	9,378,405	19,595,135	9,429,655	0.110414
2012	9,788,294	20,387,766	9,796,780	0.112727
2013	10,199,115	21,146,370	10,144,397	0.114936
2014	10,596,197	21,872,327	10,480,911	0.117615
2015	10,972,180	22,595,539	10,826,332	0.119196
2016	11,336,153	23,366,395	11,208,302	0.122236
2017	11,709,761	24,233,963	11,645,254	0.125169
2018	12,122,899	25,220,713	12,139,621	0.128642
2019	12,595,507	26,318,648	12,681,186	0.132551
2020	13,130,214	27,505,836	13,259,486	0.136777
2021	13,715,971	28,754,901	13,859,078	0.141137
2022	14,341,460	30,034,925	14,466,294	0.145480
2023	14,989,979	31,333,474	15,083,394	0.149810
2024	15,646,744			
2025	16,314,199			

IV. Interpretation of Results

We will interpret the first two lines of Table 4. During 1999, contributions of 75,942,936x = (6,328,578)12x units of money would be provided by a combination of employee, employer, and national government contributions, for each citizen aged 20 through 59 at the beginning of each month during the year 1999 that he (she) is alive. The contribution rate would be 0.114033. This would provide a fund on Jan. 1, 2000 of 79,740,084x = (6,645,007)12x units of money. During the year 2000, the 79,740,084x units of money would be expended, with each citizen aged 60 and higher receiving x units of money at the beginning of each month that he (she) is alive during the year 2000. During the year 2000, contributions of 77,957,484x = (6,496,457)12x units of money would be collected at a rate of 0.112911 to develop a fund of 81,855,360x units of money on Jan. 1, 2001. This one-year roll-forward reserve would be sufficient for the outgo during the year 2001 of 81,855,360x units of money. Similar interpretations could be given for the other lines of Table 4.

Let us now interpret parts of the first three lines of Table 5. In preparation for outgoes beginning in the year 2000, during 1998, contributions of 72,326,604x = 6,027,217(12x) units of money would be provided by a combination of employee, employer, and national government contributions, for each citizen aged 20 through 59 at the beginning of each month during the year 1998 that he (she) is alive. This is the present value of the 79,740,084x = 6,645,007(12x) units of money expended during the year 2000, with each citizen aged 60 and higher receiving x units of money at the beginning of each month that he (she) is alive during the year 2000. The contributions during 1999 would be 74,245,224x = 6,187,102(12x) units of money. The contribution rates for 1998 and 1999 would be 0.112308 and 0.111484, respectively. This would provide a fund on Jan. 1, 2000 of 157,697,568x = 13,141,464(12x) units of money. This two-year roll-forward reserve, when increased with interest, would be sufficient for the outgoes during the years 2000 and 2001. Similar interpretations could be given for the other lines of Table 5.

The contribution rates in Tables 4 and 5 can be compared with those of (Nesbitt, Cohen, Gallers, Houghton, Myler, and Weiss, 1994). The one-year and two-year roll-forward reserves contribution rates for OASDI under Alternative II are contained in tables OASDI-II-1 and OASDI-II-2 on pages 71 and 73, loc. cit.. The OASDI contribution rates involve the incomes required in years k from workers to the taxable payrolls in years k. Our contribution rates involve one year annuity values for the populations aged 60 and higher, and the populations aged 20 to 59. Despite these differences, the cited tables contain fairly close numerical values.

The U.S. Social Security system now covers more than 90% of the U.S. citizens. However, the coverage didn't start that high in 1935. Rather, more and more people have been included in the system. Our projections assume a 100% level for contributions, and income outgo. Although that level may not be achieved for some years, clearly that is the intent of the number one recommendation in the United Nations sponsored report (Kabir, 1994).

V. Future Research

In a future paper, the authors will discuss a suitable Survivors Program, and Disability Program for a Bangladesh Social Security program. This would complete the development of a full Social Security program as described in (Andrews-Beekman, 1987). A second research project would be to develop an Old-Age Security Program where contributions would only come from salaried employees, and benefits would only be paid to retirees of that set of workers. A third research project would be to develop a level contribution rate for the program, constant over m years, where m is a multiple of n. The theory for such constant rates has been developed in (Nesbitt et al, 1995); and (Nesbitt et al, 1996). A fourth project would be to suggest possible break-downs of the θ rates between employee, employer, and national government contributions. This would involve a study of Social Security systems in various countries.

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