

FF_OPTIM_MZOOM_SAVEZRONE Derivative Multisection

back to [Fan's Intro Math for Econ](#), [Matlab Examples](#), or [Dynamic Asset Repositories](#)

This is the example vignette for function: [ff_optim_mzoom_savezrone](#) from the [MEconTools Package](#). This functions solves for optimal savings/borrowing level given an anonymous function that provides the utility (not derivative) of a intertemporal savings problem. This is a vectorized function solves for multiple state-space elements at the same time. The function allows for controls of iteration counts, the number of evaluations per iteration, and how much to "zoom-in" for each iteration around the last iteration's maximum/optimal choice.

Note that if first order conditions are available this method should not be used, but [ff_optim_mlsec_savezrone](#) should be used. [ff_optim_mlsec_savezrone](#) relies on bisection. In the first example below more [it_mzoom_jnt_pnts](#) values are needed to achieve the same precision than under [ff_optim_mlsec_savezrone](#). However, increasing [it_mzoom_jnt_pnts](#) might not expensive given vectorization, should increase time cost linearly in generally. MZOOM is much more robust than bisection based methods. And by increasing the number of points evaluated per iteration, in limited number of iterations, the approximately exact optimal savings choice can be found.

The vectorized zooming savings problem rely on this function to solve for optimal savings choices:

- States Grid + Approximate Continuous Exact Savings (zoom) as Share of Cash-on-Hand **Vectorized**:
[ff_vfi_az_zoom_vec](#), precision and speed

Test FF_OPTIM_MZOOM_SAVEZRONE One Individual

Bisection for savings choice at one state:

```
% Generate the state-space and function
[fl_z1, fl_z2, fl_r, fl_beta] = deal(0.4730, 0.6252, 0.0839, 0.7365);
% ffi_intertemporal_max is a function in ff_optim_mlsec_savezrone for testing
fc_util = @(x) ffi_intertemporal_util(x, fl_z1, fl_z2, fl_r, fl_beta);
% Call Function
bl_verbose = false;
bl_timer = true;
% optimally borrowing given the parameters here
mp_mzoom_ctrlinfo = containers.Map('KeyType','char','ValueType','any');
mp_mzoom_ctrlinfo('it_mzoom_jnt_pnts') = 15;
mp_mzoom_ctrlinfo('it_mzoom_max_iter') = 10;
mp_mzoom_ctrlinfo('it_mzoom_zm_ratio') = 0.25;
[fl_opti_save_frac, fl_opti_save_level] = ...
    ff_optim_mzoom_savezrone(fc_util, bl_verbose, bl_timer, mp_mzoom_ctrlinfo)
```

```
Elapsed time is 0.011586 seconds.
fl_opti_save_frac = 0.4241
fl_opti_save_level = -0.1316
```

Test FF_OPTIM_MZOOM_SAVEZRONE 4 Individuals 3 Iterations 50 Points Per Iteration

5 grid points per iteration, and 5 iterations.

```

% Generate the state-space and function
rng(123);
it_draws = 4; % must be even number
ar_z1 = exp(rand([it_draws,1])*3-1.5);
ar_z2 = exp(rand([it_draws,1])*3-1.5);
ar_r = (rand(it_draws,1)*10.0);
ar_beta = [rand(round(it_draws/2),1)*0.9+0.1; rand(round(it_draws/2),1)*0.9+1];
fc_util = @(x) ffi_intertemporal_util(x, ar_z1, ar_z2, ar_r, ar_beta);
% Call Function
bl_verbose = true;
bl_timer = true;
mp_mzoom_ctrlinfo = containers.Map('KeyType','char','ValueType','any');
mp_mzoom_ctrlinfo('it_mzoom_jnt_pnts') = 50;
mp_mzoom_ctrlinfo('it_mzoom_max_iter') = 3;
mp_mzoom_ctrlinfo('it_mzoom_zm_ratio') = 0;
[fl_opti_save_frac, fl_opti_save_level] = ...
    ff_optim_mzoom_savezrone(fc_util, bl_verbose, bl_timer, mp_mzoom_ctrlinfo);

```

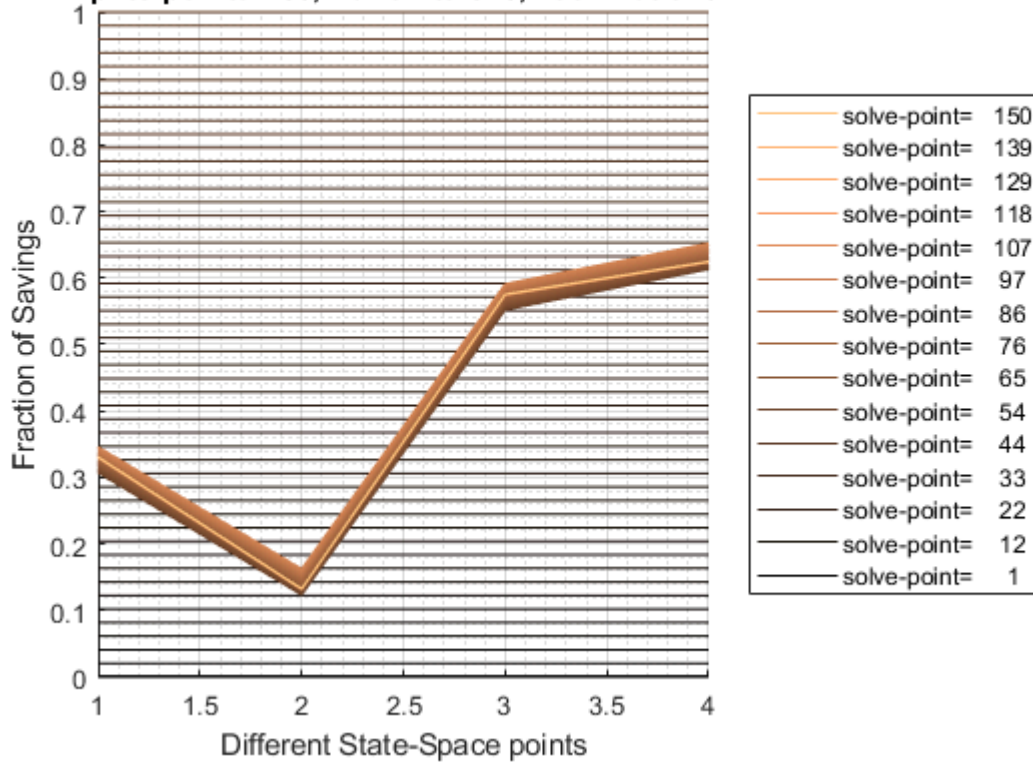
| iter | cl_row_names_a | Var1 | Var2 | Var3 | Var4 |
|------|----------------|----------|----------|----------|----------|
| 1 | "point=1" | 1e-05 | 1e-05 | 1e-05 | 1e-05 |
| 1 | "point=2" | 0.020418 | 0.020418 | 0.020418 | 0.020418 |
| 1 | "point=3" | 0.040826 | 0.040826 | 0.040826 | 0.040826 |
| 1 | "point=4" | 0.061233 | 0.061233 | 0.061233 | 0.061233 |
| 1 | "point=5" | 0.081641 | 0.081641 | 0.081641 | 0.081641 |
| 1 | "point=6" | 0.10205 | 0.10205 | 0.10205 | 0.10205 |
| 1 | "point=7" | 0.12246 | 0.12246 | 0.12246 | 0.12246 |
| 1 | "point=8" | 0.14286 | 0.14286 | 0.14286 | 0.14286 |
| 1 | "point=9" | 0.16327 | 0.16327 | 0.16327 | 0.16327 |
| 1 | "point=10" | 0.18368 | 0.18368 | 0.18368 | 0.18368 |
| 1 | "point=11" | 0.20409 | 0.20409 | 0.20409 | 0.20409 |
| 1 | "point=12" | 0.2245 | 0.2245 | 0.2245 | 0.2245 |
| 1 | "point=13" | 0.2449 | 0.2449 | 0.2449 | 0.2449 |
| 1 | "point=14" | 0.26531 | 0.26531 | 0.26531 | 0.26531 |
| 1 | "point=15" | 0.28572 | 0.28572 | 0.28572 | 0.28572 |
| 1 | "point=16" | 0.30613 | 0.30613 | 0.30613 | 0.30613 |
| 1 | "point=17" | 0.32653 | 0.32653 | 0.32653 | 0.32653 |
| 1 | "point=18" | 0.34694 | 0.34694 | 0.34694 | 0.34694 |
| 1 | "point=19" | 0.36735 | 0.36735 | 0.36735 | 0.36735 |
| 1 | "point=20" | 0.38776 | 0.38776 | 0.38776 | 0.38776 |
| 1 | "point=21" | 0.40817 | 0.40817 | 0.40817 | 0.40817 |
| 1 | "point=22" | 0.42857 | 0.42857 | 0.42857 | 0.42857 |
| 1 | "point=23" | 0.44898 | 0.44898 | 0.44898 | 0.44898 |
| 1 | "point=24" | 0.46939 | 0.46939 | 0.46939 | 0.46939 |
| 1 | "point=25" | 0.4898 | 0.4898 | 0.4898 | 0.4898 |
| 1 | "point=26" | 0.5102 | 0.5102 | 0.5102 | 0.5102 |
| 1 | "point=27" | 0.53061 | 0.53061 | 0.53061 | 0.53061 |
| 1 | "point=28" | 0.55102 | 0.55102 | 0.55102 | 0.55102 |
| 1 | "point=29" | 0.57143 | 0.57143 | 0.57143 | 0.57143 |
| 1 | "point=30" | 0.59183 | 0.59183 | 0.59183 | 0.59183 |
| 1 | "point=31" | 0.61224 | 0.61224 | 0.61224 | 0.61224 |
| 1 | "point=32" | 0.63265 | 0.63265 | 0.63265 | 0.63265 |
| 1 | "point=33" | 0.65306 | 0.65306 | 0.65306 | 0.65306 |
| 1 | "point=34" | 0.67347 | 0.67347 | 0.67347 | 0.67347 |
| 1 | "point=35" | 0.69387 | 0.69387 | 0.69387 | 0.69387 |
| 1 | "point=36" | 0.71428 | 0.71428 | 0.71428 | 0.71428 |
| 1 | "point=37" | 0.73469 | 0.73469 | 0.73469 | 0.73469 |
| 1 | "point=38" | 0.7551 | 0.7551 | 0.7551 | 0.7551 |
| 1 | "point=39" | 0.7755 | 0.7755 | 0.7755 | 0.7755 |
| 1 | "point=40" | 0.79591 | 0.79591 | 0.79591 | 0.79591 |

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|---|------------|---------|---------|---------|---------|
| 1 | "point=41" | 0.81632 | 0.81632 | 0.81632 | 0.81632 |
| 1 | "point=42" | 0.83673 | 0.83673 | 0.83673 | 0.83673 |
| 1 | "point=43" | 0.85714 | 0.85714 | 0.85714 | 0.85714 |
| 1 | "point=44" | 0.87754 | 0.87754 | 0.87754 | 0.87754 |
| 1 | "point=45" | 0.89795 | 0.89795 | 0.89795 | 0.89795 |
| 1 | "point=46" | 0.91836 | 0.91836 | 0.91836 | 0.91836 |
| 1 | "point=47" | 0.93877 | 0.93877 | 0.93877 | 0.93877 |
| 1 | "point=48" | 0.95917 | 0.95917 | 0.95917 | 0.95917 |
| 1 | "point=49" | 0.97958 | 0.97958 | 0.97958 | 0.97958 |
| 1 | "point=50" | 0.99999 | 0.99999 | 0.99999 | 0.99999 |
| 2 | "point=1" | 0.30693 | 0.12326 | 0.55182 | 0.61304 |
| 2 | "point=2" | 0.30773 | 0.12406 | 0.55262 | 0.61384 |
| 2 | "point=3" | 0.30853 | 0.12486 | 0.55342 | 0.61464 |
| 2 | "point=4" | 0.30933 | 0.12566 | 0.55422 | 0.61544 |
| 2 | "point=5" | 0.31013 | 0.12646 | 0.55502 | 0.61624 |
| 2 | "point=6" | 0.31093 | 0.12726 | 0.55582 | 0.61704 |
| 2 | "point=7" | 0.31173 | 0.12806 | 0.55662 | 0.61784 |
| 2 | "point=8" | 0.31253 | 0.12886 | 0.55742 | 0.61865 |
| 2 | "point=9" | 0.31333 | 0.12966 | 0.55822 | 0.61945 |
| 2 | "point=10" | 0.31413 | 0.13046 | 0.55902 | 0.62025 |
| 2 | "point=11" | 0.31493 | 0.13126 | 0.55982 | 0.62105 |
| 2 | "point=12" | 0.31573 | 0.13206 | 0.56062 | 0.62185 |
| 2 | "point=13" | 0.31653 | 0.13286 | 0.56142 | 0.62265 |
| 2 | "point=14" | 0.31733 | 0.13366 | 0.56222 | 0.62345 |
| 2 | "point=15" | 0.31813 | 0.13446 | 0.56302 | 0.62425 |
| 2 | "point=16" | 0.31893 | 0.13526 | 0.56382 | 0.62505 |
| 2 | "point=17" | 0.31973 | 0.13606 | 0.56462 | 0.62585 |
| 2 | "point=18" | 0.32053 | 0.13686 | 0.56542 | 0.62665 |
| 2 | "point=19" | 0.32133 | 0.13766 | 0.56623 | 0.62745 |
| 2 | "point=20" | 0.32213 | 0.13846 | 0.56703 | 0.62825 |
| 2 | "point=21" | 0.32293 | 0.13926 | 0.56783 | 0.62905 |
| 2 | "point=22" | 0.32373 | 0.14006 | 0.56863 | 0.62985 |
| 2 | "point=23" | 0.32453 | 0.14086 | 0.56943 | 0.63065 |
| 2 | "point=24" | 0.32533 | 0.14166 | 0.57023 | 0.63145 |
| 2 | "point=25" | 0.32613 | 0.14246 | 0.57103 | 0.63225 |
| 2 | "point=26" | 0.32693 | 0.14326 | 0.57183 | 0.63305 |
| 2 | "point=27" | 0.32773 | 0.14406 | 0.57263 | 0.63385 |
| 2 | "point=28" | 0.32853 | 0.14487 | 0.57343 | 0.63465 |
| 2 | "point=29" | 0.32934 | 0.14567 | 0.57423 | 0.63545 |
| 2 | "point=30" | 0.33014 | 0.14647 | 0.57503 | 0.63625 |
| 2 | "point=31" | 0.33094 | 0.14727 | 0.57583 | 0.63705 |
| 2 | "point=32" | 0.33174 | 0.14807 | 0.57663 | 0.63785 |
| 2 | "point=33" | 0.33254 | 0.14887 | 0.57743 | 0.63865 |
| 2 | "point=34" | 0.33334 | 0.14967 | 0.57823 | 0.63945 |
| 2 | "point=35" | 0.33414 | 0.15047 | 0.57903 | 0.64025 |
| 2 | "point=36" | 0.33494 | 0.15127 | 0.57983 | 0.64105 |
| 2 | "point=37" | 0.33574 | 0.15207 | 0.58063 | 0.64185 |
| 2 | "point=38" | 0.33654 | 0.15287 | 0.58143 | 0.64265 |
| 2 | "point=39" | 0.33734 | 0.15367 | 0.58223 | 0.64345 |
| 2 | "point=40" | 0.33814 | 0.15447 | 0.58303 | 0.64425 |
| 2 | "point=41" | 0.33894 | 0.15527 | 0.58383 | 0.64506 |
| 2 | "point=42" | 0.33974 | 0.15607 | 0.58463 | 0.64586 |
| 2 | "point=43" | 0.34054 | 0.15687 | 0.58543 | 0.64666 |
| 2 | "point=44" | 0.34134 | 0.15767 | 0.58623 | 0.64746 |
| 2 | "point=45" | 0.34214 | 0.15847 | 0.58703 | 0.64826 |
| 2 | "point=46" | 0.34294 | 0.15927 | 0.58783 | 0.64906 |
| 2 | "point=47" | 0.34374 | 0.16007 | 0.58863 | 0.64986 |
| 2 | "point=48" | 0.34454 | 0.16087 | 0.58943 | 0.65066 |
| 2 | "point=49" | 0.34534 | 0.16167 | 0.59023 | 0.65146 |
| 2 | "point=50" | 0.34614 | 0.16247 | 0.59103 | 0.65226 |
| 3 | "point=1" | 0.32937 | 0.13129 | 0.57426 | 0.62348 |
| 3 | "point=2" | 0.3294 | 0.13132 | 0.57429 | 0.62351 |
| 3 | "point=3" | 0.32943 | 0.13135 | 0.57432 | 0.62354 |
| 3 | "point=4" | 0.32946 | 0.13139 | 0.57435 | 0.62357 |
| 3 | "point=5" | 0.32949 | 0.13142 | 0.57439 | 0.6236 |

| | | | | | |
|---|------------|---------|---------|---------|---------|
| 3 | "point=6" | 0.32952 | 0.13145 | 0.57442 | 0.62364 |
| 3 | "point=7" | 0.32955 | 0.13148 | 0.57445 | 0.62367 |
| 3 | "point=8" | 0.32959 | 0.13151 | 0.57448 | 0.6237 |
| 3 | "point=9" | 0.32962 | 0.13154 | 0.57451 | 0.62373 |
| 3 | "point=10" | 0.32965 | 0.13157 | 0.57454 | 0.62376 |
| 3 | "point=11" | 0.32968 | 0.13161 | 0.57457 | 0.62379 |
| 3 | "point=12" | 0.32971 | 0.13164 | 0.5746 | 0.62382 |
| 3 | "point=13" | 0.32974 | 0.13167 | 0.57464 | 0.62385 |
| 3 | "point=14" | 0.32977 | 0.1317 | 0.57467 | 0.62389 |
| 3 | "point=15" | 0.32981 | 0.13173 | 0.5747 | 0.62392 |
| 3 | "point=16" | 0.32984 | 0.13176 | 0.57473 | 0.62395 |
| 3 | "point=17" | 0.32987 | 0.13179 | 0.57476 | 0.62398 |
| 3 | "point=18" | 0.3299 | 0.13182 | 0.57479 | 0.62401 |
| 3 | "point=19" | 0.32993 | 0.13186 | 0.57482 | 0.62404 |
| 3 | "point=20" | 0.32996 | 0.13189 | 0.57486 | 0.62407 |
| 3 | "point=21" | 0.32999 | 0.13192 | 0.57489 | 0.62411 |
| 3 | "point=22" | 0.33003 | 0.13195 | 0.57492 | 0.62414 |
| 3 | "point=23" | 0.33006 | 0.13198 | 0.57495 | 0.62417 |
| 3 | "point=24" | 0.33009 | 0.13201 | 0.57498 | 0.6242 |
| 3 | "point=25" | 0.33012 | 0.13204 | 0.57501 | 0.62423 |
| 3 | "point=26" | 0.33015 | 0.13208 | 0.57504 | 0.62426 |
| 3 | "point=27" | 0.33018 | 0.13211 | 0.57508 | 0.62429 |
| 3 | "point=28" | 0.33021 | 0.13214 | 0.57511 | 0.62433 |
| 3 | "point=29" | 0.33025 | 0.13217 | 0.57514 | 0.62436 |
| 3 | "point=30" | 0.33028 | 0.1322 | 0.57517 | 0.62439 |
| 3 | "point=31" | 0.33031 | 0.13223 | 0.5752 | 0.62442 |
| 3 | "point=32" | 0.33034 | 0.13226 | 0.57523 | 0.62445 |
| 3 | "point=33" | 0.33037 | 0.1323 | 0.57526 | 0.62448 |
| 3 | "point=34" | 0.3304 | 0.13233 | 0.5753 | 0.62451 |
| 3 | "point=35" | 0.33043 | 0.13236 | 0.57533 | 0.62455 |
| 3 | "point=36" | 0.33046 | 0.13239 | 0.57536 | 0.62458 |
| 3 | "point=37" | 0.3305 | 0.13242 | 0.57539 | 0.62461 |
| 3 | "point=38" | 0.33053 | 0.13245 | 0.57542 | 0.62464 |
| 3 | "point=39" | 0.33056 | 0.13248 | 0.57545 | 0.62467 |
| 3 | "point=40" | 0.33059 | 0.13252 | 0.57548 | 0.6247 |
| 3 | "point=41" | 0.33062 | 0.13255 | 0.57551 | 0.62473 |
| 3 | "point=42" | 0.33065 | 0.13258 | 0.57555 | 0.62477 |
| 3 | "point=43" | 0.33068 | 0.13261 | 0.57558 | 0.6248 |
| 3 | "point=44" | 0.33072 | 0.13264 | 0.57561 | 0.62483 |
| 3 | "point=45" | 0.33075 | 0.13267 | 0.57564 | 0.62486 |
| 3 | "point=46" | 0.33078 | 0.1327 | 0.57567 | 0.62489 |
| 3 | "point=47" | 0.33081 | 0.13273 | 0.5757 | 0.62492 |
| 3 | "point=48" | 0.33084 | 0.13277 | 0.57573 | 0.62495 |
| 3 | "point=49" | 0.33087 | 0.1328 | 0.57577 | 0.62498 |
| 3 | "point=50" | 0.3309 | 0.13283 | 0.5758 | 0.62502 |

Vectorized Exact Zooming Optimization, Savings Fractions

pnts-per-iter=50, nbr-of-its=3, zoom-ratio=0

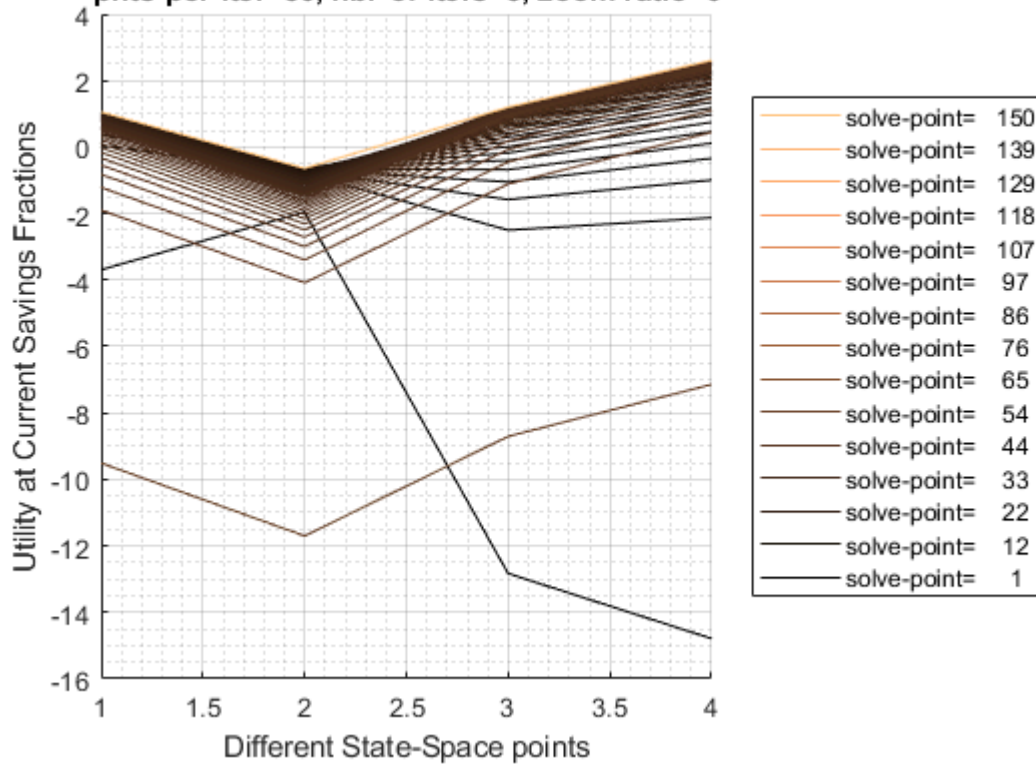


| iter | cl_row_names_a | Var1 | Var2 | Var3 | Var4 |
|------|----------------|----------|----------|----------|----------|
| 1 | "point=1" | -3.6912 | -1.9565 | -12.83 | -14.789 |
| 1 | "point=2" | 0.058694 | -0.80561 | -2.4984 | -2.1254 |
| 1 | "point=3" | 0.38043 | -0.72015 | -1.5784 | -0.99337 |
| 1 | "point=4" | 0.55947 | -0.67935 | -1.0493 | -0.34024 |
| 1 | "point=5" | 0.67979 | -0.65711 | -0.68055 | 0.11647 |
| 1 | "point=6" | 0.7677 | -0.64529 | -0.39997 | 0.46531 |
| 1 | "point=7" | 0.8349 | -0.64026 | -0.17534 | 0.74571 |
| 1 | "point=8" | 0.88763 | -0.6401 | 0.010483 | 0.9787 |
| 1 | "point=9" | 0.92959 | -0.64367 | 0.16774 | 1.1768 |
| 1 | "point=10" | 0.96316 | -0.65026 | 0.30302 | 1.3481 |
| 1 | "point=11" | 0.98996 | -0.65938 | 0.4208 | 1.4981 |
| 1 | "point=12" | 1.0111 | -0.67071 | 0.52427 | 1.6308 |
| 1 | "point=13" | 1.0275 | -0.684 | 0.61578 | 1.7489 |
| 1 | "point=14" | 1.0397 | -0.6991 | 0.69709 | 1.8547 |
| 1 | "point=15" | 1.0482 | -0.71588 | 0.76958 | 1.9499 |
| 1 | "point=16" | 1.0533 | -0.73426 | 0.83429 | 2.0357 |
| 1 | "point=17" | 1.0554 | -0.75419 | 0.8921 | 2.1132 |
| 1 | "point=18" | 1.0546 | -0.77564 | 0.94367 | 2.1833 |
| 1 | "point=19" | 1.0512 | -0.79861 | 0.98955 | 2.2467 |
| 1 | "point=20" | 1.0451 | -0.82309 | 1.0302 | 2.3039 |
| 1 | "point=21" | 1.0366 | -0.8491 | 1.066 | 2.3554 |
| 1 | "point=22" | 1.0256 | -0.87669 | 1.0971 | 2.4015 |
| 1 | "point=23" | 1.0123 | -0.90591 | 1.124 | 2.4425 |
| 1 | "point=24" | 0.99654 | -0.93682 | 1.1466 | 2.4788 |
| 1 | "point=25" | 0.97838 | -0.9695 | 1.1652 | 2.5104 |
| 1 | "point=26" | 0.95775 | -1.004 | 1.1798 | 2.5375 |
| 1 | "point=27" | 0.93459 | -1.0406 | 1.1905 | 2.5602 |
| 1 | "point=28" | 0.90881 | -1.0792 | 1.1973 | 2.5785 |
| 1 | "point=29" | 0.88029 | -1.1202 | 1.2002 | 2.5925 |
| 1 | "point=30" | 0.84886 | -1.1635 | 1.1991 | 2.6022 |
| 1 | "point=31" | 0.81434 | -1.2096 | 1.1938 | 2.6073 |
| 1 | "point=32" | 0.77649 | -1.2587 | 1.1843 | 2.6078 |

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|---|------------|-----------|----------|-----------|---------|
| 1 | "point=33" | 0.73504 | -1.3109 | 1.1703 | 2.6035 |
| 1 | "point=34" | 0.68964 | -1.3668 | 1.1514 | 2.594 |
| 1 | "point=35" | 0.63987 | -1.4268 | 1.1274 | 2.5792 |
| 1 | "point=36" | 0.58522 | -1.4913 | 1.0978 | 2.5584 |
| 1 | "point=37" | 0.52505 | -1.5611 | 1.062 | 2.5312 |
| 1 | "point=38" | 0.45857 | -1.6369 | 1.0192 | 2.4968 |
| 1 | "point=39" | 0.38475 | -1.7198 | 0.96837 | 2.4541 |
| 1 | "point=40" | 0.3023 | -1.8111 | 0.90834 | 2.4021 |
| 1 | "point=41" | 0.20947 | -1.9126 | 0.83737 | 2.3388 |
| 1 | "point=42" | 0.10391 | -2.0266 | 0.75313 | 2.2622 |
| 1 | "point=43" | -0.017693 | -2.1564 | 0.65234 | 2.1687 |
| 1 | "point=44" | -0.16019 | -2.3069 | 0.53016 | 2.0538 |
| 1 | "point=45" | -0.33112 | -2.4857 | 0.37908 | 1.9097 |
| 1 | "point=46" | -0.54312 | -2.7054 | 0.18649 | 1.724 |
| 1 | "point=47" | -0.81989 | -2.9896 | -0.071303 | 1.4729 |
| 1 | "point=48" | -1.2146 | -3.3917 | -0.44748 | 1.1033 |
| 1 | "point=49" | -1.8971 | -4.0814 | -1.1118 | 0.44547 |
| 1 | "point=50" | -9.5085 | -11.7 | -8.7054 | -7.1418 |
| 2 | "point=1" | 1.0535 | -0.64017 | 1.1975 | 2.6074 |
| 2 | "point=2" | 1.0536 | -0.64009 | 1.1977 | 2.6075 |
| 2 | "point=3" | 1.0537 | -0.64001 | 1.1979 | 2.6076 |
| 2 | "point=4" | 1.0539 | -0.63995 | 1.198 | 2.6077 |
| 2 | "point=5" | 1.054 | -0.63989 | 1.1982 | 2.6077 |
| 2 | "point=6" | 1.0541 | -0.63983 | 1.1984 | 2.6078 |
| 2 | "point=7" | 1.0542 | -0.63979 | 1.1985 | 2.6079 |
| 2 | "point=8" | 1.0543 | -0.63975 | 1.1986 | 2.6079 |
| 2 | "point=9" | 1.0544 | -0.63971 | 1.1988 | 2.608 |
| 2 | "point=10" | 1.0545 | -0.63969 | 1.1989 | 2.608 |
| 2 | "point=11" | 1.0546 | -0.63967 | 1.199 | 2.6081 |
| 2 | "point=12" | 1.0547 | -0.63966 | 1.1992 | 2.6081 |
| 2 | "point=13" | 1.0548 | -0.63965 | 1.1993 | 2.6081 |
| 2 | "point=14" | 1.0548 | -0.63965 | 1.1994 | 2.6081 |
| 2 | "point=15" | 1.0549 | -0.63966 | 1.1995 | 2.6081 |
| 2 | "point=16" | 1.055 | -0.63967 | 1.1996 | 2.6081 |
| 2 | "point=17" | 1.0551 | -0.63969 | 1.1997 | 2.6081 |
| 2 | "point=18" | 1.0551 | -0.63971 | 1.1998 | 2.6081 |
| 2 | "point=19" | 1.0552 | -0.63975 | 1.1998 | 2.6081 |
| 2 | "point=20" | 1.0552 | -0.63978 | 1.1999 | 2.6081 |
| 2 | "point=21" | 1.0553 | -0.63983 | 1.2 | 2.608 |
| 2 | "point=22" | 1.0553 | -0.63988 | 1.2 | 2.608 |
| 2 | "point=23" | 1.0553 | -0.63993 | 1.2001 | 2.6079 |
| 2 | "point=24" | 1.0554 | -0.63999 | 1.2001 | 2.6079 |
| 2 | "point=25" | 1.0554 | -0.64006 | 1.2002 | 2.6078 |
| 2 | "point=26" | 1.0554 | -0.64013 | 1.2002 | 2.6077 |
| 2 | "point=27" | 1.0555 | -0.64021 | 1.2002 | 2.6077 |
| 2 | "point=28" | 1.0555 | -0.64029 | 1.2003 | 2.6076 |
| 2 | "point=29" | 1.0555 | -0.64038 | 1.2003 | 2.6075 |
| 2 | "point=30" | 1.0555 | -0.64048 | 1.2003 | 2.6074 |
| 2 | "point=31" | 1.0555 | -0.64058 | 1.2003 | 2.6073 |
| 2 | "point=32" | 1.0555 | -0.64069 | 1.2003 | 2.6071 |
| 2 | "point=33" | 1.0555 | -0.6408 | 1.2003 | 2.607 |
| 2 | "point=34" | 1.0555 | -0.64091 | 1.2003 | 2.6069 |
| 2 | "point=35" | 1.0555 | -0.64104 | 1.2002 | 2.6067 |
| 2 | "point=36" | 1.0554 | -0.64116 | 1.2002 | 2.6066 |
| 2 | "point=37" | 1.0554 | -0.64129 | 1.2002 | 2.6064 |
| 2 | "point=38" | 1.0554 | -0.64143 | 1.2001 | 2.6063 |
| 2 | "point=39" | 1.0554 | -0.64157 | 1.2001 | 2.6061 |
| 2 | "point=40" | 1.0553 | -0.64172 | 1.2001 | 2.6059 |
| 2 | "point=41" | 1.0553 | -0.64188 | 1.2 | 2.6057 |
| 2 | "point=42" | 1.0552 | -0.64203 | 1.1999 | 2.6056 |
| 2 | "point=43" | 1.0552 | -0.6422 | 1.1999 | 2.6053 |
| 2 | "point=44" | 1.0551 | -0.64236 | 1.1998 | 2.6051 |
| 2 | "point=45" | 1.0551 | -0.64254 | 1.1997 | 2.6049 |
| 2 | "point=46" | 1.055 | -0.64271 | 1.1996 | 2.6047 |
| 2 | "point=47" | 1.0549 | -0.64289 | 1.1995 | 2.6045 |

| | | | | | |
|---|------------|--------|----------|--------|--------|
| 2 | "point=48" | 1.0549 | -0.64308 | 1.1994 | 2.6042 |
| 2 | "point=49" | 1.0548 | -0.64327 | 1.1993 | 2.604 |
| 2 | "point=50" | 1.0547 | -0.64347 | 1.1992 | 2.6037 |
| 3 | "point=1" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=2" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=3" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=4" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=5" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=6" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=7" | 1.0555 | -0.63967 | 1.2003 | 2.6081 |
| 3 | "point=8" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=9" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=10" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=11" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=12" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=13" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=14" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=15" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=16" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=17" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=18" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=19" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=20" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=21" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=22" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=23" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=24" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=25" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=26" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=27" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=28" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=29" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=30" | 1.0555 | -0.63966 | 1.2003 | 2.6081 |
| 3 | "point=31" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=32" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=33" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=34" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=35" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=36" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=37" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=38" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=39" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=40" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=41" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=42" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=43" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=44" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=45" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=46" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=47" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=48" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=49" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |
| 3 | "point=50" | 1.0555 | -0.63965 | 1.2003 | 2.6081 |

Vectorized Exact Zooming Optimization, U(save) pnts-per-iter=50, nbr-of-iters=3, zoom-ratio=0



Elapsed time is 1.304303 seconds.

XX

CONTAINER NAME: mp_container_map ND Array (Matrix etc)

XX

| | i | idx | ndim | numel | rowN | colN | sum | mean | std | coefvari |
|--------------------|---|-----|------|-------|------|------|---------|---------|---------|----------|
| | — | — | — | — | — | — | — | — | — | — |
| ar_opti_foc_obj | 1 | 1 | 2 | 4 | 1 | 4 | 4.2243 | 1.0561 | 1.3298 | 1.2592 |
| ar_opti_save_frac | 2 | 2 | 2 | 4 | 4 | 1 | 1.664 | 0.416 | 0.2284 | 0.54904 |
| ar_opti_save_level | 3 | 3 | 2 | 4 | 1 | 4 | 0.80247 | 0.20062 | 0.37807 | 1.8845 |

xxx TABLE:ar_opti_foc_obj XXXXXXXXXXXXXXXXXXXX

| | c1 | c2 | c3 | c4 |
|----|--------|----------|--------|--------|
| | — | — | — | — |
| r1 | 1.0555 | -0.63965 | 1.2003 | 2.6081 |

xxx TABLE:ar_opti_save_frac XXXXXXXXXXXXXXXXXXXX

| | c1 |
|----|---------|
| | — |
| r1 | 0.33086 |
| r2 | 0.13278 |
| r3 | 0.57575 |
| r4 | 0.62461 |

xxx TABLE:ar_opti_save_level XXXXXXXXXXXXXXXXXXXX

| | c1 | c2 | c3 | c4 |
|----|---------|-----------|----------|---------|
| | — | — | — | — |
| r1 | 0.37401 | -0.070015 | -0.15125 | 0.64972 |

Test FF_OPTIM_MZOOM_SAVEZRONE 8 Individuals 3 Iterations 10 Points Per Iteration, 0.25 zoom in ratio

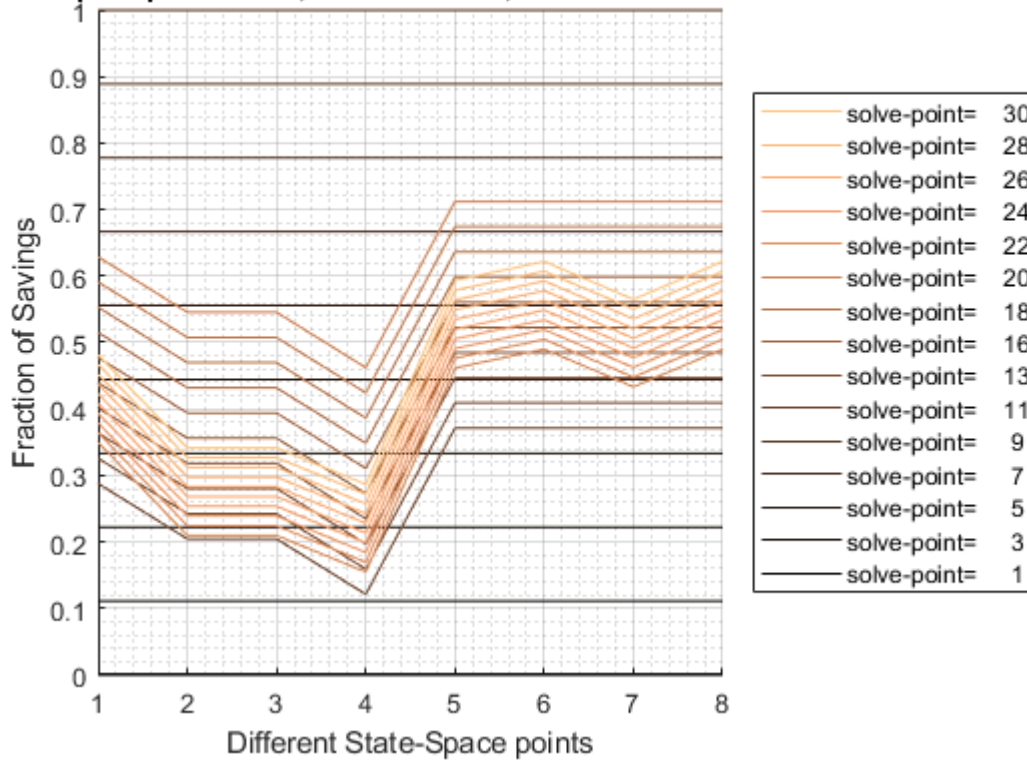
10 grid points per iteration, and 3 iterations.

```
% Generate the state-space and function
rng(123);
it_draws = 8; % must be even number
ar_z1 = exp(rand([it_draws,1])*3-1.5);
ar_z2 = exp(rand([it_draws,1])*3-1.5);
ar_r = (rand(it_draws,1)*10.0);
ar_beta = [rand(round(it_draws/2),1)*0.9+0.1; rand(round(it_draws/2),1)*0.9+1];
fc_util = @(x) ffi_intertemporal_util(x, ar_z1, ar_z2, ar_r, ar_beta);
% Call Function
bl_verbose = true;
bl_timer = true;
mp_mzoom_ctrlinfo = containers.Map('KeyType','char','ValueType','any');
mp_mzoom_ctrlinfo('it_mzoom_jnt_pnts') = 10;
mp_mzoom_ctrlinfo('it_mzoom_max_iter') = 3;
mp_mzoom_ctrlinfo('it_mzoom_zm_ratio') = 0.25;
[fl_opti_save_frac, fl_opti_save_level] = ...
    ff_optim_mzoom_savezrone(fc_util, bl_verbose, bl_timer, mp_mzoom_ctrlinfo);
```

| iter | cl_row_names_a | Var1 | Var2 | Var3 | Var4 | Var5 | Var6 | Var7 | Var8 |
|------|----------------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1 | "point=1" | 1e-05 | 1e-05 | 1e-05 | 1e-05 | 1e-05 | 1e-05 | 1e-05 | 1e-05 |
| 1 | "point=2" | 0.11112 | 0.11112 | 0.11112 | 0.11112 | 0.11112 | 0.11112 | 0.11112 | 0.11112 |
| 1 | "point=3" | 0.22223 | 0.22223 | 0.22223 | 0.22223 | 0.22223 | 0.22223 | 0.22223 | 0.22223 |
| 1 | "point=4" | 0.33334 | 0.33334 | 0.33334 | 0.33334 | 0.33334 | 0.33334 | 0.33334 | 0.33334 |
| 1 | "point=5" | 0.44445 | 0.44445 | 0.44445 | 0.44445 | 0.44445 | 0.44445 | 0.44445 | 0.44445 |
| 1 | "point=6" | 0.55555 | 0.55555 | 0.55555 | 0.55555 | 0.55555 | 0.55555 | 0.55555 | 0.55555 |
| 1 | "point=7" | 0.66666 | 0.66666 | 0.66666 | 0.66666 | 0.66666 | 0.66666 | 0.66666 | 0.66666 |
| 1 | "point=8" | 0.77777 | 0.77777 | 0.77777 | 0.77777 | 0.77777 | 0.77777 | 0.77777 | 0.77777 |
| 1 | "point=9" | 0.88888 | 0.88888 | 0.88888 | 0.88888 | 0.88888 | 0.88888 | 0.88888 | 0.88888 |
| 1 | "point=10" | 0.99999 | 0.99999 | 0.99999 | 0.99999 | 0.99999 | 0.99999 | 0.99999 | 0.99999 |
| 2 | "point=1" | 0.28788 | 0.20455 | 0.20455 | 0.12122 | 0.37121 | 0.37121 | 0.37121 | 0.37121 |
| 2 | "point=2" | 0.32576 | 0.24243 | 0.24243 | 0.1591 | 0.40909 | 0.40909 | 0.40909 | 0.40909 |
| 2 | "point=3" | 0.36364 | 0.28031 | 0.28031 | 0.19698 | 0.44697 | 0.44697 | 0.44697 | 0.44697 |
| 2 | "point=4" | 0.40152 | 0.31819 | 0.31819 | 0.23485 | 0.48485 | 0.48485 | 0.48485 | 0.48485 |
| 2 | "point=5" | 0.4394 | 0.35606 | 0.35606 | 0.27273 | 0.52273 | 0.52273 | 0.52273 | 0.52273 |
| 2 | "point=6" | 0.47727 | 0.39394 | 0.39394 | 0.31061 | 0.5606 | 0.5606 | 0.5606 | 0.5606 |
| 2 | "point=7" | 0.51515 | 0.43182 | 0.43182 | 0.34849 | 0.59848 | 0.59848 | 0.59848 | 0.59848 |
| 2 | "point=8" | 0.55303 | 0.4697 | 0.4697 | 0.38637 | 0.63636 | 0.63636 | 0.63636 | 0.63636 |
| 2 | "point=9" | 0.59091 | 0.50758 | 0.50758 | 0.42424 | 0.67424 | 0.67424 | 0.67424 | 0.67424 |
| 2 | "point=10" | 0.62879 | 0.54545 | 0.54545 | 0.46212 | 0.71212 | 0.71212 | 0.71212 | 0.71212 |
| 3 | "point=1" | 0.34987 | 0.20972 | 0.20972 | 0.15479 | 0.46161 | 0.49001 | 0.4332 | 0.49001 |
| 3 | "point=2" | 0.3645 | 0.22435 | 0.22435 | 0.16943 | 0.47624 | 0.50465 | 0.44783 | 0.50465 |
| 3 | "point=3" | 0.37913 | 0.23899 | 0.23899 | 0.18406 | 0.49087 | 0.51928 | 0.46247 | 0.51928 |
| 3 | "point=4" | 0.39377 | 0.25362 | 0.25362 | 0.1987 | 0.50551 | 0.53392 | 0.4771 | 0.53392 |
| 3 | "point=5" | 0.4084 | 0.26826 | 0.26826 | 0.21333 | 0.52014 | 0.54855 | 0.49174 | 0.54855 |
| 3 | "point=6" | 0.42304 | 0.28289 | 0.28289 | 0.22797 | 0.53478 | 0.56319 | 0.50637 | 0.56319 |
| 3 | "point=7" | 0.43767 | 0.29752 | 0.29752 | 0.2426 | 0.54941 | 0.57782 | 0.52101 | 0.57782 |
| 3 | "point=8" | 0.45231 | 0.31216 | 0.31216 | 0.25724 | 0.56405 | 0.59246 | 0.53564 | 0.59246 |
| 3 | "point=9" | 0.46694 | 0.32679 | 0.32679 | 0.27187 | 0.57868 | 0.60709 | 0.55027 | 0.60709 |
| 3 | "point=10" | 0.48158 | 0.34143 | 0.34143 | 0.28651 | 0.59332 | 0.62173 | 0.56491 | 0.62173 |

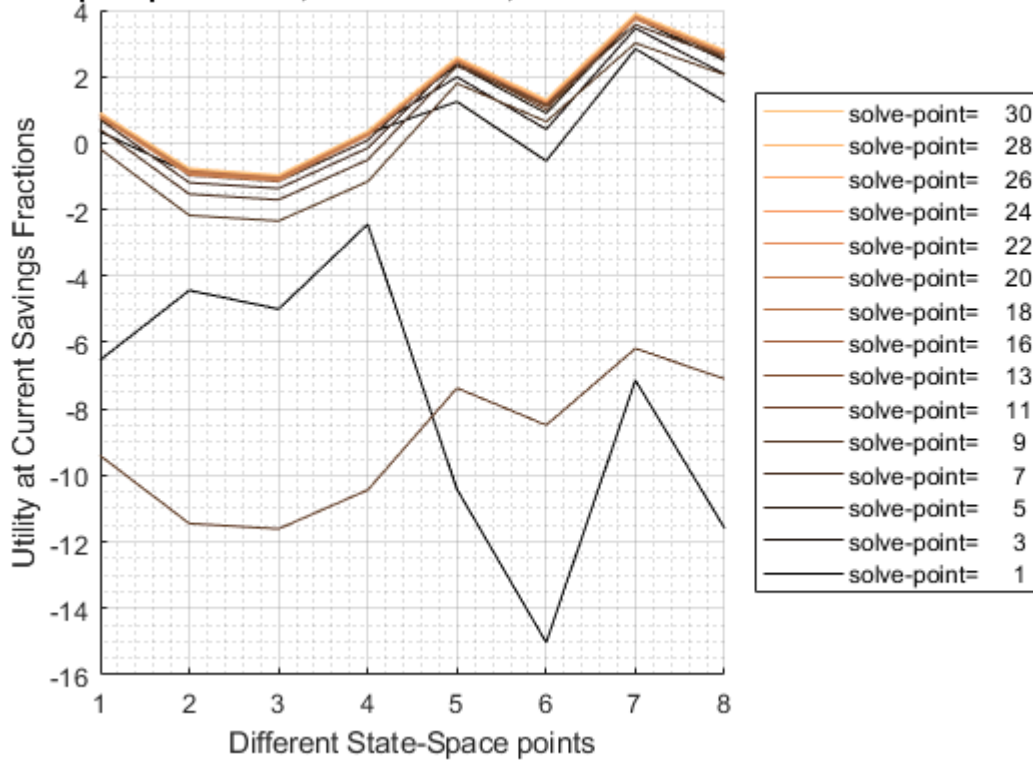
Vectorized Exact Zooming Optimization, Savings Fractions

pnts-per-iter=10, nbr-of-iters=3, zoom-ratio=0.25



| iter | cl_row_names_a | Var1 | Var2 | Var3 | Var4 | Var5 | Var6 | Var7 | Var8 |
|------|----------------|----------|----------|----------|----------|---------|----------|---------|----------|
| 1 | "point=1" | -6.5286 | -4.4312 | -4.9951 | -2.4407 | -10.415 | -15.025 | -7.1352 | -11.1352 |
| 1 | "point=2" | 0.34227 | -0.90966 | -1.148 | 0.28691 | 1.2451 | -0.53687 | 2.835 | 1.1352 |
| 1 | "point=3" | 0.7287 | -0.77242 | -0.98657 | 0.36508 | 1.9879 | 0.4163 | 3.452 | 2.6352 |
| 1 | "point=4" | 0.87872 | -0.76818 | -0.96816 | 0.33477 | 2.3463 | 0.89785 | 3.737 | 2.6352 |
| 1 | "point=5" | 0.91222 | -0.83811 | -1.028 | 0.24031 | 2.5277 | 1.1666 | 3.8662 | 2.7352 |
| 1 | "point=6" | 0.85648 | -0.97408 | -1.1562 | 0.085331 | 2.5867 | 1.2933 | 3.8847 | 2.7352 |
| 1 | "point=7" | 0.70558 | -1.1905 | -1.3663 | -0.14666 | 2.5296 | 1.2915 | 3.7944 | 2.7352 |
| 1 | "point=8" | 0.41577 | -1.5358 | -1.7061 | -0.50502 | 2.319 | 1.1277 | 3.5559 | 2.5352 |
| 1 | "point=9" | -0.17716 | -2.1767 | -2.3424 | -1.1573 | 1.7947 | 0.64395 | 3.0074 | 2.6352 |
| 1 | "point=10" | -9.4046 | -11.446 | -11.608 | -10.437 | -7.3721 | -8.4872 | -6.1808 | -7.6352 |
| 2 | "point=1" | 0.8347 | -0.78233 | -0.99938 | 0.30205 | 2.4239 | 1.0081 | 3.795 | 2.5352 |
| 2 | "point=2" | 0.87277 | -0.76475 | -0.97586 | 0.34105 | 2.4846 | 1.0983 | 3.8381 | 2.6352 |
| 2 | "point=3" | 0.89748 | -0.75933 | -0.96536 | 0.36018 | 2.5303 | 1.1709 | 3.8677 | 2.7352 |
| 2 | "point=4" | 0.91044 | -0.76388 | -0.96549 | 0.36559 | 2.5622 | 1.2275 | 3.8849 | 2.7352 |
| 2 | "point=5" | 0.91269 | -0.7771 | -0.97477 | 0.36049 | 2.581 | 1.269 | 3.89 | 2.7352 |
| 2 | "point=6" | 0.90477 | -0.79823 | -0.99237 | 0.34672 | 2.5867 | 1.296 | 3.883 | 2.7352 |
| 2 | "point=7" | 0.88684 | -0.8269 | -1.0178 | 0.32535 | 2.5793 | 1.3084 | 3.8637 | 2.7352 |
| 2 | "point=8" | 0.85872 | -0.86304 | -1.051 | 0.29697 | 2.5578 | 1.3055 | 3.831 | 2.7352 |
| 2 | "point=9" | 0.81987 | -0.90685 | -1.0921 | 0.26182 | 2.5209 | 1.2862 | 3.7837 | 2.7352 |
| 2 | "point=10" | 0.76932 | -0.95877 | -1.1415 | 0.21989 | 2.4664 | 1.2483 | 3.7192 | 2.7352 |
| 3 | "point=1" | 0.88992 | -0.7791 | -0.99528 | 0.33777 | 2.5443 | 1.234 | 3.8584 | 2.7352 |
| 3 | "point=2" | 0.8979 | -0.77144 | -0.98526 | 0.3479 | 2.5562 | 1.251 | 3.8683 | 2.7352 |
| 3 | "point=3" | 0.90413 | -0.7658 | -0.97741 | 0.35543 | 2.5661 | 1.2659 | 3.8762 | 2.7352 |
| 3 | "point=4" | 0.90869 | -0.762 | -0.97154 | 0.3607 | 2.5741 | 1.2785 | 3.8824 | 2.7352 |
| 3 | "point=5" | 0.91163 | -0.75989 | -0.96746 | 0.36397 | 2.5801 | 1.289 | 3.8867 | 2.7352 |
| 3 | "point=6" | 0.91299 | -0.75934 | -0.96506 | 0.36546 | 2.5842 | 1.2974 | 3.8892 | 2.7352 |
| 3 | "point=7" | 0.91281 | -0.76025 | -0.96421 | 0.36532 | 2.5864 | 1.3035 | 3.89 | 2.7352 |
| 3 | "point=8" | 0.91112 | -0.76255 | -0.96482 | 0.3637 | 2.5866 | 1.3074 | 3.889 | 2.7352 |
| 3 | "point=9" | 0.90792 | -0.76615 | -0.96683 | 0.3607 | 2.5849 | 1.3091 | 3.8861 | 2.7352 |
| 3 | "point=10" | 0.90324 | -0.77102 | -0.97016 | 0.35641 | 2.5811 | 1.3085 | 3.8815 | 2.7352 |

Vectorized Exact Zooming Optimization, U(save)
pnts-per-iter=10, nbr-of-its=3, zoom-ratio=0.25



Elapsed time is 0.997040 seconds.

 xxx
 CONTAINER NAME: mp_container_map ND Array (Matrix etc)
 xxx

| | i | idx | ndim | numel | rowN | colN | sum | mean | std | coefvari |
|--------------------|---|-----|------|-------|------|------|--------|---------|---------|----------|
| ar_opti_foc_obj | 1 | 1 | 2 | 8 | 1 | 8 | 10.125 | 1.2656 | 1.731 | 1.3677 |
| ar_opti_save_frac | 2 | 2 | 2 | 8 | 8 | 1 | 3.3843 | 0.42304 | 0.15074 | 0.35632 |
| ar_opti_save_level | 3 | 3 | 2 | 8 | 1 | 8 | 4.965 | 0.62062 | 0.71498 | 1.152 |

xxx TABLE:ar_opti_foc_obj xxxxxxxxxxxxxxxxxxxxxxx

| | c1 | c2 | c3 | c4 | c5 | c6 | c7 | c8 |
|----|---------|----------|----------|---------|--------|--------|--------|--------|
| r1 | 0.91163 | -0.75989 | -0.96506 | 0.36397 | 2.5864 | 1.3074 | 3.8892 | 2.7911 |

xxx TABLE:ar_opti_save_frac xxxxxxxxxxxxxxxxxxxxxxx
 c1

| | |
|----|---------|
| r1 | 0.4084 |
| r2 | 0.26826 |
| r3 | 0.28289 |
| r4 | 0.21333 |
| r5 | 0.54941 |
| r6 | 0.59246 |
| r7 | 0.50637 |
| r8 | 0.56319 |

xxx TABLE:ar_opti_save_level xxxxxxxxxxxxxxxxxxxxxxx

| c1 | c2 | c3 | c4 | c5 | c6 | c7 | c8 |
|----|----|----|----|----|----|----|----|
|----|----|----|----|----|----|----|----|

Test FF_OPTIM_MZOOM_SAVEZRONE Speed

Test Speed doing 6.25 million state-spcae points for a savings problem:

```
% Generate the state-space and function
rng(123);
it_draws = 6250000; % must be even number
ar_z1 = exp(rand([it_draws,1])*3-1.5);
ar_z2 = exp(rand([it_draws,1])*3-1.5);
ar_r = (rand(it_draws,1)*10.0);
ar_beta = [rand(round(it_draws/2),1)*0.9+0.1; rand(round(it_draws/2),1)*0.9+1];
% ffi_intertemporal_max is a function in ff_optim_mlsec_savezrone for testing
fc_util = @(x) ffi_intertemporal_util(x, ar_z1, ar_z2, ar_r, ar_beta);
% Call Function
bl_verbose = false;
bl_timer = true;
% set parameters
mp_mzoom_ctrlinfo = containers.Map('KeyType','char','ValueType','any');
mp_mzoom_ctrlinfo('it_mzoom_jnt_pnts') = 20;
mp_mzoom_ctrlinfo('it_mzoom_max_iter') = 10;
mp_mzoom_ctrlinfo('it_mzoom_zm_ratio') = 0.25;
[ar_opti_save_frac, ar_opti_save_level] = ...
    ff_optim_mzoom_savezrone(fc_util, bl_verbose, bl_timer, mp_mzoom_ctrlinfo);
```

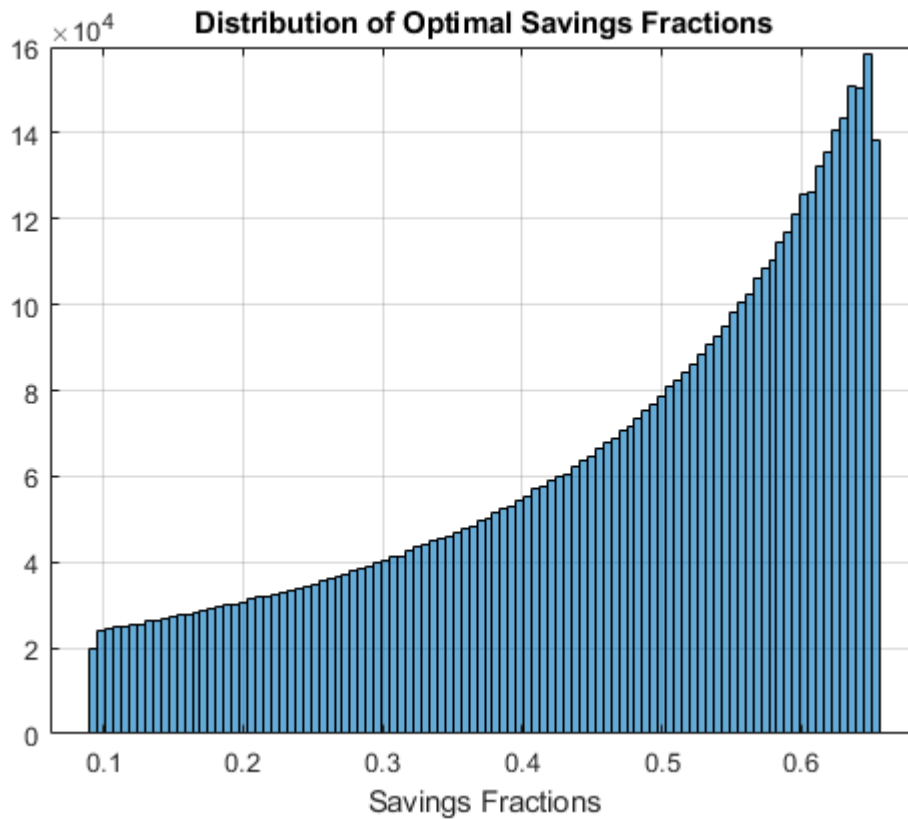
Elapsed time is 64.837799 seconds.

```
mp_container_map = containers.Map('KeyType','char','ValueType','any');
mp_container_map('ar_opti_save_frac') = ar_opti_save_frac;
mp_container_map('ar_opti_save_level') = ar_opti_save_level;
mp_container_map('ar_opti_save_frac_notnan') = ar_opti_save_frac(~isnan(ar_opti_save_frac));
ff_container_map_display(mp_container_map);
```

```
-----
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CONTAINER NAME: mp_container_map ND Array (Matrix etc)
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

| | i | idx | ndim | numel | rowN | colN | sum | mean | std |
|--------------------------|---|-----|------|----------|----------|------|------------|---------|---------|
| ar_opti_save_frac | 1 | 1 | 2 | 6.25e+06 | 6.25e+06 | 1 | 2.8839e+06 | 0.46142 | 0.15305 |
| ar_opti_save_frac_notnan | 2 | 2 | 2 | 6.25e+06 | 6.25e+06 | 1 | 2.8839e+06 | 0.46142 | 0.15305 |
| ar_opti_save_level | 3 | 3 | 2 | 6.25e+06 | 6.25e+06 | 1 | 2.9481e+06 | 0.47169 | 0.66665 |

```
figure();
histogram(ar_opti_save_frac(~isnan(ar_opti_save_frac)),100);
title('Distribution of Optimal Savings Fractions');
xlabel('Savings Fractions');
grid on;
```



Define Two Period Intertemporal Log Utility No Shock Utility Function

See [Household's Utility Maximization Problem](#) and [Two-Period Borrowing and Savings Problem](#) given Endowments.

```
function [ar_util, ar_saveborr_level] = ...
    ffi_intertemporal_util(ar_saveborr_frac, z1, z2, r, beta)

ar_saveborr_level = ar_saveborr_frac.*(z1+z2./(1+r)) - z2./(1+r);
ar_util = log(z1 - ar_saveborr_level) + beta.*log(ar_saveborr_level.*(1+r) + z2);

end
```