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Sustainability of the Turkish PAYGO System's Generosity in People's Eyes

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Abstract: An unsustainable pay-as-you-go system produces two outcomes: generous social security wealth and an uncertainty about this wealth. The results of my previous study imply that the unprecedented generosity of the Turkish paygo boosts consumption. In this present study, when the second effect is controlled, the results imply that declining expectations on the sustainability of the paygo system reduce consumption. What is the net consequence of these two opposite effects on consumption? This paper models this ambiguity and confirms its existence for Turkey.

Keywords: consumption, expectations, life-cycle saving, paygo, social security wealth.

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An unsustainable pay-as-you-go (paygo) system produces two outcomes: generous social security wealth (SSW) and an uncertainty about this wealth. A review of the literature indicates that the debate over how social security wealth impacts saving is far being resolved and the best modeling approach for testing the argument is unclear. By their nature, SSW series represent expected pension wealth and aggregate time-series studies assume that there is no uncertainty about these expectations. However, this is an unrealistic assumption because as parametric reforms are used to secure paygo systems in the face of cumulating adverse demographic shocks, people may become uncertain about their future net pension entitlements.

Two years ago I published a paper (Aydede, 2008) analyzing the effect of the Turkish pension system on saving. In that paper, I used social security wealth (SSW) series calculated for the first time for Turkey and showed that the generosity of the Turkish pay-as-you-go (paygo) boosts consumption. Unlike time-series studies investigating developed countries with relatively stable paygo system, my initial work analyzes an exceptional case: the Turkish paygo is the most generous pension system in the Organization for Economic Development and Co-operation (OECD) region while it is totally insolvent.[1] The system's deficit is 4.5 per cent gross national product (GNP) in 2004. Between 1990 and 2003, the present value of the total resources used to finance its deficit is almost equal to the GNP created in 2003.[2]

The fact that the Turkish paygo has long become an unsustainable Ponzi scheme is not controlled in my previous analysis. This is an important missing factor because when people (particularly young cohorts) expect social security promises will not be honored by the government, they may consume less and save more. The results in my earlier paper imply that social security depresses saving around 24 per cent.[3] In this present study, when I control the uncertainty, the results imply that declining expectations about the sustainability of the paygo system reduce consumption. What is the net aggregate consequence of these two opposite effects on consumption? This paper argues that the coefficient of SSW in aggregate time-series analyses cannot be used to measure its impact on saving without controlling the uncertainty about SSW.

This paper relates to an extensive body of literature. More specifically, it refers to studies by Feldstein (1974, 1996), Auerbach and Kotlikoff (1983), and Blake (2004) on social security and saving; Kotlikoff (2003) on intergenerational

[1] Pension at a Glance, OECD (2005, 2006).
[2] The World Bank Report 2003.
[3] The calculation is given in Appendix 2.

redistribution of wealth by paygo systems; and Brook and Whitehouse (2006) and the OECD reports (2005, 2006) on generosity and generational fairness of the Turkish pension system. First, I will explain the model and, then test the model's predictions with two different econometric frameworks. To compare the empirical results with those in my previous study, I will start with the same econometric approach then extend it with a vector error correction model. I interpret the results at the end.

The Model

When the planner faces an adverse shock and decides on a parametric reform to secure the system, expectations about the future can deviate from what the planner promises—depending on sustainability of the actual policy in people's eyes. For example, when the young are asked to raise their contributions to the system to keep the current benefit level constant,[4] they may question not only this policy's credibility but also the system's ability to honor its promises to them in the future.

To show formally how expectations on the pension system affect total consumption, I use a simple two-period overlapping-generations model where there is no productive capital and identical individuals are endowed by w. They save (s) in the first period, then retire and spend their saving in the second period. There is no uncertainty in lifetime, liquidity constraint, bequest, and growth in endowment. To avoid defining the utility function explicitly, I assume that the real interest rate (r) is equal to the personal discount rate (ρ). The planner runs a balanced paygo system where the young, y, pay taxes, τ, and the seniors, o, receive benefits, b. In all periods …, $t-2$, $t-1$, there exists a steady state with

$$Rb = L\tau \Rightarrow b = (1+n)\tau, \tag{1}$$

R and L stand for numbers of retirees (the old) and workers (the young) respectively. The population grows by n, which is the implicit rate of return (IRR) of the system.[5] In period t there is an adverse demographic shock (θ), so that $n_t = n - \theta_t$. Consequently, the budget of the pension system changes to

[4] The planner can keep the benefit and contribution levels unchanged by financing the deficit with public debt, which shifts the burden onto unborn generations.
[5] The condition for balanced budget (1) implies that when IRR is equal to r the paygo system does not reduce resources of existing generations, i.e. the implicit tax rate (see Sinn, 2000) is zero, so that $c_y + c_o/(1+r) = w - \tau + b/(1+r) = w.$

$$b_t = (1+n-\theta_t)(\tau+\tau_t^s). \tag{2}$$

The government uses tax surcharges (τ^s) and splits the fiscal burden $\theta_t\tau$ between existing generations at time t so that elderly and young cohorts have to bear a share 1– δ_t and δ_t respectively. Consequently, we have

$$b_t = b-(1-\delta_t)\theta_t\tau. \tag{3}$$

Substituting (3) into (2) and using the definition for b (1) we can derive

$$\tau_t^s = \frac{\delta_t\theta_t\tau}{1+n-\theta_t}. \tag{4}$$

Note that if δ_t = 1 we have b_t = b so that the old in t bear no burden from the shock. In this sense, when an adverse shock hits, the planner's decision on δ becomes a parametric reform for the existing paygo system and constitutes unexpected wealth transfers among generations similar to those at the system's introduction point, where the initial seniors receive a windfall.[6]

From the individual's perspective, shocks are recognized when the young are required to pay tax surcharges (τ^s), and they form their expectations on δ in the first period determined by the planner in the second period. Formally, every young person who is required to pay taxes, τ, and tax surcharges, τ^s, maximizes

$$U_j(c_{yj},c_{oj+1}) = u(c_{yj})+(1+\rho)^{-1}u(c_{oj+1}),$$

subject to

$$c_{yj} = w-\tau-\tau_j^s-s_j \text{ and } s_j = \left(\frac{c_{oj+1}-E_jb_{j+1}}{1+r}\right).$$

If the utility function satisfies the conventional conditions and $\rho = r$, the young at time t solves this problem with the following values:

$$c_{yt} = \frac{1+r}{2+r}\left[w-\tau-\tau_t^s+E_tb_{t+1}(1+r)^{-1}\right], \tag{5}$$

[6] When δ is set to one for all current and future generations, if the implicit rate of return is less than r, the young at time t and next generations face a burden since the implicit tax rate rises from zero to a positive number.

$$s_t = 1/(2+r)\left[w - \tau - \tau_t^s - E_t b_{t+1}\right] \tag{6}$$

Given that all individuals recognize that the planner commits to a balanced budget (2), the young's expectation about benefits at t becomes:

$$E_t b_{t+1} = (1 + n_{t+1} - E_t\theta_{t+1})(\tau + E_t \tau_{t+1}^s). \tag{7}$$

Assuming that $E_t\theta_{t+1} = 0$, and using (4), we obtain

$$(1 + n_{t+1}) E_t \tau_{t+1}^s = \theta_t \tau E_t \delta_{t+1}. \tag{8}$$

Using (8) and the fact that $(1 + n_{t+1}) = (1 + n - \theta_t)$, (7) becomes

$$E_t b_{t+1} = \tau(1+n) - \theta_t \tau (1 - E_t \delta_{t+1}). \tag{9}$$

Substituting (9) and (4) into (5), we obtain

$$c_{yt} = \frac{1}{2+r}\left[(1+r)w + (n - \theta_t - r)\tau - \frac{(1+r)\theta_t \tau \delta_t}{1+n-\theta_t} + \theta_t \tau E_t \delta_{t+1}\right]. \tag{10}$$

Likewise, the old also face the following consumption function at time t:

$$c_{ot} = (1+r)s_{t-1} + b_t = \frac{1+r}{2+r}\left[w - \tau - E_{t-1} b_t\right] + b_t. \tag{11}$$

Since $E_{t-1}\theta_t = 0$ and $E_{t-1} b_t = (1+n)\tau$, when we substitute (2) for b_t, (11) becomes:

$$c_{ot} = \frac{1+r}{2+r} w + \frac{n-r}{2+r}\tau - \theta_t \tau (1 - \delta_t). \tag{12}$$

By using (10) and (12), the marginal effect of the policy on the total consumption, $C_t = R_t c_{ot} + L_t c_{yt}$, can be observed as follows:

$$\frac{dC_t}{d\delta_t} = \frac{1}{2+r}\left[1 + \frac{dE_t \delta_{t+1}}{d\delta_t}(1 + n - \theta_t)\right]\theta_t \tau, \tag{13}$$

where we use $L_t = (1 + n - \theta_t) L_{t-1}$ with L_{t-1} (i.e. R_t) normalized to one. Note that the sign of (13) depends on the sign of the expression in the brackets. In other words, even if the system promises a generous SSW by setting δ to one, when it is not sustainable in people's eyes, consumption may decline. The diversion between expectations and the actual policy becomes more likely as each generation faces increasing tax surcharges (or rising public debt) in the face of cumulating shocks. Consequently, a binding policy (a constant δ) grows to be unsustainable, as implied by (14) below.

$$\tau_s^s = \frac{\delta_s \tau \sum_{i=t}^{s} \theta_i}{1 + n - \sum_{i=t}^{s} \theta_i}, \tag{14}$$

which has to be less than or equal to (w-τ). This brings up a possibility that the planner may decide to end the program (gradually or all at once) so that the expectation about the policy variable (δ) can realistically be lower than zero.[7] This brings up a theoretical ambiguity to how a Ponzi-scheme-like paygo affects consumption.

Empirical Test

My empirical goal here is to test the existence of this theoretical ambiguity in time-series models with aggregate SSW series using the Turkey case. More specifically, I want to test how (1) the perception of the system's unprecedented generosity by the young cohorts affects consumption and (2) the implied effect of SSW on consumption changes, when this perception is controlled. To be

[7] If we allow that expected benefits can be zero at time s as follows,

$$E_{s-1}b_s = \tau\left(1 + n_t - \sum_{i=t}^{s-1}\theta_i - E_{s-1}\theta_s\right) + \tau E_{s-1}\delta_s\left(\sum_{i=t}^{s-1}\theta_i + E_{s-1}\theta_s\right) = 0,$$

we obtain the following constraint for expectations on the policy variable:

$$1 - \frac{1+n}{E_{s-1}\theta_s + \sum_{i=t}^{s-1}\theta_i} \le E_{s-1}\delta_s \le 1,$$

which is bounded at the minimum by a negative value. To see it explicitly, suppose that the system is terminated in the first period when $n = 0$: the lower limit reduces to $(\theta - 1)/\theta$.

consistent, I will first apply the same econometric approach used in my previous study and then estimate vector error correction models with two additional variables: (1) expected implicit rate of return (IRR) for younger cohorts and (2) the system's dependency ratio, which is the number of workers per retiree. Based on (13), the second variable is supposed to capture the effect of differences in marginal propensity to consume (MPC) out of rest-of-the-life resources between retirees and workers on consumption.[8] I expect this effect to be negative. My prior expectation on the first variable is also negative and can be justified by total consumption aggregated at time t+1:[9]

$$C_{t+1} = w + \frac{1}{2}\theta_t \tau (E_{t+1}\delta_{t+2} - E_t\delta_{t+1} + \delta_{t+1} - \delta_t). \quad (15)$$

If the policy is binding and credible it becomes irrelevant, as expected, in terms of its effect on consumption in the second and subsequent periods. This can be seen when $E_t\delta_{t+1} = E_{t+1}\delta_{t+2} = \delta_t = \delta_{t+1}$. However, even if the planner maintains the same policy in the long run as $0 < \delta_t = \delta_{t+1} = ... = \delta_T$, when expectations deviate from the actual policy, (15) becomes:

$$C_{t+1} = w + \frac{1}{2}\theta_t \tau (E_{t+1}\delta_{t+2} - E_t\delta_{t+1}). \quad (16)$$

Note that declining expectations ($E_{t+1}\delta_{t+2} < E_t\delta_{t+1}$) of the contemporaneous young can reduce total consumption. Expected IRR can be defined as $E_t\phi_{t+1} = E_t b_{t+1}(1+r)^{-1}/(\tau + \tau_t^s) - 1$, so that we can express the change in expectations in (16) as follows:[10]

$$E_{t+1}\delta_{t+2} - E_t\delta_{t+1} = \gamma_t (E_{t+1}\phi_{t+2} - E_t\phi_{t+1}), \quad (17)$$

where $\lambda_t = [1 - \theta_t(1-\delta)]/(1-\theta_t)$. Based on (17), the paygo system's IRR for new members can be used as a proxy for the system stability perceived by the young cohorts. I calculated IRR series in a separate study (Aydede, 2009) from 1970 to 2003 by using the same method I applied in the aggregate SSW simulations (Aydede 2008). I find the net SSW, which is the difference between the present

[8] In the model, since MPC for the old is higher than MPC for the young, the difference reflected by 1/(2+r) in (13) is positive. Therefore, if the old consume more as the model implies, a decline in the system's dependency ratio should affect consumption negatively. (See Kotlikoff 2003).
[9] See the Appendix 1 for its derivation.
[10] See Appendix 1 for its derivation.

value of contributions and benefits expected by young cohorts based on survival probabilities and the system's parameters. The results are summarized in Table 1 below.[11]

Table 1: Expected Implicit Rate of Return (IRR) for New Members (TL in 1987 prices)

Birth	Year at 17	P.V. of Benefits	P.V. of Taxes	SSW	IRR
1953	1970	2,628,340	1,312,728	1,315,612	100%
1958	1975	3,969,752	2,271,582	1,698,170	75%
1963	1980	2,300,589	2,939,206	-638,617	-22%
1968	1985	1,933,805	3,481,683	-1,547,879	-44%
1973	1990	2,810,633	3,970,193	-1,159,560	-29%
1978	1995	2,233,560	3,929,594	-1,696,034	-43%
1983	2000	4,257,867	6,434,893	-2,177,026	-34%
1984	2001	3,974,374	5,044,661	-1,070,286	-21%
1985	2002	4,392,501	4,308,405	84,096	2%
1986	2003	5,102,381	4,259,426	842,955	20%

Source: Aydede (2009)

Even though the specification of conventional aggregate consumption functions has become increasingly more sophisticated over the years, a typical aggregate time-series study tests changes in consumption due to pension wealth. Within the framework of a traditional life-cycle model (Ando and Modigliani, 1963 and Feldstein 1974) I apply the same individual consumption function, $\mathrm{c}_t = \alpha + \beta HW_t + \lambda \mathrm{W}_t$, as the underlying optimizing behaviour and aggregate it[12] to

$$\begin{aligned} \mathrm{C}_t &= \beta_0 + \beta_1 \mathrm{Y}_t^e + \beta_2 \mathrm{SSW}_t + \beta_3 \mathrm{HW}_t + \beta_4 \mathrm{FW}_t \\ &+ \beta_5 \mathrm{CRTP}_t + \beta_6 \mathrm{R}_t + \beta_7 \mathrm{Inf}_t + \beta_8 \mathrm{Old}_t + \beta_9 \mathrm{Young}_t \\ &+ \beta_{10} \mathrm{LFPR}_t + \beta_{11} \mathrm{Urban}_t + \beta_{12} \mathrm{Un}_t + \beta_{13} \Delta \mathrm{EIRR}_t + \beta_{14} \mathrm{DR}_t, \end{aligned} \tag{18}$$

with the same set of variables[13] and the data as estimated in my previous study. The only difference in (18) is that I add $\Delta EIRR$ and DR— changes in expected IRR for new members of the system and the number of workers per retiree,

[11] The details about the simulation are given in Appendix 3.
[12] W is directly observable real wealth (housing wealth, financial wealth etc.). HW is human wealth, not directly observable, and reflects the present value of current and future labour income and pension entitlements.
[13] The list of variables and data sources is given in Appendix.

respectively.

The regression results in Table 2 (given in Appendix 4) follow the same order as in my previous study: the first estimation is the baseline estimation, which suffers from the apparent autocorrelation problem. The series in the second and third estimations use AR(1) and AR(2) transformation. The forth estimation is the extended version of the first one with all variables. In estimation 5 and 6, after confirming their very low pair-wise correlations, I remove insignificant variables by using the Wald test. The last one applies a two-stage-least-squares estimation to solve simultaneity problem, where I use government spending, net export, and investment as instrumental variables for private disposable income. In Estimation 6, inclusion of dummy variable improves Akaike and Schwrz criterion relative to Estimation 5. As discussed lengthy in my previous study, results improve when the estimation is specified well and autocorrelation is removed. Therefore, I consider the last three estimations as being more reliable among all.

The first observation of all estimations confirms that the variables $\Delta EIRR$ and *DR* have stable and negative signs consistent with what the model suggests and their robustness picks up in the last three estimations. Comparing the current results with my earlier ones shows that the inclusion of $\Delta EIRR$ and *DR* does not change signs of variables or improve insignificant ones. However, the explanatory power of the specifications improves and already significant variables get better; particularly the coefficients of SSWG rise while its robustness improves.

In Table 3, I estimate 3 additional specifications. The first two specifications use Equation 6 with and without new variables ($\Delta EIRR$ and *DR*) after the logarithmic transformation. The linearity provided by the log transformation improves the significance of new variables. The results confirm that the coefficient of *SSWG* is not sensitive to log transformation. Moreover, a comparison of the first two columns implies that controlling the uncertainty increases its magnitude. The last column applies the first-difference to the specification in column (2) and shows the elasticities. While the results do not change fundamentally when the variables are presented in growths, we observe that *SSWG* becomes insignificant. This can be a result of drawbacks of the first-difference transformation.[14]

Although, the time-series literature in our subject implicitly uses Durbin-Watson (DW) statistics to detect the "spurious significance" problem, I apply both a residual-based test in a single equation as well as the Johansen cointegration test. The second specification in Table 3, which rises as a reference regression among

[14] Among others, the number one problem is the complex error term due to double differencing in $\Delta EIRR$ and *DR*.

all, contain $I(1)$ variables expect for $\Delta EIRR$ and DR, which are $I(0)$. The ADF test rejects the unit-root in the error term at the 10% significance-level, indicating that the results are not spurious.[15]

The advantage of a vector error correction (VEC) model is that it has cointigration relations built in the specification so that it restricts the log-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustments. Hence, I relax the exogeneity assumption on income and the real interest rate in the second specification in Table 3. The Johansen test results given in Table 4 indicate one cointregrating relation for each model.

Table 5 reports the results of the unconditional VEC model using the two lags of the first differences of the endogenous variables and the error term. The speed of adjustment coefficient for the error correction term in the consumption equation is negative and significant, implying that deviations from the long-run equilibrium are corrected by reduction in consumption in the next period. Moreover, all three variables of interest (*SSWG*, $\Delta EIRR$, and *DR*) are statistically significant and their signs are consistent with what we expect. It is interesting to observe that a 1-percent decline in expectations (measured by change in EIRR) reduces consumption by 0.21 percent. This decline, however, is offset by the positive impact of SSW on consumption, which has 0.22 of elasticity with respect to SSW. The results also provide evidence that a decrease in dependency ratio (number of workers per retiree) has negative effects on consumption.

All other variables are consistent with our prior expectations. The negative impact of financial wealth, which is proxied by M2, may reflect the fact that when nominal interest rates are no so responsive, the real money balance could be negatively related to consumption. Even though it is not significant, housing wealth, which is controlled by the direct and imputed income from dwellings, increases consumption. Lastly, the significant relationship between consumption and credit constraint proxied by per capita credit to private sector confirms the fact that as people barrow against their future income and illiquid assets, consumption increases.[16]

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[15] The test statistics for the null hypothesis stating there is a unit root in residuals is -5.607. McKinnon critical value at %5 and 10% significance-levels (for n=34 with constant and trend in the cointegrating equation that includes 7 variables) is -5.9398 and -5.5109. For further discussion see McKinnon (1993).

[16] More discussions on these observations can be found in my previous works.

Conclusion

How does the generosity of the Turkish paygo affect saving? This is an important question because pension wealth is the biggest part of household wealth in Turkey. The results in my earlier study show that SSW has robust positive effects on consumption. Following Feldstein's (1996) approach I quantify the reduction in saving to show the magnitude of coefficients: the existence of the paygo system reduces the national saving in 2003 around 24 per cent. Feldstein finds it between 30-60 per cent for the US. This approach has been criticized in the literature on the basis of SSW calculations: SSW series reflect expectations not accrued values. How people, particularly young cohorts, form their expectations on their future pension entitlements is an open question. This fact is not controlled in time-series studies. As they are far from retirement, this uncertainty grows for younger cohorts and reduces the impact of expected pension wealth on their current consumption, particularly in countries with unstable public pension systems. The results here imply that negative effects of expectations on consumption and declining dependency ratios bring up an empirical ambiguity about a decline in saving due to social security. This paper is the first study that tests this ambiguity in the aggregate time-series literature and confirms its existence for Turkey.

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Appendix 1

<u>Derivation of (14)</u>

If we assume that $r = n_t - \theta_t = 0$ and $E_t \theta_{t+1} = \theta_{t+1} = 0$, (10) becomes:

$$c_{yt} = \frac{1}{2}\left[w - \theta_t \tau \delta_t + \theta_t \tau E_t \delta_{t+1}\right]. \quad \text{(A1)}$$

Since $c_{ot+1} = (1+r)s_t + b_{t+1}$, we obtain:

$$c_{ot+1} = (1+r)\left[w - \tau + \theta_t \tau \delta_t - c_{yt}\right] + b_{t+1}, \quad \text{(A2)}$$

where $b_{t+1} = \tau - \theta_t \tau \delta_{t+1}$. Similarly to (10), the young also have the following consumption function at time t+1:

$$c_{yt+1} = \frac{1}{2}\left[w - \theta_t \tau \delta_t + \theta_t \tau E_{t+1} \delta_{t+2}\right]. \quad \text{(A3)}$$

To aggregate (A2) and (A3), we use $L_{t+1} = (1+n_t - \theta_t)^2 L_{t-1}$. Because L_{t-1} (i.e. R_t)

was normalized to one before and, given the assumptions that $\theta_{t+1} = 0$ and $n_{t+1} = n_t - \theta_t = 0$, the number of retirees and workers is reduced to $L_{t+1} = (1 + n_t - \theta_t)^2 L_{t-1} = R_{t+1} = 1$. By substituting (A2) and (3) into $C_{t+1} = R_{t+1}c_{ot+1} + L_{t+1}c_{yt+1}$ we obtain (14).

Derivation of (16)
To simply the derivation, we assume that $n = r = 0$ and $E_t\theta_{t+1} = E_{t+1}\theta_{t+2} = 0.$ By using (9) and (4), expected IRR at time t, $E_t\phi_{t+1} = E_t b_{t+1}/(\tau + \tau_t^s) - 1,$ becomes

$$E_t\phi_{t+1} = \frac{\tau - \theta_t\tau(1 - E_t\delta_{t+1})}{\tau + \dfrac{\delta_t\tau\theta_t}{1-\theta_t}} - 1, \qquad \text{(A4)}$$

and at time t+1

$$E_{t+1}\phi_{t+2} = \frac{\tau - \theta_t\tau(1 - E_{t+1}\delta_{t+2})}{\tau + \dfrac{\delta_{t+1}\tau\theta_t}{1-\theta_t}} - 1, \qquad \text{(A5)}$$

We assume that the policy is binding so that $\delta_t = \delta_{t+1} = \delta_{t+2} = ... = \delta_{t+s} = \delta.$ Using this fact in (A4) and (A5) results in (16).

Appendix 2

Applying the Feldstein's method (1996), we can assess the quantitative importance of a positive coefficient of SSW. In my previous paper, the coefficient of SSW ranges from 0.0165 to 0.313 with different assumptions in SSW definitions. In other words, every additional 1 TL of SSW increases consumption between 0.0165 and 0.0313 TL. For instance, in 2003, the consumption is higher 4,816,282 million TL (283,310,716 million TL SSW— with 1987 prices— times 0.0165) than would be the case without the public social security. This implies the same amount of reduction in private saving. Moreover, since the private disposable income is reduced by the total contributions to the pension system (5,943,740 million TL), using the estimated marginal propensity to save (72% in Table 4, Equation 6), we can conclude that social security contributions also reduce saving by 4,279,493 million TL. Consequently, the total reduction in private saving (since the system works on paygo basis, national saving declines by the same amount as well) amounts 9,095,775 million TL (4,279,493 + 4,816,282). The national saving is 29,482,465 million TL in 2003, which would be 38,578,240 million TL without the paygo system. This implies that the pension system reduces national saving 24%, when it is calculated by the coefficient of 0.0165 and could increase as higher coefficients being used. As stated earlier, this measure cannot reflect a "true" value of the reduction. However, it indicates the quantitative importance of a positive coefficient of SSW.

Appendix 3

If an individual at the age of (*a*) in year (*t*) survives to the retirement age (*ra*) and if his current wage (or income that the old-age security is based on), $w_{(a,t)}$, grows at a constant rate of growth, *g*, then he will have $w_{t+ra-a} = w_t(1+g)^{(ra-a)}$, at the retirement age of *ra*. In order to calculate the first annuity for this individual, we use a benefit factor, (*bf*), which is basically the ratio of his first annuity to his last wage (or to his insurable income if he is a self-employed individual). Given the benefit factor, the individual will be entitled to his first annuity at *ra*, which is: $B_{(a,t)}=bf_t w_t(1+g)^{(ra-a)}$. If we further assume that real annuities grow after *ra* by *ga* until the age of death (*da*), given the survival probabilities, $S_{(i,j)}$, for that particular individual, the actuarial present value of future annuities (*PVA*) can be calculated at *ra*, where $S_{(i,j)}$ presents the probability of living at least to the age of *j*, given that the person lived to the age *i*.

With the personal discount rate (*d*) for future real incomes, at the age of *ra*, present value of annuities becomes:

$$PVA_{ra} = \sum_{da \geq n \geq ra} S_{(ra,n)} B_{(a,t)} (1+g)^{(n-ra)} (1+d)^{-(n-ra)}$$

At time (*t*), after substituting $B_{(a,t)}$ into *PVA* above, the person has the following expected present value of benefits at the age of *a*:

$$SSWG_{(a,t)} = bf_t W_t S_{(a,ra)} \left[(1+g)/(1+d)\right]^{(ra-a)} \sum_{da \geq n \geq 65} S_{(ra,n)} \left[(1+g)/(1+d)\right]^{(n-ra)}$$

This also includes survival probabilities between the age of retirement (*ra*) and the current age (*a*) at time (*t*). If the same individual at the age of (*a*) in year (*t*) survives to age *ra* and if his current wage (or income that the old-age security is based on), $w_{(a,t)}$, grows at a constant rate of growth, *g*, then the expected present value of all his future contributions until age *ra* can be calculated as follows:

$$SSTX_{a,t} = \sum_{m=a}^{ra} S_{a,m}\theta_{t+m-a}W_t\left[(1+g)/(1+d)\right]^{m-a}$$

where θ is the ratio of Social Security taxes to his wages through his working years, and the person expects that at age *m* he will pay a tax of $T_{t+m-a}=\theta_{t+m-a}w_t(1+g)^{m-a}$. Using these two definitions, *SSWG* and *SSWT*, I simulated present value of contributions and taxes expected by young cohorts. The details of this simulation and data resources can be found in Aydede (2008).

Appendix 4

Table 2: Estimation Results of (18)

Estimation	1	2	3	4	5	6	7
Income	0.513	0.493	0.575	0.358	0.265	0.240	0.145
	0.00	0.00	0.00	0.01	0.00	0.00	0.07
SSWG	0.022	0.027	0.037	0.019	0.020	0.030	0.035
	0.11	0.07	0.05	0.13	0.05	0.00	0.00
ΔEIRR	-31,236	-24,243	-25,005	-28,781	-35,731	-35,586	-43,229
	0.28	0.29	0.14	0.23	0.11	0.07	0.04
DR	-18,991	-11,776	-19,360	-9,591	-9,725	-15,592	-16,923
	0.08	0.48	0.44	0.45	0.39	0.13	0.12
HW	1.366	1.499	2.123	0.562	1.125	1.174	0.919
	0.02	0.02	0.00	0.54	0.01	0.00	0.02
FW	-0.094	-0.190	-0.251	-0.238	1.125	-0.173	-0.181
	0.22	0.05	0.00	0.05	0.04	0.01	0.01
R				-86,987	-104,471	-96,263	-111,082
				0.25	0.02	0.02	0.01
CRTP				0.363	0.478	0.484	0.544
				0.02	0.00	0.00	0.00
Inf				-132.79			
				0.77			
Old				-116,822			
				0.31			
Young				-32,668			
				0.19			
LFPR				8,425			
				0.16			
Un				-525,519			
				0.42			
Urban				-16,952			
				0.28			
Time		2,766	556	18,697	6,823	6,291	8,123
		0.5	0.92	0.14	0.03	0.02	0.01
D95		46,894	41,560			59,637	63,430
		0.08	0.03			0.01	0.01
Constant	353,952	322,443	254,515	2,386,385	412,598	450,844	526,267
	0.01	0.02	0.14	0.19	0	0	0
AR(1)ρ		0.4984	0.813				
		0.03	0				
AR(2)ρ			-0.6597				
			0				
DW	1.1913	1.5534	1.8484	2.4596	2.1186	2.1588	2.186
R2	0.973	0.980	0.985	0.990	0.987	0.991	0.990
SSR	2.21E+10	1.51E+10	1.02E+10	8.33E+09	1.03E+10	7.60E+09	8.24E+09
W	0.024	0.4019	0.824	0.2179	0.2012	0.7384	0.4427
LM		0.0028	0.2026				

Notes:

(1) All variables are in levels and deflated to 1987 prices, except for ratios and SSW which is in 1987 prices by calculation. Data sources are provided in my previous paper.

(2) Probabilities for coefficient being zero are given below the values of coefficients.

(3) W represents the White test, the probability that the estimation does not suffer heteroskedasticity.

(4) Since Durbin-Watson (DW) statistic is not strictly applicable with autoregressive transformation, I use the Breusch-Godfrey test to diagnose autocorrelation. The probability of there is no first-degree autocorrelation is given next to LM.

(5) I assume that the error term follows the first-order autoregressive scheme in Estimation 2 as $\mu_t = \rho\mu_{t-1}+\varepsilon_t$, where ε is a white noise process.

(6) R2 is adjusted R^2 and SSR denotes the sum of squared residuals.

(7) Correlation between *SSWG* and Δ*EIRR* is close to zero.

(8) Since the estimations use time-series data and high DW statistics do not necessarily ensure that results are not spurious, I used the same residual-based cointegration test as in my previous study, which indicates that results are not spurious.

Variables:

C represents consumption expenditures including durable goods.

$\boldsymbol{Y^e}$ is the permanent income estimated by the current private disposable income.

HW denotes wealth in real estate proxied by imputed rents from ownerships of dwellings.

FW is for financial wealth proxied by Money-Quasi Money (M2).

CRPT is 'credit to private sector' to control liquidity constraint.

R is real interest rate calculated on nominal interest rates 1-year time deposit accounts and consumer price inflation.

Inf is for capturing uncertainty calculated on 3-year moving average consumer price index.

Young and ***Old*** are the dependency ratios for the number of people younger than 15 and older than 65 relative to working population (15-65).

LFPR is labour force participation rate to control very low retirement age and the effect of informal labour force.

Urban captures the rapid change in urbanization in the last 40 years by calculating the ratio of number of people living in cities relative to the whole population.

Un represents unemployment which is a part of permanent income.

D95 represents a dummy for year 1995 to control the outlier tested by using one-step-ahead prediction errors about the zero line.

Table 3: Estimation results after log transformation

Estimation	**1**	**2**	**3**
LIncome	0.3120	0.2157	0.4836
	0.0000	0.0240	0.0000
LSSWG	0.0384	0.0660	0.0353
	0.0528	0.0025	0.2449
∆LEIRR		-0.0511	0.0396
		0.0307	0.0295
LDR		-0.1092	-0.1439
		0.0505	0.0348
LHW	0.1127	0.0701	0.0518
	0.0000	0.0153	0.1932
LFW	-0.1424	-0.1435	-0.1818
	0.0025	0.0000	0.0000
LR	-0.0845	-0.0811	-0.0434
	0.0730	0.0639	0.3282
LCRTP	0.1445	0.1602	0.1074
	0.0000	0.0000	0.0043
Time	0.0114	0.0008	
	0.0000	0.0211	
D95	0.0048	0.0488	0.1074
	0.0514	0.0343	0.0001
Constant	7.4720	8.8787	
	0.0000	0.0000	
DW	1.7619	2.1137	2.1206
R2	0.9827	0.9851	0.8569

Notes: (1) All variables are in logs. (2) Standard errors are robust and probabilities for coefficient being zero are given below the values of coefficients. (3) R2 is adjusted R^2. (4) Column 3 represents the first-difference estimator. (5) Variables are as defined before.

Table 4: The Johansen test results

Included observations: 31

Series: LConsumption Lincome LRINTR

Exogenous series: D(LEIRR) D(LSSWG) LDR D(LFW) D(LHW) D(CRTP)

Lags interval: 1 to 2

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	1	1	1
Max-Eig	1	1	1	1	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	179.3258	179.3258	181.3359	181.3359	182.8517
1	189.3445	190.5452	192.3982	196.9322	197.5534
2	192.6878	195.3482	197.0742	202.5087	202.7202
3	194.2529	197.0879	197.0879	203.0541	203.0541
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	-10.40812	-10.40812	-10.34425	-10.34425	-10.24849
1	-10.66738	-10.68033	-10.67085	-10.89885*	-10.80989
2	-10.49599	-10.5386	-10.58543	-10.80701	-10.75614
3	-10.20987	-10.19922	-10.19922	-10.39058	-10.39058
	Schwarz Criteria by Rank (rows) and Model (columns)				
0	-9.575481	-9.575481	-9.372842	-9.372842	-9.138311
1	-9.557201	-9.523893	-9.421898	-9.603634*	-9.422165
2	-9.108256	-9.058351	-9.058927	-9.187996	-9.090866
3	-8.54459	-8.395173	-8.395173	-8.447763	-8.447763

Notes: (1) All variables are in logs. (2) To pick the optimal lag length of the models, we estimated VAR models with maximum 6 lags and then decided on the lag where the AIC and SBC values at the minimum.

Table 5: Unconditional vector error correction model

Cointegrating Eq:	LCONS(-1)	LY(-1)	LRINTR(-1)	Trend	C
CointEq1	1.0000	-1.9246	-1.0788	0.0605	11.8651
		0.4514	0.2564	0.0204	

Error Correction:	D(LCONS)	D(LY)	D(LRINTR)
CointEq1	-0.1888	-0.0425	0.6009
	0.0536	0.1095	0.2013
D(LCONS(-1))	-0.1551	-0.0519	0.2213
	0.1749	0.3571	0.6568
D(LCONS(-2))	-0.3295	-0.3587	-0.1930
	0.1736	0.3543	0.6517
D(LY(-1))	-0.4089	-0.0776	0.2386
	0.1484	0.3029	0.5571
D(LY(-2))	0.0029	0.1484	0.4176
	0.1942	0.3964	0.7291
D(LRINTR(-1))	-0.0848	0.1035	0.2410
	0.0707	0.1444	0.2656
D(LRINTR(-2))	-0.0412	-0.0586	0.1021
	0.0449	0.0917	0.1686
C	0.1458	0.0642	-0.3677
	0.0384	0.0784	0.1442
D(LIRR)	-0.2132	-0.3434	0.1531
	0.0377	0.0770	0.1416
D(LSSWG)	0.2210	0.3294	-0.2219
	0.0469	0.0958	0.1761
LDR	-0.1081	-0.0428	0.3213
	0.0325	0.0663	0.1219
D(LM2)	-0.2434	-0.2320	0.3225
	0.0575	0.1173	0.2157
D(LDWELL)	0.0675	-0.0837	-0.2859
	0.0557	0.1137	0.2091
D(LCRTP)	0.0865	0.0777	0.3061
	0.0384	0.0784	0.1441
R-squared	0.9087	0.6824	0.7055
Adj. R-squared	0.8389	0.4395	0.4802
Sum sq. resids	0.0080	0.0332	0.1124
S.E. equation	0.0217	0.0442	0.0813
F-statistic	13.0204	2.8095	3.1321
Log likelihood	84.1264	62.0009	43.1118
Akaike AIC	-4.5243	-3.0968	-1.8782
Schwarz SC	-3.8767	-2.4492	-1.2306
Mean dependent	0.0140	0.0189	0.0016

Notes: (1) All variables are in logs. (2) D and L in front of variables represent difference and log values, respectively. (3) Values under the coefficients are standard errors. (4) Endogenous variables are *Cons* (consumption), *Y* (income) and *RINTR* (real interest rate) which are *I*(1). Exogenous variables, *IRR* (expected implicit rate of return – *I*(1)), *SSWG* (social security wealth – *I*(1)), *DR* (dependency ratio – *I*(0)), *M2* (financial wealth – *I*(1)), *Dwell* (housing wealth – *I*(1), and *CRTP* (credit to private sector *I*(1). (5) To pick the optimal lag length of the models, we estimated VAR models with maximum 10 lags and then decided on the lag where the AIC and SBC values at the minimum.