Solution of the Fortis Bank case (EN)

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The recent credit crunch, which started as a subprime mortgage crisis in the United States, also caused serious problems for many European banks. One of the biggest banks of the Benelux (Belgium, the Netherlands and Luxembourg), the Fortis Bank, almost went bankrupt. The governments of the three countries met in a great hurry in the weekend of September 27-28 2008 to rescue the Fortis Bank. The reason for rescuing the bank at all cost is that the Fortis Bank is a system bank, which means that its collapse leads to a collapse of the rest of the financial system.

So let us go back to the weekend of September 27-28, let us ignore what happened afterwards, and assume that: In spite of the fact that you are not a financial specialist, you are asked by the three ministers of finance (probably because of your excellent System Dynamics Modelling skills) to help them really understand the issue at hand and help them design an appropriate policy to prevent the Fortis Bank from going bankrupt. Several top-level financial/banking experts and government officials are able to provide you with some general, high-level information, and more specific details concerning the Fortis Bank.

The *stock market value* of the Fortis company can only increase by means of an inflow –the *stock market value increase*– and can only decrease by means of an outflow –the *stock market value loss*. Generally speaking, the *stock market value loss* equals the relative *perceived overvaluation* times the *stock market value* divided by the *market loss delay* of about 1 week. And the *stock market value increase* equals the *perceived market opportunity* times the *stock market value* divided by a *market increase delay* of about 4 weeks. The *initial stock market value* of the Fortis Bank, some 10 weeks before the critical week, amounted to €24.6.

The *perceived overvaluation* –in relative terms, thus expressed in percentages– is then nothing but the difference between the *stock market value* and the *estimated underlying asset value*, divided by the *stock market value*. One of the financial experts advices you to model the *perceived market opportunity* as: (100% - *instant market fear and uncertainty*) ∗ *perceived undervaluation*. The *perceived undervaluation* –in relative terms, thus expressed as a percentage– is then nothing but the difference between the *estimated underlying asset value* and the *stock market value*, divided by the *stock market value*.

The *estimated underlying asset value* (per stock) of the Fortis Bank amounted initially, some 10 weeks before the catastrophic week, to €25. The *estimated underlying asset value* can increase by means of *underlying asset increase*s and can decrease by means of *underlying asset loss*es (e.g. in case of a run on the bank, loss of unsecured assets, et cetera). The *underlying asset increase* could be simplified as the *average profitability* on the underlying assets times the *estimated underlying asset value*. The *average profitability* of the assets amounts to 0.2% per week. The financial advisors agree that the *underlying asset loss* –which should always be > 0– should best be modelled as:

$$\textit{external real value loss shock} * \textit{estimated underlying value} + \\ \textit{liquid deposits and loans loss fraction} * \textit{fraction of asset loss to deposit loss}$$

The *liquid deposits and loans loss fraction* equal the *average bank client's fear and uncertainty* divided by the *average stickiness of deposits and loans*. Assume at first that the *fraction of asset loss to deposit loss* is equal to 1. [The assumption behind this formulation is of course that when fear and uncertainty increase, average bank depositors start to empty their deposits and average lenders stop lending, which needs to be compensated from the bank's assets. In reality these compensating assets are liquid at first but afterwards more and more fixed (by liquidating them), and losses are made. For a better formulation, see the policy model that will be discussed next lecture.]

The *external real value loss shock* should be used to model and simulate the asset shock as a percentage of the *estimated underlying asset value*. This *external real value loss shock* amounted in week 10 to 35% in this 1 week time[1]... The exact *average stickiness of the assets* of the Fortis Bank is unknown: it could lie anywhere between 4 weeks and 52 weeks. Just take the average value of 28 weeks for a start. The *average bank client's fear and uncertainty* follows the *market fear and uncertainty*, but then smoothed. Model the *average bank client's fear and uncertainty* therefore as a third order delay of the *instant market fear and uncertainty* with an *uncertainty and fear delay* of 2 weeks. Initially, the *average bank client's fear and uncertainty* is equal to 0%.

The *instant market fear and uncertainty* could be modelled as:

[1] Hint: you can model this for example by means of two step functions.

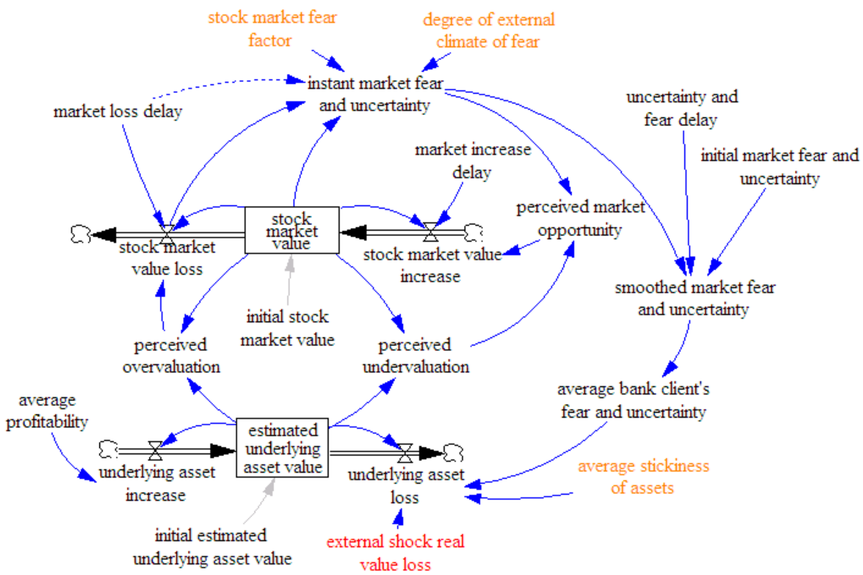
$$\textit{instant market fear and uncertainty} = \textit{degree of external climate of fear} * \textit{stock market value loss} / (\textit{stock market value} / \textit{market loss delay} * \textit{stock market fear factor}).$$

The *instant market fear and uncertainty* should also remain between 0% (absence of uncertainty and fear) and 100% (complete uncertainty and fear). The *stock market fear factor* is assumed to be some 25%. This factor is used to put the loss into perspective – that is to say, relative to the share price: the 25% means that people freak out completely if the share price drops 25% of its initial value during the *market loss delay* period of one week. Since the general climate is one of uncertainty and fear, the *degree of external climate of fear* could be assumed to be rather high, for example twice as high as before the crisis, thus 200%.

1. (/6) Make a System Dynamics simulation model of this issue on your computer. Save the model using your family name or student number and the version of the model.

/3 – Model: 2 stock-flow structures and rest of feedback loop structure

In Vensim:



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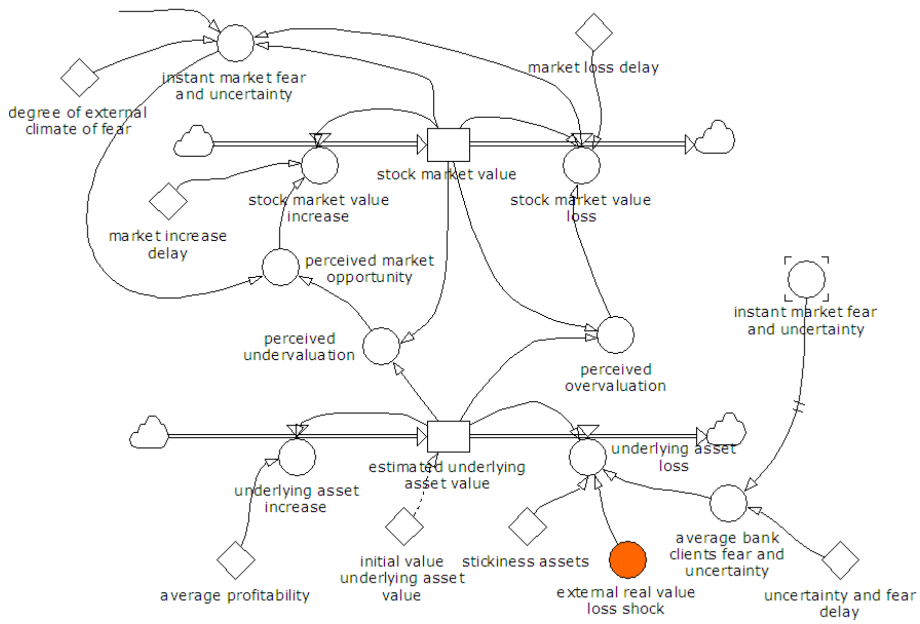


/1 – Settings: time step, integration method, time horizon

Euler (very discontinuous exogenous input) with a small time step.

/1 – Specification: equations

See models on blackboard.

/0.5 – Specific function 1: min (max) function *instant market fear and uncertainty*

instant market fear and uncertainty = ***MIN(1,MAX(0,****degree of external climate of fear * stock market value loss / (stock market value / market loss delay * stock market fear factor)****))***

/0.5 – Specific function 2: Information Delay, not a Material Delay

average bank clients fear and uncertainty = ***DELAYINF****(instant market fear and uncertainty, uncertainty and fear delay, 3, 0)*

2. (/2) Verify the model very briefly. Include the necessary formulas/code/structures that ensure that variables that cannot become negative indeed remain greater or equal to zero. Examples are: the *perceived overvaluation*, the *perceived undervaluation*, and the *underlying asset loss*. Why do these variables always need to be greater than 0?

/1 – Verification: Units, more specifically of *external real value loss shock* Units of *external real value loss shock*: $1/wk$

/1 – Verification: Max functions? Why?

Variables *perceived overvaluation* and *perceived undervaluation* need to be positive because there is *either* a *perceived overvaluation* *or* a *perceived undervaluation*, but not both. Negative values for these variables might turn the inflow (outflow) into an outflow (inflow). An asset loss cannot be negative. Otherwise it would be a gain instead of a loss.

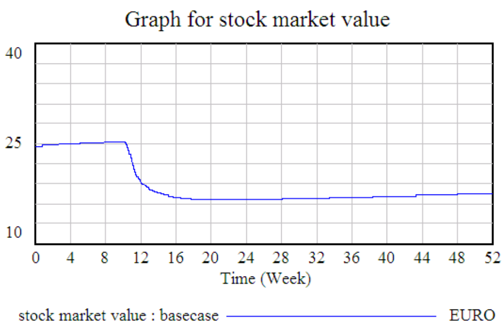
3. (/1) Validate the model extremely briefly. Use maximum 2 very simple tests. Do not perform any extensive tests or sensitivity analyses here. Name or briefly describe the tests used.

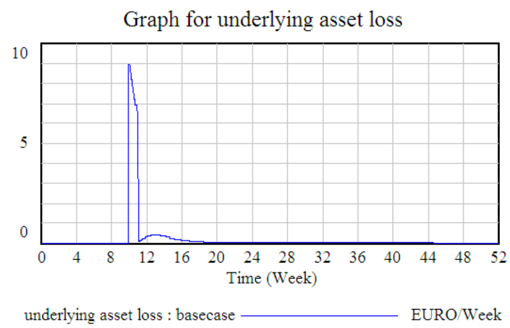
/0.5 – Validated? Impossible Outcomes? If so, realised?

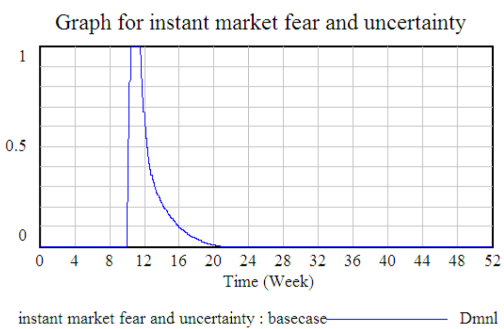
/0.5 – 2 tests. E.g. Face validation, extreme conditions test,. . .

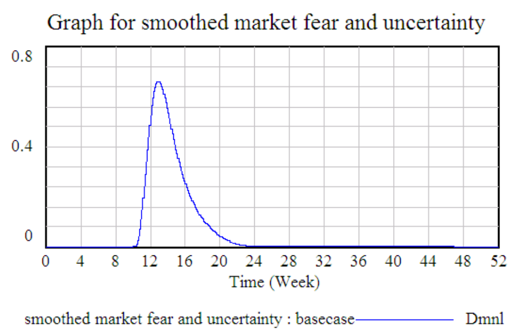
4. (/1) Simulate the model for a period of 52 weeks. Make graphs for following variables: *stock market value*, *underlying asset loss*, *instant market fear and uncertainty*, and *smoothed market fear and uncertainty*. Sketch them on this exam copy too.

   /1 – Basic behaviour correct?









5. (/2) Three variables are particularly uncertain, simply because they are unknown: the *stock market fear factor*, the *average stickiness of assets*, and the *degree of external climate of fear*. Test the sensitivity of your model (manually) to changes in these variables. Keep it simple!!! What can you conclude regarding the sensitivity of your model?

   Conclusion: The model is mostly not behaviourally sensitive, except when the *stock market fear factor* is very high AND the *average stickiness of assets* is very low AND the *degree of external climate of fear* is very high. Then, the bank goes bankrupt! There is a clear bifurcation point. Hence, the behaviour of the model is behaviourally sensitive to a really heavy crisis. . . Proactive policies are therefore needed to prevent a collapse of the bank, but only in case of a crisis.

   /1 – analysis / graphs.

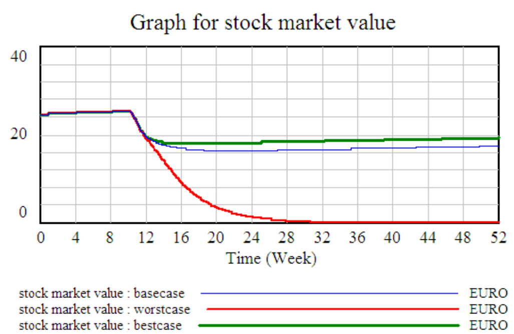
   /1 – Conclusion.

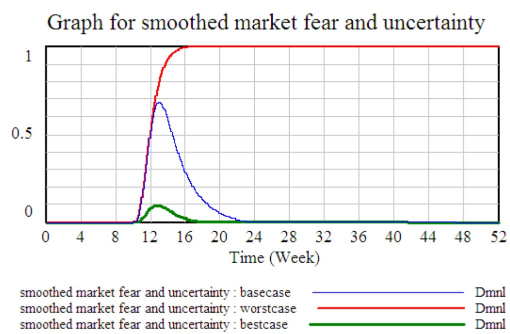
6. (/2) Sketch the dynamics of the *stock market value* and the *smoothed market fear and uncertainty* for the worst case and best case scenarios in just two graphs on your exam copy (use different colours except red):

   - a *stock market fear factor* of 25%, an *average stickiness of assets* of only 4 weeks, and a *degree of external climate of fear* of 200%.

- a *stock market fear factor* of 100%, an *average stickiness of assets* of only 52 weeks, and a *degree of external climate of fear* of 100%.

/2 – Correct Graphs :



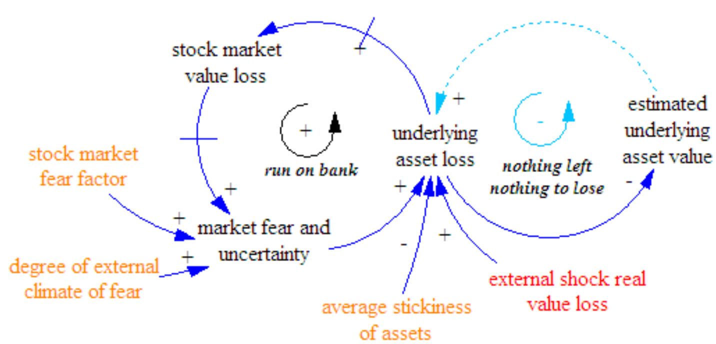


7. (/4) Draw an extremely aggregated/simple *causal loop diagram* of the system to help you communicate the main feedback effects responsible for the worst case system behaviour.

/2 – General diagram: names and link polarities

/1 – Feedback Loops and Loop polarities

/1 – Intelligently named loops



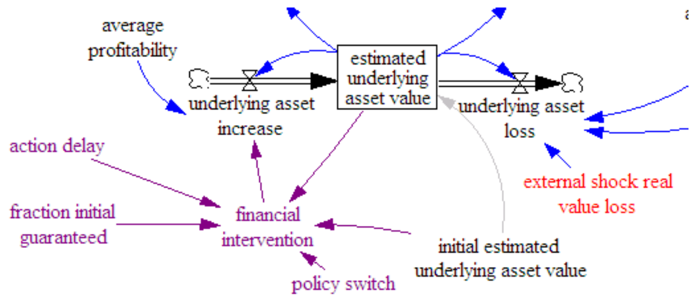
8. (/1) Explain the link between structure & behaviour briefly for the worst case scenario only.

/1 – Explanation

A strongly decreasing stock market value leads to fear and uncertainty, which incites people to empty their bank accounts, causing the stock market value to even fall further, etc. This positive feedback –if fast and strong– is hard to stop before the bottom is hit. . .

9. (/1) Save your model under another name and add a simple closed loop policy (in colour) that prevents the bank from collapsing, no matter which of the scenarios actually materialises. Name or describe the policy briefly. Test the policy at least in case of the worst case scenario and sketch the resulting dynamics on your exam sheet.

Policy: governmental guarantee of 50% of the initial underlying total asset value, no matter the asset loss. . .



/1 – Effective closed Loop Policy Measure? The consequence is that the government only needs to pay in the exceptional case of a really heavy crisis and subsequent run on the bank. In all other cases, this policy does not cost any money (see for example the basecase where no intervention is needed)!