Market Model 8.1 Users Manual by Ralph Abraham
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WHAT IS IT?

User's Manual for NetLogo Market Model 8.1 rev 05b of 31 December 2006, by Ralph Abraham and Dan Friedman. This manual is devoted primarily to the Graphical User Interface of the model. The NetLogo code (under the Procedures tab) is explained in another document, the Program Guide.

This is the first extension of a NetLogo model for financial markets. It implements two innovations: surprise (stochastic variations in payoff) and the c2-dynamic (varying the c2 coefficient in the gradient rule). Further background may be found at www.vismath.org/research/landscapedyn/models/market.

HOW IT WORKS

The turtles represent money market managers. Each manager is shown as a small triangle in the graphics window. They have different colors just for the visual effect. When several are on the same patch (discretized interval of the strategy space) only the top one can be seen in entirety, but the x and y positions are floating point numbers, so parts of lower turtles may be seen.

The state space is shown as the upper half of the graphics window. The horizontal axis represents a unit interval corresponding to the choice of strategy, u. This is the degree to which the manager is willing to invest in risky assets. Moving to the right increases risk.

The vertical axis represents the value of the manager's portfolio. Zero is indicated by the horizontal magenta strip in the center of the graphics window. The upper limit is set by a slider, the default value is four. A portfolio value of one is normal.

A chosen number of managers begin at initial positions in the state space. Model coordinates (u, z) correspond to screen coordinates (xcor, ycor). The initial distribution is important to the outcome of a run. The model starts up with a random distribution in a rectangle of setable width (sliders for width and center) and height (sliders for altitude and height).

At the start, and after each step of the run, the density of managers as a function of the horizontal coordinate in the strategy space is shown as a histogram in the plot window.

The stepsize may be set with the "frequency" chooser (drop-down menu). For example, if "52" is chosen in the drop-down menu, this signifies a frequency of 52 steps per year (weeks), and the variable "stepsize" in the program is set to 1/52 years.

An additional parameter, u-steps, may be set with a chooser. This is the number of substeps in a step. Increasing u-steps decreases the substepsize, called stepsize-u, to stepsize/u-steps, and decreases the numerical error in the Euler integration of the hill-climbing process. The speed of the simulation is slower of course.

That is, stepsize is a unit of time for periodic reports of financial data, including z updates, while stepsize-u is the increment for the Euler steps of the gradient dynamics of strategy adjustment, or updates of u.

Using the Euler algorithm, each manager is assumed to move horizontally up the slope of the payoff function by the substep increment, u-jump = stepsize-u * slope. This increment is clipped to a maximum size set by a slider, max-u-jump. With every step (or u-step substeps) there is also a vertical motion due to increment or decrement of the size of the manager's portfolio due to payoffs.

The slope of the landscape, or gradient of phi, phisubx, is shown in color on a row in the center of the graphics window. Here is the color code: red for positive slopes (move to the right), green for negative slopes (move to the left) and yellow for a narrow zone around zero.

HOW TO USE IT

STEP #1: SET THE INITIAL HERD ("Add Managers" Panel)

(1a) Set the "population" slider to determine the number of managers in the initial herd.

(1b) Set the "center" slider to locate the horizontal center of the initial herd. Horizontal axis corresponds to strategy choice.

(1c) Set the "width" slider to determine the horizontal width of the initial herd, as a percentage of the total horizontal width of the window.

(1d) Set the "altitude" slider to locate the vertical center of the initial herd. Vertical axis corresponds to initial portfolio size.

(1e) Set the "height" slider to determine the vertical width of the initial herd, as a percentage of the total vertical width of the window.

(1f) Press the "setup" button to create the initial distribution of managers. The initial histogram shows the initial distribution.

STEP #2: SET THE RUNTIME PARAMETERS ("Runtime Dashboard")

(2a) Adjust the "frequency" chooser for the desired number of steps per year.

(2b) Adjust the "u-steps" chooser for the desired number of substeps per step.

(2c) A slider called "yellow-width" adjusts the width of the yellow band in the color bar, which shows where the slope is in the u-interval
        (-yellow-width, +yellow-width)
SO, if the yellow bar is too wide, just:
        A. stop with a press on the GO button
        B. reduce this "yellow-width" slider
        C. press STEP once to see if new value is OK
        D. press GO again
OR, simply adjust the slider during a run.

(2d) Adjust the "loss-redline" slider to reveal the local losses, Lhat, of the managers.

(2e) Change "turtle-size" at any time for visibility of managers' turtles

(2f, g, h) Experiment with different values of gs1, R0, and dR
(note: Rs = R0 + dR).

(2i, j) Experiment with the sliders for sigma and tau to control the O-U process for surprise. The button "show-jiggle" indicates the magnitude of the surprise process.

(2k) The "alpha" slider controls the exponent in the price formula, B+C (4).

(2l) The "beta" slider controls the magnitude of the c2-dynamic,
as c2 = beta * mean-Lhat.

(2m, n) Experiment with the "eta" slider to control the strength of the local loss memories, Lhat.

WRITE DATA section

To save time-series data to a file, set "write-data?" switch to "on".
Then press "setup" to start a new run, or press"init-datafile" if you want to continue the current run. In either case, a file "time-series.txt" is opened in the current directory, with a header showing the parameters of the current run. It a file times-series.txt already exists, it will be appended with a new header.

Header data includes: time and date, frequency, u-steps, totalpop, center, width, altitude, height, gs1, R0, dR, sigma, tau, beta, eta, W, and T.

Time series data includes: totalsteps, totaltime, DPM, R1, c2, mean-Lhat, and "crash-detected". The latter is one if the minimum price divided by maximum price (in the time window of length "W" steps) is less than "T".
Both "W" and "T" are set by sliders.

STEP #3: ACTION (Top row of buttons)

(3a) Press "setup" to begin a simulation.

(3b) Press the "step" button to activate a single step in the market game. Every manager will take one step:
* horizontally in proportion to the slope of the landscape at its current position (the value of phisubx at its current u), and
* vertically in proportion to its value in the payoff function
You will see the managers move, and then the histogram will be redrawn.

Press "step" several times to judge the stepsize choice, and the jitter in the position of the maximum, indicated by the yellow zone in the color bar. After ten

clicks the plots will be refreshed.

(3c) Press "go" to trigger a rapid sequence of steps. Press "go" again to halt the action.

(3d) Press "substep" to monitor the effect of a single substep.

(3e) Press "show-jiggle" to display the effect of jiggle.

(3e) While action is stopped, press "do-math" to update most variables (in case some sliders have been changed) without actually taking a step of the simulation.

(3e) Press "restore" to reset sliders to default values.

(3f) Press "rewind1" (while simulation os on pause) to restore all variables to the preceding step.

(3g) Press "rewind2" to go back two steps.

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THE GRAPHICS WINDOW

The Mean Queen, a large white circle in the Graphics Window, indicates the position, (mean-u, mean-z).

The Yellow King is a yellow triangle just above the slope color bar. It's horizontal position shows the value of the cluster point u* (see page 8 of B+C). Eventually, if the herd converges to a cluster, u* will be at the maximimum of phi, and zero of phisubx, and thus, the yellow king will be within the yellow bar.

The cluster point, u*, is the solution of an algebraic equation derived from slope=0 under the assumptions:

A. u[i] = mean-u, all i (that is, a cluster), and
B. mean-u-dot = 0 (that is, the cluster is at a critical point).

To solve the equation, we have used an approximation obtained numerically by Newton's method.

THE PLOTS

With each ten steps, the plots are redrawn:

* Density of managers vs u (essentially a histogram)
* Landscape (phi) vs u
* PM (price of the risky asset) vs step number (a tickertape display)

At present, the density plot is only approximate.

THE MONITORS (to the right of the plots)

After each step, the monitors are updated, showing:

* z-min, totalpop
* mean-u and mean-z (same as the mean-queen) and mean-u-dot
* DPM, the detrended price of the risky assets.
* R0, Rs, and R1 (multiplier of u-term in phi)

* totalsteps, totaltime (based on number of steps)
and lcoaltime (based on number of substeps)
* stepsize, and stepsize-u

The zmin monitor shows the fixed zmin of the model, which occurs in the center of the graphics window. The zmax slider allows the upper limit of the z-scale to be set between 0 and 10. This is an absolute maximum for the portfolio worth of any manager, and should be a positive integer. After changing this slider, one must click "setup" and begin a fresh run.

DIAGNOSTICS

Below the Landscape plot is a pair of diagnostic tools created by Pablo Viotti. These can be switched on and off, and track the attributes of interesting managers.

THINGS TO TRY

Begin by using the 'default' startup settings with c2, Frequency, and zmax. The sliders for max-u-jump and climbrate will be adjusted later as well. Push the 'setup' button and then press the 'go' button.

How do the managers react and how long does it take to reach a stable position? Now while still running the simulation, adjust your c2 slider to a lower number (lets say 3) to adjust for a different 'risk cost' (or risk premium). How do the managers react? Now move your slider again to a higher value of c2 (lets say 7), how do they react now?

The 'frequency' choice (drop down) also plays an important role for determining how the simulation proceeds. After picking values for your 'risk cost' (c2), choose different values of time by adjusting the drop down, notice the different speeds of convergence or divergence.

Play with different groupings of managers by selecting different values for 'center', 'width', 'population', etc. Try creating a group of managers at different ends of the veiw window. Maybe a 'puff' at center 20 and another at center 80. How does this affect the outcome? How does a weighted group balance with a lighter one (one group with higher population compared to a smaller one)?

Finally, the values for 'max-u-jump' and 'climbrate' will help you to avoid or control numerical artifacts. If the setting you choose create large spikes in the the behavior of your managers, it may be a good idea to lower your climbrate, and then adjust your max-u-jump, to help reduce or eliminate these types of swings. You can also try setting your model out from the beginning with a very low climbrate and max-u-jump and see how your simulation reacts.

THINGS TO NOTICE

Notice the landscape view window, and watch how the steepness or shallowness of your selection changes the behavior of your managers. How does the c2 slider affect this dynamic? How about the influence of time (frequency) and the climbrate? Also notice

how the yellow triangle behaves: where does the simulation expect our managers to go?

Also notice the risky price or yeild that your model may or may not stabalize around: does it go up or does it go down with a specific selection?

Watch the behavior of your managers, given different time frequencies, when you change your climbrate.

CREDITS AND REFERENCES

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