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 0.004395 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

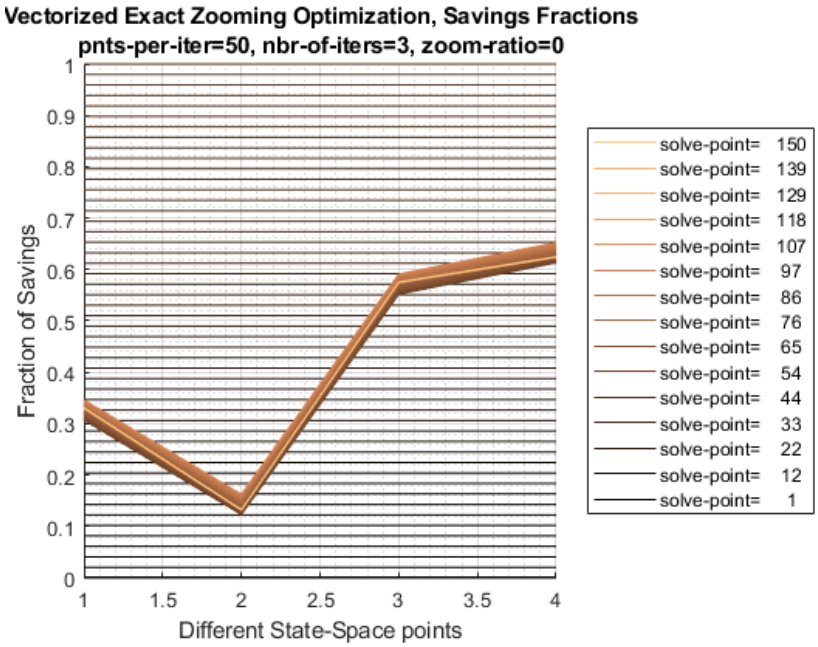
5 grid points per iteration, and 5 iterations.

```
% 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;
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
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

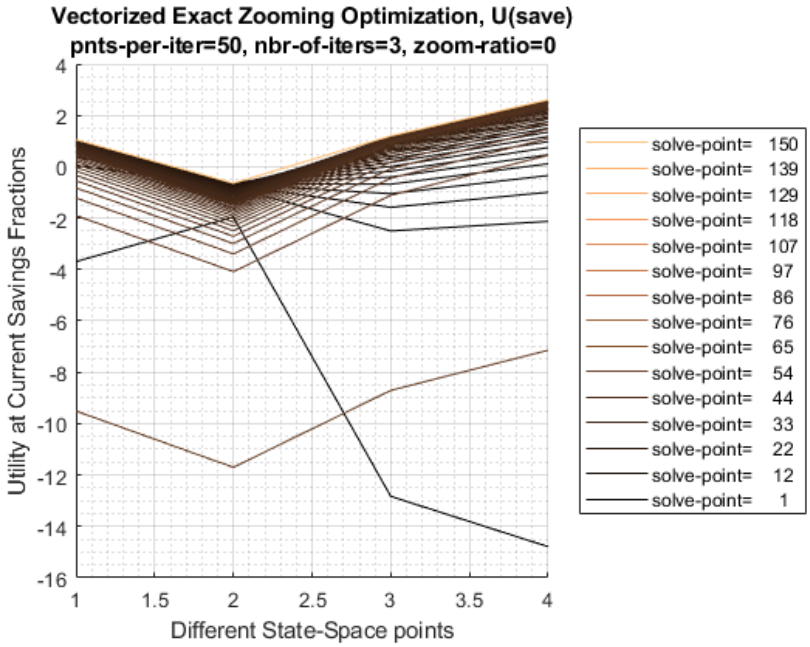
3	"point=7"	0.32955	0.13148	0.57445	0.62367
3	"point=8"	0.32959	0.13151	0.57448	0.6237
3	"point=9"	0.32962	0.13154	0.57451	0.62373
3	"point=10"	0.32965	0.13157	0.57454	0.62376
3	"point=11"	0.32968	0.13161	0.57457	0.62379
3	"point=12"	0.32971	0.13164	0.5746	0.62382
3	"point=13"	0.32974	0.13167	0.57464	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



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
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




```
Elapsed time is 1.292487 seconds.
----------------------------------------
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
CONTAINER NAME: mp_container_map ND Array (Matrix etc)
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

	i	idx	ndim	numel	rowN	colN	sum	mean	std	coefvari	mi
ar_opti_foc_obj	1	1	2	4	1	4	4.2243	1.0561	1.3298	1.2592	-0.6
ar_opti_save_frac	2	2	2	4	4	1	1.664	0.416	0.2284	0.54904	0.1

```
xxx TABLE:ar_opti_foc_obj xxxxxxxxxxxxxxxxxx
```

	c1	c2	c3	c4
r1	1.0555	-0.63965	1.2003	2.6081

```
xxx TABLE:ar_opti_save_frac xxxxxxxxxxxxxxxxxx
```

	c1
r1	0.33086
r2	0.13278
r3	0.57575
r4	0.62461

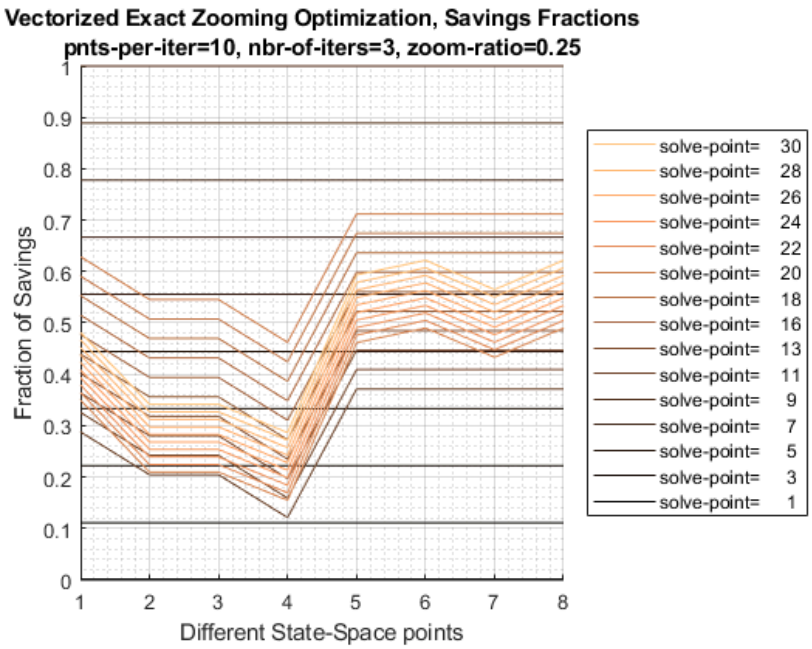
Test FF_OPTIM_MZOOM_SAVEZRONE 8 Individuals 3 Iterations 10 Points Per Iteration, 0.25 zoom in ratio

10 grid points per iteration, and 3 iterations.

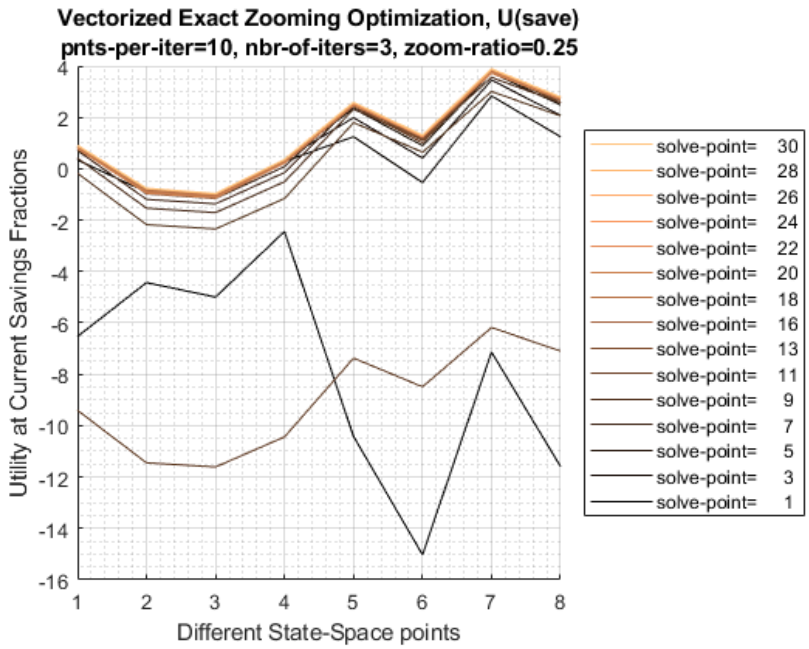
```
% Generate the state-space and function
rng(123);
it_draws = 8; % must be even number
ar_z1 = exp(rand([it_draws,1])*3-1.5);
ar_z2 = exp(rand([it_draws,1])*3-1.5);
ar_r = (rand(it_draws,1)*10.0);
ar_beta = [rand(round(it_draws/2),1)*0.9+0.1; rand(round(it_draws/2),1)*0.9+1];
```

```
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;
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



iter	cl_row_names_a	Var1	Var2	Var3	Var4	Var5	Var6	Var7	Var
1	"point=1"	-6.5286	-4.4312	-4.9951	-2.4407	-10.415	-15.025	-7.1352	-11.
1	"point=2"	0.34227	-0.90966	-1.148	0.28691	1.2451	-0.53687	2.835	1.
1	"point=3"	0.7287	-0.77242	-0.98657	0.36508	1.9879	0.4163	3.452	2.0
1	"point=4"	0.87872	-0.76818	-0.96816	0.33477	2.3463	0.89785	3.737	2.4
1	"point=5"	0.91222	-0.83811	-1.028	0.24031	2.5277	1.1666	3.8662	2.7
1	"point=6"	0.85648	-0.97408	-1.1562	0.085331	2.5867	1.2933	3.8847	2.7
1	"point=7"	0.70558	-1.1905	-1.3663	-0.14666	2.5296	1.2915	3.7944	2.7
1	"point=8"	0.41577	-1.5358	-1.7061	-0.50502	2.319	1.1277	3.5559	2.5
1	"point=9"	-0.17716	-2.1767	-2.3424	-1.1573	1.7947	0.64395	3.0074	2.0
1	"point=10"	-9.4046	-11.446	-11.608	-10.437	-7.3721	-8.4872	-6.1808	-7.0
2	"point=1"	0.8347	-0.78233	-0.99938	0.30205	2.4239	1.0081	3.795	2.5
2	"point=2"	0.87277	-0.76475	-0.97586	0.34105	2.4846	1.0983	3.8381	2.6
2	"point=3"	0.89748	-0.75933	-0.96536	0.36018	2.5303	1.1709	3.8677	2.7
2	"point=4"	0.91044	-0.76388	-0.96549	0.36559	2.5622	1.2275	3.8849	2.7
2	"point=5"	0.91269	-0.7771	-0.97477	0.36049	2.581	1.269	3.89	2.
2	"point=6"	0.90477	-0.79823	-0.99237	0.34672	2.5867	1.296	3.883	2.7
2	"point=7"	0.88684	-0.8269	-1.0178	0.32535	2.5793	1.3084	3.8637	2.7
2	"point=8"	0.85872	-0.86304	-1.051	0.29697	2.5578	1.3055	3.831	2.7
2	"point=9"	0.81987	-0.90685	-1.0921	0.26182	2.5209	1.2862	3.7837	2.
2	"point=10"	0.76932	-0.95877	-1.1415	0.21989	2.4664	1.2483	3.7192	2.7
3	"point=1"	0.88992	-0.7791	-0.99528	0.33777	2.5443	1.234	3.8584	2.7
3	"point=2"	0.8979	-0.77144	-0.98526	0.3479	2.5562	1.251	3.8683	2.7
3	"point=3"	0.90413	-0.7658	-0.97741	0.35543	2.5661	1.2659	3.8762	2.
3	"point=4"	0.90869	-0.762	-0.97154	0.3607	2.5741	1.2785	3.8824	2.7
3	"point=5"	0.91163	-0.75989	-0.96746	0.36397	2.5801	1.289	3.8867	2.7
3	"point=6"	0.91299	-0.75934	-0.96506	0.36546	2.5842	1.2974	3.8892	2.7
3	"point=7"	0.91281	-0.76025	-0.96421	0.36532	2.5864	1.3035	3.89	2.7
3	"point=8"	0.91112	-0.76255	-0.96482	0.3637	2.5866	1.3074	3.889	2.7
3	"point=9"	0.90792	-0.76615	-0.96683	0.3607	2.5849	1.3091	3.8861	2.7
3	"point=10"	0.90324	-0.77102	-0.97016	0.35641	2.5811	1.3085	3.8815	2.7




```
Elapsed time is 1.047404 seconds.
----------------------------------------
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
CONTAINER NAME: mp_container_map ND Array (Matrix etc)
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

	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	-0
ar_opti_save_frac	2	2	2	8	8	1	3.3843	0.42304	0.15074	0.35632	0

xxx TABLE:ar_opti_foc_obj xxxxxxxxxxxxxxxxxx

	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 xxxxxxxxxxxxxxxxxx

	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

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);
```

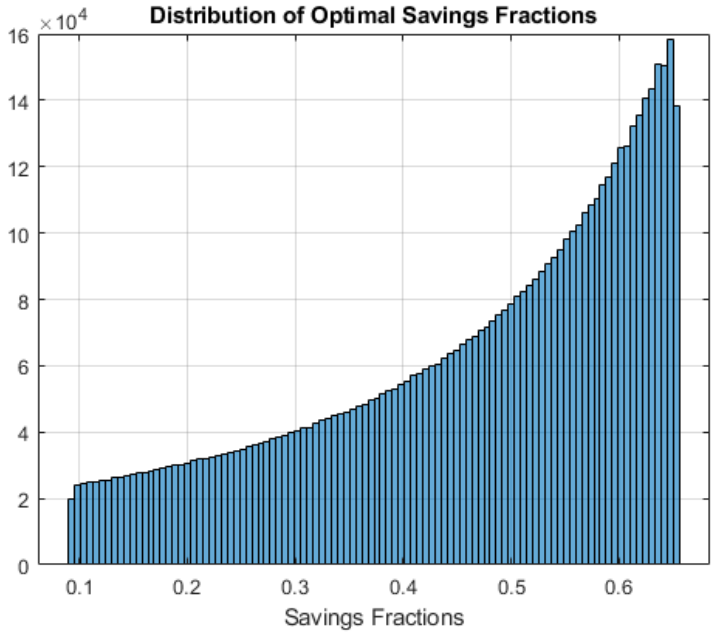
```
Elapsed time is 54.241104 seconds.
```

```
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);
```

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

	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
```