Online appendix to
" Social Security Reforms: Benefit Claiming, Labor Force Participation and Long-run Sustainability"

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This document provides additional policy experiments, sensitivity analysis and extensions of the model that are not contained in the paper.

1 Social Security reforms under the current demographics

Table 1 summarizes the effects of the three Social Security reforms we discussed in the paper, in the economy with current demographic variables rather than the projected variables for 2080. The changes in the table are with respect to the calibrated benchmark economy, where we approximate the current Social Security system and demographics.

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Table 1: Effects of Social Security reforms

	Benchmark	Benefit 50% ⇓	ERA 62 → 64	NRA 66 → 68
Aggregate capital	–	+9.9%	−0.11%	+2.4%
Aggregate labor	–	+3.1%	+0.18%	+0.7%
Average work hours	–	+0.2%	−0.04%	+0.1%
Wage	–	+2.4%	−0.10%	+0.6%
Interest rate (%)	5.54%	4.95%	5.56%	5.39%
Labor income tax: $\tau^l + \tau^{ss} + \tau^{med}$ (%)	35.0%	28.1%	34.9%	33.2%
Social Security budget balance (% of GDP)	+0.48%	+0.30%	+0.54%	+1.32%
Average assets at 62 (in 2008 $1,000)	277.6	329.8	278.9	292.8
	–	+18.8%	+0.5%	+5.5%
Retirement (Social Security already claimed)				
at 62	49.9%	29.6%	–	39.3%
by 66	98.1%	95.7%	97.9%	87.4%
by 69	100.0%	100.0%	100.0%	100.0%
Labor force participation				
Age 60-69	49.8%	61.5%	52.4%	52.2%
Age 20-59	92.5%	93.9%	92.3%	92.9%

In general, qualitative effects of the reforms are the same as those reported in the paper, but the magnitude of the effects is smaller in the economy with current demographic variables.

A 50% benefit reduction increases aggregate capital by 9.9%, much smaller than the 17.5% increase under the same experiment in the economy with aging. With the longer expected life, households would have to accumulate more savings in order to supplement old age consumption when retirement benefits are reduced. The response in the labor supply is smaller as well and the participation rate of the elderly at age 60-69 will rise from 50.2% to 61.5% by 11.7 percentage points, compared to 16.6 percentage points in the economy with aging.

The effect of the increase in the early retirement age is small as in the economy with aging. The participation of the elderly will rise by 2.6 percentage points, somewhat greater than the rise of 1.6 percentage points in the economy with aging. Since fewer people claim benefits at age 62 once the demographic transition occurs, not many people would be affected by the reform. When the normal retirement age is raised by 2 years, which implies but a lower benefit for a given retirement age, both saving and labor participation increase by a smaller magnitude than under the same reform in the economy with aging, for the same reason as the smaller effects of the benefit cut.

2 Social Security rules and reform uncertainty

In this section, we will run sensitivity analysis on the features of the Social Security system and the benefit rules in order to understand how they affect the life-cycle decisions of individuals, including the timing of benefit claiming and labor force participation.

Earnings test (A1): To identify the role of the earnings test, we run the benchmark model without the earnings test, where Social Security benefits are no longer subject to taxation no matter how much one earns while receiving benefit prior to the normal retirement age. The results are shown in column labeled A1 in Table 2. The benefit claim at the earliest retirement age will rise significantly from 49.9% to 76.7%. Those who postpone the claim in the benchmark economy since they intend to earn more than the threshold of the earnings test may be inclined to claim benefits early, now that there is no penalty on earnings. The participation rate among the elderly will rise by 1.5%. The effect on the participation is smaller than what other papers have found, in which only the taxation part of the earnings test is captured but not the "undoing" part of the test which will restores the penalty imposed by the ARF. In other words, the participation would have been lower in the benchmark economy if there was not the second part of the earnings test and we would have observed a larger effect in participation by eliminating the earnings test. Benitez-Sílva et al. (2007) study the effect of the ARF adjustment associated with the earnings test and show that the adjustment will raise the participation of the elderly at ages between 62 and 65 by 4 to 9 percentage points.

Actuarial Reduction Factor (ARF) (A2): In this experiment, we assume that there is no penalty by the ARF for early retirement and try to quantify the negative effect of the ARF on the labor force participation of the elderly. There would be less incentive to wait until the normal retirement age to retire since one would simply forgo the benefits during the years between 62 and 66. The claim at the earliest retirement age will jump to 96%. The cost of providing permanently higher benefits for the large number of early retirees is reflected in the change in the labor income tax, which increases by approximately 5 percentage points to 39.8%. Coupled with a greater annuity provided by the Social Security, both savings and labor supply will fall. Aggregate capital declines by 6.7% and participation of the elderly will drop significantly from 50% to 30%.

Early retirement (A3): We now assume that early retirement is no longer possible and the earliest age to claim the benefit is the normal retirement age of 66. The results of this experiment are similar to those of the reform to increase the earliest retirement age to 64. Macro variables barely change under the experiment. The tax rate remains almost unchanged since the average benefits are higher by forcing them to retire late and the total spending does not change much.

Uncertainty about future Social Security system (A4): In this experiment we incorporate some uncertainty about the future of the Social Security system and individuals' expectation about the reform. We assume that individuals expect a reform

to occur in the next period with a certain probability and if it does, the benefits of new retirees will be permanently reduced. In the experiment, we set the probability of reform at 10% and the benefit will be reduced by 5%.[1] The effects are negligibly small, except for the early retirement at age 62 that increases by 8.7%. Note that we made a rather strong assumption that the benefit will not be affected by the reform if an individual has already claimed the benefits before the reform happens, driving an additional incentive to claim early and fix the benefit for the rest of their life. If we allow for an equivalent adjustment for those who are already retired, we expect the change in the retirement to be much smaller.

[1]For simplicity, we compute the continuation value when the reform happens by assuming that the same aggregate conditions including the factor prices and fiscal variables would prevail as in the stationary equilibrium and we do not compute an explicit transition dynamics in response to the change in benefits.

Table 2: Sensitivity analysis (1): Social Security rules and reform uncertainty

	Benchmark	A1 No earn. test	A2 No ARF	A3 No early retire.	A4 Reform uncertainty
Aggregate capital	–	+0.60%	−6.7%	−0.28%	+0.31%
Aggregate labor	–	+0.22%	−3.2%	−0.31%	−0.04%
Average work hours	–	−0.08%	+0.3%	+0.04%	−0.03%
Wage	–	+0.14%	−1.3%	−0.21%	+0.12%
Interest rate (%)	5.5%	5.5%	5.9%	5.6%	5.5%
Labor income tax: $\tau^l + \tau^{ss} + \tau^{med}$ (%)	35.0%	34.8%	39.8%	34.9%	34.8%
Average assets at 62 (in 2008 $1,000)	277.6	273.9	254.5	278.9	279.8
	–	−1.3%	−8.3%	+0.5%	+0.8%
Retirement (Social Security already claimed)					
at 62	49.9%	76.7%	96.0%	–	58.6%
by 66	98.1%	99.5%	99.9%	83.8%	99.2%
by 69	100.0%	100.0%	100.0%	100.0%	100.0%
Labor force participation					
Age 60-69	49.8%	51.2%	30.0%	53.7%	49.4%
Age 20-59	92.5%	92.5%	92.0%	92.2%	92.5%

3 Labor supply elasticity

In this section, we study the sensitivity of our main findings regarding the effects of Social Security reforms to alternative values of the Frisch elasticity of labor supply. The estimates of this important parameter in the literature lie in a wide range. Early estimates that use male samples such as MaCurdy (1981) and Altonji (1986) are very small, between 0.035 and 0.567. More recent estimates are higher and close to unity; see for example Domeij and Floden (2006) and Browning et al. (1999) for a survey. We chose the value of the Frisch elasticity γ at 0.5 in the benchmark calibration, which lies in the range of classic micro estimates and experiment in this section with two alternative values of 0.25 and 1.0. Since the purpose of the sensitivity analysis is to compare the quantitative effects of the Social Security reforms under alternative degrees of labor supply elasticity, we recalibrate the parameters of the economy to match the same aggregate statistics that we used as calibration targets as we discussed in the paper.[2]

Results are summarized in Tables 3 and 4. The experiments are conducted in the economy with the current demographics. Therefore the results should be compared to those reported in Table 1 of this document. Across the three reform experiments, results are very similar to those under the benchmark calibration, not only qualitatively but also quantitatively. The finding that the aggregate effects are not sensitive to the value of labor supply elasticity is consistent with the results of İmrohoroğlu and Kitao (2009).

[2]More precisely, we calibrate the value of TFP A, discount factor β, the preference weight parameter χ, weight on bequest utility ψ_1 and cost of participation ϕ to match the target that corresponds to each parameter. The re-calibrated values for $\{A, \beta, \chi, \psi_1, \phi(h^g), \phi(h^b)\}$ are $\{1.6, 0.966, 270, 26, 0.64, 1.05\}$ for $\gamma = 0.25$ and $\{1.6, 0.963, 10, 27, 0.33, 0.7\}$ for $\gamma = 1.0$.

Table 3: Effects of Social Security reforms: Frisch elasticity γ=0.25

	Benchmark	Benefit 50% $\Downarrow$	ERA 62 $\rightarrow$ 64	NRA 66 $\rightarrow$ 68
Aggregate capital	–	+9.7%	+0.34%	+2.7%
Aggregate labor	–	+2.6%	+0.29%	+0.7%
Average work hours	–	+0.1%	−0.04%	+0.03%
Wage	–	+2.4%	+0.02%	+0.7%
Interest rate (%)	5.41%	4.81%	5.40%	5.24%
Labor income tax: $\tau^l + \tau^{ss} + \tau^{med}$ (%)	34.9%	27.9%	34.3%	32.8%
Social Security budget balance (% of GDP)	+0.51%	+0.31%	+0.58%	+1.34%
Average assets at 62 (in 2008 $1,000)	283.1	335.4	284.3	299.5
	–	+18.5%	+0.4%	+5.8%
Retirement (Social Security already claimed)				
at 62	45.5%	27.2%	–	35.6%
by 66	97.3%	93.4%	96.9%	86.1%
by 69	100.0%	100.0%	100.0%	100.0%
Labor force participation				
Age 60-69	50.0%	62.1%	52.8%	52.6%
Age 20-59	92.8%	94.2%	92.7%	93.2%

Table 4: Effects of Social Security reforms: Frisch elasticity γ=1.0

	Benchmark	Benefit 50% ⇓	ERA 62 → 64	NRA 66 → 68
Aggregate capital	–	+9.9%	+0.40%	+3.1%
Aggregate labor	–	+2.9%	+0.35%	+0.9%
Average work hours	–	+0.4%	−0.03%	+0.07%
Wage	–	+2.4%	+0.02%	+0.8%
Interest rate (%)	5.51%	4.92%	5.51%	5.31%
Labor income tax: $\tau^l + \tau^{ss} + \tau^{med}$ (%)	34.9%	27.9%	33.9%	32.2%
Social Security budget balance (% of GDP)	+0.53%	+0.32%	+0.59%	+1.37%
Average assets at 62 (in 2008 $1,000)	283.8	340.1	287.9	302.5
	–	+20.1%	+1.7%	+6.8%
Retirement (Social Security already claimed)				
at 62	54.5%	32.6%	–	42.7%
by 66	97.3%	93.4%	96.7%	89.2%
by 69	100.0%	100.0%	100.0%	100.0%
Labor force participation				
Age 60-69	49.9%	61.5%	52.9%	52.8%
Age 20-59	92.5%	94.0%	92.5%	93.1%

4 More sensitivity analysis

In this section we conduct sensitivity analysis to study how various features of the model besides the rules of the Social Security system affect the outcome of the model and the pattern of retirement and labor force participation.

Health expenditures and shocks (B1 and B2): In order to understand the role of health expenditures and their variability, we compute an equilibrium in which health expenditure uncertainty is eliminated (B1). We let agents face a deterministic profile of medical expenditures that depends only on age. The level of expenditures at each age is based on the average expenditures from the distribution used in the benchmark model. We also assume away private health insurance. Second, we completely eliminate the expenditures from the model (B2).[3] The results are shown in Table 5 in columns labeled B1 and B2. In B1, aggregate capital and labor supply will fall but the change is less than a percentage point. Even without the uncertainty, individuals will still need to accumulate enough savings in order to finance the expenditures that rise rapidly with age. In B2, the saving will fall significantly and aggregate capital and labor decline by 6.5% and 8.5% respectively. The labor participation of the elderly at age 60-69 will fall

[3]In B2, we assume away both health insurance and Medicare.

by more than 10% to 37.9%. The decline is more pronounced among the elderly in bad health, who incur more disutility from working, since they do not have to work as hard as they did in the benchmark in order to pay for the high medical costs. Their participation rate falls from 28.5% in the benchmark to 10.6%.

Consumption floor $\underline{c}$ (B3): In order to assess the sensitivity of our results to the level of the consumption floor, we compute an equilibrium in which the floor is set at \$1,500, half of the level in the benchmark economy. Since the consequence of running out of assets is more severe, there will be a stronger incentive to accumulate buffer stock savings against expenditure shocks and aggregate capital will rise by about 1%. The labor force participation will rise slightly but there is not much change in the benefit take-up.

Bequest motives (B4): We now completely eliminate warm-glow bequest motives by setting the value of parameter ψ_2 to 0. Individuals will begin to quickly run down the assets after mid-50s and aggregate capital will fall by as much as 22%. The participation rate of the elderly will also fall significantly from 49.8% to 38.5%.

Private health insurance (B5): To understand the role of health insurance, we run a model assuming that all agents pay the entire gross expenditures out of pocket and there is no employer-provided health insurance. As shown in Table 5, there is a decline in the labor force participation, which is concentrated among those in bad health status. Since the coverage by the employer-based health insurance was conditional on employment, some individuals, especially those in bad health and expecting to incur larger expenditures stayed at work mainly because they would like to keep the coverage. There is an incentive to do so at least until age 65, when everyone becomes eligible to be covered by Medicare, which is less generous in terms of coverage rate than the employer based insurance, but still covers a significant amount of expenditures. The job exit rate (defined as the change in participation rate) at age 65 falls from 19.4% in the benchmark economy to 7.5% in the economy without private health insurance. Rust and Phelan (1997) also emphasize the distortions on the participation decisions caused by the Medicare eligibility. Our finding is consistent with theirs, though the magnitude of the exit at this particular age is smaller in the benchmark, since the agents in our model can also self-insure against the expenditure risks by accumulating riskless assets, whereas Rust and Phelan (1997) focus on poor households and abstract from saving decisions.

Medicare (B6): We assume there is no Medicare. All individuals above age 65 pay the entire gross expenditures out of pocket. The additional expenditure risks and the need to cover large expenditures at old ages will raise the precautionary saving demand and aggregate capital will increase by 3.6%. The early benefit claiming at age 62 will fall from 49.9% to 43.8%. More individuals choose to postpone the benefit take-up and increase the value of annuity at older ages in order to supplement the loss of insurance provided by Medicare.

Rise in medical expenditures (B7): Medical expenditures have been rising much faster than the general output of the economy in recent years. In order to understand the effect of a further rise in the medical cost relative to the cost of other goods, we run an experiment where the real expenditures rise by 50% universally. The last column of Table 5 shows the results. Despite the rise in the resources allocated to the medical expenditures, aggregate capital barely changes and declines only by 0.4%. It implies that individuals allocate relatively more of their income towards savings. In fact, non-medical consumption drops by as much as 5.7% in the economy with the high expenditures. Early retirement at age 62 will fall by about 5 percentage points and the labor participation of the elderly will rise by 3.2 percentage points.

Table 5: Sensitivity analysis (2)

	Benchmark	B1 No hlth exp shock	B2 No hlth exp.	B3 C. floor $1,500	B4 No bequest	B5 No health insurance	B6 No Medicare	B7 High med. exp.
Aggregate capital	–	−0.29%	−6.5%	+0.92%	−22.1%	−0.57%	+3.6%	−0.4%
Aggregate labor	–	−0.77%	−8.5%	+0.39%	−5.2%	−1.38%	+1.3%	+2.0%
Average work hours	–	+0.40%	+2.7%	+0.05%	+2.2%	+0.32%	+0.2%	+1.6%
Wage	–	+0.17%	+0.8%	+0.19%	−6.8%	+0.30%	+0.8%	−0.9%
Interest rate (%)	5.5%	5.5%	5.3%	5.3%	7.5%	5.5%	5.3%	5.8%
Labor income tax: $\tau^l + \tau^{ss} + \tau^{med}$ (%)	35.0%	35.0%	38.0%	34.6%	39.8%	35.8%	32.3%	36.1%
Average assets at 62 (in 2008 $1,000)	277.6	270.1	254.3	281.2	209.0	265.8	297.6	275.6
	–	−2.7%	−8.4%	+1.3%	−24.7%	−4.2%	+7.2%	−0.7%
Retirement (Social Security already claimed)								
at 62	49.9%	52.1%	59.2%	49.5%	53.8%	51.1%	43.8%	45.1%
by 66	98.1%	98.2%	98.6%	98.2%	96.8%	97.9%	97.6%	97.7%
by 69	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Labor force participation								
Age 60-69								
- all	49.8%	48.0%	37.9%	50.2%	38.5%	47.3%	52.8%	53.0%
- good health	57.9%	59.1%	48.4%	58.1%	45.8%	57.7%	61.6%	60.9%
- bad health	28.5%	18.9%	10.6%	29.6%	19.4%	20.2%	29.8%	32.4%
Age 20-59								
- all	92.5%	91.7%	87.3%	93.3%	86.7%	90.7%	93.2%	92.3%
- good health	96.2%	96.9%	94.0%	96.4%	92.0%	96.3%	96.7%	96.0%
- bad health	67.5%	56.6%	41.8%	72.6%	51.0%	52.7%	69.6%	67.0%

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