Value and Consumption Low vs Higher Interest Rates Results Comparison

This is the example vignette for function: **snw_vfi_main_bisec_vec** from the **PrjOptiSNW Package.** This function solves for the V(states) for individuals at lower and higher savings interest rate. Note that welfare improves for all when interest rate goes up for savings in a model where borrowing is not allowed. However, an increase change in the interest rate generates both an income effect (higher resources) and also changes relative price of consumption today vs tomorrow. The change in income increases incentive to consume, the change in relative price depresses incentives to consume today. The combined effect of rising interest rate on savings on consumption/savings differs by the state-space, households might overall consume more or less depending on their state-space.

Solve Model at 4 Percent Interest Rate

Solve the benchmark model at 4 percent savings interest rate.

```
% mp_params = snw_mp_param('default_dense');
mp_params = snw_mp_param('default_docdense');
mp_params('beta') = 0.95;
fl_higher_r = 0.04;
fl_lower_r = 0.02;
mp_params('r') = fl_higher_r;
mp_controls = snw_mp_control('default_test');
mp_controls('bl_print_vfi') = false;
mp_controls('bl_print_vfi_verbose') = false;
mp_controls('bl_timer') = true;
[V_ss_r04,~,cons_ss_r04,~] = snw_vfi_main_bisec_vec(mp_params, mp_controls);
```

```
Completed SNW_VFI_MAIN_BISEC_VEC;SNW_MP_PARAM=default_docdense;SNW_MP_CONTROL=default_test;time=496.1817
```

Solve Model at 2 Percent Interest Rate

Solve the benchmark model at 2 percent savings interest rate.

```
mp_params('r') = fl_lower_r;
mp_controls = snw_mp_control('default_test');
mp_controls('bl_print_vfi') = false;
mp_controls('bl_print_vfi_verbose') = false;
mp_controls('bl_timer') = true;
[V_ss_r02,~,cons_ss_r02,~] = snw_vfi_main_bisec_vec(mp_params, mp_controls);
```

```
Completed SNW_VFI_MAIN_BISEC_VEC;SNW_MP_PARAM=default_docdense;SNW_MP_CONTROL=default_test;time=495.0637
```

Generate Interest Rate Comparison Matrixes

Take the difference between 4 percent and 2 percent savings interest rate results. When interest rates are higher, greater incentive to save, but leads to heterogeneous responses by income and other characteristics, note that this changes both relative prices as well as total resource/budget, so there is both income and price effects that differ in magnitudes depending on the individual's statespace. Welfare does improve for all higher higher r. Welfare is converted to units in fixed life-time consumption.

```
gamma = mp_params('gamma');
mn_V_gain_r = snw_hh_welfare(V_ss_r04, gamma) - snw_hh_welfare(V_ss_r02, gamma);
mn_C_gain_r = cons_ss_r04 - cons_ss_r02;
fl_r_gap = fl_higher_r - fl_lower_r;
```

Dense Param Results Define Frames

Define the matrix dimensions names and dimension vector values. Policy and Value Functions share the same ND dimensional structure.

```
% Grids:
age_grid = 18:100;
agrid = mp_params('agrid')';
eta_H_grid = mp_params('eta_H_grid')';
eta_S_grid = mp_params('eta_S_grid')';
ar_st_eta_HS_grid = string(cellstr([num2str(eta_H_grid', 'hz=%3.2f;'), num2str(eta_S_grid', 'wz
edu_grid = [0,1];
marry_grid = [0,1];
kids_grid = (1:1:mp_params('n_kidsgrid'))';
% NaN(n_jgrid,n_agrid,n_etagrid,n_educgrid,n_marriedgrid,n_kidsgrid);
cl_mp_datasetdesc = {};
cl_mp_datasetdesc{1} = containers.Map({'name', 'labval'}, {'age', age_grid});
cl_mp_datasetdesc{2} = containers.Map({'name', 'labval'}, {'savings', agrid});
cl_mp_datasetdesc{3} = containers.Map({'name', 'labval'}, {'eta', 1:length(eta_H_grid)});
cl_mp_datasetdesc{4} = containers.Map({'name', 'labval'}, {'edu', edu_grid});
cl_mp_datasetdesc{5} = containers.Map({'name', 'labval'}, {'marry', marry_grid});
cl_mp_datasetdesc{6} = containers.Map({'name', 'labval'}, {'kids', kids_grid});
```

Analyze Difference in V and C with Higher and Lower Savings Interest Rate

The difference between V and C with higher and lower r.

```
% Generate some Data
mp_support_graph = containers.Map('KeyType', 'char', 'ValueType', 'any');
mp_support_graph('cl_st_xtitle') = {'Savings States, a'};
mp_support_graph('st_legend_loc') = 'eastoutside';
mp_support_graph('bl_graph_logy') = true; % do not log
mp_support_graph('it_legend_select') = 21; % how many shock legends to show
mp_support_graph('cl_colors') = 'jet';
```

MEAN(MN_V_GAIN(A,Z))

Tabulate value and policies along savings and shocks:

```
% Set
ar_permute = [1,4,5,6,3,2];
% Value Function
st_title = ['MEAN(MN_V_Gain(A,Z)), r_gap=' num2str(fl_r_gap) ];
tb_az_v = ff_summ_nd_array(st_title, mn_V_gain_r, true, ["mean"], 4, 1, cl_mp_datasetdesc, ar_p
```

```
xxx  MEAN(MN_V_Gain(A,Z)), r_gap=0.02  xxxxxxxxxxxxxxxxxxxxxxxxxxx
    group      savings       mean_eta_1     mean_eta_2     mean_eta_3     mean_eta_4     mean_eta_5     mean_eta_6     mean_
    _____    __________      __________     __________     __________     __________     __________     __________     _____

      1              0      4.6652e-05      4.802e-05     4.9487e-05     5.1045e-05     5.2688e-05     5.4417e-05     5.623
      2     0.00051498       4.725e-05     4.8601e-05     5.0052e-05     5.1595e-05     5.3225e-05     5.4941e-05     5.674
      3      0.0041199      5.1273e-05     5.2516e-05     5.3868e-05      5.532e-05     5.6863e-05     5.8496e-05     6.022
      4       0.013905       6.118e-05     6.2221e-05     6.3373e-05     6.4635e-05     6.5996e-05     6.7452e-05     6.900
      5       0.032959      7.7395e-05     7.8196e-05     7.9136e-05     8.0192e-05     8.1347e-05     8.2598e-05     8.394
      6       0.064373      9.9291e-05     9.9974e-05     0.00010079     0.00010171     0.00010271     0.00010381     0.000
```

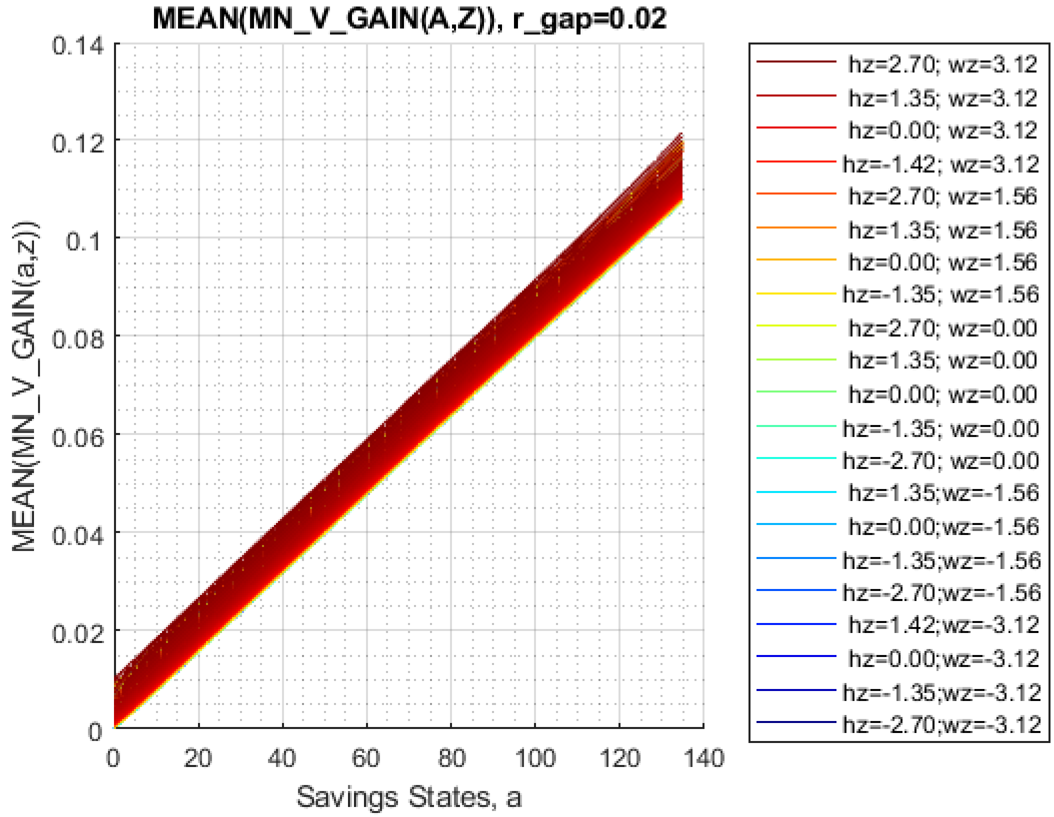
```
% Consumption
st_title = ['MEAN(MN_C_Gain(A,Z)), r_gap=' num2str(fl_r_gap) ];
tb_az_c = ff_summ_nd_array(st_title, mn_C_gain_r, true, ["mean"], 4, 1, cl_mp_datasetdesc, ar_p
```

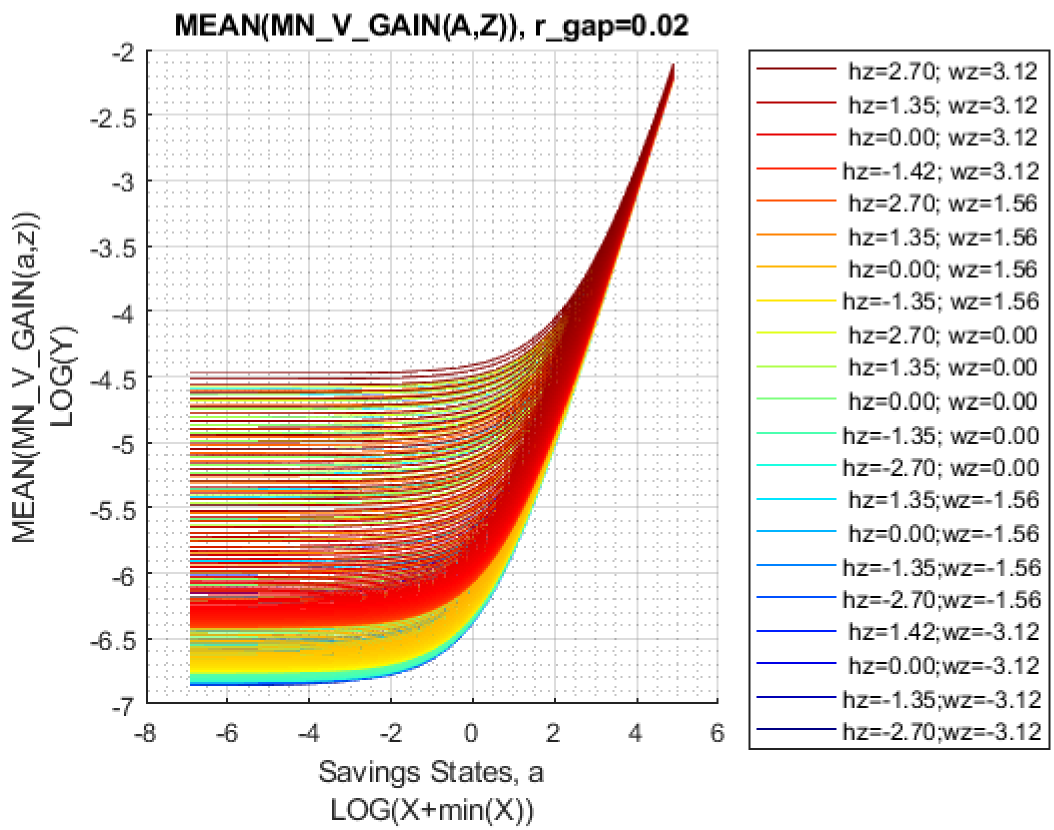
```
xxx  MEAN(MN_C_Gain(A,Z)), r_gap=0.02  xxxxxxxxxxxxxxxxxxxxxxxxxxx
    group      savings       mean_eta_1      mean_eta_2      mean_eta_3      mean_eta_4      mean_eta_5      mean_eta_6
    _____    __________      ___________     ___________     ___________     ___________     ___________     ___________

      1              0               0               0               0               0               0               0
      2     0.00051498      9.0758e-06      9.0577e-06      9.0392e-06      9.0202e-06      9.0007e-06      8.9809e-06
      3      0.0041199      6.9258e-05      5.9037e-05      5.5968e-05       5.437e-05      5.3887e-05      5.3137e-05
      4       0.013905       0.0001131      0.00016511      0.00017196      0.00016519      0.00015748       0.0001458
      5       0.032959      0.00026095      0.00020294       0.0001617      0.00014482      0.00014062      0.00014373
      6       0.064373      0.00022015      0.00011898      5.4936e-05      2.3556e-05      1.5431e-05      2.7756e-05
```

Graph Mean Values:

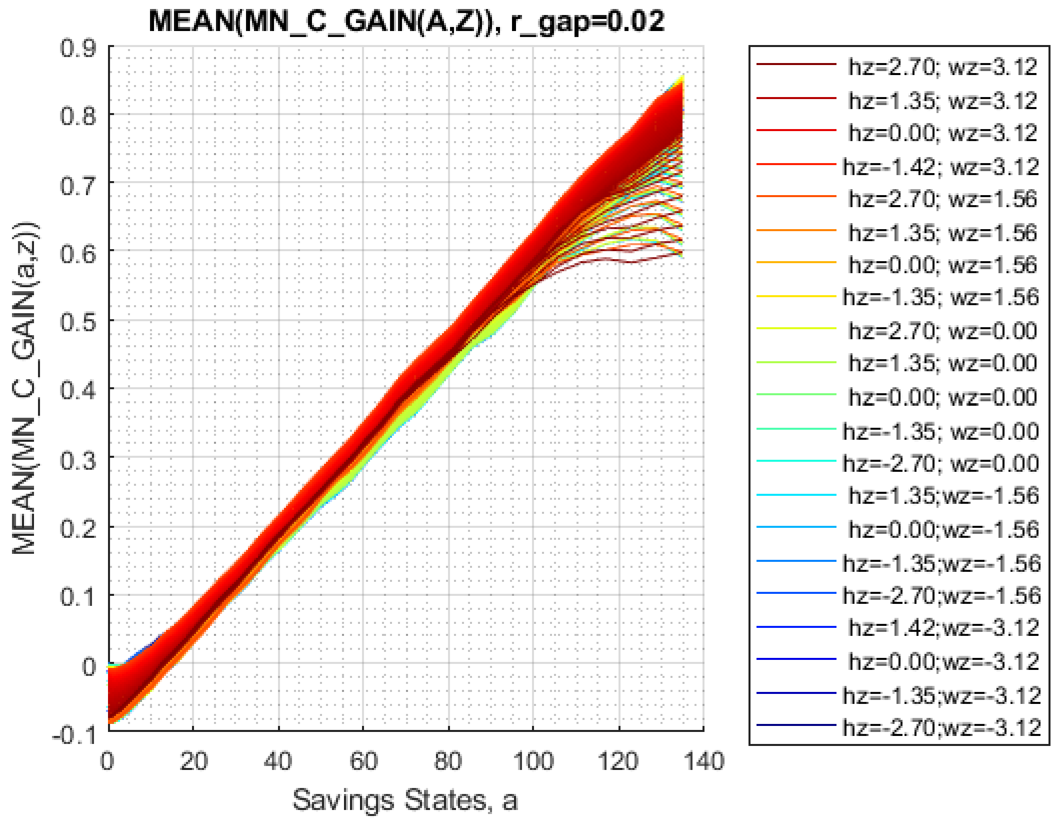
```
st_title = ['MEAN(MN\_V\_GAIN(A,Z)), r\_gap=' num2str(fl_r_gap)  ''];
mp_support_graph('cl_st_graph_title') = {st_title};
mp_support_graph('cl_st_ytitle') = {'MEAN(MN\_V\_GAIN(a,z))'};
ff_graph_grid((tb_az_v{1:end, 3:end})', ar_st_eta_HS_grid, agrid, mp_support_graph);
```

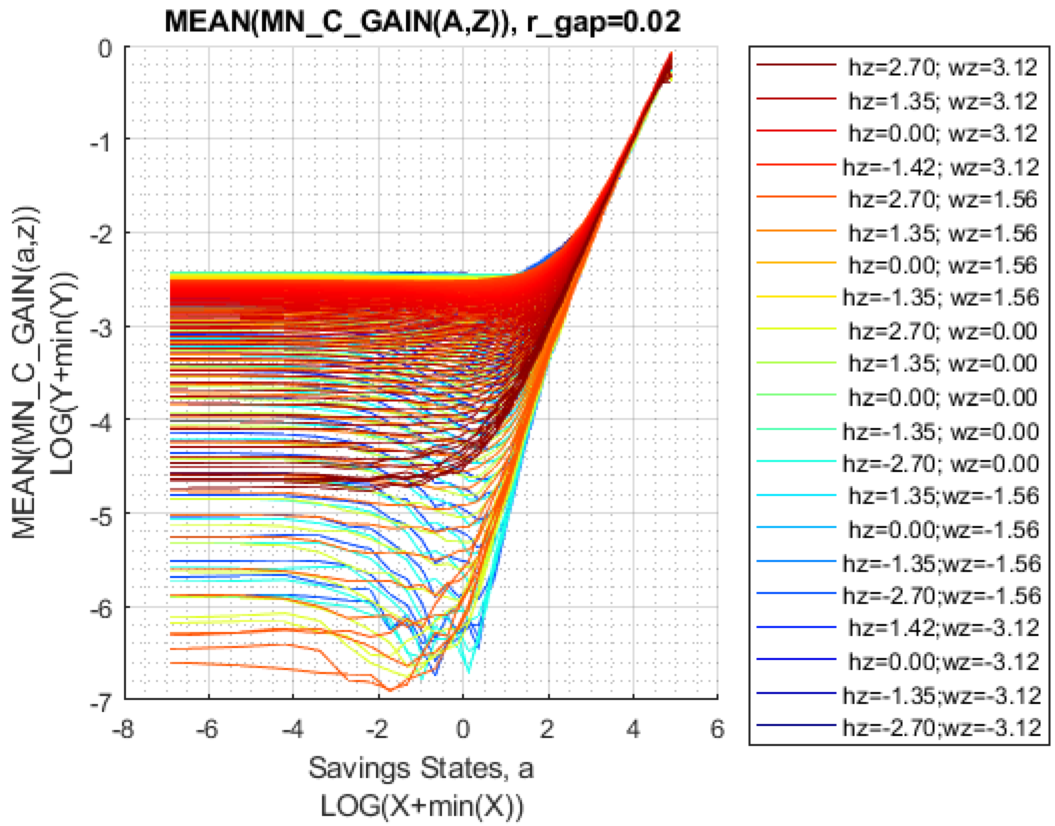




Graph Mean Consumption:

```
st_title = ['MEAN(MN\_C\_GAIN(A,Z)), r\_gap=' num2str(fl_r_gap)  ''];
mp_support_graph('cl_st_graph_title') = {st_title};
mp_support_graph('cl_st_ytitle') = {'MEAN(MN\_C\_GAIN(a,z))'};
ff_graph_grid((tb_az_c{1:end, 3:end})', ar_st_eta_HS_grid, agrid, mp_support_graph);
```





Analyze Kids and Marriage and Age

Aggregating over education, savings, and shocks, what are the differential effects of Marriage and Age.

```
% Generate some Data
mp_support_graph = containers.Map('KeyType', 'char', 'ValueType', 'any');
ar_row_grid = [...
    "k0M0", "K1M0", "K2M0", "K3M0", "K4M0", ...
    "k0M1", "K1M1", "K2M1", "K3M1", "K4M1"];
mp_support_graph('cl_st_xtitle') = {'Age'};
mp_support_graph('st_legend_loc') = 'best';
mp_support_graph('bl_graph_logy') = true; % do not log
mp_support_graph('st_rounding') = '6.2f'; % format shock legend
mp_support_graph('cl_scatter_shapes') = {...
    'o', 'd' ,'s', 'x', '*', ...
    'o', 'd', 's', 'x', '*'};
mp_support_graph('cl_colors') = {...
    'red', 'red', 'red', 'red', 'red'...
    'blue', 'blue', 'blue', 'blue', 'blue'};
```

MEAN(VAL(KM,J)), MEAN(AP(KM,J)), MEAN(C(KM,J))

Tabulate value and policies:

```
% Set
% NaN(n_jgrid,n_agrid,n_etagrid,n_educgrid,n_marriedgrid,n_kidsgrid);
ar_permute = [2,3,4,1,6,5];
% Value Function
```

```
st_title = ['MEAN(MN_V_Gain(KM,J)), r_gap=' num2str(fl_r_gap) ];
tb_az_v = ff_summ_nd_array(st_title, mn_V_gain_r, true, ["mean"], 3, 1, cl_mp_datasetdesc, ar_p
```

```
xxx  MEAN(MN_V_Gain(KM,J)), r_gap=0.02  xxxxxxxxxxxxxxxxxxxxxxxxxxx
    group    kids    marry    mean_age_18    mean_age_19    mean_age_20    mean_age_21    mean_age_22    mean_age_23
    _____    ____    _____    ___________    ___________    ___________    ___________    ___________    __________

      1        1       0        0.015087       0.015546       0.016026        0.01653       0.017025       0.017508
      2        2       0        0.011707       0.012061       0.012444       0.012858       0.013278       0.013703
      3        3       0        0.010499       0.010777       0.011081       0.011412       0.011749       0.012091
      4        4       0       0.0094894      0.0097107      0.0099547       0.010224         0.0105       0.010781
      5        5       0         0.00886      0.0090319      0.0092234      0.0094371      0.0096558      0.0098787
      6        1       1        0.010229       0.010593       0.010984       0.011405       0.011831       0.012259
      7        2       1        0.008528      0.0087978      0.0090932      0.0094182      0.0097531       0.010096
      8        3       1       0.0079012      0.0081252      0.0083716      0.0086439      0.0089244      0.0092117
      9        4       1       0.0073246      0.0075062      0.0077075      0.0079319      0.0081637      0.0084017
     10        5       1         0.00696      0.0071075      0.0072717      0.0074553       0.007644      0.0078372
```

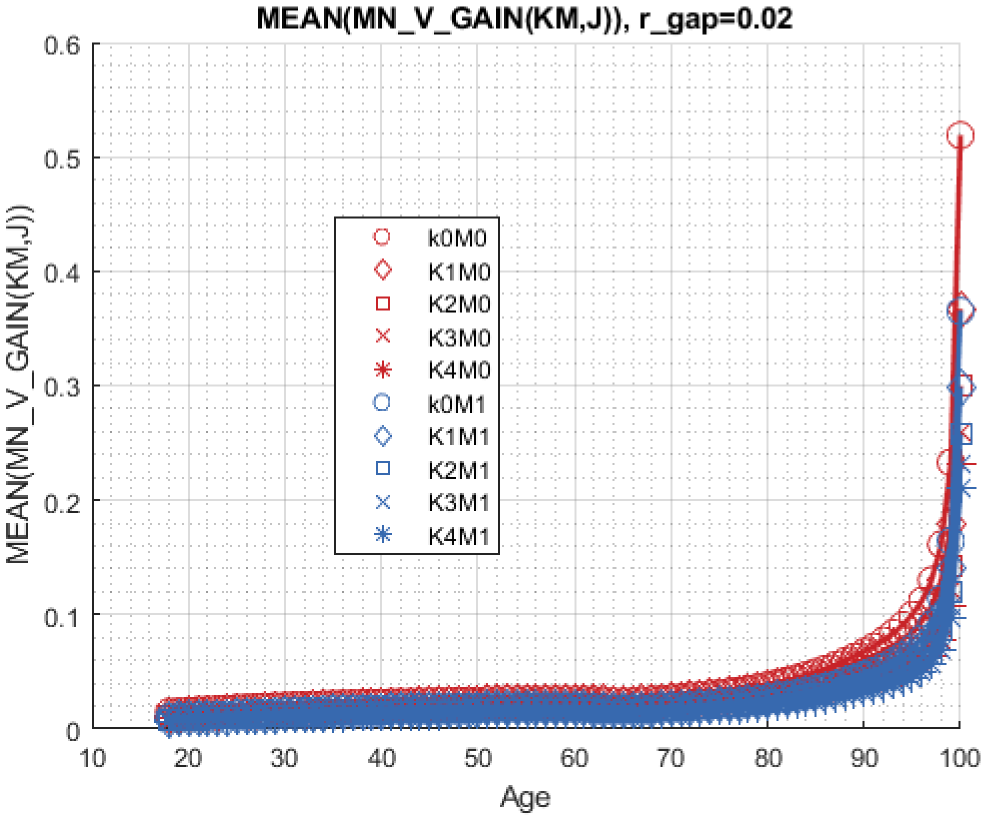
```
% Consumption Function
st_title = ['MEAN(MN_C_Gain(KM,J)), r_gap=' num2str(fl_r_gap) ];
tb_az_c = ff_summ_nd_array(st_title, mn_C_gain_r, true, ["mean"], 3, 1, cl_mp_datasetdesc, ar_p
```

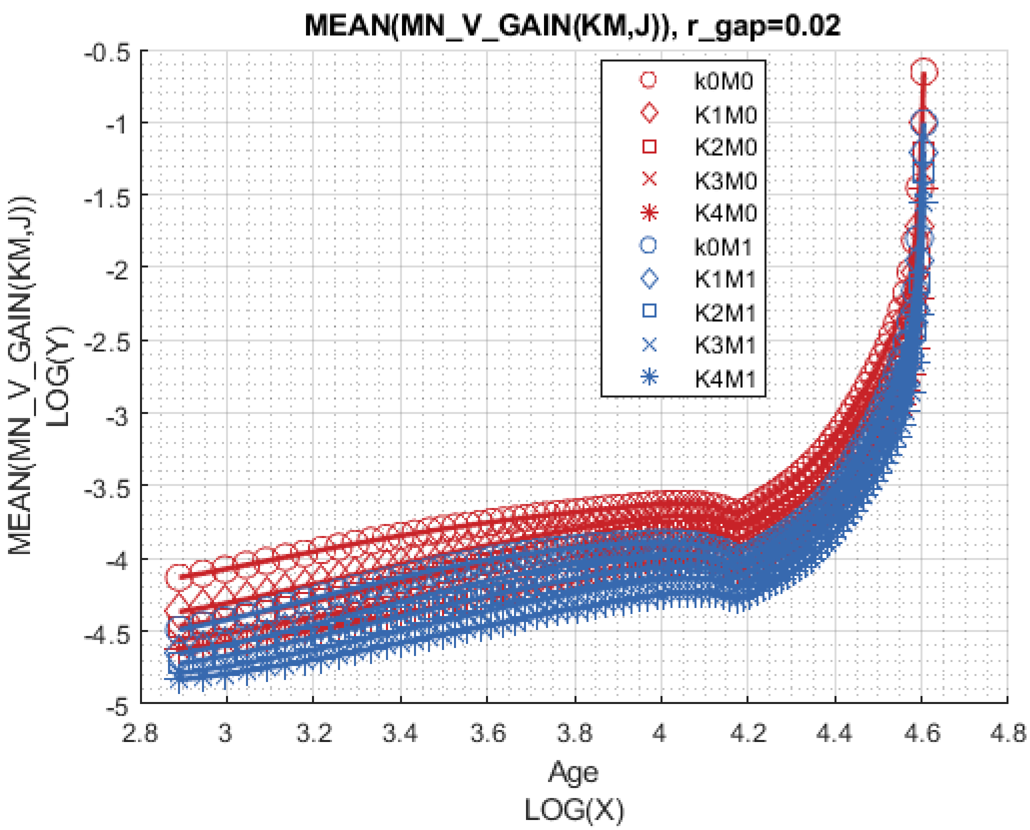
```
xxx  MEAN(MN_C_Gain(KM,J)), r_gap=0.02  xxxxxxxxxxxxxxxxxxxxxxxxxxx
    group    kids    marry    mean_age_18    mean_age_19    mean_age_20    mean_age_21    mean_age_22    mean_age_23
    _____    ____    _____    ___________    ___________    ___________    ___________    ___________    __________

      1        1       0        0.055699       0.056856       0.058874       0.061289       0.064119       0.067235
      2        2       0        0.051038       0.052145       0.054007       0.055436       0.057546       0.060312
      3        3       0        0.050801        0.05338       0.054644       0.055147        0.05643       0.058389
      4        4       0        0.050711       0.052919       0.054103       0.053992        0.05454       0.055872
      5        5       0        0.052196       0.053297       0.054608       0.053912       0.053811       0.054449
      6        1       1       -0.022203      -0.022187      -0.021707      -0.021466      -0.020507      -0.018751
      7        2       1       -0.019706      -0.020509      -0.020942       -0.02173      -0.021723      -0.020839
      8        3       1       -0.016291      -0.017215      -0.017899      -0.019714       -0.02062      -0.020552
      9        4       1       -0.013267      -0.013589      -0.013895      -0.016006      -0.017459      -0.018261
     10        5       1         -0.0131      -0.012701      -0.011796      -0.013633      -0.014917      -0.015545
```

Graph Mean Values:

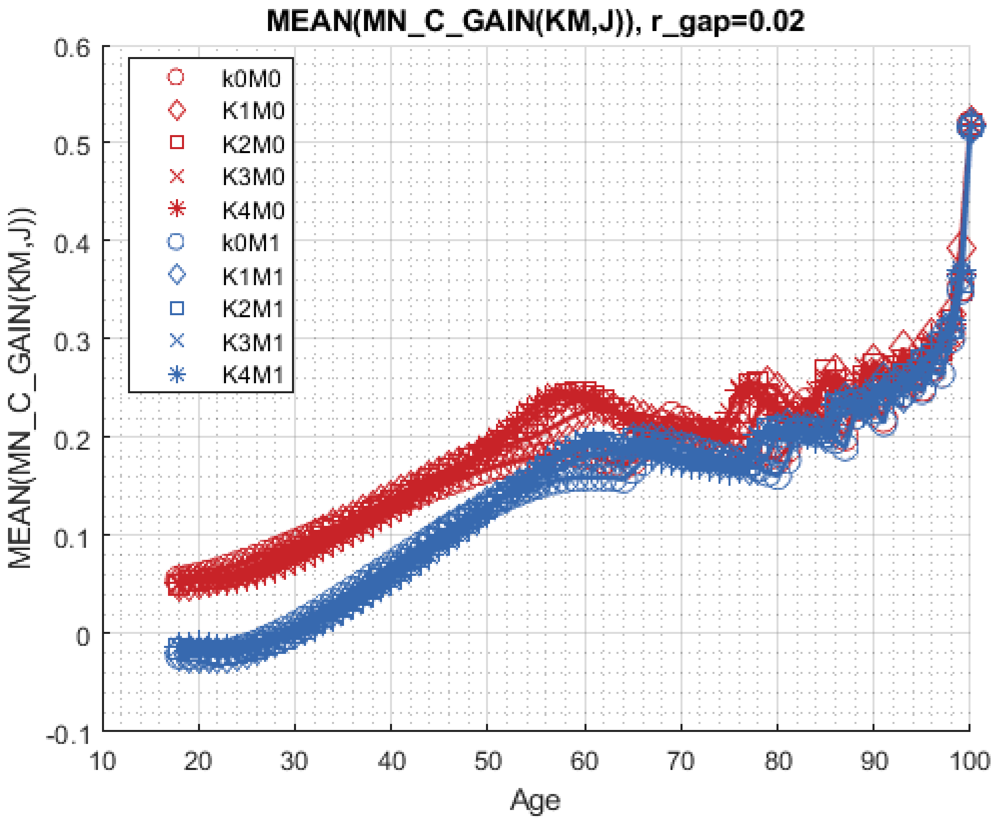
```
st_title = ['MEAN(MN\_V\_GAIN(KM,J)), r\_gap=' num2str(fl_r_gap)  ''];
mp_support_graph('cl_st_graph_title') = {st_title};
mp_support_graph('cl_st_ytitle') = {'MEAN(MN\_V\_GAIN(KM,J))'};
ff_graph_grid((tb_az_v{1:end, 4:end}), ar_row_grid, age_grid, mp_support_graph);
```

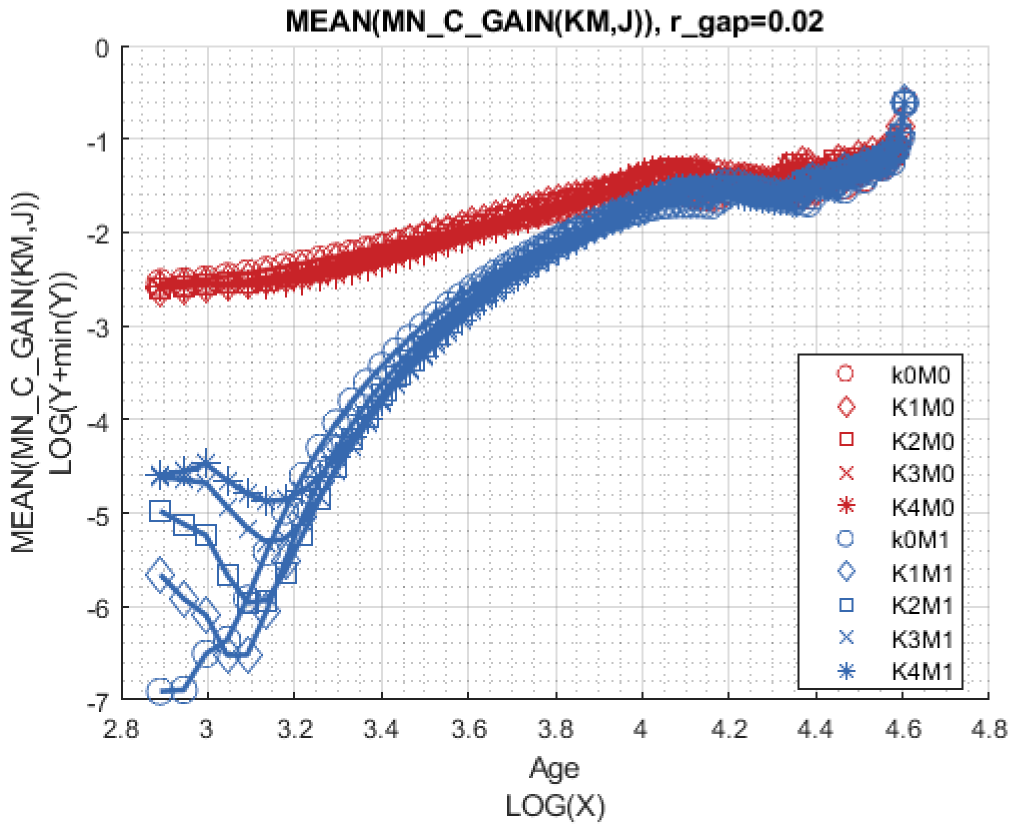




Graph Mean Consumption:

```
st_title = ['MEAN(MN\_C\_GAIN(KM,J)), r\_gap=' num2str(fl_r_gap)  ''];
mp_support_graph('cl_st_graph_title') = {st_title};
mp_support_graph('cl_st_ytitle') = {'MEAN(MN\_C\_GAIN(KM,J))'};
ff_graph_grid((tb_az_c{1:end, 4:end}), ar_row_grid, age_grid, mp_support_graph);
```





Analyze Education and Marriage

Aggregating over education, savings, and shocks, what are the differential effects of Marriage and Age.

```
% Generate some Data
mp_support_graph = containers.Map('KeyType', 'char', 'ValueType', 'any');
ar_row_grid = ["E0M0", "E1M0", "E0M1", "E1M1"];
mp_support_graph('cl_st_xtitle') = {'Age'};
mp_support_graph('st_legend_loc') = 'best';
mp_support_graph('bl_graph_logy') = true; % do not log
mp_support_graph('st_rounding') = '6.2f'; % format shock legend
mp_support_graph('cl_scatter_shapes') = {'*', 'p', '*','p' };
mp_support_graph('cl_colors') = {'red', 'red', 'blue', 'blue'};
```

MEAN(VAL(EM,J)), MEAN(AP(EM,J)), MEAN(C(EM,J))

Tabulate value and policies:

```
% Set
% NaN(n_jgrid,n_agrid,n_etagrid,n_educgrid,n_marriedgrid,n_kidsgrid);
ar_permute = [2,3,6,1,4,5];
% Value Function
st_title = ['MEAN(MN_V_Gain(EM,J)), r_gap=' num2str(fl_r_gap) ];
tb_az_v = ff_summ_nd_array(st_title, mn_V_gain_r, true, ["mean"], 3, 1, cl_mp_datasetdesc, ar_p
```

```
xxx  MEAN(MN_V_Gain(EM,J)), r_gap=0.02  xxxxxxxxxxxxxxxxxxxxxxxxxxx
    group    edu    marry    mean_age_18    mean_age_19    mean_age_20    mean_age_21    mean_age_22    mean_age_23
    _____    ___    _____    ___________    ___________    ___________    ___________    ___________    ___________
```

1	0	0	0.011474	0.011736	0.012012	0.012305	0.012599	0.012892
2	1	0	0.010783	0.011115	0.011479	0.011879	0.012285	0.012692
3	0	1	0.0084099	0.0086195	0.0088444	0.0090861	0.0093328	0.0095836
4	1	1	0.0079671	0.0082324	0.0085268	0.0088556	0.0091936	0.0095387

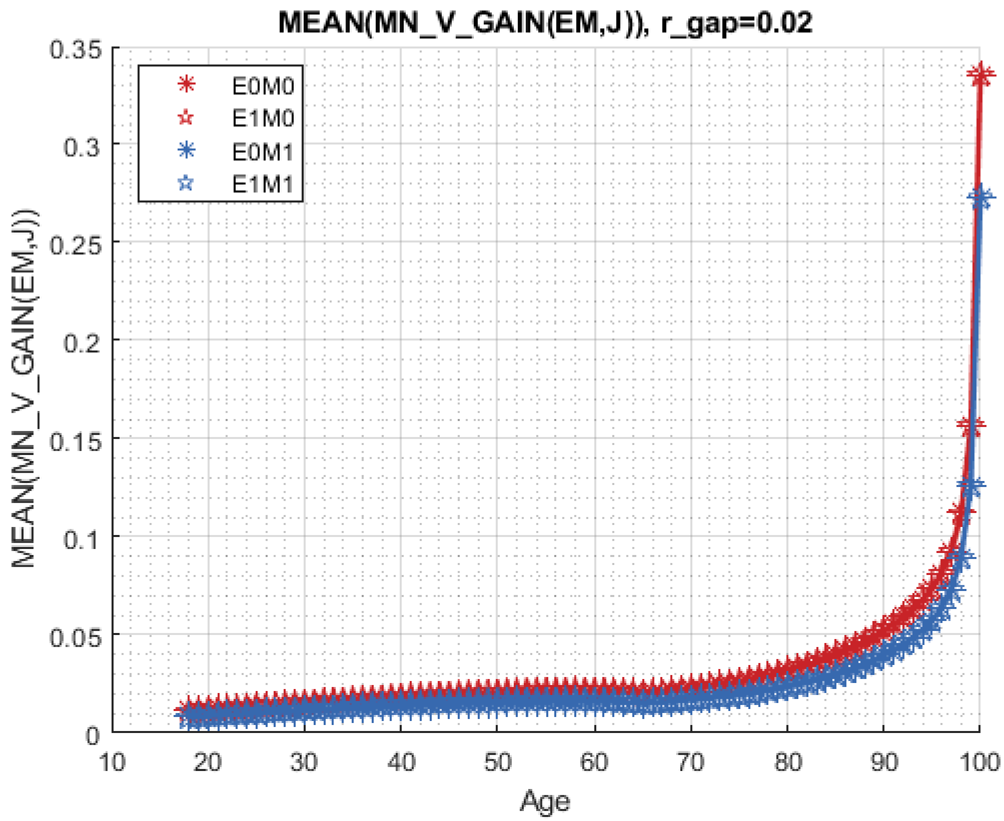
```
% Consumption
st_title = ['MEAN(MN_C_Gain(EM,J)), r_gap=' num2str(fl_r_gap) ];
tb_az_c = ff_summ_nd_array(st_title, mn_C_gain_r, true, ["mean"], 3, 1, cl_mp_datasetdesc, ar_p
```

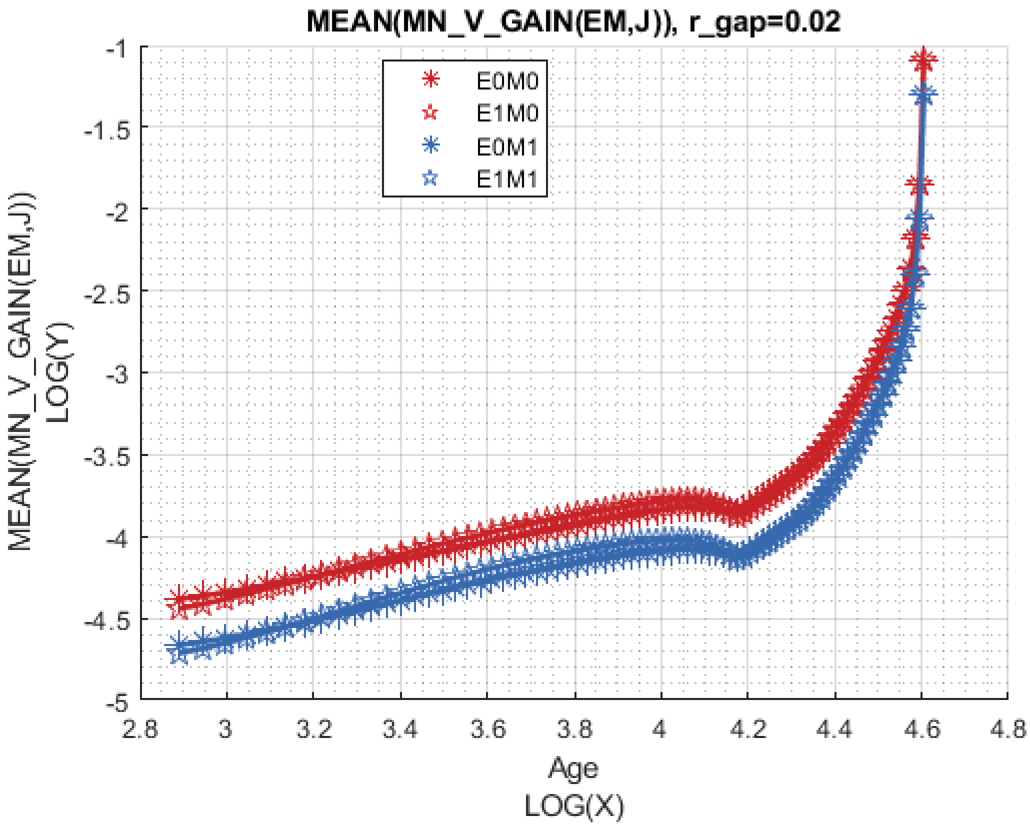
xxx MEAN(MN_C_Gain(EM,J)), r_gap=0.02 xxxxxxxxxxxxxxxxxxxxxxxxxx

group	edu	marry	mean_age_18	mean_age_19	mean_age_20	mean_age_21	mean_age_22	mean_age_23
1	0	0	0.06916	0.070507	0.072258	0.07446	0.076888	0.07952
2	1	0	0.035018	0.036932	0.038237	0.03745	0.037691	0.038982
3	0	1	-0.0014877	-0.001014	-0.00023405	0.00057466	0.0018134	0.0035145
4	1	1	-0.032339	-0.033466	-0.034261	-0.037595	-0.039904	-0.041093

Graph Mean Values:

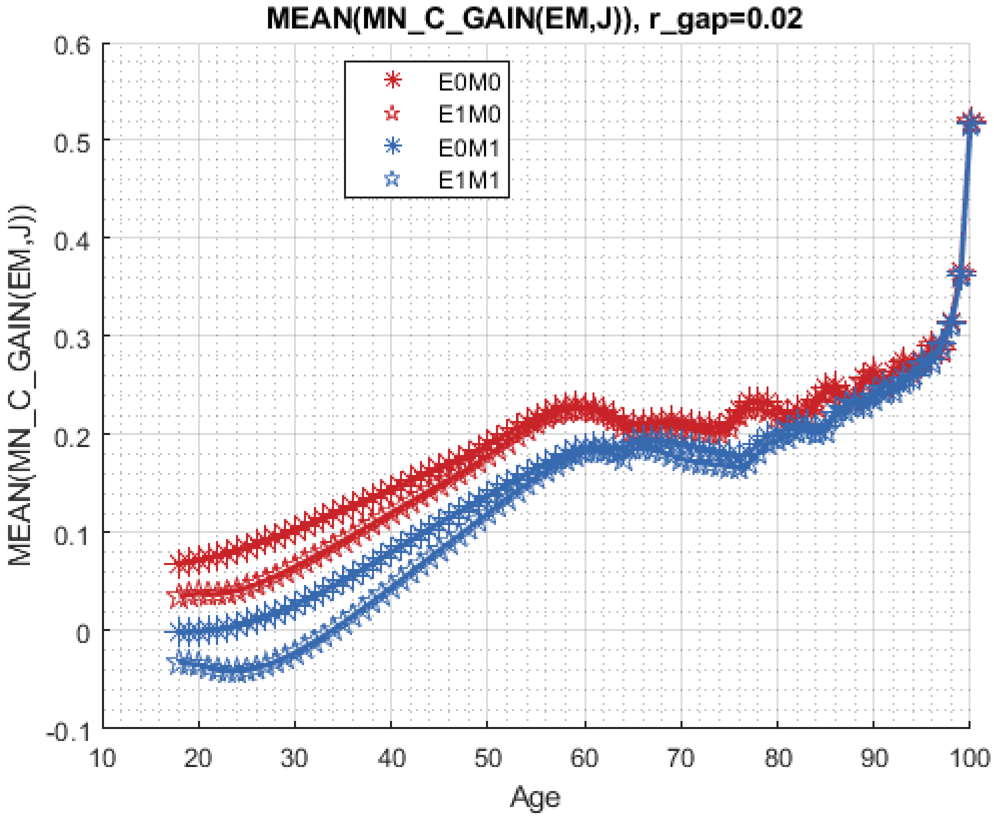
```
st_title = ['MEAN(MN\_V\_GAIN(EM,J)), r\_gap=' num2str(fl_r_gap)  ''];
mp_support_graph('cl_st_graph_title') = {st_title};
mp_support_graph('cl_st_ytitle') = {'MEAN(MN\_V\_GAIN(EM,J))'};
ff_graph_grid((tb_az_v{1:end, 4:end}), ar_row_grid, age_grid, mp_support_graph);
```

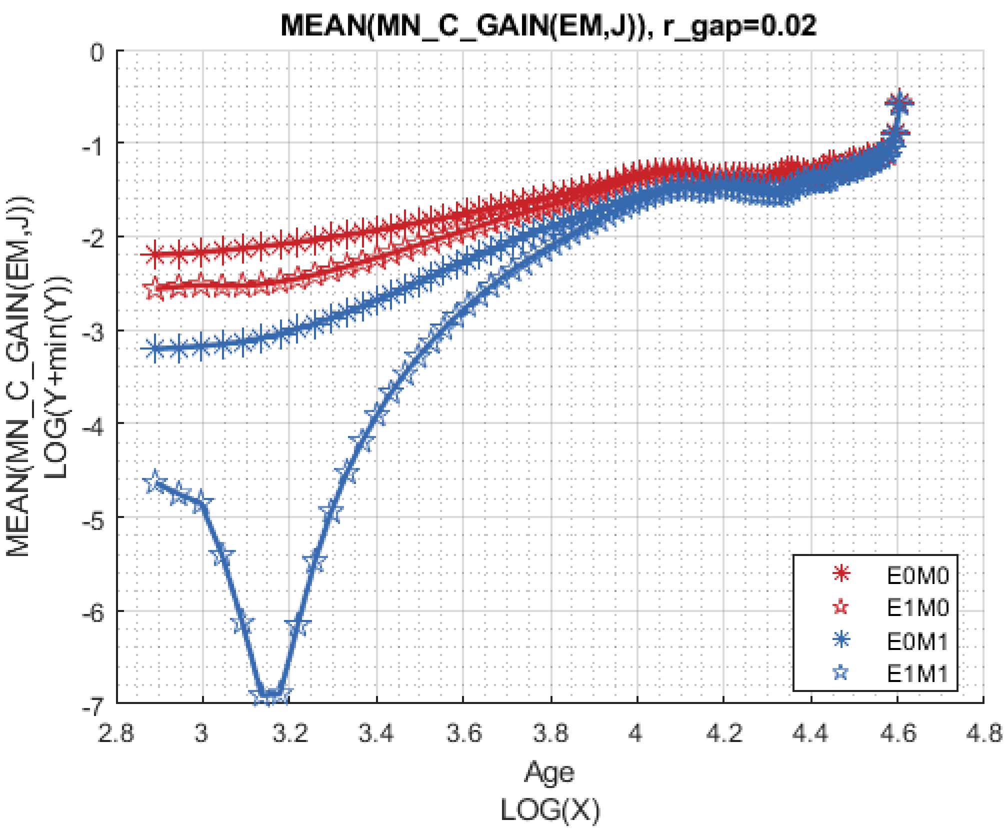




Graph Mean Consumption:

```
st_title = ['MEAN(MN\_C\_GAIN(EM,J)), r\_gap=' num2str(fl_r_gap)  ''];
mp_support_graph('cl_st_graph_title') = {st_title};
mp_support_graph('cl_st_ytitle') = {'MEAN(MN\_C\_GAIN(EM,J))'};
ff_graph_grid((tb_az_c{1:end, 4:end}), ar_row_grid, age_grid, mp_support_graph);
```


MEAN(MN_C_GAIN(EM,J)), r_gap=0.02
E0M0
E1M0
E0M1
E1M1
MEAN(MN_C_GAIN(EM,J))
Age


MEAN(MN_C_GAIN(EM,J)), r_gap=0.02
E0M0
E1M0
E0M1
E1M1
MEAN(MN_C_GAIN(EM,J))
LOG(Y+min(Y))
Age
LOG(X)