Market Model 8.0 Users Manual by Ralph Abraham

WHAT IS IT?

User's Manual for NetLogo Market Model 8.0 rev 03, 12 November 2006, by Ralph Abraham and Dan Friedman. This manual, revised 01 January 2007 with additions by Don Carlisle, 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 basic version of a NetLogo model for financial markets. Further background may be found at www.vismath.org/research/landscapedyn/models/market. More elaborate models will be built on this as a base.

HOW IT WORKS

The turtles are 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 consumers 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 4. A portfolio value of one is considered normal.

A chosen number of managers begin at initial positions in the state space. Model coords (u, z) correspond to screen coords (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 is shown as a histogram in the plot window. Here, density is shwown as a function of u, the horizontal coordinate in the strategy space.

The stepsize may be set with the "frequency" chooser, a drop-down menu. For example, if "52" is chosen in the drop-down menu, this signifies a frequency of 52 (weekly) steps per year, 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 the ratio stepsize/u-steps, and decreases the numerical error in the Euler integration.

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, jump-u = stepsize-u * slope. 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 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. The c2 slider sets an important coefficient in the payoff function, phi, and in the slope, phisubx.

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.

(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 herd of managers.

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-g) Experiment with different values of R0, dR, c2, and gs1 (note: Rs = R0 + dR).

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. After ten clicks the plots will be refreshed.

Press "step" several times to judge the stepsize choice. If the position of the maximum -- indicated by the yellow zone in the color bar -- jitters too much, try increasing u-steps.

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

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

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 the condition 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).
Rather than solving the cubic equation by the exact method of Omar Khayyam, we have used a crude 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
        * DPM (detrended 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 (also shown in the tickertape plot)
* 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 .01) 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 .2), 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. If your settings generate wild fluctuations, an important thing to notice is if you have high enough frequency or an appropriate number of u-steps. Low Frequencies and low u-steps do not allow the model to calculate the behavior of the managers. If these settings are to low, then they can create numerical "artifacts" that can disrupt the "normal" behavior of the model. The values for 'max-u-jump' will help you to avoid or control numerical artifacts as well.

You can also 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)?

Other parameters that can be chosen consist of gs1 (the overall market condition), R0

(the safe asset constant return) and dR (remember Rs=R0+dR).

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) on your managers and the market? Also notice how the yellow triangle behaves: where does the simulation expect our managers to go?

Notice the price 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, and when you change your gs1 slider (to affect the market condition).

Additionally, it is important to keep in mind that this model is the "base" model for further exploration. A great deal of "playing" with the model may or may not help you understand further extensions. It also may be helpful to refer back to this "base model", after some amount of experimentation with additional models.

CREDITS AND REFERENCES

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