

HIGH LEVEL DESIGN And USER DOCUMENTATION For CmLab (CONSERVATION OF MONEY LABORATORY)

Frontispiece

PANEL 01 THE MODEL
Conservation of Money Laboratory (NetLogo Platform)

FAST START:
1. Setup
2. Go

STARTUP SLIDERS:
q-scenario: Prsns Only
q-use-this-seed: 7
q-crb-assets-per-prsn: 3000 \$

OPERATIONS CONTROLS:
One Tick: []
g-halt-at-tick: -1
Go: []

Prsns-To-Banks Flows:
q-lorr: 2.0 %
q-lor: 1.0 %
q-cobi: 2.0 %

Banks-To-Prsns Flows:
q-bisd: 1.0 %

Other Flows:
q-reserve-requirement-ratio: 20.0 %
q-net-worth-tax-rate: 0.5 %

Net Worth of Agents:
Prsns: Green
Banks: Red

MEAN NET WORTH:

Prsns	Banks	Ticks
-2723.8	114596.21	50000

2-Breeds; 3-Money Supplies; 4-Debug Tools; 5/6/7/8-Graphs

PANEL 07 LINE GRAPHS

Money Supplies: Dollars (\$) vs Ticks. Shows MS-I (black), MS-II (green), and MS-III (red).

Bank PO Assets - (Min, Mean, Max): PO (\$) vs Ticks. Includes VC, ER and RR PO assets.

Mean Net Worth: Wealth (\$) vs Ticks. Shows Prsns Max, Mean, Min and Banks Max, Mean, Min.

No of Prsns: Count vs Ticks.

Ticks	Banks	B-Max	Prsns	P-Max	L1 Loans	P. Births	P. Deaths	B. Births	B. Deaths
50000	20	20	400	400	31370	400	0	20	0

Clear All Plots | Setup | One Tick | Go

8-More Line Graphs ---->>>

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1 - References

- A. 160218 PPR A Restatement of Odum's Maximum Power Principle R5.pdf
- B. 160210 NTF Critique of Restatement R5.pdf
- C. 151224 NTF ICBT and PowEff R7.pdf
- D. 151116 PPT MPP Presentation 30 Mins R15.pptx
- E. EiLab, OpenABM, <https://www.openabm.org/model/3860/version/3/view>
- F. 160316 NTF MPP and Global Economy R5.pdf
- G. 160330 NTF Conservation of Money R9.pdf
- H. CmLab V1.17.nlogo – The NetLogo model that is the focus of this NTF
- I. “The Economics of Money and Banking”, a MOOC from INET, by Dr Perry Mehrling, <https://www.coursera.org/course/money>
- J. ModEco and The PMM, a C++ model, OpenAbm, <https://www.openabm.org/model/3613/version/2/view>
- K. Model Economy V1.38, “The PMM”, a NetLogo model, http://modelingcommons.org/browse/one_model/4219#model_tabs_browse_info
- L. Maximum Power Principle: OamLab V1.07, http://modelingcommons.org/browse/one_model/4268#model_tabs_browse_info
- M. MppLab I V1.xx.nlogo – The NetLogo model that explores the workings of the Maximum Power Principle.
- N. “Conservation of Mechanical Energy”, <http://physics.bu.edu/~duffy/py105/EnergyConservation.html>
- O. 141129 NTF - NetLogo Stds for OrrerySW R2.pdf
- P. https://en.wikipedia.org/wiki/Money_supply

2 - Background

This is part of a personal study of the nature of sustainable economic systems, with a focus on the very basic dynamics of persistent economic processes and types of output. At the time of writing of this manual the reference documents are very much in need of revision. However, I decided to push through to the end of my logical trajectory to see if all of the stepping stones along the way were identifiable. Having a glimmer of hope, I wanted to see if that glimmer was a will-o-the-wisp, or a real lantern in the distance. So, here is a brief description of the Refs.

Ref A is my draft paper (unpublished) in which I attempt to “re-state” H.T. Odum’s Maximum Power Principle (MPP) as three falsifiable hypotheses. I felt this was necessary because I could not find in his writings a presentation of that principle that was complete, clear and falsifiable. In fact, there were several different aspects of the MPP that I had difficulty fitting together. Ref A was a partially successful and partially failed effort. The process of writing it clarified many things for me, but raised a number of other questions.

Ref B is my note to file (NTF) in which I did a “fault mode analysis” of the Ref A paper exploring some of those questions. That is, I attempted to find the logical faults in the paper and describe them in as much detail as I could muster. One particularly relevant and difficult observation coming out of the thought processes of Refs A and B was the conclusion that a “Goldilocks” curve HAD to be involved in EVERY energy transformation in persistent self-

organizing physical systems, and, likewise, one HAD to be involved in EVERY persistent sort of commercial transaction in persistent self-organizing economic systems. This was/is an extremely general claim that was absolutely key to my growing understanding of the MPP. My first attempts to show it to be true, in the past, however, had all failed. This became, for me, a test case to see if the fundamental assumptions of the two documents were valid. So, I set out to show that such Goldilocks curves were indeed ubiquitous in nature and in economic systems.

Ref C is a collection of mathematical exercises. With little sophistication and absolutely no elegance, I address every realistic combination (and a few unrealistic ones) of Income, Cost, and Benefit curves (ICB) and show that a Goldilocks curve is implicit. I think that my definition of income, costs and benefits is broad enough to address flows of energy, flows of mass, or flows of any other type of “stuff”, whether physical or logical. Significant lacks in that Ref C presentation, however, are a serious treatment of time, and a serious treatment of multi-variate relationships. I am convinced that a mathematician with more skills than me would be able to make those arguments, and address those lacks. Time (T) is the missing bit of the ICBT curve sets. So, that needs a lot of work, but I am now convinced that it can be done and the conclusions are valid.

Having established, to my own satisfaction at least, that Goldilocks curves are indeed ubiquitous in both natural and economic systems, and have been from the appearance of the very first economic systems in human history, I was drawn into thought about how the MPP might explain the phenomenon that I spoke about in my Ref D presentation at the CANUSSEE/BPE conference in Vancouver in October. In that presentation I discussed the observation that the financial economy took flight and separated from the “real” economy, at some time in the 1970s. My thought processes there were based on my study of the “capital exchange” models of Benatti, Drăgulescu and Yakovenko (the so-called BDY models), and the variations on those models that I had implemented in the EiLab application (see Ref E).

That led to the writing of the Ref F NTF in which I develop a concept of the history of money systems, driven by the MPP to ever more complexity and sophistication, and supporting an ever more sophisticated and complex society, paid for by ever larger quantities of energy in the form of fossil fuels. Key to THAT (as yet unfinished) argument was/is the idea that the conservation of money in a modern (post 1970) economy provides a logical platform directly analogous (or homologous) to the first law of thermodynamics. And, upon that logical platform, two different types of dynamics contend in an ever-lasting battle for supremacy – a battle that continues as long as there is a flow of energy (and of its proxy – capital) to sustain it. And THERE we get to sustainability issues, and issues of the persistence of natural and economic systems. Those two dynamics are entropy production (2nd law) and complexity production (proposed 4th law). BUT, for that to work, I need to propose that the entropy and complexity produced by each dynamic need NOT be purely physical, but might also be largely logical in form. Ref F remains in unfinished form, needing some substantiation of key assumptions, such as the one that money is a conserved quantity. The only real feedback I received on the Ref F document was along the lines that “but, of course, money is NOT conserved, because money supplies expand and contract as needed”.

Ref G is the response to that observation – an unfinished NTF in which I explore the nature of the phenomenon of the conservation of money, and propose a version of the “1st law of econodynamics” ☺

That leads me to Ref H, the NetLogo computer model that I wrote to further explore the concepts developing in the Ref G NTF. And, that is the focus of this NTF. The other Refs are cited as needed.

3 - Purpose

The purpose of the Ref H computer application is to explore the nature of a monetary system that is managed using a “fractional reserve banking system” and “double-entry book-keeping”. It is an extension of the BDY models of Benatti, Drăgulescu and Yakovenko, in that it is a “capital exchange model” in which no physical goods or services are exchanged. The focus is entirely on money. This is, I think, the “money view” that Dr Perry Mehrling advocates in his lectures, at Ref I. The goal is to explore when and how money is “conserved”, and when and how it is not conserved, in such a modern money supply.

The purpose of this note to file (NTF) is to document and discuss the output of one run of V1.17 of the Ref H computer application – i.e. of the Conservation of Money Laboratory. Within this note I will refer to it as CmLab.

4 - Discussion

My approach in this discussion will be to address two issues in parallel:

- I’ll describe the design and operational characteristics of CmLab; and
- In parallel, I will present and describe the output of a specific set in input parameters, the default set.

4.1 - Design Elements

4.1.1 - Technical Platform

CmLab is implemented in NetLogo version 5.0.5. This version has now been somewhat surpassed by the developers of the NetLogo platform, which is a fast-moving target. I don’t want to get into an endless loop of upgrading my models, so I decided to stick with the application development environment that I first used for the “PMM”, “OamLab” and “MppLab” models. (See Refs J, K and L.).

4.1.1.1 - Capital Exchange Models

CmLab is a capital exchange model. It is a peculiar sort of economic model in which there are no goods and services sold, and nothing is priced. Price and quantity have no role. It is a purely “money view”. When one economic agent purchases something from another agent, it appears no different from a gift, from one agent to the other. So the kinds of exchanges of capital involve taxes collected, government spending, bank spending, spending by prsns, interest payments on loans, etc.

4.1.1.2 - Agent Based Models

CmLab is an agent-based model (ABM). There are four kinds of economic agents that interact with each other, making a variety of capital exchanges.

This is not an economic model in the sense applied to most classical economic models. There are no equations balancing the changes in dozens, or hundreds, of variables. There are no differential equations describing the dynamics of changes. While some arithmetic is necessarily used to calculate interest payments and other things, there is no mathematical model functioning behind the scenes.

In place of those modeling equations, the economic agents are defined, each of which has “characters” (characteristic behaviours and holdings). Those agents interact with one another in pre-determined ways. In particular, in this model, they interact following an abstraction of the rules of a fractional reserve banking system, and the rules of double-entry book-keeping. So, rather than having a top-down design, the programmer designs the detailed interactions between agents, and the combined high-level effects emerge naturally.

For example, in this model there is no equation or conversion factor that relates the GDP (flow of capital per year) to the interest rates, or that relates the size of the money supplies to the interest rates. Such relationships, if they exist, emerge from the model. Such emergent effects are not just common in ABMs, but expected.

The significant difference in the design and behaviour of ABMs arises from the different perspective of the designer. In a standard economic model, the macro-economic variables are the primary variables in the model, and the hypothesis to be tested is formulated as equations relating the variables. But, in an ABM, the micro-characteristics of the objects and agents in the model are the primary variables, and the hypothesis to be tested is formulated as micro-interactions between agents. The macro-economic variables are all implicit and emergent. And those emergent behaviours provide insight into real-world dynamics.

4.1.1.3 - Verification, Validation, Simulation and Demonstration;

When a new computer model is constructed there are two ways to test it:

- **Verification** – Is the code free of error – does the software process data as intended?
- **Validation** – Is the model a valid simulation of reality?

A computer model can represent reality in two distinctly different ways:

- **Simulation** – The model is attempting to reproduce, with as much accuracy as possible, a data stream that can be obtained empirically from measurements in the real world. When simulation is sufficiently accurate, then the model may be used to predict future events from past events. Weather models, for example, are of this type. Most economic models are of this type. Usually they are built on macro-level mathematical models involving otherwise intractable differential equations.
 - **Demonstration** – The model is demonstrating dynamic behaviour that is implicit in its design, and can be studied as a dynamic system in its own right. While the understandings gained from such studies may be applicable to real-world systems, there is no intent to use the model to duplicate empirical data streams obtained from real-world systems. The “Game
-

of Life”, or the study of “Finite State Machines” would fall into this category. Whereas few would argue that such models simulate, or even emulate, reality, they are clearly applicable, and the things learned in their study has been hugely informative. ABMs excel at this sort of modelling.

CmLab is NOT a simulation of anything. It is a demonstration of the dynamics that emerge out of the rules of fractional reserve banking, and double-entry book-keeping. That is all that it is. The process of “validation” of a model involves comparison of model output with real-world data. CmLab is not meant to be validated by comparing numeric output from this model to real-world data. The goal is NOT to replicate some stream of real-world data accurately. The goal is to generate data that exemplifies the interactions of such rule-based systems, so that the dynamic relationships between variables can be better understood.

On the other hand, the process of “verification” of computer code is the process of finding and eliminating all of the bugs and programming errors. A computer program is considered verified if it has no logical bugs, and runs as intended. This application contains many hundreds of debug calls that are designed to find and eliminate all such bugs. As far as I know, the economic engine of this application is 100% verified to be running as I intended. All design decisions are documented in detail in this document, and in the code itself, and all evidence of bugs of all sorts in the economic engine has been addressed.

So, I prefer to say that CmLab is not a simulation of any banking system that needs to be verified. Rather, it is a demonstration of the dynamics of an abstracted fractional reserve banking system.

4.1.1.4 - A Model “Run”

CmLab is what one of my students once referred to as a “zero person game”. You set some parameters, start it up, and then watch it run until it comes to a conclusion (economic collapse?) or until you get tired of watching it (steady state?). In this case, the run that is documented in this NTF, and in the annexes, is the default run. The random seed is a 7. There are 20 chartered banks and 400 prsns participating in the economy. All input parameters governing interest rates and capital exchange events are set to default values. It eventually comes to a steady state in which there is an unhappy balance between the real economy (the prsns) and the financial economy (the banks).

4.1.1.5 - The “Economic Arena”

A standard feature of every NetLogo model is a spatial representation of the model. I have no need of such a spatial representation, as I do not model real geographic space in any way. I have left this feature visible, however, just because it is boring to watch a model in which nothing is happening. To be absolutely clear, the “economic arena” is just a dummy window, with pretty truck-like icons moving about, and it has no real meaning for the model.

4.1.1.6 - User Interface Panels

NetLogo does not allow a programmer to temporarily “paint” the computer screen with a type of output placed into a “window”. Instead, most graphic output mechanisms (monitors and graphs) must be placed on a single area of logical real estate, and the user can use scroll bars to look at different parts of that real estate. These output mechanisms have static size and location, and

only the content varies. I have organized them all, along with the input parameters and controls, into eight “panels” each of which has a general purpose. Screen grabs of each of the eight panels are in Annex A of this NTF. The eight panels are:

- PANEL 01 – Main panel with basic controls and output;
- PANEL 02 – Monitors for variables, organized by type of breed of agent, by type of money;
- PANEL 03 – Monitors for variables, organized by money supply, by type of money;
- PANEL 04 – Debug tools and “advanced” parametric controls;
- PANEL 05 – Histograms;
- PANEL 06 – More histograms;
- PANEL 07 – Line graphs; and
- PANEL 08 – More line graphs.

4.1.1.7 - The Code

The code is readily accessible in any NetLogo model under the “Code” tab. This application has 6,561 lines of code (v1.17) under that tab, which sounds like a lot, but I use a lot of white space, and the code is very heavily commented. The distribution of types of “lines of code” breaks down like this:

<u>TYPE</u>	<u>No Of Lines</u>	<u>%</u>
Native code	2,384 Lines	36%
Comments	2,695 Lines	41%
Debug calls	494 Lines	7%
<u>White space</u>	<u>989 Lines</u>	<u>15%</u>
Total	6,562 lines	100%

In total there are just over 2,000 lines of effective code, and over 2,000 lines of comments explaining what I am doing and why I am doing it that way. In many instances I discuss theory and options and implement one or another of the options discussed. That is roughly equivalent to 40 pages of documentation right in the code. So, I think that the very best documentation of this application is the code itself. I have done it this way to enable other interested coders to modify or expand upon the model easily.

4.1.2 - Logical Concepts

The various output panels in the user interface of CmLab use a lot of jargon-like symbols and terms that are unavoidable. These are based on the concepts developed in notes at Refs F and G, but expand or refine those concepts as needed. I plan to go back and revise those Refs based on what I am learning in this modeling exercise. Those logical concepts are as follows.

4.1.2.1 - Money Supplies – MS-I, MS-II and MS-III

There are three distinct money supplies (see Panel 03, or sections 4.2.3 or 7.3):

MS-I – The physical money supply. In the parlance of those who study such things, this might be similar to what is called the “money base” and designated MB, but not the same. I distinguish between the physical piece of paper or coin, and the logical face value of that paper or coin. MS-I tracks the physical objects, as if they were are \$1 bills or coins. In this system mass is conserved, and MS-I is of fixed size.

MS-II – The logical money supply. This is the total of the face values of the physical money supply, plus all logical money created by explicit loans from chartered banks and placed into the checking accounts of Prsns. The logical money supply expands as new bank loans are approved, and shrinks as those bank loans are paid off. This would not include interest owed to banks on loans, or banking fees, unless those monies are explicitly added to the principal of loans.

MS-III – The “shadow” money supply. I confess that I borrowed this word “shadow” from the lectures of Dr Mehrling (see Ref I), in which he used it in reference to so-called “shadow banks” operating within the financial economy. My meaning is more broad than his, and I apply it to the money supply itself, and not the source. In this model, the shadow money supply includes all logical money created by loans from agents other than chartered banks, and placed into ledgers that are largely (but not necessarily) invisible to the chartered banks, and the government institutions that monitor such things. In this model, MS-III consists of interest that has accrued but is, as yet, unpaid, and commercial transactions with 30-day terms of payment. I consider such a “loan” to have been let each time a transaction happens with explicit deferred payment, other than by check.

4.1.2.2 - Breeds of Agents

In NetLogo, which is an application development environment (or ADE) explicitly intended for agent based models (ABMs), the agents come in flavours called “breeds”. I have implemented four such breeds, with many pre-existing hooks to add a fifth breed (corps), if I ever decide it will be insightful, as follows:

The GCRA breed – GCRA stands for the Government Consolidated Revenue Accounts. There is only one agent of this breed, and it is located in the centre of the “economic arena” (see the graphic for Panel 01, in section 7.1) as a black triangle. The GCRA taxes prsns, and spends money by paying prsns. The GCRA connects to a single chartered bank, where it opens a checking account that is used to hold its current money. Its bank holdings are maintained in a C1-type variable called its check book.

The CRB breed – CRB stands for Central Reserve Bank. There is only one agent of this breed, and it is also located in the centre of the “economic arena” (see Panel 01 again) as a yellow triangle. The CRB initially creates the money base by fiat, and, on behalf of the government, distributes that to the prsns in the real economy. The chartered banks have no funding initially. The CRB also contacts each chartered bank daily (minimum of once per tick of the model), or as may be needed in addition to the daily attention, to ensure that sufficient funds are placed in reserve deposits to cover current loans extended by the chartered banks. The CRB pays interest to chartered banks for required reserve (RR) deposits and for excess reserve (ER) deposits. Essentially, the CRB manages the physical money supply (MS-I). Like the GCRA, the CRB connects to a single chartered bank, where it opens a checking account that is used to hold its current money. Its bank holdings are maintained in a C1-type variable called its check book.

The bank breed – Bank stands for chartered bank. Banks are depicted as stationary red targets in the economic arena. A chartered bank has two roles that I distinguish as the “front room” corporate role and the “back room” public trust role. The front room is responsible to make a profit, so it charges and collects interest, pays interest, and possibly makes purchases (gets involved in daily capital exchanges). The back room looks after the financial accounts of the clients of the bank – those who have deposited money into the bank. In this role of public trust the bank ensures that money is conserved in all of its transactions, and it uses double-entry book-keeping logic to do that. The back room manages the bank vault, and the ER and RR deposits with the CRB. But, the front room collects any interest due from the CRB. The front room is a

special client of its own back room, and keeps track of its own deposits in its own check book, maintained in a C1-type variable.

The prsn breed – Prsn is short for person, and can mean any person under the law that is competent to enter into commercial transactions. This includes workers, store owners, small business operators, professionals, government agencies. This is meant to exclude those agents that sell stocks or issue bonds. (See “The corp breed” below.) Prsns receive an initial endowment of physical funds (\$1 bills) as determined by a parametric slider, and they deposit that money into a chartered bank of their choice (randomly selected, actually). They then move much of that into a savings account, take some out as currency, and leave the rest in their checking account to support daily business transactions. The bank then moves the physical money into an excess reserve (ER) deposit with the CRB. Prsns engage daily in capital exchanges of cash with other prsns, and they engage in daily capital exchanges on 30-day terms, paid by post-dated unsecured checks. They receive interest from their bank on savings deposits. Each day, a shortage of money in cash or checking accounts is replenished from savings. When savings are depleted, a prsn can request a bank loan, which expands the MS-II money supply. Prsns pay interest on outstanding principle of bank loans. Payments on principal are made monthly (every 30 ticks). So, the activities of prsns cause both the MS-II and MS-III money supplies to expand and contract again.

The corp breed – Corp is short for corporation, and can mean any extra-ordinary prsn that, in addition to the characteristics and activities described above, has the ability to garner money by selling stocks or letting out bonds. I have not implemented corps, as this gets into a grey area where I have to “price” stocks and bonds. As soon as you talk about prices you are getting out of the pure “money view” and getting into the complicated interface between money systems and the real-world markets in which goods and services are bought and sold. I have put many “hooks” into the code, most marked with “TODO:” to make them easily locatable. So corps can be easily implemented in a new scenario. But, for the moment, corps do not appear in the economic arena, and play no role in this version of the model. I am currently undecided as to whether my decision not to implement corps is a good decision or a bad decision. The model provides lots of insight the way it is now, as was hoped, without the addition of corps. The addition of corps might obfuscate that insight, or might sharpen it. I don’t know.

4.1.2.3 - Details and Aggregates

Details – Each of the four breeds of agent has its own profile of characters (of variables) in which the details of that agent’s holdings are maintained. For example, a prsn agent has a variable called “P0-assets” which contains a whole number representing the count of \$1 bills and coins held in its wallet. Each prsn also has a variable called “L1-assets” which represents the number of logical dollars held in its checking account. Such variables that represent a single type of holding of a single agent might be considered detail-type variables.

Operational Aggregates – Each bank must serve many clients in the form of prsns, and possibly the CRB and GCRA. If I were to do a complete simulation, the checking account of each client would be represented by its own detail-type L1-assets variable in the bank, as clients are added or removed, the bank would have variables added or removed in some sort of array of variables. This is complicated to program, and somewhat redundant. I have chosen to represent the bank’s liabilities for all of its client’s checking accounts as a single variable called L1-debts. So the sum of all L1-assets for all clients of a bank is equal to the L1-debts variable of the bank. The bank keeps no record (no array) of who its clients are. But each client keeps a record (a single number) of which bank it has deposited its money into. So the detail-type variables in the clients’ records

are used to break out the bank's aggregated liabilities associated with all clients. I call such aggregate variables in the banks the "operational aggregates". By this technique, I make the coding less complicated, and it runs with dramatically better performance than I would have otherwise. Because of this, most interactions between banks and clients are simple additions and subtractions from operational aggregates within the bank's accounts. Chartered banks have operational aggregates for dealing with the accounts of prsns, the GCRA, and the corporate funds of banks and the CRB. The CRB has operational aggregates for dealing with ER and RR deposits from chartered banks.

Display Aggregates – In a typical run of the model, there are many agents including 20 banks, 400 prsns, 1 GCRA and 1 CRB, and they utilize several thousands of detailed and aggregated operational variables of many types. To display meaningful data respecting so many detailed variables and operational aggregates, it is necessary to compute aggregates such as means and sums. These aggregates are NOT involved in the model in any way, usually, and are for display purposes. This means, they are presented in a small NetLogo window called a monitor, or they are used in a line graph. A histogram is a special type of graph that creates its own aggregates. These sorts of display-only aggregates are computed at the end of each tick, usually, and the monitors, line graphs, and histograms are updated at that time.

All of the data displayed in the user interface of the CmLab model is of the form of display aggregates. They are all sums across all relevant agents of that breed, unless a mean is indicated.

4.1.2.4 - Types of Money Variables

I have already made reference to types of money variables. They require some explanation. I started by studying the money supplies as described in Wikipedia (see Ref P), but they were confusing, and difficult to model, and just generally not very helpful. For the purposes of this model, I found I had to re-define the concepts of the money supplies, and I developed a variety of variable naming conventions in the code to keep track of different kinds of money. In the following table I try to match a standard interpretation of kinds of money, and the symbols used in the Wikipedia article, to the variable names that I have used in this application.

CmLab symbols		Related Wikipedia Symbols	
Sym-bol	Description	Sym-bol	Description
P0	Physical bills, in \$1 denominations. In circulation or in bank vaults, or in the CRB in ER and RR deposits. MS-I consists of all P0 money.	M0 Or MB	Currency in circulation. Physical money in circulation, or in vaults, or in ER and RR deposits.
L0	Face value of physical bills, while in circulation. Convertible to L1 when deposited into a chartered bank.		
L1	Logical money, not associated with physical bills or coins, found in bank checking accounts, or in the bank-related ledgers of prsns such as their check books. Does not include L0 in circulation, but does include L0 deposited into banks.	M1	Includes checkable bank accounts, but also includes M0.
L1-loan	Logical money that is unpaid principle of a bank loan. The MS-II money supply	M1	This is the basis of the expansion of the M1 type of money.

	consists of the sum of all L1-loan money plus L0 money.		
CmLab symbols		Related Wikipedia Symbols	
Sym-bol	Description	Sym-bol	Description
L2	Logical money that resides in savings accounts opened by prsns to hold any overflow of L1 money not needed for daily capital exchanges. Does not include L1 or L0 money.	M2	Includes money in savings accounts, but also includes M1 and M0 money.
C1	This is L1 money as recorded in the check books of the “front room” of any banks, including the CRB and chartered banks. Since banks must, in their “back room” role, keep track of L1 money for all of their clients, a different variable is required to track their “front room” funds. These include income and losses from daily receipts and payments relating to interest.	M1	This would be considered part of M1.
S1	This is shadow money. It is the prime component of the shadow money supply (MS-III). It is the unpaid payables and receivables associated with accrued interest and 30-day commercial capital exchanges. It exists only in the ledgers of the parties to the agreements. When the debts are paid, L0/L1 money is used, and the S1 assets and liabilities collapse and disappear again.	XX	This would not be considered to be part of any official estimate of the money supply, but might be implied by the so-called “multiplier effect”. This is money which is less liquid, and turns over less quickly, having a slower velocity than L0 or L1 money.

The fundamental distinctions between my definitions of types of money tend to be by their source (how created). L0/P0 is created by government fiat. L1/L2 is created by bank fiat (via loans). S1 is created by commercial fiat (via terms of deferred payment). P0 is of fixed size. L1, L2 and S1 are of varying sizes.

The fundamental distinctions between standard definitions of types of money tends to be their “width”, in the sense that M0 (circulating currency) is considered the most “narrow” definition of money supply, while M1, M2, M3 and M4 are considered to be more and more broad definitions of money, each including less and less money-like media of exchange.

4.1.2.5 - Positive and Negative Money

Debt, I have been told, is the oldest kind of money. When you consider the ancient cuneiform records of Mesopotamia, that argument seems to have some validity.

When a bank loans money, credits are deposited into a person’s checking account, and, at the same time, a debt consisting of a loan is recorded in another account against that same person. The net worth of the bank has not changed. The net worth of the borrower has not changed. And yet, there is considerably more spendable money available to the borrower, and considerably more debt to be paid off as well. When monetary assets (positive money) are

created in this way, monetary liabilities (negative money) of the same magnitude are simultaneously created.

But, though they arise from the same creation events, and they share many characteristics, they have different uses and different trajectories through a financial system. Credits tend to be attracted to massive pools of credit, such as pension funds, or equity markets, while debts tend to be attracted to massive pools of debt, such as sovereign debt funds, or bond markets.

In the displays in Panels 02 and 03, the monitors display both assets and liabilities. You will see that some remain paired, the assets and liabilities matching in size, while in other instances they become separated and pool together over time.

4.1.2.6 - Public and private money

Some money is owned by agents within the economy, and contributes to their net worth. At the same time, other money is held in trust, on behalf of those who own it, and that money can be considered as part of a public trust. Money held in trust is usually held in both positive and negative amounts that cancel, so the net value of holdings of public money is often zero, and does not contribute to the net worth of the agents holding it. The primary role of the back rooms of chartered banks is to hold money in public trust, and to ensure that such money is properly conserved.

4.1.2.7 - Double-entry book-keeping

This is a method of accounting that tracks both liabilities and assets in exchange after exchange. A significant aspect of such an approach is that every change in the holdings of assets and/or liabilities **MUST** be recorded twice. For example, if the credits of one agent rise, then there must be a counter-balancing, or off-setting, entry made in the accounts of the same agent or another agent such that either its credits fall, or its liabilities rise, by an equivalent amount.

For example, if one agent gives \$5 in currency (L0/P0) to another agent, the assets of the first donating agent decline by \$5 and the assets of the receiving agent rise by \$5. This is among the most simple of all transactions, requiring a total of four entries – two for the L0 money, and two for the P0 money. The “wallets” of both parties to the transaction are adjusted, and the net worth of both parties changes, but the total L0 and P0 money in the system does not change. There may be many reasons why the money was “given” from one to the other, but, in the money view, the reason is not important. Only the effects on the conservation and distribution of money are important.

As another example, if a person takes a bank loan, four entries are required, as follows:

- The bank takes a copy of the loan agreement and stores it, calling it an asset of type L1-loan. This asset (the principal of the loan) is reduced only when a specific instruction identifies later payment from the bank’s client as a payment on the principal of the loan.
 - Similarly, the client of the bank takes a copy of the loan and files it as a debt of type L1-loan. They also do not reduce the amount of this debt unless they specifically make a payment on the principal of the loan. That’s two entries.
-

- The bank releases some L1 money of the same amount into the client’s checking account, money which can now be drawn on, by the client, at any time, by writing a check. This the bank records as a liability of type L1.
- At the same time, the client enters that amount into its check book, its own personal records, as money that can be drawn on by check. This the client records as an asset of type L1.
- The pairs of entries are L1-loan-asset (bank), L1-loan-debt (client), L1-debt (bank) and L1-asset (client). These four entries leave the net worth of both the bank and the client unchanged, but create L1 money, expanding the MS-II money supply.

As a third example, suppose one prsn wishes to pay another prsn by check, and they both have different banks. This requires a total of six entries as follows:

- The two parties to the transaction note the check in their respective check books, one as a decrease in L1-assets, and the other as an increase in L1-assets.
- The two banks, each in their “back room” role of public trust, must each make two entries to “settle” the checks. They must each reduce/increase respectively, the assets available in the bank accounts of the two clients. At the same time, they must reduce/increase respectively, their own liability for the maintenance of those assets as a public trust – the liabilities which have been moved from bank to bank.
- In this transaction, the net worth of the two clients have changed, but the net worth of the back room books of each of the banks has not changed.

When double-entry book-keeping is applied in this way a couple of general observations can be made:

- Every capital exchange requires an even number of entries into the account books of the various participants.
- The change in the net worth of the holdings of the “back room” of any chartered bank always remains as zero at the end of any complex transaction, once all appropriate entries have been made.
- Every change in assets of size ΔM in one asset account must be matched with an offsetting change of $-\Delta M$ in another asset account, or a counterbalancing change of ΔM in a liabilities (debt) account. So, for example, if a transaction requires a total of six entries, they can be logically formed into a set of three such pairs of off-setting or counterbalancing entries, such that the total amount of money is preserved, with a net change of zero.
- This conservation of money at the level of individual transactions is a defining characteristic of the double-entry book-keeping system.

4.1.2.8 - Transactional Conservation of Money Supply (TCMS)

The above observations lead to the formulation of what was referred to, in Ref I, as the “transactional conservation of a money supply” (TCMS, for short), which can be written mathematically as:

$\sum (\Delta assets) - \sum (\Delta liabilities) = 0$	Equ 01
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On a transaction-by-transaction basis, this is true for all transactions affecting any of the three money supplies. The only breach of this law is during the original creation, by fiat, of physical currency by the government. (I note that counterfeiting and destruction or defacing of currency is illegal, and generally not done.)

But Equ 01 has some rather far-reaching implications. First, this can be applied to each of the three money supplies considered in this model economy. We can refer to this as the principle of “Strong Conservation of Money Supply” (or SCMS).

$\sum (assets) - \sum (liabilities) = constant$	Equ 02
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When the sums of assets and liabilities are each zero, the constant is the non-transient quantity of money in the money supply.

If the transfer of net worth, when measured in monetary terms, is via capital exchanges, then we can write an equation for the total net worth in the system like this. Denote the net worth of an agent as $N(\text{agent})$. Denote the amount of currency created by fiat by the government as the constant MB . Then:

$\sum N(\text{prsns}) + \sum N(\text{banks}) + N(\text{GCRA}) + N(\text{CRB}) = MB$	Equ 03
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With a little thought, we see that Equ 03 is merely a re-statement of Equ 02, which could be written as $\sum N(\text{agents}) = MB$. However, Equ 03 is in a form more directly comparable to the laws of conservation of energy.

MB can be considered the “internal money” of the system, once all transient forms of money have been stripped away, analogous to the internal energy of a thermodynamic system. This is highly analogous to the various statements of the laws of conservation of energy coming out of the studies of mechanics and thermodynamics. For example, compare Equ 03 with the statement of the law of conservation of mechanical energy (see Equ 04, and Ref N).

$\sum (potential\ energies) + \sum (kinetic\ energies) = constant$	Equ 04
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I am tempted to make an analogy between $N(\text{banks})$ and potential energies, as opposed to $N(\text{all other agents})$ and kinetic energies. But that is more of a political opinion than an opinion based on mathematical characteristics.

The most general expression of the law of conservation of energy in a closed system (wrt mass) is in equation 05, based on the Wikipedia article at Ref Q:

$dU = \delta Q - \delta W$	Equ 05
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This is a rather subtle equation that requires much explanation – beyond what I can undertake here. The very short version is like this. dU represents an infinitesimal change in the internal energy of a closed system (wrt mass). That is, energy can enter and leave the system, but mass cannot. δQ , which can be written as $T \times \delta S$ (where T is temperature and S is entropy), denotes an infinitesimal increase in energy associated with entropy changes. δW denotes an infinitesimal amount of work done by or on the system. Two kinds of infinitesimal are implied by the two symbols d and δ . The explanation gets into issues of Gibb’s Free Energy, entropy production, and the interaction between these as internal energy is altered.

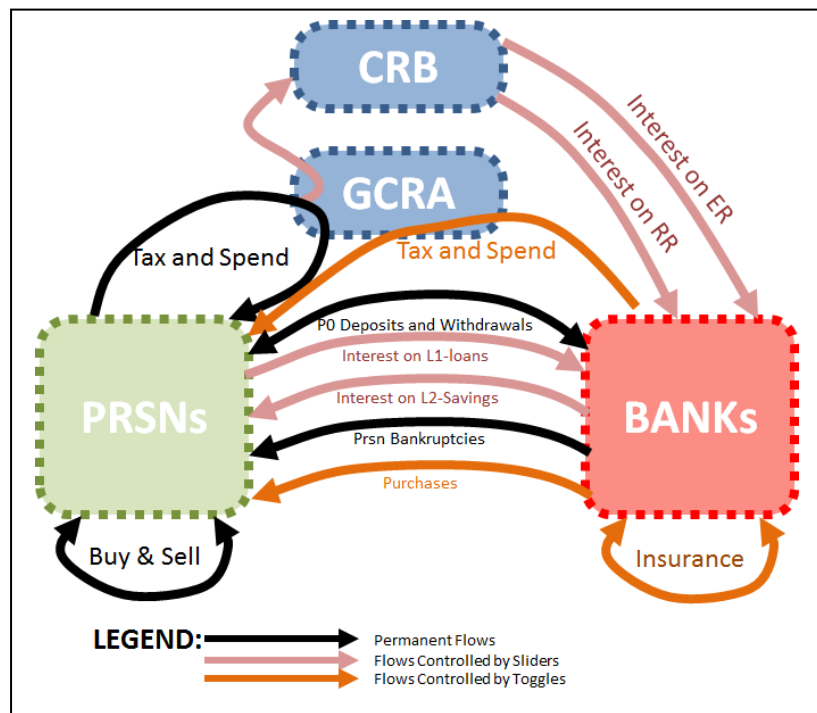
I hypothesize that a very similar argument can be made with the following analogies:

- The internal energy U is analogous to the effective money supply;
- The δW is analogous to money injected into the economy – perhaps as more fiat currency, perhaps as part of the expanding logical or shadow money supply;
- The δQ is analogous to the ability of the economy to redistribute wealth (i.e. alter the economic entropy) and, in effect, do economic work in response to the injection of money.

IF the details of such an application of this equation can be worked out, then it would provide insight into how an economy functions, and how it can be made sustainable. It would have policy implications. For example, if a government has the ability to alter δQ continuously, the economy will respond by altering δW continuously. Implicit in this equation is the need to return to statistical equilibrium when perturbed. This idea needs a lot of work to be useful, or proven, and maybe an NTF of its own. But this is where this study seems to be going.

4.1.2.9 - Management of Flows of Capital

There are several controls in Panel 01, and more in Panel 04, that control flows. A capital exchange model economy is, at its heart, little more than a collection of pools of capital, connected by



flows of capital from one such pool to another. Sometimes conversions or transformations take place as the capital flows. On a grand scale, two kinds of flows are important in this model. Flows of net worth from prsns (representing the real economy) to banks (representing the financial economy) in the form of interest payments (on L1-loans, on ER deposits, and on RR deposits) operate in one direction. Flows of net worth from banks to prsns in the form of L1-loan write-offs (prsn bankruptcies) provide the flow of net worth in the other direction. Unfortunately, the flows from the banking sector to the real economy do not kick in until the real economy is in desperate conditions, living, so-to-speak, a subsistence-level existence on the constant brink of bankruptcy. The various flows in dark brown can be toggled on, and were developed as means to find a balance.

The “laboratory” approach to building model economies allows the user to experiment with various aspect of model design. One can determine different possible flow channels (or connections between types of stores) that can be opened, and the flows through these channels can be regulated. The transient and steady-state behaviour of the model can then be observed. Within CmLab, all of the flow channels associated with interest payments (light purple) can be turned off, by the simple expedient of setting the interest rate to zero. In fact, it is not difficult to modify the controls to allow for negative interest rates.

The balance between the financial economy and the real economy in this model seems to be an unstable balance. That is, I found it difficult to imagine a realistic but simple self-regulating mechanism by which the two opposing sectors stayed healthy and robust. In fact, without some clear public policy intervention, the primary path by which money flows from banks to prsns seems to be through personal bankruptcies. And other channels needed monitoring, opening them sometimes, and closing them sometimes, to achieve an acceptable long-term balance.

Those channels between these two grand sectors I have labelled as follows:

- -btpfs- This stands for “banks to prsns flows” and this regime consists of several optional channels of flows in that direction.
- -ptbfs- This stands for “prsns to banks flows” and this regime consists of several optional channels of flows in that direction.

It would be easy to program other optional flow channels into the model, but that would make the model more complex without necessarily delivering more insight towards the main goal of the model, which is an understanding of the phenomenon of conservation of money, with a longer goal of understanding the dynamics of a sustainable economy.

The chanelns in the -btpfs- regime are:

- **Default – non-optional – prsns bankruptcies.** When a prsn goes bankrupt, one or more the banks suffer a loss of net worth. Strangely, the effect is a transfer of net worth from the banking sector to the real economy. That transfer happened over time, a little bit at a time, as the prsn frittered away its own net worth, getting deeper and deeper into debt. The beneficiaries are the commercial partners in the ongoing capital exchanges that benefited from those exchanges. And, in every exchange, there was a winner and a loser. Those chickens come home to roost when the prsn goes into bankruptcy, and the banks bear the losses.
-

- **Optional – Interest on savings deposits.** This interest rate can be set to zero but is normally positive. Wealthy prsns will have savings deposits and will receive an income from the banks in this fashion. Most prsns will be living from day to day, and will get only intermittent income from this source, while bearing regular expenses for L1-loans.
- **Optional – Daily purchases of goods and services.** This flow can be toggled on. Banks are simulated as making daily purchases in the form of wages paid, supplies purchased, building and lot maintenance bills paid, etc. This seems like a logical flow to add. If this flow is too small, or turned on too late, the banking sector dominates. If it is too large, or turned on too soon, the banking sector collapses. It is effective if applied intermittently. It remains in the model if others wish to make it more sophisticated.
- **Optional – Special monthly tax.** Once per month the government may impose a tax on all corporate profits in the banks, essentially returning all C1 profits into the hands of the prsns who contributed to them. This is immediately effective, does not cause the banking sector to collapse, and does enable a healthy sustainable real economy. HOWEVER, it is Draconian in the extreme, as it strips chartered banks of all profits on a monthly basis. It is effective, but not very realistic.

The channels in the -ptbfs- regime are more natural, in some sense, and include:

- **Optional - Simple interest paid by the CRB on ER and RR deposits.** This money does not appear to come from prsns, but it does, indirectly. CRB costs (interest payments) are covered by the GCRA, which gets its funds from the stream of taxes and payments. The taxpayers are ultimately the source of this transfer of net worth between the Prsn sector and the Bank sector.
- **Optional - Simple interest paid by prsns on L1-loans.** By default, the associated interest rate is larger than the rate of payment of interest on L2 savings deposits. So the net flow is clearly from prsns to banks. But, interest on L2 deposits is intermittent, whereas interest on L1-loans is constant. So even if the banks offer better interest terms on L2 deposits, the general transfer of net worth from the real economy to the financial economy may continue.

4.2 - Descriptions of the Panels

4.2.1 - Panel 01 – The Model

This is the main panel, the panel that you see when you first start up the CmLab application. On this panel you will find:

- Instructions for a “fast start” (click on two buttons) for casual observation, or for a “careful start” (using buttons and sliders, on this panel and on Panel 04) for more serious users.
- Instructions on how to expand or contract the view.
- The “economic arena” which is just for show, and plays no role whatsoever in the model.
- Two categories of controls labelled “Setup controls” and “operations controls”.
- A small histogram of the net worth of prsns and banks, together with three “monitors” that display the real-time values of three model variables: the mean net worth of prsns, the mean net worth of the banks (front room), and the current tick.

The controls are used to set parameters in the model. The monitors are used to examine the current values of aggregate variables in the model. Line graphs can be used to monitor the

values of aggregate variables as they change over time. Histograms can be used to monitor the instantaneous distribution of values of a non-aggregate variable within a population of agents.

For all programming I follow the coding conventions and variable naming conventions established at Ref K.

Here is a description of the controls found in Panel 01 of the CmLab application. These can be divided into two groups called “Setup Controls” and “Operations controls”. Setup controls are to be used once at the beginning of a specific run. Once the run has begun, they should not be used, or they will invalidate the run, and possibly cause errors. The operational controls, on the other hand, can be altered at any time during a run. It is best if the run is paused before the control is adjusted, but that is not a necessity. However, the model does not keep track of such changes in control settings, and such runs are not repeatable.

4.2.1.1 - Setup Controls for Panel 01

Panel 01 has the following setup controls:

- **gs-scenario** – This is a “chooser” that lets a user select one of several scenarios. At the moment there is only one scenario available – the “Prsns Only” scenario. In the future I may add a second scenario in which corporations that sell stocks and issue bonds are also included.
- **g-use-this-seed** – This slider lets the user choose a seed for the pseudo-random number generator (PRNG). A different seed results in a different run. The same seed, if used with care, results in repeatable runs. The PRNG is invoked by NetLogo for many commands, so, if you stop a run, issue a few commands from the prompt line, and then resume a run, it may not be repeatable. If the only controls used to pause and resume are the “Go” and “One Tick” buttons, then the run is repeatable.
- **g-crb-assets-per-prsn** – This slider lets the user choose the size of the money base in a run of the model, but in combination with other sliders in Panel 04. When the model is initialized, the CRB makes a one-time initial endowment to each prsn (but not to banks) of an amount of physical money (LO and PO) determined by this slider. The two other sliders in Panel 04 control the number of banks, and the number of prsns per bank on startup. These three sliders together determine the total initial money base for the run.
- **Setup** – This button invokes a routine that initializes all agents and all variables. It should be pressed once only at the beginning of a run. If pressed (during a pause) in the middle of a run, it will reset everything according to the controls, and restart the model at tick 0.

4.2.1.2 - Operational Controls for Panel 01

Panel 01 has the following operational controls:

- **One Tick** – This button invokes a routine that makes the model execute a single tick. That is, the model moves forward in time by one tick. Many sub-routines are called during a tick, in serial order, as follows:
 - **Do-pre-tick** – this sub-routine attends to a small number of behind-the-scenes technical matters associated with data collection and display, or model performance, that must be addressed prior to the initiation of the other sub-routines.
 - **Do-move** – this sub-routine normally handles the movement of agents within the “arena” found in Panel 01. Since this model does not involve spatial elements, this routine

simply moves the prsns (small trucks) to the right in a random fashion to give the user something to watch. It is a place-holder routine with “hooks” that may be useful if I later add spatial issues to the model.

- ***Do-buy-sell*** – this sub-routine has several calls to even lower-level sub-routines. In particular, in the steps within this sub-routine:
 - Prsns buy and sell using currency. That is, they exchange cash (currency in the form of L0 and P0 currency) between their “wallets”. This does not involve the banks. Money is exchanged in the spirit of a “capital exchange model”, in the sense that money moves from hand to hand without attention to issues of a real-world economy such as prices and quantities of goods and services. Prsns appear to simply “give” L0/P0 assets to one another randomly.
 - Banks makes “purchases” of goods and services using checks. This is part of the optional –btpfs– regime (banks to prsns flows regime) discussed below. Banks make payments using inter-bank checks that must be settled immediately. Again, prices and quantities make no appearance. The banks appear to simply “give” L1 assets to various prsns randomly.
 - Prsns make purchases using checks on 30-day terms. All such purchases are time-stamped, and payable 30 ticks later. The amounts of these purchases become part of the shadow money supply (MS-III). Effectively, prsns are exercising their ability, as participants in the commercial environment, to create shadow money.
 - Prsns pay any 30-day payables that have come due, created 30 ticks previously. Payments are made using inter-bank checks. If a prsn finds it has insufficient funds in its checking account and savings account to cover the payables, it will seek a bank loan to address the insufficiency.
 - All agents recalculate their net worth, and all model aggregates, such as mean net worth, are recalculated.
 - ***Do-accrue-interest*** – In this sub-routine, interest payments are accrued. All interest is accrued using simple interest. Annual rates are divided by $(12 * 30)$ to find a “daily” rate, and that portion of the interest-bearing liability is accrued. However, interest payments are made only on the end-of-month ticks, and are the sum of all amounts accrued over the previous 30 ticks. As such, the accrued interest due is part of the shadow money supply until it is paid. Four kinds of interest are accrued, as follows:
 - Prsns accrue interest on L1-loans, to be paid to banks;
 - Banks accrue interest on L2 savings deposits, to be paid to depositors;
 - The CRB accrues interest on ER (excess reserve) deposits, to be paid to banks;
 - The CRB accrues interest on RR (required reserve) deposits, to be paid to banks.
 - ***Do-monthly*** – In this sub-routine those activities that must be undertaken at the end of the month are undertaken. This includes:
 - The GCRA reconciles its accounts with the CRB. The CRB is a non-profit public institution. It maintains an account with some randomly selected chartered bank from which it issues inter-bank checks to banks. Once a month any excess costs incurred by the CRB are transferred to the GCRA, i.e. the government’s consolidated revenue accounts. These costs are associated with payments of interest to banks for ER and RR deposits.
-

- All accrued interest payments are paid, by the banks, by the CRB, and by prsns, as required. These elements of the shadow money supply (MS-III) are thereby collapsed and disappear.
- Those agents with L1-loan-debts on their books make a payment on the principal of the associated loans to the chartered bank that holds the L1-loan-assets. These elements of the logical money supply (MS-II) are thereby partially collapsed and partially disappear.
- The government, via the agency of the GCRA, spends money (in the spirit of a capital exchange model, it appears to give it randomly to various prsns), and then taxes some of that money back (from prsns). The GCRA maintains an account with some randomly selected chartered bank in which it stores collected taxes, and from which it issues checks for inter-bank payments to prsns.
- The government, optionally, as part of the –btpfs– regime, taxes money out of the hands of the bankers and spends it by putting it directly into the hands of prsns.
- **Do-banking** – In this sub-routine all end-of-day bank reconciliation is done. This has many sub-sub-routines as follows:
 - Each prsn visits their chartered bank and withdraws currency (L0/P0 funds), and moves sufficient money from L2 savings deposits into L1 checking accounts. These must be sufficient to enable the prsn to participate in the “buy-and-sell” activities of the next tick.
 - If the L2 savings deposits are insufficient, the prsn applies for a loan of L1 funds to cover the insufficiency. If the bank can, it will create L1 funds and issue a loan to the prsn, thereby expanding the size of the logical money supply (MS-II).
 - If the bank has insufficient ER funds to support such a loan, the prsn is declared bankrupt.
 - The CRB supervises the ER and RR deposits, ensuring that chartered banks have deposited sufficient required reserves (RR) to support the L1-loan-assets that they currently hold, and sufficient vault cash (VC) to support the needs of their clients for the following day. Because of the daily “buy-and-sell” activities of prsns, and the daily deposits and withdrawals of cash by prsns, physical money moves randomly from bank to bank. If a bank accidentally gets into a position of having insufficient funds to function, it is declared bankrupt.
 - All personal bankruptcies are processed. All of the assets and liabilities of the bankrupt person are resolved. Interest due is collected, regardless as to whether it is due now or at the end of the month. Interest payable is paid. 30-day payables and receivables are also processed as if immediately due. The net worth of the prsn is converted by the bank’s “back room” using this process into L1-loan-debts. Ultimately that is all that remains. Whether positive or negative, the bank absorbs this amount into its own corporate C1 accounts (front room profit/loss centre). In the overwhelming number of cases, this is a loss. If the “bank insurance” feature is turned on, the bank can share these losses across the C1 accounts of all chartered banks.
 - All bankruptcies of banks are processed. If the bankruptee is acting as the chartered bank for the GCRA or the CRB, then these government institutions have their accounts moved to some other randomly selected, but still solvent, bank. All of those prsns holding checking, savings, or L1-loan accounts with the bankruptee have their

- accounts moved to another bank. Any remaining profits or losses held in the bank's C1 account are spread across the other remaining banks.
- **Do-post-tick** – In this subroutine several activities associated with maintenance of the model are undertaken. This includes updating aggregate variables, etc. But there are two important functions performed here that need special mention:
 - If any prsns have gone bankrupt during this tick, and have been removed, the prsn must be replaced. The mean net worth of all surviving prsns is determined, then they are all “canvassed” for “donations”, from each according to his ability. The replacement prsn then has the mean net worth of the population at large, and the relative wealth of the canvassed prsns does not change.
 - If any banks have gone bankrupt during this tick, and have been removed, the bank must be replaced. This is similar to the way prsns are replaced, with this additional issue. Banks must have clients to provide them income, in order to survive. So clients are moved from existing banks to the new bank, from each according to their share. A bank with a lot of clients gives up a lot. A bank with few clients may not give up any.
 - **Go** – This button invokes the same sub-routine as the “One Tick” button, but it continues to run that sub-routine over and over again until the “Go” button is pressed one more time. The Go button turns black when pressed, and turns grey-blue again when un-pressed. Note that there are in fact several copies of the Go button in the various panels. Only one should be pressed at once. Each launches an additional thread of execution, and the results of multiple threads will be unpredictable, and probably not good.
 - **g-halt-at-tick** – This light-green coloured box is an input box. Any value entered here will be stored in the g-halt-at-tick variable. It will be used to terminate execution of a run at a pre-determined tick. Essentially, it un-presses the Go button when that tick arrives. This is useful for debugging, or for the purposes of exploration of events at special ticks, such as those that are end-of-month ticks (divisible by 30).
 - **g-iorr** – This slider controls the interest rates for payments by the CRB to banks on required reserve (RR) deposits. This is part of the default -ptbfs- regime of transfers of net worth. When set to zero, the feature is turned off and no related interest calculations are made.
 - **g-ioer** – This slider controls the interest rates for payments by the CRB to banks on excess reserve (ER) deposits. This is part of the default -ptbfs- regime of transfers of net worth. When set to zero, the feature is turned off and no related interest calculations are made.
 - **g-iobl** – This slider controls the interest rates for payments by prsns to banks on L1-loan-debts. This is part of the default -ptbfs- regime of transfers of net worth. When set to zero, the feature is turned off and no related interest calculations are made.
 - **g-iosd** – In contrast to the previous three sliders, this slider controls interest rates for payments flowing in the opposite direction, as part of the -btpfs- regime. It controls the interest rates for payments on L2 savings deposits. This money is paid by banks to prsns. When set to zero, the feature is turned off and no related interest calculations are made.
 - **gb-btpfs-bankruptcies** – This toggle switch is always on, and cannot be turned off. This is the primary default mode for transfers of net worth from the banking sector to the prsns in the real economy. When prsns go bankrupt, the banks are forced to absorb the loss, either as a single bank, or all banks together. This is the primary channel for flows of net worth from the banking sector to prsns, and as such, is part of the -btpfs- regime.
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- **gb-btpfs-daily-purchases** – This toggle turns this flow channel on or off. When on, the banks spend money daily on such things as wages, supplies, or maintenance. As CmLab is a capital exchange model, taking the money view, it appears as if the bank transfers small amounts of net worth to random prsns. For more about the -btpfs- regime and this role of this channel, see section 4.1.2.9 above. This channel of flow is off by default. It is called the “little gun” as it has some long-term effects, but is generally ineffective.
- **gb-btpfs-monthly-taxes** – This toggle turns this flow channel on or off. When on, banks are taxed monthly for the full amount of their C1-assets, whether positive or negative, and that amount is then given to prsns. In other words, it fully and completely nullifies any negative effects of unbalanced flows of net worth from the real economy to the financial economy. When this toggle is turned on, the real economy remains relatively healthy and stable for long periods.
- **g-reserve-requirement-ratio** – This slider determines the percentage of each L1-loan that a chartered bank must deposit with the CRB as a required reserve (RR) deposit. In most real world economies that still use this method of assigning required reserves, this ratio is often set at 3%. The default value here is 20%. This determines the maximum size of the logical money supply (MS-II) that the banks are able to support with a given physical money base (MS-I).
- **g-net-worth-tax-rate** – This slider controls the annual tax rate that is used by the government monthly. This tax is collected from prsns monthly, and the income is spent as a distribution to prsns monthly. The government budget is therefore relatively revenue-neutral, as the government makes neither a profit nor a loss, on average, month after month. Since this tax is based on net worth, its effect is somewhat like an income tax. The wealthy pay more taxes, and the extremely poor get a fair share of the government expenditures. The overall effect is a redistribution of wealth away from the most wealthy prsns towards the least wealthy prsns.
- **gb-plot-data** – This toggle is a native NetLogo feature that can be used to control the speed of development of a run. It toggles data plotting on (the default) or off. Data plotting is CPU-intensive activity, so a run without plotting is much faster. However, in NetLogo line graphs collect and store historical data for every tick plotted, and so they become a data capture and storage mechanism. If you want to collect the data and, later, save it in a CSV file, this must be left on.
- **Reset Defaults** – This button invokes a routine that resets the default values of all of the setup and operational controls to a profile of values that are known to be interesting. When these controls are changed, and the model is saved to file, the new values are persistent across such a save operation. Many combinations of control settings are of little interest as they are extremely unrealistic, and possibly dysfunctional. This button enables the user to return all controls to default values, at need.

4.2.1.3 - Data Display Devices in Panel 01

There are four data display devices in Panel 01:

- **“Net Worth of Agents” Histogram** – This histogram is repeated in Panel 05. It is the primary means by which a user can watch the effects of the various controls as a run of the model proceeds. The distribution of net worth of the prsns is shown in green, while the distribution of the net worth of banks is shown in red. When a run starts, the net worth of all banks is zero, and the net worth of each prsn is the value determined by the g-crb-net-worth-

per-prsn slider at the far left of Panel 01. As a run proceeds, under the default values of all controls, the distributions slowly trade places until the banks hold most of the wealth, and the prsns are living destitute lives on the brink of bankruptcy. It may seem that the model was designed, nefariously, to show this. I admit that I worried something like this would be the outcome. I was chagrined to learn how effectively the collection of interest migrates the base of wealth out of the real economy and into the financial economy.

- **Prsns** – This monitor window reports the value of a hidden aggregate variable - **g-mean-net-worth-priv-prsns**. This variable is updated during each tick, in the Do-post-tick sub-routine, and it is the mean net worth of prsns held in private funds, as opposed to public funds. Since all of the net worth of banks and prsns is held in private funds, this is the mean net worth. It always starts with a value set by the **g-crb-assets-per-prsn** slider, seen to the far left of Panel 01.
- **Banks** – This monitor window reports the value of the hidden aggregate variable - **g-mean-net-worth-priv-banks**. This is the mean net worth of the banks. It always starts at zero, since all funds are initially given to the prsns, and held by them.

That's it for the controls on Panel 01. At the bottom of this panel, and of all other panels, there is a reminder in red of the displays and controls that can be found on the other panels, located to the right of the main panel.

4.2.2 - Panel 02 – Breakout of Holdings by Breed of Agent

There are only three controls in this panel, and they are copies of buttons found on the main panel. The **Setup**, **One Tick** and **Go** buttons on this panel enable a user to initialize, step through, or continuously operate a run of the model which watching these monitors. The only caution is this – do not press any of these buttons if a **Go** button is already active, and the numbers in the display monitors are changing.

All other items are called “monitors” and they report the value of hidden aggregate variables updated at the end of each tick of the model. The description of these monitors will unfortunately be long and tedious, but it needs to be done, so here it is.

In naming the monitors I was forced to use some very cryptic short forms in order to fit all of them into one Panel. There is a legend at the bottom that should help with the interpretation. Or users can refer to this document, or the code itself, for more informative interpretations.

4.2.2.1 - Vertical and Horizontal Groupings

- You will note that the monitor are grouped into four vertical groups, associated with each of the four breeds of agents in this “agent based model”, or ABM – the CRB, the GCRA, chartered banks, and Prsns.
- Within each such vertical group of monitors, there is a further vertical division into assets and liabilities, for a total of eight such vertical groups. Some monitors straddle the line between assets and liabilities, and these are Net values, computed as $Net = \sum assets - \sum liabilities$.
- Finally, within each such vertical grouping there are three horizontal groupings – physical assets and liabilities associated with the physical money supply (MS-I), logical assets and

liabilities associated with the public trust that banks guard, and, finally, at the bottom, private assets and liabilities, associated with commercial activities of agents. Prsns have no role associated with the public trust, but the GCRA, the CRB, and chartered banks do. This horizontal breakout tries to underscore the effects of that public trust.

4.2.2.2 - CRB Monitors

The CRB is primarily involved in the creation of physical money and commissioning it (for lack of a better word) with logical face values, and then managing that money base. These monitors therefore display P0 values (counts of physical \$1 bills and coins), L0 values (the face value of those physical items), and C1 values (its own private corporate-level debts generated by paying interest on ER and RR deposits). Here's a description of the monitors for the CRB:

- **Physical, Public, P0 assets** – When money is first created by government fiat, the physical count is put here. But it is quickly distributed to prsns, and this number falls to zero and remains there because all the created physical money base has been issued.
 - **Physical, Public, P0 liabilities** – Of all of the monitors described for Panels 02 and 03, this is the only one that gave me great pause. I don't know whether this monitor has meaning. Under the strict rules of double-entry accounting, every change in an asset needs an offsetting change in a liability. So it is included. However, when the government creates fiat money "ex nihilo", does that rule still apply? The law of "conservation of money" may be broken in that singular event. If it is, then this monitor need not exist, as the government does not create a liability in that act of creation. On the other hand, it does not change the way the model operates if this monitor (and its hidden variable, and the role of that variable) is included or not. So, perhaps it is a somewhat moot issue. This issue is discussed in some detail in a "THEORY" section within the code, and interested readers can check there for more detail.
 - **Physical, Public, P0 ER and RR assets** – These are the counts of the physical bills and coins that the CRB is holding as deposits of the chartered banks. Prsns were given the cash by the CRB during Setup. Prsns then deposited the cash into the chartered banks when they opened checking and savings accounts, and the bank then deposited the currency back into the CRB as ER and RR.
 - **Physical, Public, Net P0** – This is the sum of the MS-I assets minus the MS-I liabilities. It is placed on the line between the two. This plus the cash in prsns' wallets, plus money in bank vaults, is the total money base.
 - **Public L0 assets; Public L0 liabilities** – These two monitors are always equal in size, and represent the total logical assets and liabilities of the money base. These assets were created during fiat creation of money by the government. These liabilities were created when the CRB issued (gave) circulation money to the prsns, with the promise to redeem damaged and destroyed bills and coins with gold, or some other suitable substitute. Of course, that never happens now. But these two monitors are vestigial remnants of that act of creation and beneficence. They do not change during a run.
 - **Net Public** – The CRB, as a bank, has responsibility to guard the public trust. The net public assets must be conserved. This value should always be zero. This represents the "back room" activities of the CRB, which are not at all active.
 - **Private, C1 assets** – When the CRB pays interest on P0 RR and P0 ER deposits, it pays with real logical money. This is a corporate loss. I record these as negative assets, in place of liabilities. On a monthly basis the GCRA takes any losses into its own accounts and clears
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this monitor. Of course, interest is accrued daily but paid monthly, just after the GCRA clears it, so this monitor never actually reports a zero. It reports the losses of the previous month.

- **Private, ER and RR Interest payable** – The CRB aggregates the interest payables that have accrued, which are reflected here, and under the chartered banks as interest receivable.
- **Net Private** – This is the private assets minus the private liabilities.

4.2.2.3 - GCRA Monitors

I have not modelled the inner workings of the government, so there are very few associated variables for the GCRA. However, when you consider the “money view”, the role of the government is very straight forward – tax and spend – tax wisely and spend wisely. I suppose that the government in this model only has monetary policy goals, and no other program goals, and that makes it easy. A real government must also have program goals for the real economy, such as building and maintaining infrastructure, and regulating other matters such as education, health, justice and the environment. Taxes must fund those goals. Deficit budgets arise from the multidimensional goals of a government. But, fundamentally, all of that reduces to “tax wisely, spend wisely” when you reduce it to the money view. These are the monitors associated with the GCRA:

- **Physical, Public, Net P0** – The GCRA has no real role to play in the day-to-day management of the money base (MS-I). This is the only monitor in that level, and it is always zero.
- **Public, L1 assets** – The GCRA is in some sense a super prsn. It opens a checking account with a randomly selected chartered bank, and maintains its accounts there. Because its budgets are always balanced, it has no need of an L2 savings account (that would be easy to implement) or an L1-loan-debt (also easy to implement). The L1 assets are the checking account in which taxes are held when collected, and from which checks are issued when payments are made to prsns. This is also the account into which the CRB net profits or losses are absorbed monthly. This IS the government’s consolidated revenue account.
- **Public, L1-loan-debts** – This is there as a hook in case I decide to implement deficit budgeting by the government, but so far I have not have a need for that. See the opening comments for this section about program goals. This monitor is always zero.
- **Net Public** – This is the public assets minus the public liabilities. Since the public liabilities are always zero, as described above, this is always equal to the public assets in the L1-assets variable.
- **Private, L1-interest payable** – The government is not a profit-making organization, and has no private Lx-type assets. If it were to run deficit budgets, and needed therefore to take out loans from its chartered bank (or, maybe, issue government bonds), then it might have interest payable of some kind. In this version of the model it does not. This is always zero.
- **Net Private** – This is always zero.

In short, in this model, the GCRA only has a public role that consists of taxing, spending, and absorbing revenue/losses from the CRB (and this implies other government operations).

4.2.2.4 - Monitors for Chartered banks

Now we get to the more interesting and tricky monitors for chartered banks. The chartered banks have a significant role at all three horizontal levels in the Panel 02 graphic:

- **Physical, Public, P0 VC assets** – this is the count of physical \$1 bills and coins in the banks' vaults. When a prsn withdraws cash for its daily round of “buy and sell” it takes physical currency, but the bank must match that with logical currency (L1-type money) from its L1 assets. It converts those to L0 assets, figuratively marries those with the P0 assets, and issues it as currency. The prsn then has not just physical tokens (P0), but buying power (L0), in its wallet. But, a bank does not want to keep too much cash in its vault when it could deposit it with the CRB and earn interest.
 - **Physical, Public, P0 RR and ER assets** – These bills and coins are NOT stored in the banks' vaults, but have been physically shipped to the CRB and are stored there. They are accounted as either RR or ER, and earn appropriate interest.
 - **Physical, Public, P0 RR and ER liabilities** – These variables are used to record the fact that the bills and coins have been moved out of the banks' vaults into the CRB's vault. At the time of move, the CRB's P0 RR and ER asset variables record the move there. Due to the techniques of double-entry accounting, at each step along the process, pairs of entries are made. As cash moves to and from the CRB into the banks' vaults, these three pairs of variables track each other.
 - **Physical, Public, Net P0** – This monitor is the net amount of bills and coins in the banks' vaults. It equals the P0 VC assets, since the other assets and liabilities tend to cancel out.
 - **Public L0/L1 assets** – This is the sum of all logical money recorded in the check books of all clients of all chartered banks, including prsns, the CRB, the GCRA and the front rooms of all banks (C1-assets). Every agent in the model has a bank check book, and all of those entries are aggregated here.
 - **Public, L1 loans** – This is the aggregate of all bank loans currently extended to prsns. GCRA and the CRB do not take loans.
 - **Public, L1 liabilities** – This tends to rise and fall with L1 assets, but is not a perfect offset. Double-entry book-keeping requires that for normal day-to-day transactions, the changes in L1 assets and L1 liabilities of the back room must track. The movement of funds into L2 savings, and the deposit and withdrawal of cash (L0/P0 assets) tends to cause some temporary variation, as does the accrual of interest payments.
 - **Public, L2 liabilities** – This is the total of all funds held in savings accounts. Prsns are the only agents that hold savings accounts, and this number should always match the L2 assets of prsns.
 - **Net Public** – This monitor is, perhaps, the most important indicator in this panel. It represents the net worth of all of the back rooms of the chartered banks, and it must remain at zero after each one of the thousands of possible transactions that occur every tick. Within a single tick hundreds of clients make deposits, withdrawals, write and settle intra-bank and inter-bank checks, or move money between savings and checking accounts. These activities invoke a few thousands of bank “back room” actions, every tick. In every one of those actions, the net worth of the back room MUST not change. That is the core effect of the use of double-entry book-keeping that I refer to as the “public trust”. In it's role as a public trust, a chartered bank ensures that the funds owned by the public are properly conserved as exchanges are performed and debts settled. The collection and payment of interest, the collection of bank fees, the investment of monies – these are all “front room” activities that lead to banking profits and losses, and they are NOT reflected in the Public accounts.
 - **Private, RR Interest receivable** – This is accrued interest that the bank expects to receive from the CRB at the end-of-month reconciliation actions. This is front room activity and is a
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key channel – a key part – of the “prsns to banks flows” (-ptbfs-) regime described in section 4.1.2.9 above.

- **Private, ER Interest receivable** – This is accrued interest that the bank expects to receive from the CRB at the end-of-month reconciliation actions. This is front room activity and is a key channel – a key part – of the “prsns to banks flows” (-ptbfs-) regime described in section 4.1.2.9 above.
- **Private, S1 Interest receivable** – This is accrued interest that the bank expects to receive from the prsns at the end-of-month reconciliation actions. This is front room activity and is a key channel – a key part – of the “prsns to banks flows” (-ptbfs-) regime described in section 4.1.2.9 above.
- **Private, C1 assets** – This is the sum of all of the private corporate assets of the chartered banks. This is where they record the profits and losses from their front room activities undertaken apart from their role as a public trust. This number jumps during end-of-month reconciliation as interest is paid into and out of this account. It shifts with every tick if the “daily purchases” channel is opened as part of the “banks to prsns flows” (-btpfs-) regime.
- **Private, S2 Interest payable** – This is accrued interest that the bank expects to pay to prsns at the end-of-month reconciliation actions. This is front room activity and is a key channel – a key part – of the “banks to prsns flows” (-btpfs-) regime described in section 4.1.2.9 above.
- **Net Private** – This is the net worth of all of the profit-making activities of the chartered banks. The role of the “back room” does not involve profits or losses, and is executed as a public trust. Any costs associated with “front room” activities must come out of the private assets of the bank. Any losses associated with bankruptcies of either banks or prsns must also come out of these private assets.

4.2.2.5 - Monitors for Simple Prsns

Prsns is a symbol for simple “persons under the law” and may represent any commercial agent that is not selling shares or issuing bonds to the public. Most people, incorporated professionals, small businesses and partnerships would fall into this category. So, I spell it as prsns to remind myself that this does NOT JUST mean people, but all commercial agents except for a few special cases. These are the agents that represent the “real economy”, as opposed to the “financial economy”

- **Physical, P0 assets** – This is the sum of all currency in the wallets of prsns. This, together with the L0 assets described below, is what might normally correspond to M0-type money in formal definitions of money supplies. This amount is spent/augmented during the execution of the “Do-buy-and-sell” sub-routine, and is deposited/replenished at the end of each day. So it remains pretty constant, representing the daily allocation for currency for prsns.
 - **Physical, Net P0** – Since there is no real meaning for negative physical assets or for physical liabilities, the Net P0 is always the same as the P0 assets.
 - **Net Public** – Prsns have no role as a public trust. All of their accounts are private accounts, owned by themselves. They are not holding any funds, in trust, that belong to someone else. This monitor is always zero.
 - **Private, L0 assets** – This is the logical money that is implied by the existence of the P0 assets in the wallets of the prsns. This number must always match the number in the P0 assets monitor.
 - **Private, L1 assets** – This is the logical money that prsns maintain in their checking accounts so they can effectively participate in the daily commercial activities. Checks are written
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against these accounts, and paid into these accounts. At the end of every tick, each prsn visits the bank and shifts money into or out of savings, sufficient to drain or augment the contents of these checking accounts as may be needed for the commercial activities of the following day. This number tends to stay constant from tick to tick.

- **Private, L2 assets** – This is the logical money that prsns maintain in their L2 savings accounts. This number rises and falls on a tick-by-tick basis. Any shortages in L0 and L1 assets are augmented daily from savings. Any overages in L0 and L1 assets are drained into savings at end of tick. If a prsn has insufficient funds in savings at end of tick to provide the daily allocation of L0 and L1 funds, the prsn applies for an L1 loan from its bank as a last resort.
- **Private, S1 30day assets** – This is the total of all 30-day commercial receivables.
- **Private, S2 Interest receivable** – This is accrued interest on L2 savings accounts that all prsns expect to receive from banks at end of month reconciliation. This is a key channel of flow of funds in the “banks to prsns flows” (-btpfs-) regime, discussed above in section 4.1.2.9.
- **Private, L1 loan liabilities** – This is the total value of all L1 bank loans taken by prsns. This number must match the banks’ L1 loan assets. This number is a key component of the MS-II logical money supply. It expands and contracts as this number rises and falls.
- **Private, S1 Interest payable** – This is accrued interest on L1 checking accounts that all prsns expect to pay to banks at end of month reconciliation. This is a key channel of flow of funds in the “prsns to banks flows” (-ptbfs-) regime, discussed above in section 4.1.2.9. This number matches the L1 interest private assets of the banks.
- **Private, S1 30day liabilities** – This is the total of all 30-day commercial payables. This number matches the receivables described just above.
- **Net Private** – This is the total net worth of all prsns. On startup, this number is determined by the slider g-crb-assets-per-prsn. As the model runs, this net worth may be transferred from this sector (representing the “real economy”) to the banking sector (representing the “financial economy”, which starts with a net worth of zero.

4.2.3 - Panel 03 – Breakout of Holdings by Type of Money Supply

Panel 03 has monitors for many of the same aggregate variables as Panel 02, but with a few added items. The focus in Panel 02 was on the holdings by various breeds of agents. The focus in this panel is on the three types of money supply: physical (MS-I); logical (MS-II); and shadow (MS-III). There are three vertical groups in this panel:

- **Sizes** – To the far left, there is a group called “Official Size” in which there are two sorts of monitors for each of three pairs – one pair for each of the three money supplies – six monitors in total. The upper monitor in each pair is the Net Size calculated as the total assets minus the total liabilities. The lower monitor in each pair is the size of the money supply. Note that the net size of MS-I and MS-II is equal, being the amount of fiat-created money. This is the “money base” of both the physical and logical money supplies. The net size of MS-II remains zero at all times. But the absolute size of MS-II and MS-III expand and contract as chartered bank loans and non-bank commercial loans are let and paid off again.
- **Aggregates of A&L** – To the far right, is a group called “Totals” in which there are also two sorts of monitors for each of three pairs – one pair for each of the three money supplies – six monitors in total. The upper monitor in each pair is the sum of all assets recorded in the

money supply. The lower monitor in each pair is the sum of all liabilities. The difference is the net size of the money supply.

- **Individual groupings** – In the middle is a collection of monitor in six rows, two rows for each money supply. The upper row is assets, and the lower row is liabilities. You will note that many of these monitors are displaying aggregates that are also displayed in Panel 02, but grouped differently.

At the bottom of Panel 02 are three standard control buttons: Setup, One Tick, and Go. These work the same as for other panels. Note that only one Go button should be pressed at one time.

4.2.4 - Panel 04 – Debug Tools

Panel 04 has two sub-panels. All of the controls and monitors in this panel were built during the verification process. I decided to leave them as active controls for two reasons:

- Others may wish to change the model in various ways, and these tools may prove useful when the code is being re-verified by other programmers.
- Even if you are not a coder, these debug tools may give you a view inside the operations of the model that is not available via the various monitors and displays in the user interface.

4.2.4.1 - Sub-Panel 04a – Debug Tools

These controls are organized into seven groups as follows:

- **Group 1 – “Toggle Debug” button, and associated monitor.** The code contains many calls to a routine called “to LOG-TO-FILE” which prints a stream of data to a log file as the model runs. Let’s call it the log data stream. This button turns on the collection and presentation of the log data stream. This button **MUST** be pushed to turn on logging **before** any other debug actions are taken. If not, unpredictable things may happen, and the program may show errors relating to file accessibility or similar things. The monitor indicates whether a file is open or not.
 - **Group 2 – gs-debug-step-chooser.** Use this chooser to select which sub-routine is to produce a log data stream.
 - **Group 3 – gb-debug-show-steps.** Use this toggle to enable a T-junction by which the data stream is sent both to the log file, but also to the NetLogo standard “Command Centre”. This special window is available via a small set of very small caret triangles in the bottom left corner. Use the expand caret (pointing upwards) to open the command centre window, then use the two-headed arrow to expand it to fill half of the screen. Then the debug data stream will be visible in the command centre. See the graphic for Panel 01 to see the location of these tiny carets (section 7.1).
 - **Group 4 – “Set Debug Parms” button and “Reset Defaults” button.** The use of these buttons is optional. The first sets various controls in a really small configuration suitable for debugging, as it produces relatively little data. By relatively little, I mean tens of pages in place of thousands of pages. The second button is used to restore a standard set of control values.
 - **Group 5 – Setup, One Tick and Go buttons.** These are copies of three buttons described previously. They occur in each panel. Read section 4.2.1.2 for detailed information.
 - **Group 6 – Single step buttons.** It is possible to step through a tick one sub-routine at a time. This, together with the chooser in Group 2, to focus on a single sub-routine at a time.
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- **Group 7 – Miscellaneous.** These buttons were used at one time to produce special output and have been left in place.

4.2.4.2 - Sub-Panel 04b – Really Advanced Controls

These controls were originally part of the set of controls in Panel 01, but were moved here to better enable debug activities. In general, a user should not need to adjust these, and should understand the code before using them. There are four controls here:

- **gb-bank-insurance** – This toggle is on by default. When this is toggled off, when a prsn goes bankrupt, the bank of which it is a client must absorb the debt. But that applies only when this is off. When this feature is toggled on, then all banks must absorb the debt collectively. This prevents a single bank from being dragged down by repeated bankruptcies of all of its clients. Evidently this happens almost certainly when insurance is off.
- **g-bankruptcy-factor** – This is set to 2 as a default. The standard size of a loan is determined internally in the model. If a prsn goes into debt by an amount equal to two full loans, they are cut off and declared bankrupt. This control can be modified to allow prsns to go deeper into debt. Or it can be set so that no L1 loans can be made.
- **g-no-of-banks-max** – This slider determines the number of banks created during setup, and, together with the next slider, the number of prsns on setup. And, together with the g-crb-assets-per-prsn slider from Panel 01, it determines the size of the money base (L0 and P0 allocations) which determine the size of MS-I and the maximum possible size of MS-II. In addition, these sliders can be adjusted during a run. This would not change the size of the money base, but it would alter the number of banks, and by implication, the number of prsns in the model.
- **g-no-of-prsns-per-bank** – This is what it says. Together with the previous slider, this determines the number of prsns in the model on startup, the size of MS-I, the maximum size of MS-II. In addition, it can be used to change the number of prsns in a model during a run.

The default values of these three controls seem to provide results that are insightful, and I am uncertain that they would provide additional insight if varied. However, I needed them for debug activities, and so I have left them active here.

4.2.5 - Panel 05 – Net Worth Histograms

This panel has a single large histogram – **Net Worth of Prsns and Banks**. It is a repeat of the small histogram in Panel 01. The distribution of net worth of the banks is shown in red. The distribution of the net worth of the prsns is shown in green. The example in the annex shows the two distributions, for a run with the default control values, after the model has reached steady state. Note that the prsns are all living in a state of permanent debt, and the banks have wealth ranging from very poor to very very wealthy. This run started with all prsns having net worth of \$3000 and banks having net worth of \$0. The flows of money from prsns to banks is via interest on L1 loans, and interest paid by the CRB on ER and RR deposits. Flows in the opposite direction are via bankruptcies of prsns, and interest on savings deposits of prsns. The slow leakage of money from the real economy (prsns) to the financial economy (banks) eventually leads to this distribution of wealth. Alteration of the flow channels leads to different steady-state distributions.

This panel also has the standard three button controls: Setup, One Tick, and Go.

In addition, there is a button that clears all graphs in the CmLab model.

4.2.6 - Panel 06 – More Net Worth Histograms

This panel has three histograms:

- **Net Worth of Prsns** – This shows detail from the previous large histogram in Panel 05, with a focus on the prsns.
- **Net Worth of Banks** – This shows detail from the previous large histogram in Panel 05, with a focus on the chartered banks.
- **P0 Assets of Banks** – This is a new distribution, with a focus on the distribution of physical cash, including money in bank vaults, and money in ER and RR deposits in the CRB. A distribution varies because prsns buy and sell using cash, and deposit and withdraw cash from their own banks, daily.

This panel also has the standard three button controls: Setup, One Tick, and Go.

4.2.7 - Panel 07 – Line Graphs

This panel contains four line graphs, ten “event count” monitors, and four control buttons.

The four line graphs are:

- **Money Supplies** – This graph shows a historical trace of the size of each of the three money supplies. In the example, you see MS-III is relatively constant in size, while MS-I is absolutely constant in size. On the other hand, MS-II rises along a sigmoid curve, rising to a maximal value and staying there in a steady-state formation.
- **Mean Net Worth** – This graph shows a historical trace of the mean net worth of prsns and banks, but it includes not just mean values, but also maximum and minimum values. This line graph shows the edges of the changing distributions shown in the histograms in the previous panel.
- **Bank P0 Assets – (Min, Mean, Max)** – This line graph shows a historical trace of the distribution of P0 assets, as seen in the histogram in the previous panel.
- **No of Prsns** – This panel simply shows a line graph of the number of prsns. This can be adjusted via some of the controls in Panel 04.

There are ten “event count” monitors, as follows:

- **Ticks** – number of ticks since the last time the run started.
 - **Banks** – number of banks currently in the model.
 - **B-max** – the current value of the maximum number of banks possible.
 - **Prsns** – number of prsns max.
 - **P-max** – the current value of the maximum number of prsns possible.
 - **L1-loans** – the number of approved loan applications since the run started.
 - **P-Births** – the number of prsns that have been birthed. This number rises as prsns go bankrupt.
 - **P-Deaths** – the number of bankruptcies of prsns since the run started.
 - **B-Births** – number of banks that have been birthed. This number rises as banks go bankrupt.
 - **B-Deaths** – number of bankruptcies of banks since the run started.
-

4.2.8 - Panel 08 – Line Graphs – Assets By Money Supply

There are four line graphs in this panel. Each one shows the detail from the three money supplies:

- **MS-I Assets** – This shows the line graph for components of the physical money supply, that is, for currency in circulation, vault cash in banks, and excess reserve (ER) and required reserve (RR) deposits held with the CRB on behalf of the chartered banks.
- **MS-II Assets (Big Items)** – This graph shows those items in the logical money supply that dwarf the others. These are the total amounts in checking accounts (fairly constant), in savings accounts (fairly constant), bank loans and banks corporate profits (both climbing).
- **MS-II Assets (Small Items)** – This graph shows the other parts of the logical money supply that have a relatively small magnitude. Note that the CRB and GCRA components barely register above zero, while the Prsn L0 and L1 are somewhat larger. The Prsn L1 component grows as the L1-loan component grows.
- **MS-III Assets** – This shows some of the components of the shadow money supply. Note that the interest on savings reflects the growth of L2 savings in MS-II, while the interest on L1-loans reflects the growth in the L1-loan component of MS-II. At the point at which the red line exceeds the orange line the economy passes a sort of tipping point for which the flow of money from prsns to banks greatly exceeds the flow of money in the other direction. This indicates the point of clear dominance of the financial economy over the real economy.

There is also a button that clears all plots, and the three standard buttons for Setup, One Tick, and Go.

5 - Summary

This NTF documents the user interface and the key logical concepts employed in the development of the CmLab NetLogo computer program.

CmLab demonstrates various aspects of the phenomenon of the conservation of money within a modern economy that is operated in accordance with the practices of double-entry book-keeping and fractional reserve banking.

The graphics shown in the annexes show the results of a standard run after 50,000 ticks.

6 - Yet-To-Do

I need to work out the details of the connection between the conservation of money and the conservation of energy.

7 - Annex A - Examples of User Interface Panels

7.1 - Annex A1 - Panel 01 - The Model

PANEL 01 THE MODEL
Conservation of Money Laboratory
 (NetLogo Platform)

FAST START:
 1. Setup
 2. Go

SETUP
 gs-scenario: Prsns Only
 g-use-this-seed: 7
 STARTUP SLIDERS:
 g-crb-assets-per-prsn: 3000 \$

OPERATIONS CONTROLS:
 One Tick
 Go
 g-halt-at-tick: -1

Prsns-To-Banks Flows
 g-iorr: 2.0 %
 g-ioer: 1.0 %
 g-iobl: 2.0 %

Banks-To-Prsns Flows
 g-losd: 1.0 %

Other Flows:
 g-reserve-requirement-ratio: 20.0 %
 g-net-worth-tax-rate: 0.5 %

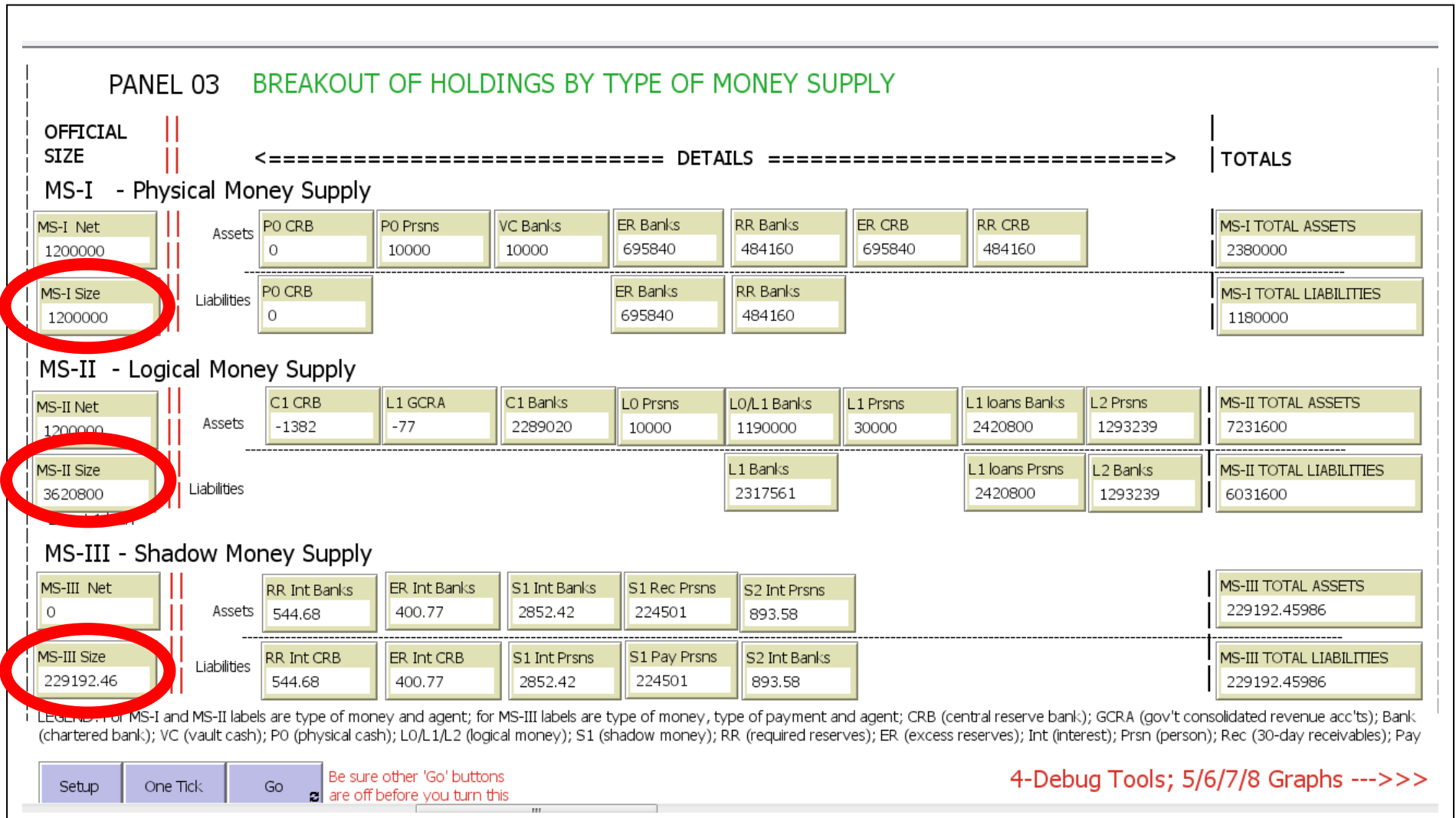
Net Worth of Agents
 Prsns: Green
 Banks: Red

MEAN NET WORTH:
 Prsns: -2723.8
 Banks: 114596.21
 Ticks: 50000

2-Breeds; 3-Money Supplies; 4-Debug Tools; 5/6/7/8-Graphs

Note the small carets (upward and downward arrow heads) used to access the NetLogo “Command Centre” (circled in red).

7.3 - Annex A3 – Panel 03 – Breakout of Holdings By Type of Money Supply



Key monitors to watch are circled in red.


7.4 - Annex A4 – Panel 04 – Debug Tools

PANEL 04 DEBUG TOOLS

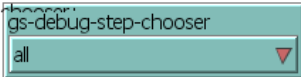
04a DEBUG TOOLS


Intructions:

To toggle the debug feature on or off use this button. This opens a log file and enables debug options. If debug is off, the other options do not record or display

1  Debug
0 (Off)

Then choose a single step, or 'all', in the

2  all ▼

3  On
Off gb-debug-show-steps [TO SEE OUTPUT IN COMMAND CENTRE, TOGGLE DEBUG ON, THEN FLIP THIS SWITCH.]

4 Set Debug Parm Reset Defaults

Banks	Prsns
20	400

STANDARD OPERATION BUTTONS:

5 Setup One Tick go Be sure other 'Go' buttons are off before you turn this Ticks
50000

SINGLE-STEP WITHIN A TICK - should be pushed in order to debug a

6 Pre-Tick Move Buy-sell Accrue-interest Monthly Banking Post-Tick


OTHER VARIOUS DEBUG FUNCTIONS

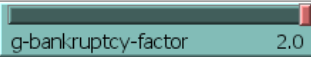
Dump-all-agent-data Setup

Compute-each-net-worth Then Pre-Tick

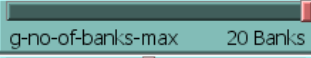
Then whatever for debug.

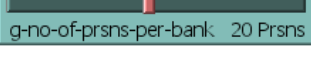
04b REALLY ADVANCED CONTROLS

 On
Off gb-bank-insurance Turn ability of banks to co-operatively share losses due to bankruptcies of

 g-bankruptcy-factor 2.0 This factor is multiplied by a standard loan amount to determine the threshold of debt causing a prsn's

These two controls determine the size of the physical money base (MS-I) during

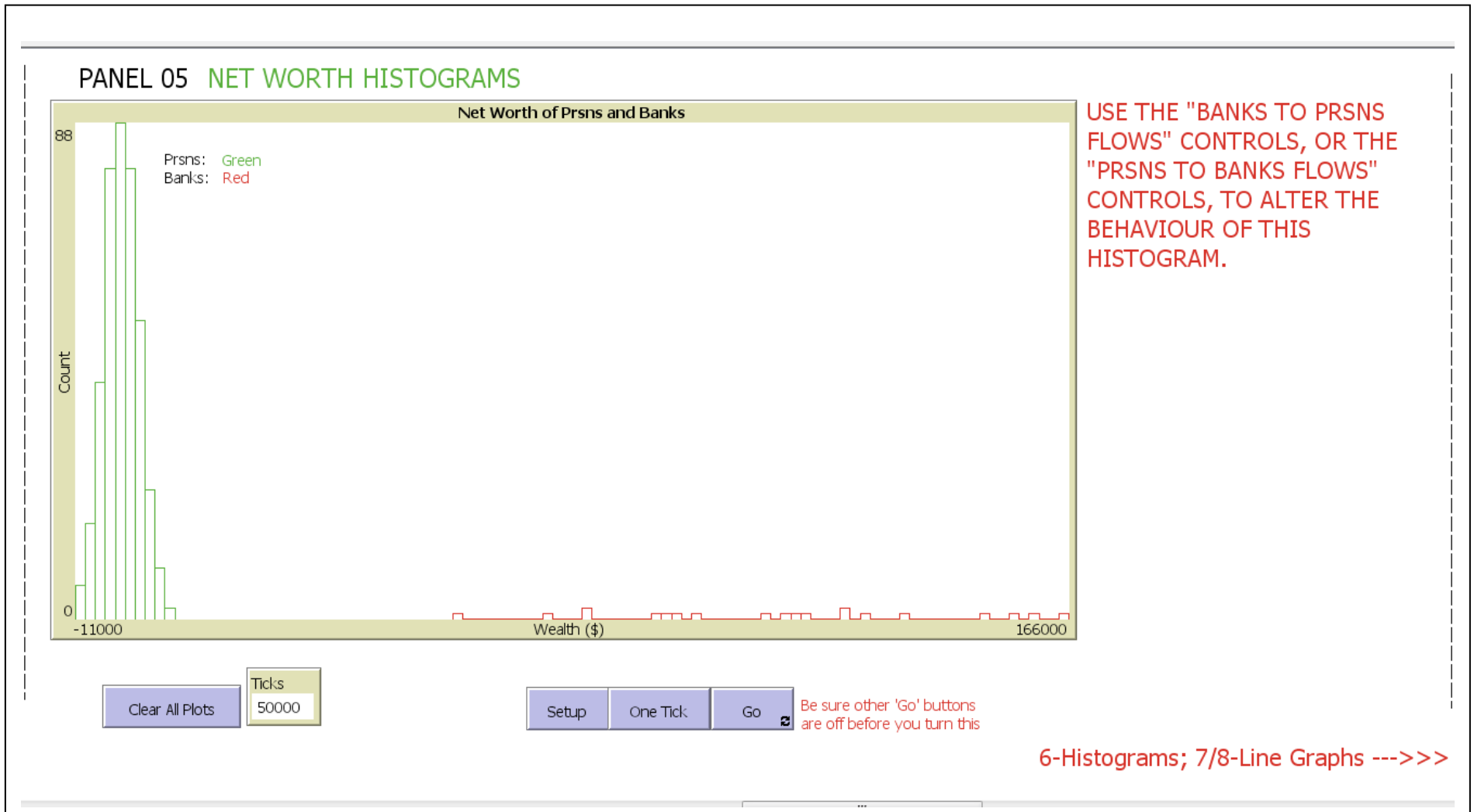
 g-no-of-banks-max 20 Banks Can increase the number of banks during a run without increasing the

 g-no-of-prsns-per-bank 20 Prsns Can increase the number of prsns during a run without increasing the money

5/6-Histograms; 7/8-Line Graphs --->>>

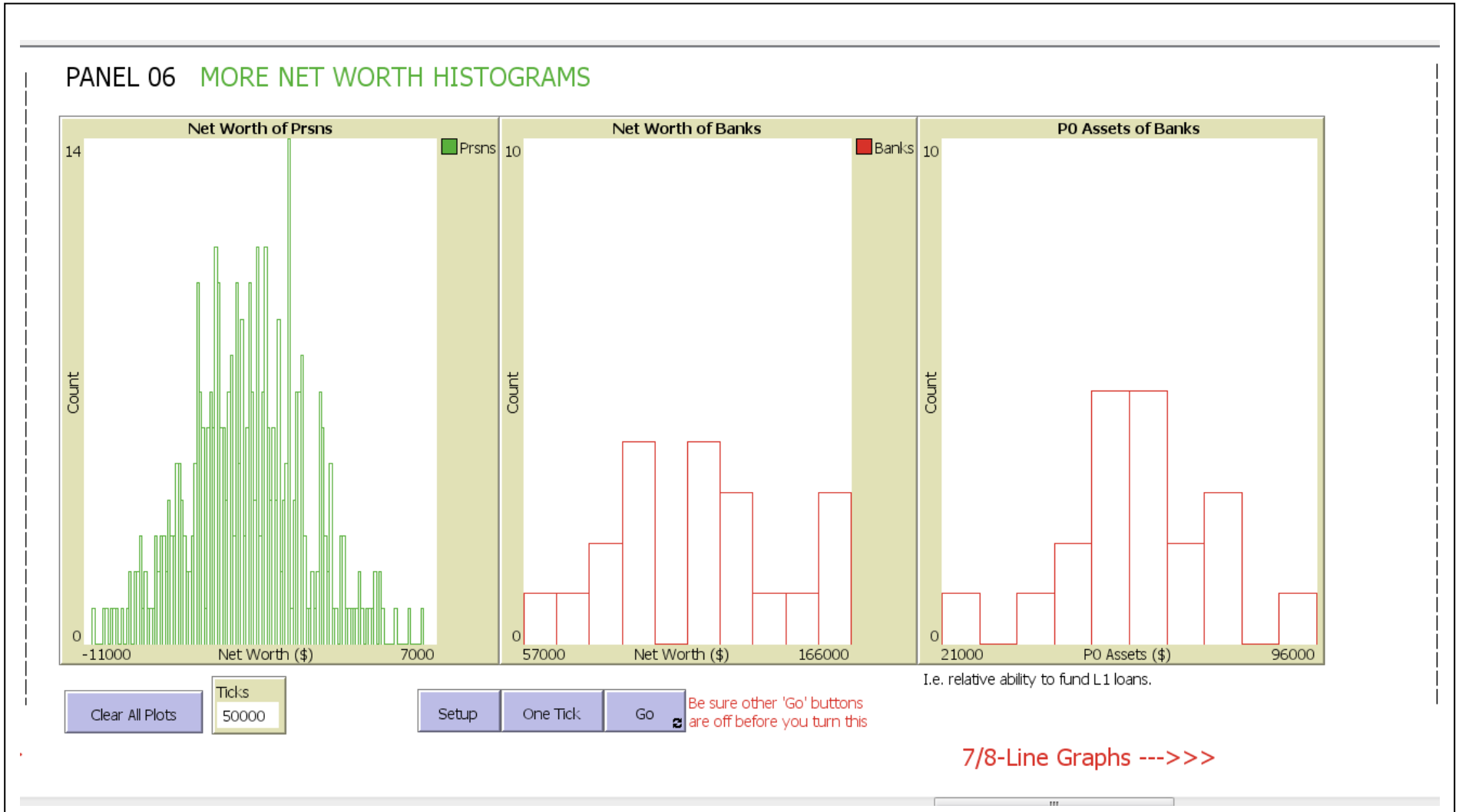
The use of the debug tools is greatly improved if you open the “Command Centre” using the control carrots identified in Panel 01.

7.5 - Annex A5 – Panel 05 – Net Worth Histograms



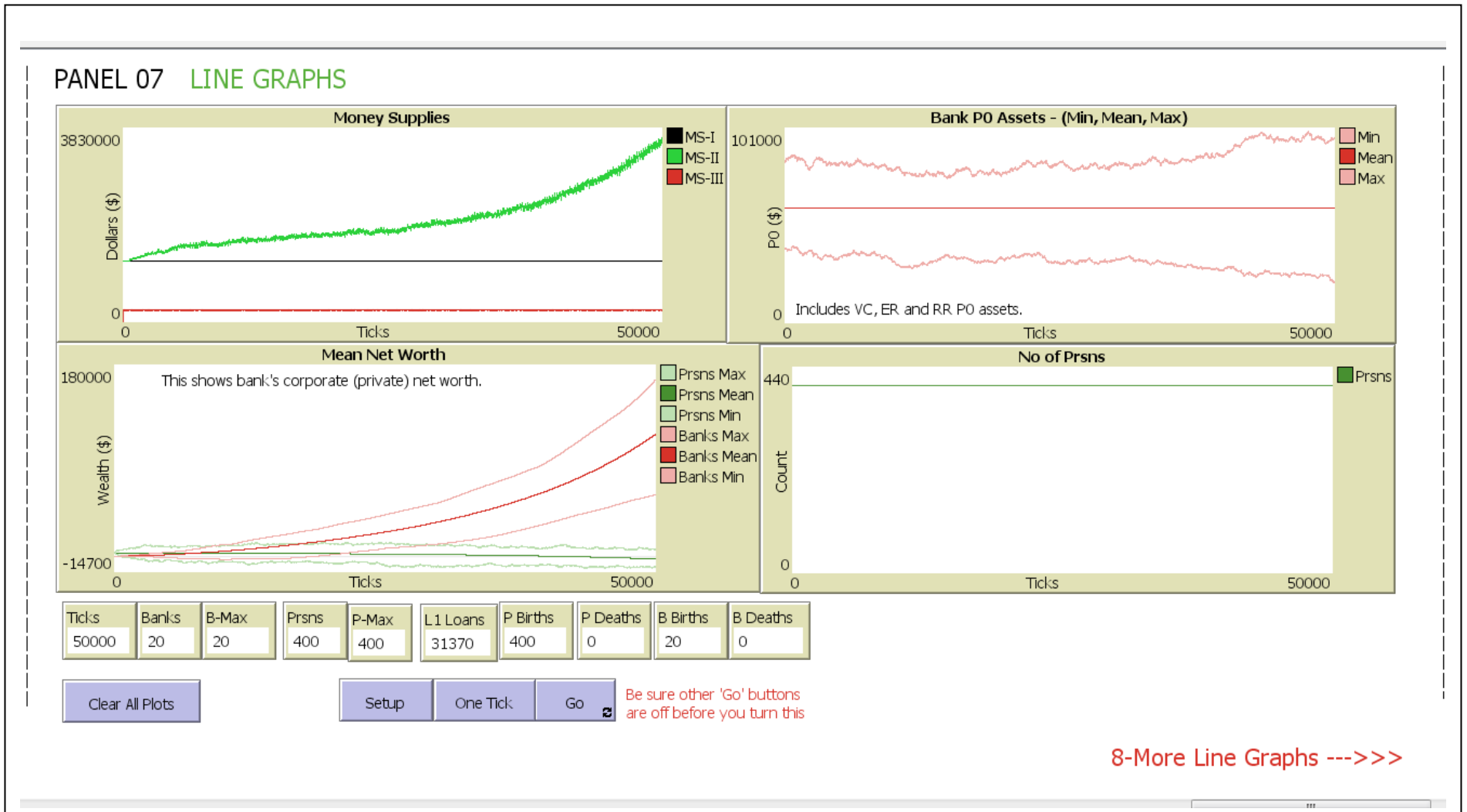
The distribution of net worth within the real economy is shown in green. The distribution of net worth in the financial economy is shown in red. This is from the standard scenario, using the default control values. Note that the net worth is shifting from the commercial agents to the financial agents.

7.6 - Annex A6 – Panel 06 – More Net Worth Histograms



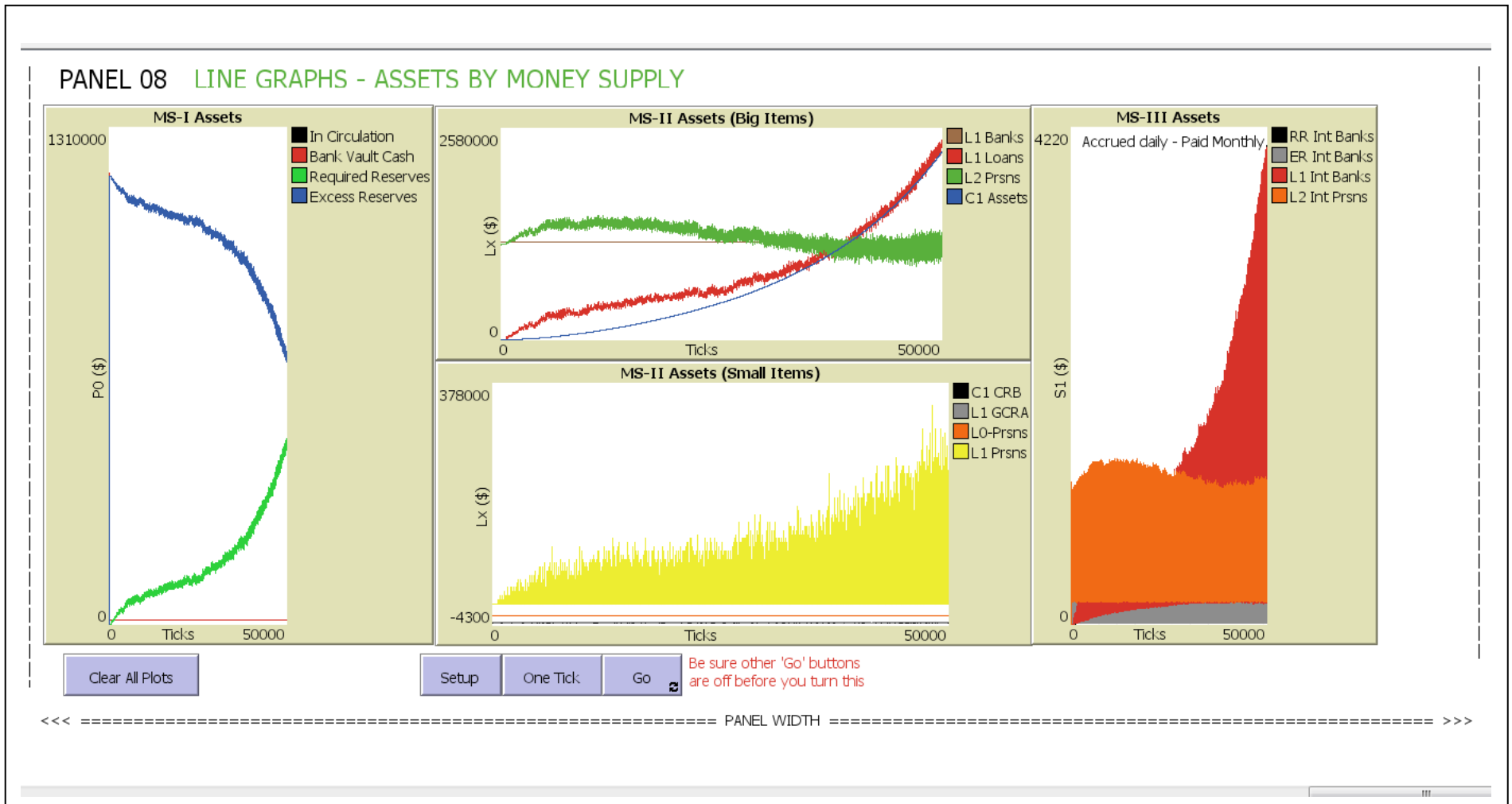
The two histograms on the left show detail from the large histogram in Panel 05.

7.7 - Annex A7 – Panel 07 – Line Graphs



The monitors along the bottom present “event counts”, such as number of bank loans issued, etc.

7.8 - Annex A8 – Panel 08 – Line Graphs – Assets By Money Supply



Note that MS-II (the logical money supply) grows along a sigmoid curve (red line, top middle graph), as does the interest paid on those loans (red area, right graph)

8 - Annex B – Examples of Debug Output

This log data stream was produced using the debug tools found in Panel 04. That required the following steps:

- First I opened the command centre so the log data stream would be visible.
 - I left-clicked on the very tiny upwards pointing carot (arrow head) found in the extreme bottom left corner of the NetLogo screen.
 - Then I found the two-headed arrow at the top right of the command centre, but which was then located at the extreme bottom right of the NetLogo screen and I left-clicked it. This expanded the command centre.
 - Then I left-clicked the “Clear” button (top right of the expanded command centre).
 - Then I turned on the debug feature:
 - I left-clicked on the “Toggle Debug” button in Panel 04.
 - I set the ‘gs-debug-step-chooser’ to “all”.
 - I set the ‘gb-debug-show-steps’ toggle to ‘on’.
 - I left-clicked the ‘Set Debug Parms’ button and the advanced parms in the Panel 04 area were altered to be in a debug configuration.
 - I produced the log data stream shown in Annex B1.
 - I left-clicked on the ‘Setup’ button.
 - I copied the output seen in the command centre to this document.
 - I turned off the debug feature by left-clicking on the ‘Toggle Debug’ button.
 - I produced the log data stream shown in Annex B2.
 - I left-clicked the ‘Go’ button to run the model forward for a few thousand ticks.
 - I cleared the command centre by left-clicking on the ‘Clear’ button.
 - I turned on the debug feature again by left-clicking on the ‘Toggle Debug’ button.
 - I produced the second log data stream by left-clicking the ‘One Tick’ button.
 - I copied the output seen in the command centre to this document.
-

8.1 - Annex B1 – Debug Data Stream From the ‘Setup’ Button

```

observer: "CmLab_Log_160505_055610.txt opened."
observer: ""
observer: "Do-setup: Debug on; tick = 0"
observer: " INTEREST RATES (Sliders):"
observer: " Int. on Required Reserves --- 2 %"
observer: " Int. on Excess Reserves ---- 1 %"
observer: " Int. on Savings Deposits ---- 1 %"
observer: " Int. on Bank Loans ----- 2 %"
observer: " OTHER GLOBALS"
observer: " g-crb-assets-per-prsn ----- 3000"
observer: " g-no-of-banks-max ----- 4"
observer: " g-no-of-prsns-per-bank ----- 2"
observer: " g-no-of-corps-per-bank ----- 1"
observer: " g-net-worth-tax-rate ----- 0.5 %"
observer: " g-reserve-requirement-ratio - 40 %"
observer: " g-no-of-banks-max ----- 4"
observer: " g-no-of-banks ----- 0"
observer: " g-no-of-prsns-max ----- 8"
observer: " g-no-of-prsns ----- 0"
observer: " g-no-of-corps-max ----- 0"
observer: " g-no-of-corps ----- 4"
observer: " g-p-daily-cost-of-living ---- 100"
observer: " g-p-daily-L0-allocation ---- 25"
observer: " g-p-daily-L1-allocation ---- 75"
observer: " g-p-standard-loan ----- 6400"
observer: " g-p-standard-loan-payment --- 800"
observer: " g-minimum-vault-cash ----- 50"
observer: " g-bankruptcy-factor ----- 1.5"
observer: " gb-plot-data ----- true"
observer: " gb-bank-insurance ----- true"
observer: " gb-btpfs-bankruptcies ----- true"
observer: " gb-btpfs-daily-purchases ---- false"
observer: " gb-btpfs-monthly-taxes ---- false"
observer: " Scenario number ----- 0"
observer: " Scenario name ----- Prsns Only"
observer: " Random seed ----- 7"
observer: "SETUP: Debug Is ----- 1"
observer: "SETUP: Debug Status Is ----- 1 (On)"
observer: "SETUP: Step Chooser Is ----- setup"
observer: "SETUP: Flow Control Is ----- 1"
(gcra 0): " Initialize GCRA 0"
(gcra 0): " L1-assets ----- 0"
(gcra 0): " L1-loan-debts ----- 0"
(gcra 0): " S1-L1ip-debts ----- 0"
(crb 1): " Initialize CRB 1"
(crb 1): " CRB MS-I P0 Assets ----- 0"
(crb 1): " CRB MS-I F0 Assets ----- 0"
(crb 1): " CRB MS-I P0 debts ----- 0"
(crb 1): " CRB MS-I F0 debts ----- 0"
(crb 1): " CRB Required reserves ----- 0"
(crb 1): " S1-rrip-debts ----- 0"
(crb 1): " CRB Excess reserves ----- 0"
(crb 1): " S1-erip-debts ----- 0"
(bank 3): " Initialize bank 3"
(bank 2): " Initialize bank 2"
(bank 5): " Initialize bank 5"
(bank 4): " Initialize bank 4"
observer: ""
observer: "CRB RECONCILES RESERVE DEPOSITS"
(bank 4): "BANK 4"
(bank 4): " L1-loan-assets ----- 0"
(bank 4): " Old settings:"
(bank 4): " P0-vc-assets ----- 0"
(bank 4): " P0-rr-assets ----- 0"
(bank 4): " P0-er-assets ----- 0"
(bank 4): " Total reserves ----- 0"
(bank 4): " CBSvcs: Amount of ER withdrawn -- 0"
(bank 4): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 4): " CBSvcs: Amount of RR deposited -- 0"
(bank 4): " CBSvcs: Amount of ER deposited -- 0"
(bank 4): " New settings:"
(bank 4): " P0-vc-assets ----- 0"
(bank 4): " P0-rr-assets ----- 0"
(bank 4): " P0-er-assets ----- 0"
(bank 4): " Total reserves ----- 0"
(bank 4): " Bank loan dept status - CLOSED"
(bank 5): "BANK 5"
(bank 5): " L1-loan-assets ----- 0"
(bank 5): " Old settings:"
(bank 5): " P0-vc-assets ----- 0"
(bank 5): " P0-rr-assets ----- 0"
(bank 5): " P0-er-assets ----- 0"
(bank 5): " Total reserves ----- 0"
(bank 5): " CBSvcs: Amount of ER withdrawn -- 0"
(bank 5): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 5): " CBSvcs: Amount of RR deposited -- 0"
(bank 5): " CBSvcs: Amount of ER deposited -- 0"
(bank 5): " New settings:"
(bank 5): " P0-vc-assets ----- 0"
(bank 5): " P0-rr-assets ----- 0"
(bank 5): " P0-er-assets ----- 0"
(bank 5): " Total reserves ----- 0"
(bank 5): " Bank loan dept status - CLOSED"
(bank 2): "BANK 2"
(bank 2): " L1-loan-assets ----- 0"
(bank 2): " Old settings:"
(bank 2): " P0-vc-assets ----- 0"
(bank 2): " P0-rr-assets ----- 0"
(bank 2): " P0-er-assets ----- 0"
(bank 2): " Total reserves ----- 0"
(bank 2): " CBSvcs: Amount of ER withdrawn -- 0"
(bank 2): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 2): " CBSvcs: Amount of RR deposited -- 0"
(bank 2): " CBSvcs: Amount of ER deposited -- 0"
(bank 2): " New settings:"
(bank 2): " P0-vc-assets ----- 0"
(bank 2): " P0-rr-assets ----- 0"
(bank 2): " P0-er-assets ----- 0"
(bank 2): " Total reserves ----- 0"
(bank 2): " Bank loan dept status - CLOSED"
(bank 3): "BANK 3"
(bank 3): " L1-loan-assets ----- 0"
(bank 3): " Old settings:"
(bank 3): " P0-vc-assets ----- 0"
(bank 3): " P0-rr-assets ----- 0"
(bank 3): " P0-er-assets ----- 0"
(bank 3): " Total reserves ----- 0"
(bank 3): " CBSvcs: Amount of ER withdrawn -- 0"
(bank 3): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 3): " CBSvcs: Amount of RR deposited -- 0"
(bank 3): " CBSvcs: Amount of ER deposited -- 0"
(bank 3): " New settings:"
(bank 3): " P0-vc-assets ----- 0"
(bank 3): " P0-rr-assets ----- 0"
(bank 3): " P0-er-assets ----- 0"
(bank 3): " Total reserves ----- 0"
(bank 3): " Bank loan dept status - CLOSED"
(gcra 0): " Found - (bank 5)"
(crb 1): " Found - (bank 5)"
(prsn 9): " Initialize prsn 9"
(prsn 9): "Prsn 9 finding a bank."
(prsn 7): " Initialize prsn 7"
(prsn 7): "Prsn 7 finding a bank."
(prsn 10): " Initialize prsn 10"
(prsn 10): "Prsn 10 finding a bank."
(prsn 8): " Initialize prsn 8"
(prsn 8): "Prsn 8 finding a bank."
(prsn 11): " Initialize prsn 11"
(prsn 11): "Prsn 11 finding a bank."
(prsn 12): " Initialize prsn 12"
(prsn 12): "Prsn 12 finding a bank."
(prsn 13): " Initialize prsn 13"
(prsn 13): "Prsn 13 finding a bank."
(prsn 6): " Initialize prsn 6"
(prsn 6): "Prsn 6 finding a bank."
(crb 1): ""
(crb 1): "Distribution of Money Base by CRB"
(prsn 7): "PRSN 7 VISITS BANK 4."
(prsn 7): " My P0-assets were ----- 3000"
(prsn 7): " My L0-assets were ----- 3000"
(prsn 7): " My L1-assets were ----- 0"
(prsn 7): " My L2-assets were ----- 0"
(prsn 7): " Total affected assets ----- 3000"
(prsn 7): " BSvcs: Amount of P0 deposited - 3000"
(prsn 7): " My P0-assets are ----- 0"
(prsn 7): " My L0-assets are ----- 0"
(prsn 7): " BSvcs: Amount of P0 withdrawn - 25"
(prsn 7): " My P0-assets are ----- 25"
(prsn 7): " My L0-assets are ----- 25"
(prsn 7): " My L1-assets are ----- 2975"
(prsn 7): " BSvcs: Moved from L1 to L2 ---- 2975"
(prsn 7): " My L1-assets are ----- 0"
(prsn 7): " BSvcs: Moved from L2 to L1 ---- 75"
(prsn 7): " My L1-assets are ----- 75"
(prsn 7): " Pre-loan - My L2-assets are --- 2900"
(prsn 7): " A loan is not required!"
(prsn 7): " Post-loan - My L0-assets are -- 25"
(prsn 7): " Post-loan - My L1-assets are -- 75"
(prsn 7): " Post-loan - My L2-assets are -- 2900"
(prsn 7): " Total affected assets ----- 3000"

```

```

(prsn 12): "PRSN 12 VISITS BANK 3."
(prsn 12): " My P0-assets were ----- 3000"
(prsn 12): " My L0-assets were ----- 3000"
(prsn 12): " My L1-assets were ----- 0"
(prsn 12): " My L2-assets were ----- 0"
(prsn 12): " Total affected assets ----- 3000"
(prsn 12): " BSVcs: Amount of P0 deposited - 3000"
(prsn 12): " My P0-assets are ----- 0"
(prsn 12): " My L0-assets are ----- 0"
(prsn 12): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 12): " My P0-assets are ----- 25"
(prsn 12): " My L0-assets are ----- 25"
(prsn 12): " My L1-assets are ----- 2975"
(prsn 12): " BSVcs: Moved from L1 to L2 ---- 2975"
(prsn 12): " My L1-assets are ----- 0"
(prsn 12): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 12): " My L1-assets are ----- 75"
(prsn 12): " Pre-loan - My L2-assets are --- 2900"
(prsn 12): " A loan is not required!"
(prsn 12): " Post-loan - My L0-assets are -- 25"
(prsn 12): " Post-loan - My L1-assets are -- 75"
(prsn 12): " Post-loan - My L2-assets are -- 2900"
(prsn 12): " Total affected assets ----- 3000"
(prsn 10): "PRSN 10 VISITS BANK 2."
(prsn 10): " My P0-assets were ----- 3000"
(prsn 10): " My L0-assets were ----- 3000"
(prsn 10): " My L1-assets were ----- 0"
(prsn 10): " My L2-assets were ----- 0"
(prsn 10): " Total affected assets ----- 3000"
(prsn 10): " BSVcs: Amount of P0 deposited - 3000"
(prsn 10): " My P0-assets are ----- 0"
(prsn 10): " My L0-assets are ----- 0"
(prsn 10): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 10): " My P0-assets are ----- 25"
(prsn 10): " My L0-assets are ----- 25"
(prsn 10): " My L1-assets are ----- 2975"
(prsn 10): " BSVcs: Moved from L1 to L2 ---- 2975"
(prsn 10): " My L1-assets are ----- 0"
(prsn 10): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 10): " My L1-assets are ----- 75"
(prsn 10): " Pre-loan - My L2-assets are --- 2900"
(prsn 10): " A loan is not required!"
(prsn 10): " Post-loan - My L0-assets are -- 25"
(prsn 10): " Post-loan - My L1-assets are -- 75"
(prsn 10): " Post-loan - My L2-assets are -- 2900"
(prsn 10): " Total affected assets ----- 3000"
(prsn 13): "PRSN 13 VISITS BANK 4."
(prsn 13): " My P0-assets were ----- 3000"
(prsn 13): " My L0-assets were ----- 3000"
(prsn 13): " My L1-assets were ----- 0"
(prsn 13): " My L2-assets were ----- 0"
(prsn 13): " Total affected assets ----- 3000"
(prsn 13): " BSVcs: Amount of P0 deposited - 3000"
(prsn 13): " My P0-assets are ----- 0"
(prsn 13): " My L0-assets are ----- 0"
(prsn 13): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 13): " My P0-assets are ----- 25"
(prsn 13): " My L0-assets are ----- 25"
(prsn 13): " My L1-assets are ----- 2975"
(prsn 13): " BSVcs: Moved from L1 to L2 ---- 2975"
(prsn 13): " My L1-assets are ----- 0"
(prsn 13): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 13): " My L1-assets are ----- 75"
(prsn 13): " Pre-loan - My L2-assets are --- 2900"
(prsn 13): " A loan is not required!"
(prsn 13): " Post-loan - My L0-assets are -- 25"
(prsn 13): " Post-loan - My L1-assets are -- 75"
(prsn 13): " Post-loan - My L2-assets are -- 2900"
(prsn 13): " Total affected assets ----- 3000"
(prsn 6): "PRSN 6 VISITS BANK 4."
(prsn 6): " My P0-assets were ----- 3000"
(prsn 6): " My L0-assets were ----- 3000"
(prsn 6): " My L1-assets were ----- 0"
(prsn 6): " My L2-assets were ----- 0"
(prsn 6): " Total affected assets ----- 3000"
(prsn 6): " BSVcs: Amount of P0 deposited - 3000"
(prsn 6): " My P0-assets are ----- 0"
(prsn 6): " My L0-assets are ----- 0"
(prsn 6): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 6): " My P0-assets are ----- 25"
(prsn 6): " My L0-assets are ----- 25"
(prsn 6): " My L1-assets are ----- 2975"
(prsn 6): " BSVcs: Moved from L1 to L2 ---- 2975"
(prsn 6): " My L1-assets are ----- 0"
(prsn 6): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 6): " My L1-assets are ----- 75"
(prsn 6): " Pre-loan - My L2-assets are --- 2900"
(prsn 6): " A loan is not required!"
(prsn 6): " Post-loan - My L0-assets are -- 25"
(prsn 6): " Post-loan - My L1-assets are -- 75"
(prsn 6): " Post-loan - My L2-assets are -- 2900"
(prsn 6): " Total affected assets ----- 3000"
(prsn 8): "PRSN 8 VISITS BANK 3."
(prsn 8): " My P0-assets were ----- 3000"
(prsn 8): " My L0-assets were ----- 3000"
(prsn 8): " My L1-assets were ----- 0"
(prsn 8): " My L2-assets were ----- 0"
(prsn 8): " Total affected assets ----- 3000"
(prsn 8): " BSVcs: Amount of P0 deposited - 3000"
(prsn 8): " My P0-assets are ----- 0"
(prsn 8): " My L0-assets are ----- 0"
(prsn 8): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 8): " My P0-assets are ----- 25"
(prsn 8): " My L0-assets are ----- 25"
(prsn 8): " My L1-assets are ----- 2975"
(prsn 8): " BSVcs: Moved from L1 to L2 ---- 2975"
(prsn 8): " My L1-assets are ----- 0"
(prsn 8): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 8): " My L1-assets are ----- 75"
(prsn 8): " Pre-loan - My L2-assets are --- 2900"
(prsn 8): " A loan is not required!"
(prsn 8): " Post-loan - My L0-assets are -- 25"
(prsn 8): " Post-loan - My L1-assets are -- 75"
(prsn 8): " Post-loan - My L2-assets are -- 2900"
(prsn 8): " Total affected assets ----- 3000"
(prsn 9): "PRSN 9 VISITS BANK 4."
(prsn 9): " My P0-assets were ----- 3000"
(prsn 9): " My L0-assets were ----- 3000"
(prsn 9): " My L1-assets were ----- 0"
(prsn 9): " My L2-assets were ----- 0"
(prsn 9): " Total affected assets ----- 3000"
(prsn 9): " BSVcs: Amount of P0 deposited - 3000"
(prsn 9): " My P0-assets are ----- 0"
(prsn 9): " My L0-assets are ----- 0"
(prsn 9): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 9): " My P0-assets are ----- 25"
(prsn 9): " My L0-assets are ----- 25"
(prsn 9): " My L1-assets are ----- 2975"
(prsn 9): " BSVcs: Moved from L1 to L2 ---- 2975"
(prsn 9): " My L1-assets are ----- 0"
(prsn 9): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 9): " My L1-assets are ----- 75"
(prsn 9): " Pre-loan - My L2-assets are --- 2900"
(prsn 9): " A loan is not required!"
(prsn 9): " Post-loan - My L0-assets are -- 25"
(prsn 9): " Post-loan - My L1-assets are -- 75"
(prsn 9): " Post-loan - My L2-assets are -- 2900"
(prsn 9): " Total affected assets ----- 3000"
(carb 1): " After CRB distribution"
(carb 1): " CRB P0-assets ----- 0"
(carb 1): " CRB L0-assets ----- 24000"
(carb 1): " CRB P0-debts ----- 0"
(carb 1): " CRB L0-debts ----- 24000"
(carb 1): " CRB P0-rr-assets ----- 0"
(carb 1): " CRB P0-er-assets ----- 0"
(carb 1): " All Prsns P0-assets ----- 200"
(carb 1): " All Prsns L0-assets ----- 200"
observer: " EVERYBODY VISITS BANK"
(prsn 13): "PRSN 13 VISITS BANK 4."
(prsn 13): " My P0-assets were ----- 25"
(prsn 13): " My L0-assets were ----- 25"
(prsn 13): " My L1-assets were ----- 75"
(prsn 13): " My L2-assets were ----- 2900"
(prsn 13): " Total affected assets ----- 3000"
(prsn 13): " BSVcs: Amount of P0 deposited - 25"
(prsn 13): " My P0-assets are ----- 0"
(prsn 13): " My L0-assets are ----- 0"
(prsn 13): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 13): " My P0-assets are ----- 25"
(prsn 13): " My L0-assets are ----- 25"
(prsn 13): " My L1-assets are ----- 75"
(prsn 13): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 13): " My L1-assets are ----- 0"

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(prsn 13): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 13): " My L1-assets are ----- 75"
(prsn 13): " Pre-loan - My L2-assets are --- 2900"
(prsn 13): " A loan is not required!"
(prsn 13): " Post-loan - My L0-assets are -- 25"
(prsn 13): " Post-loan - My L1-assets are -- 75"
(prsn 13): " Post-loan - My L2-assets are -- 2900"
(prsn 13): " Total affected assets ----- 3000"
(prsn 8): "PRSN 8 VISITS BANK 3."
(prsn 8): " My P0-assets were ----- 25"
(prsn 8): " My L0-assets were ----- 25"
(prsn 8): " My L1-assets were ----- 75"
(prsn 8): " My L2-assets were ----- 2900"
(prsn 8): " Total affected assets ----- 3000"
(prsn 8): " BSVcs: Amount of P0 deposited - 25"
(prsn 8): " My P0-assets are ----- 0"
(prsn 8): " My L0-assets are ----- 0"
(prsn 8): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 8): " My P0-assets are ----- 25"
(prsn 8): " My L0-assets are ----- 25"
(prsn 8): " My L1-assets are ----- 75"
(prsn 8): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 8): " My L1-assets are ----- 0"
(prsn 8): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 8): " My L1-assets are ----- 75"
(prsn 8): " Pre-loan - My L2-assets are --- 2900"
(prsn 8): " A loan is not required!"
(prsn 8): " Post-loan - My L0-assets are -- 25"
(prsn 8): " Post-loan - My L1-assets are -- 75"
(prsn 8): " Post-loan - My L2-assets are -- 2900"
(prsn 8): " Total affected assets ----- 3000"
(prsn 10): "PRSN 10 VISITS BANK 2."
(prsn 10): " My P0-assets were ----- 25"
(prsn 10): " My L0-assets were ----- 25"
(prsn 10): " My L1-assets were ----- 75"
(prsn 10): " My L2-assets were ----- 2900"
(prsn 10): " Total affected assets ----- 3000"
(prsn 10): " BSVcs: Amount of P0 deposited - 25"
(prsn 10): " My P0-assets are ----- 0"
(prsn 10): " My L0-assets are ----- 0"
(prsn 10): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 10): " My P0-assets are ----- 25"
(prsn 10): " My L0-assets are ----- 25"
(prsn 10): " My L1-assets are ----- 75"
(prsn 10): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 10): " My L1-assets are ----- 0"
(prsn 10): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 10): " My L1-assets are ----- 75"
(prsn 10): " Pre-loan - My L2-assets are --- 2900"
(prsn 10): " A loan is not required!"
(prsn 10): " Post-loan - My L0-assets are -- 25"
(prsn 10): " Post-loan - My L1-assets are -- 75"
(prsn 10): " Post-loan - My L2-assets are -- 2900"
(prsn 10): " Total affected assets ----- 3000"
(prsn 11): "PRSN 11 VISITS BANK 2."
(prsn 11): " My P0-assets were ----- 25"
(prsn 11): " My L0-assets were ----- 25"
(prsn 11): " My L1-assets were ----- 75"
(prsn 11): " My L2-assets were ----- 2900"
(prsn 11): " Total affected assets ----- 3000"
(prsn 11): " BSVcs: Amount of P0 deposited - 25"
(prsn 11): " My P0-assets are ----- 0"
(prsn 11): " My L0-assets are ----- 0"
(prsn 11): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 11): " My P0-assets are ----- 25"
(prsn 11): " My L0-assets are ----- 25"
(prsn 11): " My L1-assets are ----- 75"
(prsn 11): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 11): " My L1-assets are ----- 0"
(prsn 11): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 11): " My L1-assets are ----- 75"
(prsn 11): " Pre-loan - My L2-assets are --- 2900"
(prsn 11): " A loan is not required!"
(prsn 11): " Post-loan - My L0-assets are -- 25"
(prsn 11): " Post-loan - My L1-assets are -- 75"
(prsn 11): " Post-loan - My L2-assets are -- 2900"
(prsn 11): " Total affected assets ----- 3000"
(prsn 11): " BSVcs: Amount of P0 deposited - 25"
(prsn 11): " My P0-assets are ----- 0"
(prsn 11): " My L0-assets are ----- 0"
(prsn 11): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 11): " My P0-assets are ----- 25"
(prsn 11): " My L0-assets are ----- 25"
(prsn 11): " My L1-assets are ----- 75"
(prsn 11): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 11): " My L1-assets are ----- 0"
(prsn 11): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 11): " My L1-assets are ----- 75"
(prsn 11): " Pre-loan - My L2-assets are --- 2900"
(prsn 11): " A loan is not required!"
(prsn 11): " Post-loan - My L0-assets are -- 25"
(prsn 11): " Post-loan - My L1-assets are -- 75"
(prsn 11): " Post-loan - My L2-assets are -- 2900"
(prsn 11): " Total affected assets ----- 3000"
(prsn 12): " My P0-assets were ----- 25"
(prsn 12): " My L0-assets were ----- 25"
(prsn 12): " My L1-assets were ----- 75"
(prsn 12): " My L2-assets were ----- 2900"
(prsn 12): " Total affected assets ----- 3000"
(prsn 12): " BSVcs: Amount of P0 deposited - 25"
(prsn 12): " My P0-assets are ----- 0"
(prsn 12): " My L0-assets are ----- 0"
(prsn 12): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 12): " My P0-assets are ----- 25"
(prsn 12): " My L0-assets are ----- 25"
(prsn 12): " My L1-assets are ----- 75"
(prsn 12): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 12): " My L1-assets are ----- 0"
(prsn 12): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 12): " My L1-assets are ----- 75"
(prsn 12): " Pre-loan - My L2-assets are --- 2900"
(prsn 12): " A loan is not required!"
(prsn 12): " Post-loan - My L0-assets are -- 25"
(prsn 12): " Post-loan - My L1-assets are -- 75"
(prsn 12): " Post-loan - My L2-assets are -- 2900"
(prsn 12): " Total affected assets ----- 3000"
(prsn 9): "PRSN 9 VISITS BANK 4."
(prsn 9): " My P0-assets were ----- 25"
(prsn 9): " My L0-assets were ----- 25"
(prsn 9): " My L1-assets were ----- 75"
(prsn 9): " My L2-assets were ----- 2900"
(prsn 9): " Total affected assets ----- 3000"
(prsn 9): " BSVcs: Amount of P0 deposited - 25"
(prsn 9): " My P0-assets are ----- 0"
(prsn 9): " My L0-assets are ----- 0"
(prsn 9): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 9): " My P0-assets are ----- 25"
(prsn 9): " My L0-assets are ----- 25"
(prsn 9): " My L1-assets are ----- 75"
(prsn 9): " BSVcs: Moved from L1 to L2 ---- 75"
(prsn 9): " My L1-assets are ----- 0"
(prsn 9): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 9): " My L1-assets are ----- 75"
(prsn 9): " Pre-loan - My L2-assets are --- 2900"
(prsn 9): " A loan is not required!"
(prsn 9): " Post-loan - My L0-assets are -- 25"
(prsn 9): " Post-loan - My L1-assets are -- 75"
(prsn 9): " Post-loan - My L2-assets are -- 2900"
(prsn 9): " Total affected assets ----- 3000"
observer: "Each net worth will be computed. "
observer: " Do-aaa: All aggregates updated. "
(gcra 0): " "
(gcra 0): "DUMP GCRA who# <<< 0 >>>"
(gcra 0): "bank-who ----- 5"
(gcra 0): "L1-assets ----- 0"
(gcra 0): "L1-loan-debts ----- 0"
(gcra 0): "S1-Llip-debts ----- 0"
(gcra 0): "ttl-P0-assets ----- 0"
(gcra 0): "ttl-publ-assets ----- 0"
(gcra 0): "ttl-publ-debts ----- 0"
(gcra 0): "ttl-priv-assets ----- 0"
(gcra 0): "ttl-priv-debts ----- 0"
(gcra 0): "net-worth-publ ----- 0"
(gcra 0): "net-worth-priv ----- 0"
(crb 1): " "
(crb 1): "DUMP CRB who# <<< 1 >>>"

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```

(crb 1): "L0-assets ----- 24000"
(crb 1): "P0-assets ----- 0"
(crb 1): "L0-debts ----- 24000"
(crb 1): "P0-debts ----- 0"
(crb 1): "P0-rr-assets ----- 0"
(crb 1): "P0-er-assets ----- 0"
(crb 1): "S1-rrip-debts ----- 0"
(crb 1): "S1-erip-debts ----- 0"
(crb 1): "C1-assets ----- 0"
(crb 1): "ttl-P0-assets ----- 0"
(crb 1): "ttl-publ-assets ----- 24000"
(crb 1): "ttl-publ-debts ----- 24000"
(crb 1): "ttl-priv-assets ----- 0"
(crb 1): "ttl-priv-debts ----- 0"
(crb 1): "net-worth-publ ----- 0"
(crb 1): "net-worth-priv ----- 0"
(bank 3): " "
(bank 3): "DUMP BANK who# <<< 3 >>>"
(bank 3): "b-bank-can-make-loans ----- 0"
(bank 3): "b-bank-is-bankrupt ----- 0"
(bank 3): "L1-assets ----- 5950"
(bank 3): "L1-loan-assets ----- 0"
(bank 3): "L1-debts ----- 150"
(bank 3): "S1-L1ir-assets ----- 0"
(bank 3): "L2-debts ----- 5800"
(bank 3): "S1-L2ip-debts ----- 0"
(bank 3): "P0-vc-assets ----- 5950"
(bank 3): "P0-rr-assets ----- 0"
(bank 3): "P0-er-assets ----- 0"
(bank 3): " "
(bank 3): "no-of-prsn-clients ----- 2"
(bank 3): "no-of-corp-clients ----- 0"
(bank 3): "no-of-gcra-clients ----- 0"
(bank 3): "no-of-crb-clients ----- 0"
(bank 3): "S1-rrir-assets ----- 0"
(bank 3): "S1-erir-assets ----- 0"
(bank 3): "C1-assets ----- 0"
(bank 3): "ttl-P0-assets ----- 5950"
(bank 3): "ttl-publ-assets ----- 5950"
(bank 3): "ttl-publ-debts ----- 5950"
(bank 3): "ttl-priv-assets ----- 0"
(bank 3): "ttl-priv-debts ----- 0"
(bank 3): "net-worth-publ ----- 0"
(bank 3): "net-worth-priv ----- 0"
(bank 2): " "
(bank 2): "DUMP BANK who# <<< 2 >>>"
(bank 2): "b-bank-can-make-loans ----- 0"
(bank 2): "b-bank-is-bankrupt ----- 0"
(bank 2): "L1-assets ----- 5950"
(bank 2): "L1-loan-assets ----- 0"
(bank 2): "L1-debts ----- 150"
(bank 2): "S1-L1ir-assets ----- 0"
(bank 2): "L2-debts ----- 5800"
(bank 2): "S1-L2ip-debts ----- 0"
(bank 2): "P0-vc-assets ----- 5950"
(bank 2): "P0-rr-assets ----- 0"
(bank 2): "P0-er-assets ----- 0"
(bank 2): " "
(bank 2): "no-of-prsn-clients ----- 2"
(bank 2): "no-of-corp-clients ----- 0"
(bank 2): "no-of-gcra-clients ----- 0"
(bank 2): "no-of-crb-clients ----- 0"
(bank 2): "S1-rrir-assets ----- 0"
(bank 2): "S1-erir-assets ----- 0"
(bank 2): "C1-assets ----- 0"
(bank 2): "ttl-P0-assets ----- 11900"
(bank 2): "ttl-publ-assets ----- 11900"
(bank 2): "ttl-publ-debts ----- 11900"
(bank 2): "S1-rrir-assets ----- 0"
(bank 2): "S1-erir-assets ----- 0"
(bank 2): "C1-assets ----- 0"
(bank 2): "ttl-P0-assets ----- 0"
(bank 2): "ttl-priv-assets ----- 0"
(bank 2): "ttl-publ-debts ----- 0"
(bank 2): "ttl-priv-debts ----- 0"
(bank 2): "net-worth-publ ----- 0"
(bank 2): "net-worth-priv ----- 0"
(bank 4): " "
(bank 4): "DUMP BANK who# <<< 4 >>>"
(bank 4): "b-bank-can-make-loans ----- 0"
(bank 4): "b-bank-is-bankrupt ----- 0"
(bank 4): "L1-assets ----- 11900"
(bank 4): "L1-loan-assets ----- 0"
(bank 4): "L1-debts ----- 300"
(bank 4): "S1-L1ir-assets ----- 0"
(bank 4): "L2-debts ----- 11600"
(bank 4): "S1-L2ip-debts ----- 0"
(bank 4): "P0-vc-assets ----- 11900"
(bank 4): "P0-rr-assets ----- 0"
(bank 4): "P0-er-assets ----- 0"
(bank 4): " "
(bank 4): "no-of-prsn-clients ----- 4"
(bank 4): "no-of-corp-clients ----- 0"
(bank 4): "no-of-gcra-clients ----- 0"
(bank 4): "no-of-crb-clients ----- 0"
(bank 4): "S1-rrir-assets ----- 0"
(bank 4): "S1-erir-assets ----- 0"
(bank 4): "C1-assets ----- 0"
(bank 4): "ttl-P0-assets ----- 11900"
(bank 4): "ttl-publ-assets ----- 11900"
(bank 4): "ttl-publ-debts ----- 11900"
(bank 4): "S1-rrir-assets ----- 0"
(bank 4): "S1-erir-assets ----- 0"
(bank 4): "C1-assets ----- 0"
(bank 4): "ttl-P0-assets ----- 0"
(bank 4): "ttl-priv-assets ----- 0"
(bank 4): "ttl-publ-debts ----- 0"
(bank 4): "ttl-priv-debts ----- 0"
(bank 4): "net-worth-publ ----- 0"
(bank 4): "net-worth-priv ----- 0"
(bank 4): " "
(bank 4): "DUMP PRSN who# <<< 11 >>>"
(bank 4): "b-prsn-is-bankrupt ----- 0"
(bank 4): "Bank-who ----- 2"
(bank 4): "P0-assets ----- 25"
(bank 4): "L0-assets ----- 25"
(bank 4): "L1-assets ----- 75"
(bank 4): "L1-loan-debts ----- 0"
(bank 4): "S1-L1ip-debts ----- 0"
(bank 4): "30day payables total ----- 0"
(bank 4): "30day receivables total --- 0"
(bank 4): "L2-assets ----- 2900"
(bank 4): "S1-L2ir-assets ----- 0"
(bank 4): "ttl-P0-assets ----- 25"
(bank 4): "ttl-publ-assets ----- 0"
(bank 4): "ttl-publ-debts ----- 0"
(bank 4): "ttl-priv-assets ----- 3000"
(bank 4): "ttl-priv-debts ----- 0"
(bank 4): "net-worth-publ ----- 0"
(bank 4): "net-worth-priv ----- 3000"
(bank 7): " "
(bank 7): "DUMP PRSN who# <<< 7 >>>"
(bank 7): "b-prsn-is-bankrupt ----- 0"
(bank 7): "Bank-who ----- 4"
(bank 7): "P0-assets ----- 25"
(bank 7): "L0-assets ----- 25"
(bank 7): "L1-assets ----- 75"
(bank 7): "L1-loan-debts ----- 0"
(bank 7): "S1-L1ip-debts ----- 0"
(bank 7): "30day payables total ----- 0"
(bank 7): "30day receivables total --- 0"
(bank 7): "L2-assets ----- 2900"
(bank 7): "S1-L2ir-assets ----- 0"
(bank 7): "ttl-P0-assets ----- 25"
(bank 7): "ttl-publ-assets ----- 0"
(bank 7): "ttl-publ-debts ----- 0"
(bank 7): "ttl-priv-assets ----- 3000"
(bank 7): "ttl-priv-debts ----- 0"
(bank 7): "net-worth-publ ----- 0"
(bank 7): "net-worth-priv ----- 3000"
(bank 9): " "
(bank 9): "DUMP PRSN who# <<< 9 >>>"
(bank 9): "b-prsn-is-bankrupt ----- 0"
(bank 9): "Bank-who ----- 4"
(bank 9): "P0-assets ----- 25"
(bank 9): "L0-assets ----- 25"
(bank 9): "L1-assets ----- 75"
(bank 9): "L1-loan-debts ----- 0"
(bank 9): "S1-L1ip-debts ----- 0"
(bank 9): "30day payables total ----- 0"
(bank 9): "30day receivables total --- 0"
(bank 9): "L2-assets ----- 2900"
(bank 9): "S1-L2ir-assets ----- 0"
(bank 9): "ttl-P0-assets ----- 25"
(bank 9): "ttl-publ-assets ----- 0"
(bank 9): "ttl-publ-debts ----- 0"
(bank 9): "ttl-priv-assets ----- 3000"
(bank 9): "ttl-priv-debts ----- 0"

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(prsn 9): "net-worth-publ ----- 0"
(prsn 9): "net-worth-priv ----- 3000"
(prsn 8): " "
(prsn 8): "DUMP PRSN who# <<< 8 >>>"
(prsn 8): "b-prsn-is-bankrupt ----- 0"
(prsn 8): "Bank-who ----- 3"
(prsn 8): "P0-assets ----- 25"
(prsn 8): "L0-assets ----- 25"
(prsn 8): "L1-assets ----- 75"
(prsn 8): "L1-loan-debts ----- 0"
(prsn 8): "S1-Llip-debts ----- 0"
(prsn 8): "30day payables total ----- 0"
(prsn 8): "30day receivables total --- 0"
(prsn 8): "L2-assets ----- 2900"
(prsn 8): "S1-L2ir-assets ----- 0"
(prsn 8): "ttl-P0-assets ----- 25"
(prsn 8): "ttl-publ-assets ----- 0"
(prsn 8): "ttl-publ-debts ----- 0"
(prsn 8): "ttl-priv-assets ----- 3000"
(prsn 8): "ttl-priv-debts ----- 0"
(prsn 8): "net-worth-publ ----- 0"
(prsn 8): "net-worth-priv ----- 3000"
(prsn 13): " "
(prsn 13): "DUMP PRSN who# <<< 13 >>>"
(prsn 13): "b-prsn-is-bankrupt ----- 0"
(prsn 13): "Bank-who ----- 4"
(prsn 13): "P0-assets ----- 25"
(prsn 13): "L0-assets ----- 25"
(prsn 13): "L1-assets ----- 75"
(prsn 13): "L1-loan-debts ----- 0"
(prsn 13): "S1-Llip-debts ----- 0"
(prsn 13): "30day payables total ----- 0"
(prsn 13): "30day receivables total --- 0"
(prsn 13): "L2-assets ----- 2900"
(prsn 13): "S1-L2ir-assets ----- 0"
(prsn 13): "ttl-P0-assets ----- 25"
(prsn 13): "ttl-publ-assets ----- 0"
(prsn 13): "ttl-publ-debts ----- 0"
(prsn 13): "ttl-priv-assets ----- 3000"
(prsn 13): "ttl-priv-debts ----- 0"
(prsn 13): "net-worth-publ ----- 0"
(prsn 13): "net-worth-priv ----- 3000"
(prsn 12): " "
(prsn 12): "DUMP PRSN who# <<< 12 >>>"
(prsn 12): "b-prsn-is-bankrupt ----- 0"
(prsn 12): "Bank-who ----- 3"
(prsn 12): "P0-assets ----- 25"
(prsn 12): "L0-assets ----- 25"
(prsn 12): "L1-assets ----- 75"
(prsn 12): "L1-loan-debts ----- 0"
(prsn 12): "S1-Llip-debts ----- 0"
(prsn 12): "30day payables total ----- 0"
(prsn 12): "30day receivables total --- 0"
(prsn 12): "L2-assets ----- 2900"
(prsn 12): "S1-L2ir-assets ----- 0"
(prsn 12): "ttl-P0-assets ----- 25"
(prsn 12): "ttl-publ-assets ----- 0"
(prsn 12): "ttl-publ-debts ----- 0"
(prsn 12): "ttl-priv-assets ----- 3000"
(prsn 12): "ttl-priv-debts ----- 0"
(prsn 12): "net-worth-publ ----- 0"
(prsn 12): "net-worth-priv ----- 3000"
observer: "File closed at: 06:00:43.956 AM 05-May-2016"
observer: "CmLab_Log_160505_060034.txt closed."

```


8.2 - Annex B2 – Debug Data Stream Made During “One Tick”

```

observer: "CmLab_Log_160505_060159.txt opened."
observer: ""
observer: "Do-pre-tick: Debug on.; tick was 2457"
observer: " Halt at tick - -1"
observer: " Current tick - 2458"
observer: " Do-pre-tick: Routine completed."
observer: ""
observer: "Do-move: Debug on; tick = 2458"
observer: " Do-move: procedure completed"
observer: ""
observer: "Do-buy-sell: Debug on; tick = 2458"
observer: ""
observer: "Do-buy-sell: cash"
(prsn 8): "Buyer: 8; Seller: 6"
(prsn 8): " L0-assets of buyer ----- 25"
(prsn 8): " L0-assets of seller ----- 25"
(prsn 8): " L0 cost of purchase ----- 22"
(prsn 8): " BSVcs: Prsn 8 paid Prsn 6 ----- 22"
(prsn 8): " L0-assets of buyer ----- 3"
(prsn 8): " L0-assets of seller ----- 47"
(prsn 11): "Buyer: 11; Seller: 13"
(prsn 11): " L0-assets of buyer ----- 25"
(prsn 11): " L0-assets of seller ----- 25"
(prsn 11): " L0 cost of purchase ----- 4"
(prsn 11): " BSVcs: Prsn 11 paid Prsn 13 -----
4"
(prsn 11): " L0-assets of buyer ----- 21"
(prsn 11): " L0-assets of seller ----- 29"
(prsn 12): "Buyer: 12; Seller: 7"
(prsn 12): " L0-assets of buyer ----- 25"
(prsn 12): " L0-assets of seller ----- 25"
(prsn 12): " L0 cost of purchase ----- 16"
(prsn 12): " BSVcs: Prsn 12 paid Prsn 7 -----
16"
(prsn 12): " L0-assets of buyer ----- 9"
(prsn 12): " L0-assets of seller ----- 41"
(prsn 9): "Buyer: 9; Seller: 10"
(prsn 9): " L0-assets of buyer ----- 25"
(prsn 9): " L0-assets of seller ----- 25"
(prsn 9): " L0 cost of purchase ----- 5"
(prsn 9): " BSVcs: Prsn 9 paid Prsn 10 ----- 5"
(prsn 9): " L0-assets of buyer ----- 20"
(prsn 9): " L0-assets of seller ----- 30"
observer: " "
observer: "Do-buy-sell: 30-day terms"
(prsn 10): "Buyer: 10; Seller: 6"
(prsn 10): " 30day payables of buyer -----
363"
(prsn 10): " 30day receivables of seller -----
464"
(prsn 10): " This purchase [sllr, tick due, amt] - [6
2488 55]"
(prsn 10): " 30day payables of buyer -----
418"
(prsn 10): " 30day receivables of seller -----
519"
(prsn 9): "Buyer: 9; Seller: 7"
(prsn 9): " 30day payables of buyer ----- 594"
(prsn 9): " 30day receivables of seller ----- 497"
(prsn 9): " This purchase [sllr, tick due, amt] - [7
2488 21]"
(prsn 9): " 30day payables of buyer ----- 615"
(prsn 9): " 30day receivables of seller ----- 518"
(prsn 12): "Buyer: 12; Seller: 13"
(prsn 12): " 30day payables of buyer -----
478"
(prsn 12): " 30day receivables of seller -----
561"
(prsn 12): " This purchase [sllr, tick due, amt] - [13
2488 28]"
(prsn 12): " 30day payables of buyer -----
506"
(prsn 12): " 30day receivables of seller -----
589"
(prsn 11): "Buyer: 11; Seller: 8"
(prsn 11): " 30day payables of buyer -----
488"
(prsn 11): " 30day receivables of seller -----
347"
(prsn 11): " This purchase [sllr, tick due, amt] - [8
2488 57]"
(prsn 11): " 30day payables of buyer -----
545"
(prsn 11): " 30day receivables of seller -----
404"
(prsn 10): " "
(prsn 10): "PRSN 10 processing 30-day payables"
(prsn 10): " This payable ----- [8 2458 1]"
(prsn 10): " Seller ----- 8"
(prsn 10): " Tick-when-due ----- 2458; now -
2458"
(prsn 10): " Seller's assets were ----- 75"
(prsn 10): " Buyer's assets were ----- 75"
(prsn 10): " Amount due ----- 1"
(prsn 10): " BSVcs: Prsn 10 paid Prsn 8 --- 1"
(prsn 10): " Seller's assets are ----- 76"
(prsn 10): " Buyer's assets are ----- 74"
(prsn 6): " "
(prsn 6): "PRSN 6 processing 30-day payables"
(prsn 6): " This payable ----- [12 2458
74]"
(prsn 6): " Seller ----- 12"
(prsn 6): " Tick-when-due ----- 2458; now -
2458"
(prsn 6): " Seller's assets were ----- 75"
(prsn 6): " Buyer's assets were ----- 75"
(prsn 6): " Amount due ----- 74"
(prsn 6): " BSVcs: Prsn 6 paid Prsn 12 --- 74"
(prsn 6): " Seller's assets are ----- 149"
(prsn 6): " Buyer's assets are ----- 1"
(prsn 7): " "
(prsn 7): "PRSN 7 processing 30-day payables"
(prsn 7): " This payable ----- [13 2458
21]"
(prsn 7): " Seller ----- 13"
(prsn 7): " Tick-when-due ----- 2458; now -
2458"
(prsn 7): " Seller's assets were ----- 75"
(prsn 7): " Buyer's assets were ----- 75"
(prsn 7): " Amount due ----- 21"
(prsn 7): " BSVcs: Prsn 7 paid Prsn 13 --- 21"
(prsn 7): " Seller's assets are ----- 96"
(prsn 7): " Buyer's assets are ----- 54"
(prsn 11): " "
(prsn 11): "PRSN 11 processing 30-day payables"
(prsn 11): " This payable ----- [9 2458
39]"
(prsn 11): " Seller ----- 9"
(prsn 11): " Tick-when-due ----- 2458; now -
2458"
(prsn 11): " Seller's assets were ----- 75"
(prsn 11): " Buyer's assets were ----- 75"
(prsn 11): " Amount due ----- 39"
(prsn 11): " BSVcs: Prsn 11 paid Prsn 9 --- 39"
(prsn 11): " Seller's assets are ----- 114"
(prsn 11): " Buyer's assets are ----- 36"
observer: "Each net worth will be computed."
observer: " Do-aaa: All aggregates updated."
observer: " Do-buy-sell: procedure completed"
observer: ""
observer: "Do-accrue-interest: Debug on; tick = 2458"
(prsn 10): " "
(prsn 10): "PRSN 10 - Savings Deposit"
(prsn 10): " Size of L2 savings deposit ---- 2772"
(prsn 10): " BSVcs: L2 interest accrued ---- 0.077"
(prsn 10): " Total interest due -----
2.88444444444444495"
(prsn 6): " "
(prsn 6): "PRSN 6 - Savings Deposit"
(prsn 6): " Size of L2 savings deposit ---- 3035"
(prsn 6): " BSVcs: L2 interest accrued ----
0.08430555555555556"
(prsn 6): " Total interest due -----
2.85016666666666656"
(prsn 7): " "
(prsn 7): "PRSN 7 - Savings Deposit"
(prsn 7): " Size of L2 savings deposit ---- 2873"
(prsn 7): " BSVcs: L2 interest accrued ----
0.07980555555555556"
(prsn 7): " Total interest due -----
2.75999999999999953"
(prsn 9): " "
(prsn 9): "PRSN 9 - Savings Deposit"
(prsn 9): " Size of L2 savings deposit ---- 2798"
(prsn 9): " BSVcs: L2 interest accrued ----
0.07772222222222222"
(prsn 9): " Total interest due -----
2.88874999999999937"
(prsn 13): " "
(prsn 13): "PRSN 13 - Savings Deposit"
(prsn 13): " Size of L2 savings deposit ---- 4004"

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(prsn 13): " BSVcs: L2 interest accrued ----
0.111222222222222222"
(observer: "Do-banking: Debug on; tick = 2458"
observer: " EVERYBODY VISITS BANK"
(prsn 13): " Total interest due -----
3.3356944444444441"
(observer: " PRSN 8 VISITS BANK 3."
(prsn 8): " My P0-assets were ----- 3"
(prsn 8): " My L0-assets were ----- 3"
(prsn 8): " My L1-assets were ----- 76"
(prsn 8): " My L2-assets were ----- 3295"
(prsn 8): " Total affected assets ----- 3374"
(prsn 8): " BSVcs: Amount of P0 deposited - 3"
(prsn 8): " My P0-assets are ----- 0"
(prsn 8): " My L0-assets are ----- 0"
(prsn 8): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 8): " My P0-assets are ----- 25"
(prsn 8): " My L0-assets are ----- 25"
(prsn 8): " My L1-assets are ----- 54"
(prsn 8): " BSVcs: Moved from L1 to L2 ---- 54"
(prsn 8): " My L1-assets are ----- 0"
(prsn 8): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 8): " My L1-assets are ----- 75"
(prsn 8): " Pre-loan - My L2-assets are --- 3274"
(prsn 8): " A loan is not required!"
(prsn 8): " Post-loan - My L0-assets are -- 25"
(prsn 8): " Post-loan - My L1-assets are -- 75"
(prsn 8): " Post-loan - My L2-assets are -- 3274"
(prsn 8): " Total affected assets ----- 3374"
(prsn 6): "PRSN 6 VISITS BANK 4."
(prsn 6): " My P0-assets were ----- 47"
(prsn 6): " My L0-assets were ----- 47"
(prsn 6): " My L1-assets were ----- 1"
(prsn 6): " My L2-assets were ----- 3035"
(prsn 6): " Total affected assets ----- 3083"
(prsn 6): " BSVcs: Amount of P0 deposited - 47"
(prsn 6): " My P0-assets are ----- 0"
(prsn 6): " My L0-assets are ----- 0"
(prsn 6): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 6): " My P0-assets are ----- 25"
(prsn 6): " My L0-assets are ----- 25"
(prsn 6): " My L1-assets are ----- 23"
(prsn 6): " BSVcs: Moved from L1 to L2 ---- 23"
(prsn 6): " My L1-assets are ----- 0"
(prsn 6): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 6): " My L1-assets are ----- 75"
(prsn 6): " Pre-loan - My L2-assets are --- 2983"
(prsn 6): " A loan is not required!"
(prsn 6): " Post-loan - My L0-assets are -- 25"
(prsn 6): " Post-loan - My L1-assets are -- 75"
(prsn 6): " Post-loan - My L2-assets are -- 2983"
(prsn 6): " Total affected assets ----- 3083"
(prsn 7): "PRSN 7 VISITS BANK 4."
(prsn 7): " My P0-assets were ----- 41"
(prsn 7): " My L0-assets were ----- 41"
(prsn 7): " My L1-assets were ----- 54"
(prsn 7): " My L2-assets were ----- 2873"
(prsn 7): " Total affected assets ----- 2968"
(prsn 7): " BSVcs: Amount of P0 deposited - 41"
(prsn 7): " My P0-assets are ----- 0"
(prsn 7): " My L0-assets are ----- 0"
(prsn 7): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 7): " My P0-assets are ----- 25"
(prsn 7): " My L0-assets are ----- 25"
(prsn 7): " My L1-assets are ----- 70"
(prsn 7): " BSVcs: Moved from L1 to L2 ---- 70"
(prsn 7): " My L1-assets are ----- 0"
(prsn 7): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 7): " My L1-assets are ----- 75"
(prsn 7): " Pre-loan - My L2-assets are --- 935"
(prsn 7): " A loan is not required!"
(prsn 7): " Post-loan - My L0-assets are -- 25"
(prsn 7): " Post-loan - My L1-assets are -- 75"
(prsn 7): " Post-loan - My L2-assets are -- 935"
(prsn 7): " Total affected assets ----- 1035"
(prsn 11): "PRSN 11 VISITS BANK 2."
(prsn 11): " My P0-assets were ----- 21"
(prsn 11): " My L0-assets were ----- 21"
(prsn 11): " My L1-assets were ----- 36"
(prsn 11): " My L2-assets were ----- 3502"
(prsn 11): " Total affected assets ----- 3559"
(prsn 11): " BSVcs: Amount of P0 deposited - 21"
(prsn 11): " My P0-assets are ----- 0"
(prsn 11): " My L0-assets are ----- 0"
(prsn 11): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 11): " My P0-assets are ----- 25"
(prsn 11): " My L0-assets are ----- 25"
(prsn 11): " My L1-assets are ----- 32"
(prsn 11): " BSVcs: Moved from L1 to L2 ---- 32"
(prsn 11): " My L1-assets are ----- 0"
(prsn 11): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 11): " My L1-assets are ----- 75"
(prsn 11): " Pre-loan - My L2-assets are --- 3459"
(prsn 11): " A loan is not required!"
(prsn 11): " Post-loan - My L0-assets are -- 25"
(prsn 11): " Post-loan - My L1-assets are -- 75"
(prsn 11): " Post-loan - My L2-assets are -- 3459"
(prsn 11): " Total affected assets ----- 3559"
(prsn 10): "PRSN 10 VISITS BANK 2."
(prsn 10): " My P0-assets were ----- 30"
(prsn 10): " My L0-assets were ----- 30"
(prsn 10): " My L1-assets were ----- 74"
(prsn 10): " My L2-assets were ----- 2772"
(prsn 10): " Total affected assets ----- 2876"
(prsn 10): " BSVcs: Amount of P0 deposited - 30"

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(prsn 10): " My P0-assets are ----- 0"
(prsn 10): " My L0-assets are ----- 0"
(prsn 10): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 10): " My P0-assets are ----- 25"
(prsn 10): " My L0-assets are ----- 25"
(prsn 10): " My L1-assets are ----- 79"
(prsn 10): " BSVcs: Moved from L1 to L2 ---- 79"
(prsn 10): " My L1-assets are ----- 0"
(prsn 10): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 10): " My L1-assets are ----- 75"
(prsn 10): " Pre-loan - My L2-assets are --- 2776"
(prsn 10): " A loan is not required!"
(prsn 10): " Post-loan - My L0-assets are -- 25"
(prsn 10): " Post-loan - My L1-assets are -- 75"
(prsn 10): " Post-loan - My L2-assets are -- 2776"
(prsn 10): " Total affected assets ----- 2876"
(prsn 13): "PRSN 13 VISITS BANK 4."
(prsn 13): " My P0-assets were ----- 29"
(prsn 13): " My L0-assets were ----- 29"
(prsn 13): " My L1-assets were ----- 96"
(prsn 13): " My L2-assets were ----- 4004"
(prsn 13): " Total affected assets ----- 4129"
(prsn 13): " BSVcs: Amount of P0 deposited - 29"
(prsn 13): " My P0-assets are ----- 0"
(prsn 13): " My L0-assets are ----- 0"
(prsn 13): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 13): " My P0-assets are ----- 25"
(prsn 13): " My L0-assets are ----- 25"
(prsn 13): " My L1-assets are ----- 100"
(prsn 13): " BSVcs: Moved from L1 to L2 ---- 100"
(prsn 13): " My L1-assets are ----- 0"
(prsn 13): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 13): " My L2-assets are ----- 75"
(prsn 13): " Pre-loan - My L2-assets are --- 4029"
(prsn 13): " A loan is not required!"
(prsn 13): " Post-loan - My L0-assets are -- 25"
(prsn 13): " Post-loan - My L1-assets are -- 75"
(prsn 13): " Post-loan - My L2-assets are -- 4029"
(prsn 13): " Total affected assets ----- 4129"
(prsn 9): "PRSN 9 VISITS BANK 4."
(prsn 9): " My P0-assets were ----- 20"
(prsn 9): " My L0-assets were ----- 20"
(prsn 9): " My L1-assets were ----- 114"
(prsn 9): " My L2-assets were ----- 2798"
(prsn 9): " Total affected assets ----- 2932"
(prsn 9): " BSVcs: Amount of P0 deposited - 20"
(prsn 9): " My P0-assets are ----- 0"

(prsn 9): " My L0-assets are ----- 0"
(prsn 9): " BSVcs: Amount of P0 withdrawn - 25"
(prsn 9): " My P0-assets are ----- 25"
(prsn 9): " My L0-assets are ----- 25"
(prsn 9): " My L1-assets are ----- 109"
(prsn 9): " BSVcs: Moved from L1 to L2 ---- 109"
(prsn 9): " My L1-assets are ----- 0"
(prsn 9): " BSVcs: Moved from L2 to L1 ---- 75"
(prsn 9): " My L1-assets are ----- 75"
(prsn 9): " Pre-loan - My L2-assets are --- 2832"
(prsn 9): " A loan is not required!"
(prsn 9): " Post-loan - My L0-assets are -- 25"
(prsn 9): " Post-loan - My L1-assets are -- 75"
(prsn 9): " Post-loan - My L2-assets are -- 2832"
(prsn 9): " Total affected assets ----- 2932"
observer: ""
observer: "CRB RECONCILES RESERVE DEPOSITS"
(bank 2): "BANK 2"
(bank 2): " L1-loan-assets ----- 0"
(bank 2): " Old settings:"
(bank 2): " P0-vc-assets ----- 51"
(bank 2): " P0-rr-assets ----- 0"
(bank 2): " P0-er-assets ----- 3531"
(bank 2): " Total reserves ----- 3582"
(bank 2): " CBSvcs: Amount of ER withdrawn -- 3531"
(bank 2): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 2): " CBSvcs: Amount of RR deposited -- 0"
(bank 2): " CBSvcs: Amount of ER deposited -- 3532"
(bank 2): " New settings:"
(bank 2): " P0-vc-assets ----- 50"
(bank 2): " P0-rr-assets ----- 0"
(bank 2): " P0-er-assets ----- 3532"
(bank 2): " Total reserves ----- 3582"
(bank 2): " Bank loan dept status - OPEN"
(bank 4): "BANK 4"
(bank 4): " L1-loan-assets ----- 0"
(bank 4): " Old settings:"
(bank 4): " P0-vc-assets ----- 87"
(bank 4): " P0-rr-assets ----- 0"
(bank 4): " P0-er-assets ----- 10544"
(bank 4): " Total reserves ----- 10631"
(bank 4): " CBSvcs: Amount of ER withdrawn -- 10544"
(bank 4): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 4): " CBSvcs: Amount of RR deposited -- 0"
(bank 4): " CBSvcs: Amount of ER deposited -- 10581"
(bank 4): " New settings:"
(bank 4): " P0-vc-assets ----- 50"

(bank 4): " P0-rr-assets ----- 0"
(bank 4): " P0-er-assets ----- 10581"
(bank 4): " Total reserves ----- 10631"
(bank 4): " Bank loan dept status - OPEN"
(bank 3): "BANK 3"
(bank 3): " L1-loan-assets ----- 0"
(bank 3): " Old settings:"
(bank 3): " P0-vc-assets ----- 12"
(bank 3): " P0-rr-assets ----- 0"
(bank 3): " P0-er-assets ----- 3625"
(bank 3): " Total reserves ----- 3637"
(bank 3): " CBSvcs: Amount of ER withdrawn -- 3625"
(bank 3): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 3): " CBSvcs: Amount of RR deposited -- 0"
(bank 3): " CBSvcs: Amount of ER deposited -- 3587"
(bank 3): " New settings:"
(bank 3): " P0-vc-assets ----- 50"
(bank 3): " P0-rr-assets ----- 0"
(bank 3): " P0-er-assets ----- 3587"
(bank 3): " Total reserves ----- 3637"
(bank 3): " Bank loan dept status - OPEN"
(bank 14): "BANK 14"
(bank 14): " L1-loan-assets ----- 0"
(bank 14): " Old settings:"
(bank 14): " P0-vc-assets ----- 50"
(bank 14): " P0-rr-assets ----- 0"
(bank 14): " P0-er-assets ----- 5900"
(bank 14): " Total reserves ----- 5950"
(bank 14): " CBSvcs: Amount of ER withdrawn -- 5900"
(bank 14): " CBSvcs: Amount of RR withdrawn -- 0"
(bank 14): " CBSvcs: Amount of RR deposited -- 0"
(bank 14): " CBSvcs: Amount of ER deposited -- 5900"
(bank 14): " New settings:"
(bank 14): " P0-vc-assets ----- 50"
(bank 14): " P0-rr-assets ----- 0"
(bank 14): " P0-er-assets ----- 5900"
(bank 14): " Total reserves ----- 5950"
(bank 14): " Bank loan dept status - OPEN"
observer: ""
observer: "Do-Post-tick: Debug on; tick = 2458"
observer: "Each net worth will be computed."
observer: " Do-aaa: All aggregates updated."
observer: " Do-post-tick: procedure completed."
observer: "File closed at: 06:02:34.105 AM 05-May-2016"
observer: "CmLab_Log_160505_060159.txt closed."

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