Manual for the use of GA Excel file

The GA excel file, which computes the GA for Korea, has 35 worksheets: (1) 1 worksheet for the assumptions (Assumption); (2) 1 worksheet for some matrices used in the calculation in different worksheets (Matrices); (3) 2 worksheets for the age profiles of taxes and transfers (age profile (m), age profile (f) for male, female, respectively); (4) 3 worksheets for population projections (Pop(m), Pop(f), Pop(T) for male, female, total); (5) 1 worksheet for GDP projection (GDP projection); (6) 2 worksheets to project the aggregate values for the taxes the government transfers, and the government consumption (aggregate(taxes and transfers, aggregate(government consumption); (7) 1 worksheet to compute the values for male age 40 (multiplier(40)), which are used to compute the net payment of the current generations in the worksheets d1-d19; (8) 18 worksheets to compute the net payment of the current generations (npd1-12, npd15-19, npd3-1); (9) 1 worksheet to compute the lifetime income of the current generations (WI); (10) 1 worksheet reporting the net payment of the current generations (netpayment(current gen.)); (11) 1 worksheet for computing the net payment of future generations (future gen netpayment); (12) 2 worksheets reporting the GA for the current generations and the future generations (GA, GA (as % of lifetime income)); (13) 1 worksheet to compute the generational imbalance and the magnitude of the tax, the transfer adjustment required to attain long-run government budgetary balance, and the sustainability gap (Sustainability).

Fill in the relevant numbers in the green cells of the worksheets, and the numbers in the other cells are automatically adjusted.

We plan to compute 2 sets of GA's using 2 methods of the public health care expenditure projection: 1) one using the spreadsheet 'aggregate(taxes and transfers)'; and 2) one using the 'Mason-and-Miller's projection'. Mason-and Miller's projection will provide the per capita values of the public healthcare expenditure by age and year. Enter the multiplication of the per capita value by the population by age and year in the green cells (cells H3:DN103, DQ3:HW102) of the spreadsheet 'npd3-1', when following 2) approach.

When following 1) approach, fill in 0's the green cells (cells H3:DN103, DQ3:HW102) in the spreadsheet 'ndp3-1'.

When following 2) approach, enter 0 in the cell c5 in the spreadsheet 'aggregate(taxes and transfers)'. In this case, you may want to adjust the projection of the medical insurance contribution, according to the budget rule of the public medical insurance budget. For example, if the medical insurance budget is ruled to maintain balanced budget, then you may want to fill in the amount of the public medical insurance expenditure, shown in the row 22, which is computed from the worksheet 'ndp3-1'), in the cells for the public medical insurance contribution (the row 6 in the spreadsheet 'aggregate(taxes and transfers)).

(1) Assumption

This worksheet reports the assumption on the productivity growth (gr: real growth rate, g:gr+inflation rate), the maximum age (100), the (nominal) discount rate, the income elasticities of social welfare expenditure (e1) and health care expenditure (e2), the total amount of government net wealth, the total value of the government consumption, its proportion, and the GDP as of the benchmark year (2000), and the classification of taxes and transfers. If you change the assumptions, the net payments of the current generations and the future generations are automatically adjusted.

(2) Matrices

The worksheet 'matrices' contains the 100*100 identity matrix and the discount matrix, and the growth matrix. The values in the first column of the discount matrix, which are values for the benchmark year are 1's. The values for the years after the benchmark year are $\left(\prod_{j=1}^{s} \frac{1}{r_{t+s-j}} \right)$'s. ($s$ is the number of the years since the benchmark year).

The values in the first column of the growth matrix, which are values for the benchmark year are 1's. The values for the years after the benchmark year are $(1+gr)^s$'s.

(3) Age profiles (age profile (m), age profile (f))

These 2 worksheets report the age profiles of taxes and transfers (item d1-19), the public educational expenditure (item d20), and the wage income. We normalize the value of the item d1-20 for male aged 40 as 1. So, the age profiles reports the value of each item relative to that for the male aged 40. We did not report the age profiles for the items d1-2, because for these items, which are assigned to the public pension benefits and contributions, the age profile changes overtime. The age profiles for the items d3-20, and the wage income profile are assumed unchanged.
If you do not compute the GA by gender separately, enter the same age profiles in both spreadsheets (age profile (m), age profile (f)).

(4) Population projections (Pop(m), Pop(f), Pop(T))

The three worksheets report the results of the population projection. We use the population projection model of the National Statistics Office of Korea. Each worksheet reports the total population of each year and the age distribution of population as of benchmark year in the row form, which is used to compute the expected value of the per capita net payment of current generations (see worksheets d1-d19). If you do not compute the GA by gender separately, enter half of the projected population in both spreadsheets (Pop(m), Pop(f)), so that the total population in spreadsheet Pop(T) become the same as your population projection.

In the worksheet 'Pop(T)', the population of the 3 age groups, the aged less than 18, the aged between 18-65, and the aged more than 65, are reported. In addition, it reports the age-profile-adjusted population of each year. The age-profile-adjusted population (APDP) is defined as:

$APDP\_i = \sum_{i,s} d_{is} pop_{is}$ (d_{is}: age profile, i: age, s: sex, pop: population)

i=3, 4, 10, 20(educational expenditure).

The total population, the population of subgroups, and the age-profile adjusted population are used in the projection of the aggregates of the taxes, the transfers, and the government consumption. You may want to use the APDP for some items. In that case, compute the APDP using the formula above, and make projection on those items using the computed APDP.

(5) Projection of GDP (GDP projection)

This worksheet reports the results of the GDP projection. We use the following formula for the GDP projection, which reflects the productivity growth, $1+gr$, and the population growth, $\frac{\sum_{is} pop_{ist+1}}{\sum_{is} pop_{ist}}$.

$$GDP\_t+1 = GDP\_t \times (1+gr) \times \frac{\sum_{is} pop_{ist+1}}{\sum_{is} pop_{ist}}$$

where pop_ist represents the population of the age group *is* at *t*.

(6) Projection of aggregate values (aggregate(taxes and transfers), aggregate(government consumption))

This worksheet reports the results of the aggregate value prediction of the taxes, the transfers, and the government consumption. The items of the transfers have negative values, because we treat the transfers as the negative taxes. The items d3-4 of the taxes and the transfer are assumed to be the age-specific depending on the age profile of the item d3. The items d5-8, d11-12 are assumed to be the age-specific depending on the population aged between 18 and 65. The items d9-10, d15-d19 are assumed non-age specific.

The aggregate values are projected using the following formulae.

$$Agg\_t+1 = Agg\_t \times \frac{pcv\_t+1}{pcv\_t} \times \frac{\sum_{is} pop_{ist+1}}{\sum_{is} pop_{ist}}$$ for non-age specific items

$$Agg\_t+1 = Agg\_t \times \frac{pcv\_t+1}{pcv\_t} \times \frac{\sum_{is \in subpop} pop_{ist+1}}{\sum_{is \in subpop} pop_{ist}}$$ for age specific items, whose aggregate values depends on the population of the age groups (*subpop*), such as the aged less than 18, the aged 18-65, and the aged more than 65.

$$Agg\_t+1 = Agg\_t \times \frac{pcv\_t+1}{pcv\_t} \times \frac{\sum_{is \in subpop} d_{is}\, pop_{ist+1}}{\sum_{is \in subpop} d_{is}\, pop_{ist}} = Agg\_t \times \frac{pcv\_t+1}{pcv\_t} \times \frac{APDP\_t+1}{APDP\_t}$$

for age specific items, whose aggregate values depends on the age profiles of a tax or a transfer item.

The per capita values (*pcv_t*) except for the items d3-4, d9-10 are assumed to increase at the productivity growth rate: i.e. $\frac{pcv\_t+1}{pcv\_t}$ is (1+productivity growth rate), which implies that their income elasticity is assumed 1. For the items d3-d4, d9-d10, we assume that the per capita values increase at the higher rate than the productivity growth: i.e. $\frac{pcv\_t+1}{pcv\_t}$ is (1+productivity growth rate ×income elasticity), and the income elasticity is larger than 1. We assume that the income elasticity of the items d3-d4 (d9-d10) is assumed to be 1.2 (1.2), unless the sum of d3 and GC5 (the sum of d9, d10 and GC6) is higher than 5.97% (4.12%) of the GDP, which implies that we restrict the level of social welfare expenditure (health care expenditure) under the level of the average of the OECD countries as of 1990's.

For the projection of the aggregates of the government consumption, we follow the same procedure. The items GC1-3, GC7-13 of the government consumption are assumed to be non-age-specific and the other items are assumed to be age-specific. The aggregate value for the item GC4 depends on the age profile of the educational expenditure (*APDP_20*), while that of the GC5 (GC6) depends on the age profile of the d3 (d10) of the taxes and transfers (*APDP_3* (*APDP_10*)). The per capita values for all the items, except for the items GC5-6, are assumed to increase at the productivity growth rate: i.e. their income elasticity is assumed 1. For the items GC5 (GC6[1]), the income elasticity is assumed to be 1.2 (1.2), unless the sum of d3 and GC5 (the sum of d9, d10, and GC6) is higher than 5.97% (4.12%) of the GDP.

[1] In the value for the item GC6, the value of the social insurance benefits are subtracted in order to prevent the double counting, because the value at the worksheet 'assumption' includes the value of the social insurance benefits.

(7) Computing values for the male aged 40

The values for the male aged 40 (H_{m40}) of each year, which is used to compute the per capita values across age groups of the current generations in the worksheets d3-d19, is computed using the following formula.

$Agg = H_{m40} \sum_{i,s} d_{is} pop_{is}$, *Agg*: aggregate value of each year.

H_{m40} becomes the value for the male aged 40, because the value of the age profile (d_{is}) is the value relative to that for the male aged 40.

(8) Computing the net payments of the current generations (npd1-npd12, npd15-npd19, npd3-1)

The spreadsheets npd1-12, npd3-1, and npd15-19 compute the expected present value of each item of the tax and the transfer for the remaining lifetime of the current generations. We divide the taxes and the transfers into two groups: (i) the group of the items whose age profile does not change (npd3-12, npd15-19); and (ii) the group of the items whose age profile changes overtime (npd1-2, ndp3-1).

The worksheets for the group (i) consists of 3 parts: ① the per capita value x the population across age groups and years x discount factor by sex and age (H3:DN102 for male, DQ3:HW102 for female); ② Adding up each generation's value for her remaining lifetime (column B for male, column D for female); and ③ dividing the sum by the population at the benchmark year (column C for male, column E for female, Column F for total).

Part ①: the per capita value (*percap*) is computed by multiplying the value for male aged 40 (H_{m40}) by the age profile. By multiplying the *percap* by the population of each age group and year x the discount factor, we get the total present value for each year and age group.

Part ②: The sum, for aged *i* at the benchmark year (omitting the subscript for the sex), computed in the step ② is expressed as follows:

$$Sum_i = \sum_{s=i}^{D} percap_{s,t+s-i}\, pop_{s,t+s-i} \left(\prod_{j=i}^{s} \frac{1}{1+r_{bt+j-i}} \right)$$

$Percap_{s,t+s-i}$: per capita value
$pop_{s,t+s-i}$: population of the year-*t* born at the age of *s*.
r: discount factor,
bt: benchmark year

Part ③: Dividing this sum by the population as of the benchmark year produces the expected discounted value for the remaining lifetime, because:

$$N_i = \frac{Sum_i}{pop_{s,t}} = \sum_{s=i}^{D} percap_{s,t+s-i} \frac{pop_{s,t+s-i}}{pop_{s,t}} \left(\prod_{j=i}^{s} \frac{1}{1+r_{bt+j-i}} \right)$$
$$= \sum_{s=i}^{D} percap_{s,t+s-i} \; S_{s|i} \left(\prod_{j=i}^{s} \frac{1}{1+r_{bt+j-i}} \right)$$

$S_{s|i}$ is the probability of surviving until the age *s*, conditional on that one is alive at the age of *i*. The third equality holds if we ignore the international mobility of the population.

We follow the same procedure for the group (ii), except for the fact that the worksheets npd1-2, ndp3-1 report the *percap* separately, because their age profile changes overtime. Therefore the worksheets npd1-d2 consists of 4 parts: ①' per capita value x the population across age groups (H3:DN102 for male, DQ3:HL102 for female); ① the per capita valuexthe population across age groups and yearsxdiscount factor by sex and age (H107:DN206 for male, DQ107:HL206 for female); ② Adding up each generation's value for her remaining lifetime (column B for male, column D for female); and ③ dividing the sum by the population at the benchmark year (column C for male, column E for female, Column F for total).

Notice: if you do not want to use the spreadsheets npd1-2, or npd3-1, the green cells (part ①') in the spreadsheet needs to leave blank. Inserting any number in the parts changes the number in the columns for the each generation's value for her remaining lifetime, computed in part ②.

(9) Computing the lifetime income of current generations (WI)

The spreadsheets WI compute the present value of the labor income of the current generations for the remaining lifetime. This worksheet consists of 2 parts: ① the per capita value x the population across age groups and years x discount factor by sex and age (H3:DN102 for male, DQ3:HW102 for female); ② Adding up each generation's value for her remaining lifetime (column B for male, column D for female)

(10) Net payment of current generations (netpayment(current gen.))

The worksheet 'netpayment(current gen.)' reports the PV of each item across age as of the benchmark year and the sum across items, which is the PV of the net tax burden. The rows, assigned to item d1-19, d3-1, in the worksheet are the transposes of the columns for the values of the expected present value for the remaining lifetime in the worksheets npd1-19, ndp3-1.

(11) Computing the per capita value of the future generations' net payment (netpayment(future gen.))

Computing the future generations' net payment starts with the intertemporal budget constraint of the government:

$$\sum_{s=0}^{D} N_{t,t-s} + \sum_{s=t}^{\infty} N_{t,t+s} = \sum_{s=t}^{\infty} G_s (1+r)^{-(s-t)} - W_t^g$$

The first summation on the left-hand side of the equation above, adds together the the present value of the remaining lifetime net payments of current generations. The term $N_{t,t-s}$ stands for the net payment of the generation born in year *t-s*: the net payment of the generation aged *s* as of the benchmark year. The index *s* in this summation runs from age 0 to age *D*, the maximum length of life. The second summation on the left-hand side adds together the present value of remaining net payments of future generations, with *s* representing the number of years after year *t* that each future generation is born. The first term on the right-hand side is the present value of government consumption. The remaining term on the right-hand side, W_t^g, denotes the government's net wealth in year *t* – its assets minus its explicit debt.

The total value of the net payment of the future generation, denoted also as 'government consumption gap' in the worksheet, is determined as a residual, because: the total net payment of the current generations is computed in the worksheets 'ndpp1-19, ndp3-1'; the government consumption is projected in the worksheet 'aggregate(government consumption)'; and we assume that the net government wealth in the worksheet 'assumption'.

To compute the per capita value of the future generations' net payment, under the assumption that the net payment is equally allocated among future generations, except for the adjustment of the technological progress. The effective population of future generations is:

$$effpop\_future = \sum_{s=1}^{\infty} pop_{0,t+s}(1+g)^s \left(\prod_{j=1}^{s} \frac{1}{1+r_{t+j}} \right)$$

The future generations' population needs to be discounted, because their net payment is computed as of their year of birth. In the worksheet 'aggregate(government consumption)', the government consumption is projected up to the year 2110. For the period after the year 2110, we assume that the total population and population structure do not change and that the per capita value of the government consumption increases at the productivity growth rate. We make the same assumption, when we compute the effective population of future generations.

The per capita value of the future generations' net payment is the total value divided by the effective population of the future generations. The accounts for the male and female future generation is computed under the assumption that their ratio is the same as that of the account for the male aged 0 to that for the female as of the benchmark year.

(12) Reporting GA's (GA, GA (as % of lifetime income))

The worksheet 'GA' reports the GA's for the current and future generations. The worksheet 'GA (as % of lifetime income)' reports the net payment as the percentage of the present value of the labor income for the remaining lifetime.

(13) Evaluating sustainability (Sustainability)

The worksheet 'sustainability' reports the generational imbalance, defined as the ratio of the difference in the net payment between the future generations and the age-0 cohorts at the benchmark year at the percentage term, and the magnitude of the increase in the tax burden, proportional to that under the current policy, required to attain the long-run budgetary balance. The worksheet reports the case where the tax burden of the current generations (the future generations) is adjusted, while that of the future generations (the current generations) is maintained at the level under the current policy. It also reports the magnitude of the required adjustment if the tax burden is adjusted for a specific year (2010, 2020, 2030) and thereafter. The year 2010 (2020, 2030) is that of 10 (20, 30) years after the benchmark year. Therefore, you need to adjust the specific year according to your benchmark.
The tax and transfer adjustment refers to the required proportional change in the tax and the transfer, when the same percentage of decrease in the transfer is accompanied with the tax increase.
The worksheet also reports the sustainability gap, which is the ratio of the government gap to the sum of the present value of the GDP after the benchmark year as percentage term.