A NEW FORM OF BANKING – CONCEPT AND MATHEMATICAL MODEL OF VENTURE BANKING

Abstract
This model contains concept, equations, and graphical results for venture banking. A system of 27 equations describes the behavior of the venture-bank and underwriter system allowing phase-space type graphs that show where profits and losses occur. These results confirm and expand those obtained from the original spreadsheet based model. An example investment in a castle at a loss is provided to clarify concept.

This model requires that all investments are in enterprises that create new utility value. The assessed utility value created is the new money out of which the venture bank and underwriter are paid. The model presented chooses parameters that ensure that the venture-bank experiences losses before the underwriter does. Parameters are: DIN Premium, 0.05; Clawback lien fraction, 0.77; Clawback bonds and equity futures discount, 1.5(USA 12 month LIBOR); Range of clawback bonds sold, 0 to 100%; Range of equity futures sold 0 to 70%.

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Correspondence: Brian P. Hanley, Butterfly Sciences, California, USA
Email: brian.hanley@ieee.org
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1 INTRODUCTION

The common concept of banking is highly flawed. In the modern world, banks do not lend money out that they have, banks create deposits by lending, which is how most money is created today (McLeay, 2014). This fact must be understood in order to properly grasp how venture banking works. While ordinary banking could potentially do this without the burden of loan insurance, this has proven problematic due to the inherent moral hazard in banking. Requiring private insurance sets up an adversarial relationship to put a brake on bad behavior. Taking advantage of money creation through loans, a venture can potentially be profitable even if it does not return the loan amount in full. To illustrate how venture banking works, I will start with a short story of building a castle using venture banking where the castle is sold for half the cost to build it.

1.1 A VENTURE BANK BUILDS A CASTLE

A private investment bank writes a loan of $1MM to build a castle. This loan becomes an asset of the bank. The terms of the loan are that all equity in the castle is the property of the bank. When a bank writes a loan, it automatically creates new money sufficient to cover the loan (Gardner, 2006). However, regulators want to see that the bank has the funds in hand, which is a challenge of the banking industry although it is not always strictly enforced. The issue is that the way the banking industry developed, there are multiple banks, and a loan may not be deposited into the bank that makes it, and as it is spent, it will end up at different banks. What this means is that banks have a surplus of funds at times, and a deficit at others. Mechanisms like LIBOR provide for overnight borrowing to cover needs. But this method bypasses that, using a method that inherently matches the loanable capital term to the long-term needs of investors.

In this method, the loan is made and a simultaneous insurance policy is purchased against the loan. That insurance policy agrees to pay off any deficit should the castle not be worth the amount of the loan investment. In this case we will assume 5 years of insurance. The underwriter is paid 5% of the $1MM per year for 5 years, and at the end, will receive half of the equity in the castle if it is a return of 1 or better. The underwriter otherwise pays face value of the insurance and receives all of the equity in the investment.

The underwriter receives $250K by the end of the 5 year term. The bank borrows the $250K to cover this loan at 2% interest. That works out to a $276K cost over 5 years.

5 years later, the castle is built. But, there is a problem.

The castle is valued at only $500K at completion, half the amount of the loan. So, the underwriter pays $1MM to the bank, and receives the castle asset valued at $500K. Simultaneous with the insurance payout, a lien for 77% of the payout is put on the bank. A pending credit for the castle asset value is active on the lien, but the underwriter has up to 180 days to accept or reject the asset valuation. This $1MM insurance payment retires the loan. At retirement of the loan, the bank’s books have:

$1MM in cash from the insurance company’s payout.
Debt of $276K on the loan it used to pay the DIN insurance.
Lien of $770K on the insurance clawback, with a pending credit of $500K for the asset equity.
The underwriter’s books have:
$250K in insurance payments
$500k (pending) assessed value of the castle equity
$770K clawback with a pending credit of $500K for the asset equity.

The underwriter has 180 days to accept the assessed asset value, deny the assessment, or find violations of the DIN contract. Let’s accept the $500K valuation, assuming that the underwriter has not found any fraud, deception, or other evidence of violations of the contract. That official acceptance means that the base amount for the clawback calculation is cut to $500K. So the 77% clawback lien becomes set at a finalized cost of $385K.

Both parties now close out their transactions. The bank pays off the $385K clawback.

The bank now has:
$1MM in cash
- $ 276K to pay off the DIN loan
- $ 385K to pay off the clawback
Total $339K ← Retained earnings on the $1MM deal.

The underwriter’s books have:
$250K in insurance payments
$500k assessed value of the castle equity
$385K clawback payments
Total $1.135MM

Net profit $135K on a the investment of $1MM minus castle equity for up to 180 days.

### 1.2 CASTLE EXAMPLE BOOKEEPING

Table 1: Venture bank and underwriter. Loan asset shown in suspense with braces {}. Insurance created asset credit shown in brackets []. Retirement of an asset or lien shown with strikeout 99999. Insurance asset credit is cancelled when insurance policy ends.

| Credit/Debit | Assets | Liabilities |
|--------------|--------|-------------|
| ($1,000,000) |        |             |
| [1,000,000]  | -$250,000 | DIN premiums (5 years) |
|              | -$26,000  | DIN premiums loan interest |
| $500,000     | Castle valuation |
| -$500,000    | Transfer castle. Assessment pending |
| $1,000,000   | DIN payout |
|              | -$1,000,000 | -$250,000 |
| -$276,000    | Clawback lien pending |
| -$385,000    | Clawback lien, castle equity accepted |
| $339,000     | Closed out investment |

| Credit/Debit | Assets | Liabilities |
|--------------|--------|-------------|
|              |        |             |
|              | $250,000 | $250,000 |
|              | $500,000 | $750,000 |
|              | -$1,000,000 | -$250,000 |
|              | -$250,000 | |
|              | -$250,000 | |
|              | $385,000 | |
|              | $135,000 | $135,000 |

Table 2: Balancing of Castle example

| Balance         |
|-----------------|
| $339,000        |
| $135,000        |
| $26,000         |
| $500,000        |

Venture bank gain
Underwriter gain
Interest paid externally
Value created
1.3 DISCUSSION

The differences between this scenario and the full venture banking model of investing below, are several. A. The model assumes that there is a large portfolio of investments which are the pool against which the underwriter is paid; B. The investment loans that fall short are paid at 5 years, and the underwriter must carry the payout expense for another 5 years, until the investments returning breakeven or better exit at 10 years. This means that the net underwriter investment in the above example is $250K plus carrying cost of $250K for 5 years, before collecting the $385K clawback. If the underwriter sells clawback shares at a discount then its true invested cost can be minimal or zero. There is some room for tweaking exactly how this model is executed, and my choices were defined to maximize stability of the underwriter's business while being fair to venture banks. Keep in kind that if the underwriter fails, then the venture banking system is over.

The model assumes that DIN policies are written such that the clawback lien is against the bank, not the specific investment, and that the bank has a very large portfolio set. Another way of working this would be to have the clawback lien be against some pool of investments. This is necessary to prevent the underwriters stacking up losses on a bad run of investments, and being unable to collect their due on heavier losses. (e.g. investments that return $0.126 on the dollar or less.) I have assumed that bad investments will be dumped faster than good ones.

This method of banking prevents perverse incentives by the bankers to under-assess the equity because of two things. First, because the underwriter collects a clawback lien at close. Second, the bank gets credit for the equity in its insured investment after a type of claims process by the underwriter on the back end.

After stepping through building a castle using this method of investment loans, the reader can see that the figures work. But some have remained suspicious, because it looks like “getting something for nothing”. “Why,” one fiduciary asked, “does this work when it could be cheaper to get a loan from another bank and pay the interest on that?” The key fact to attend to is that this bank is making a loan to itself, for its own interests. That loan it makes for the investment is creation of new money, and in this method that means that any fraction of that new money created that the bank can hold onto becomes profit. If you rerun the scenario above, but the bank has to pay off the loan to someone else first, then it becomes a loss. So this apparently very expensive form of money is actually not as expensive as it looks when all is said and done, and allows for loan losses.

2 CONCEPT AND WALK THROUGH OF VENTURE BANKING SYSTEM

Basic concepts:

1. Rate of return for venture banks is controlled by the base capital of the bank and the number of loans that can be made and insured, not by return on each investment. This is how the multiple of original capital for the bank (MOC) works.

2. Underwriter default insurance notes (DIN) have a premium payment, and at exit, the underwriter receives a percentage of the exit equity.

3. When a DIN instrument is called and paid, it is terminated with a lien on the venture bank that rides until exit of a portfolio of investments, or when the policy hits year 10. This lien is, however, only payable out of a specifically named investment pool.

4. Equity value created is the money out of which venture-bank gains, underwriter gains, and
interest paid on carrying costs cannot exceed the equity value created. In the real world, business overhead will also factor in.

**Walk through:**

There are two primary parties, the venture bank and the underwriters of default insurance notes (DIN). The DINs are written to pay the venture bank the cash value of the note, and transfer all equity assets to the underwriter.

The venture bank processes its investments as zero interest loans, and buys a DIN for each investment loan. Typically, the DIN would be equal to the investment loan amount. A DIN is classed as a derivative instrument, which makes its exercise immediate, and it cannot be stopped by bankruptcy or court action. For this reason, the clawback lien was created as the last element of derivative exercise.

The DIN instruments allow the venture bank to move their investment loans from their suspense account back into capital where it is treated as a long-term savings deposit that can be loaned out. If an investment does not return the face value of the loan, then the venture bank calls the DIN, turns over all equity assets of the investment to the underwriter, and is paid the face value of the DIN. The assessed value of the investment equity is credited to the venture bank DIN policy, and the clawback base is lowered by the amount of the equity assessment. When the DIN call closes, the underwriter receives a lien on the venture bank for a large percentage of the face value of the payoff, which is a clawback lien (Hanley, 2017a). Here, it is assumed to be 77%.

The lien on the venture bank may allow the underwriter transparency into the operations of the venture bank as they choose to investigate whether any fraud has occurred. The lien is not required to be paid off until the portfolio of the firm's other investments exit, the venture bank voluntarily decides to pay it off, or some number of years have passed, nominally 10 years.

The underwriter can sell up to 70% of the equity futures in their DIN portfolios prior to exits (Hanley, 2017b). The underwriter can sell up to 100% of its clawback liens as bonds. In this modeling, both sell at a discount. These sales can improve the underwriter's cash flow and has major effects on ROI. It also has potential to insulate them against losses, since these will be similar to LEAPS futures contract shares that the public can purchase. (LEAPS are long-term futures options, typically 1 year.)

When the venture bank exits an investment, the exit equity value retires the investment loan and the difference is made up by the underwriter. The loan is made by the venture bank for itself, and the exit equity held by the bank is unchanged by retiring the loan.

On a break-even or better investment, after retiring the loan, the underwriter's share of the equity is transferred to them. When a portfolio of investments are exited, the clawback liens will be paid. When the loan is below break-even, 100% of equity is transferred to the underwriter.

### 2.1 VENTURE BANK EARNINGS

On a per VC investment deal basis, the venture bank earnings are:

\[(\text{Total Exit Equity} - \text{Insurance Equity Share}) + \text{Gross Insurance Payout} - \text{Insurance premiums with cost to carry}\]
Clawback_Lien

Earnings_per_VC_deal

To get the venture bank's earnings, it is necessary to multiply the earnings per deal by the multiple of capital (MOC).

\[ Earnings \, per \, deal \cdot MOC = Venture \, Bank \, ROI \] (1)

Since the assumption is that all investments are the same, and equal to the initial startup capital put into the bank, and our figures are percentages of that, this above multiple should be the same as the ROI for the bank.

2.2 UNDERWRITER EARNINGS

\[
\text{Insurance} \_\text{Premium} \_\text{Total} + \text{Underwriter} \_\text{Equity} \_\text{Gains} + \text{Clawback} \_\text{Lien} - \text{Underwriter} \_\text{Payout} - \text{Cost} \_\text{of} \_\text{Money} \_\text{of} \_\text{Payout} = \text{Underwriter} \_\text{Earnings} \_\text{per} \_\text{deal} \]

To get the underwriter's ROI, divide Underwriter_Earnings_per_deal by the total cost of payouts.

\[ \frac{Underwriter \, Earnings \, per \, deal}{Insurer \, Payout + Cost \, of \, Money \, of \, Payout} = Underwriter \, ROI \, per \, deal \] (2)

3 SIMPLIFIED MATH WALK THROUGH

3.1 FINANCIAL INSTRUMENTS

- Venture capital will make their investments as loans from their own bank.
- Underwriters will write insurance for those loans.

The fundamental features of insurance are:

- A yearly premium for the life of the insurance. (Here, 5%.)
- When the venture exits the underwriter receives a percentage of the equity value. (Here, 50%)
- When the insurance policy is triggered and paid off, the underwriter receives all current equity, and liquidates it quickly. (Insurers may choose different schedules.) In this accounting, the underwriter net pays the difference between whatever the value of the equity is and amount of the investment loan.
- When the insurance policy is paid, the venture bank is immediately encumbered with a lien (clawback lien) for some fraction of the insurance policy (Hanley, 2017a). (Here, 77%) This lien does not need to be cured until exit of an investment pool.
- Under no circumstances may the owner/beneficiary of the DIN be separated from the owner/beneficiary of the investment it covers.
- The underwriter may not terminate the policy prematurely.
3.2 ASSUMPTIONS

- A venture bank can create up to 47 times the original capital can be created using this mechanism (Hanley, 2017b). However, over time, since investments are made and exited, this 47X multiplier can be exceeded.
- I make a simplifying assumption that each investment is equal to the original capital. (e.g. all investments are the same amount.) However, use of calculus should provide us with the continuous version, which should model variability as well.
- I make an assumption that each turn of the capital yields the Kauffman portfolio 20 year average over a 10 year term.
  - I will further assume that to get closer to the true internal rate of return of the Kauffman portfolio, I should divide 31% by 80%, because Kauffman only sees the net of the 2% + 20% carry. This should be conservative. See figure 1 for 2% and 20% VC structure.
  - If we set 80% of profits = 31% (e.g. the profit amount above return of capital), then the total VC profits were 31% / 80% = 38.75%. This gives us a corrected multiple of 1.3875. (The 2% per year management fee built in to Kauffman’s data is ignored here, and can account for operating costs.)
  - In the more intensive mathematical model that follows, a more detailed correction of the Kauffman data shows that when taking profits above break even, the corrected multiple is significantly higher, slightly above 1.55.
- I will assume a DIN premium of 5% per year, an exit equity fraction of 50%, and a clawback lien of 77%. These figures can change, and are set conservatively so that underwriters will have a strong business.
- The clawback lien is a fixed percentage. At 77%, this works to produce a smoothly increasing profits curve for the venture bankers, and should discourage “jackpotting” by deliberately bankrupting investments.
- I make a simplifying assumption (only for this simplified walk through) that 50% of the DINs will pay premiums for 5 years, and then the venture bank will collect its insurance payoffs. For the balance, 50% of the investments will pay premiums for 10 years and then exit. (For the Kauffman fund data, 48.9% of investments lost money, and 51.1% made money. For the calculus model that follows, losers vary from 100% to 0%.)

3.3 VENTURE BANK'S WALK THROUGH:

**DIN premiums**

At 5% per year, over 10 years, accounting for cost of money at 2%, is 54.75% of loan principal.

\[ \text{54.75\% x 50\% of investments} = 27.375\% \]

At 5% per year, over 5 years, cost is 26.02% of loan principal.

\[ \text{26.02\% x 50\% of investments} = 13.01\% \]

Total cost of insurance over 10 years = 40.385% of average loan principal.

Insurance payouts in this model are paid out in year 5. Underwriters make the venture bankers whole for any investment loan that comes in at less than principal. For the Kauffman figures, when we do the modeling math, insurance payouts work out to 13.61% of the average investment loan.

At exit, the multiple of 1.3875 is the total equity created by the venture bank for each investment. It receives this amount, and retires the loan. Note that after this loan is retired, the equity generated remains with the bank. So the valuation doesn’t drop to 0.3875, it remains valued at 1.3875 because the venture bankers are paying the loan they made to themselves off with earnings to themselves.
Next, for the investment loans that have not been paid off with insurance due to losses, the venture bank owes 50\% of equity to the underwriters at exit. However, the underwriter has already taken all of the equity in investments that are less than 1. Consequently, we don't pay half of the obvious total. In this example, the equity the underwriter has claim to is 1.028089.

\[1.028089 \times 50\% = 0.5140445\]  
(Underwriter equity)

\[1.3875 - 0.5140445 = 0.8734555\]

0.8734555 is left for the venture bank.

The venture bank then must pay off the accrued cost of insurance (assumed to be borrowed funds from some other source), which is 0.40385.

\[0.8734555 - 0.40385 = 0.4696055\]

Now let's pay off the clawback. Clawback takes 77\% of the extra earnings from insurance payments. The venture bank received 13.61\% as insurance payouts. 13.61\% x 77\% = 10.4797\% that the venture bank has to pay back to the underwriter at exit.

\[0.4696055 - 0.104797 = 0.3648085\]

The venture bank has a net 0.3648085 on each turn of capital.

Now we decide how many turns of capital the bank will make. Multiply by the MOC to find the venture bank’s earnings multiple.

\[47 \times 0.3648085 = 17.14\]
\[43 \times 0.3648085 = 15.68\]
\[30 \times 0.3648085 = 10.944\]
\[5 \times 0.3648085 = 1.82\]
\[4 \times 0.3648085 = 1.459\]
\[3 \times 0.3648085 = 1.09\]

From the above figures, we can see that it only takes 4 turns to do better than the results of the Kauffman portfolio (corrected to 1.3875 here) that we are basing this model on. And, it only takes 3 multiples of capital to equal the median venture capital fund.

### 3.4 UNDERWRITER’S WALK THROUGH:

At 5\% per year, over 10 years, premiums are, 50\% of loan principal.

50\% x 50\% of investments = 25\%

At 5\% per year, over 5 years, cost is 25\% of loan principal. 5 years is used here because after an investment goes bad, no more insurance premiums will be paid on it.

25\% x 50\% of investments = 12.5\%

Total insurance premiums collected over 10 years = 37.5\% of loan principal.

Total net payouts on year 5 is 13.61\% of loan principal. On this, premiums equal to 12.5\% of loan principal will be collected, leaving a net, uncovered cost of doing business of 1.11\% of loan principal after 5th year payouts.

At exit, underwriter receives 51.40445\% of loan principal in equity. Percentages below are percentages of the loan principal covered by insurance.

Net earnings per investment loan insured:

37.5\%  Premiums
The underwriter's multiplier for an ROI calculation is:
\[
\text{Cost to carry payouts for 5 years. At a 2\% annual interest rate, this cost is 15.61}\% \\
84.38\% \div (13.61\% + 1.416\%) = 5.62
\]

However, the ROI multiplier is higher because in the real world by year 5, only a small fraction of the insurance payouts will not be covered by the insurance premiums collected. I will not show this in the mathematical model below, because it complicates matters, and at this stage being conservative is more important. But to illustrate this, if we assume that 1.1\% of the loan principal is not covered by premiums when it comes time to pay them off, then the underwriter's ROI is over 77X.

4 MATHEMATICAL MODEL

Computations for this venture bank model performed using Maple™ (Maple™, 2018).

4.1 VENTURE CAPITAL (VC) VERSUS VENTURE BANK (VB) RETURNS

Here I will use Venture Capital (VC) portfolio and Venture Bank (VB) returns, and these are not interchangeable. I use them because the venture capital dataset that I have is for VC portfolio returns. Each one of those VC funds is, itself a portfolio. When I specify VC returns, this is a placeholder for the return on the investment for a specific portfolio. However, there may be higher variability for an individual deal.

VB returns can only be generated from a set of investments using the MOC multiplier.

Figure 1: Venture capital primary model. Note that the 20\% carry is usually taken at payout of the total fund when returns are greater than breakeven. (Used with permission from Hanley, 2017b)
4.2 ADJUSTMENT OF KAUFFMAN FUND DATASET

In figure 2, two plots are visible for the Kauffman dataset (appendix) (Mulcahy, 2012). The upper, gray-green dashed line, shows the unmodified Kauffman data. However, here we want to look at the internal returns of the venture capital funds inside the Kauffman portfolio. As shown in figure 1, Mulcahy reports them as operating with a 2% per year management fee\(^1\) and a 20% carry. The 20% carry is taken from profits, which means Kauffman sees only 80% of profits. So, for every Kauffman VC fund that returned greater than 1 after 10 years, that element of the portfolio was divided by 80%. This yielded the red stepped line. That significantly raised the total rate of return from 1.31 to 1.55 for the Kauffman portfolio of portfolios. The equation fitting the 1.55 adjusted Kauffman dataset is shown in black in figure 2. The blue line shows a curve that averages to approximately zero. The green line is shown for informational purposes only.

4.3 KAUFFMAN FUND DATASET CURVE FIT.

In this model, instead of an \(x\) axis, there is an \(h\) axis for the equations derived from the Kauffman data. There are two primary equations, a close fit, and an adequate fit. The close fit equation is, unfortunately, a 7\(^{th}\) order exponential. This could be used in a software model easily enough, using numerical methods to find the intercept on the \(y\) axis. However, this kind of equation cannot be solved algebraically for \(h\) given a \(y\) value, so I did not use it in this model. It is provided for informational purposes.

The equation used is a simpler exponential based on the natural logarithm base \(e\). Since Mulcahy states that she thinks the highest return funds are from a specific time period and may not be repeated, this simpler equation is arguably better, as it flattens the curve. It is also amenable to algebraic solving for variables of the equation.

In figure 2, we see that the fitted curve goes below zero. However, we assume that in the real world, the valuation of an investment portfolio cannot go below zero. So it is necessary to substitute zero for the fitted curve result below the zero intercept. To do that, functions that invert the fitted curve function are needed. This is another reason why the exponential equation (eq. 6 & 7) was used.

4.3.1 Close fit is a 7\(^{th}\) order equation regression

\[
-0.377 + 25.2096120002135 \cdot h - 291.398659319748 \cdot h^2 + 1671.47290175033 \cdot h^3 \\
-4939.37387988463 \cdot h^4 + 7727.69689219724 \cdot h^5 - 6072.99026870706 \cdot h^6 \\
+1886.41489392694 \cdot h^7
\]  

\[ (3) \]
Mathematical model of Venture Banking

4.3.1.1 Integral of close 7th order fit

\[
\int_{0}^{1} -0.377 + 25.2906120002135 \cdot h - 291.398659319748 \cdot h^2 + 1671.47290175033 \cdot h^3 \\
- 4939.37387988463 \cdot h^4 + 7727.69689219724 \cdot h^5 - 6072.99026870706 \cdot h^6 \\
+ 1886.4148932694 \cdot h^7 \; dh = 1.310174408
\] (4)

4.3.1.2 Indefinite integral of close 7th order fit

\[
\int -0.377 + 25.2906120002135 \cdot h - 291.398659319748 \cdot h^2 + 1671.47290175033 \cdot h^3 \\
- 4939.37387988463 \cdot h^4 + 7727.69689219724 \cdot h^5 - 6072.99026870706 \cdot h^6 \\
+ 1886.4148932694 \cdot h^7 \; dh = \\
- 0.377 \; h + 12.645306 \; h^2 - 97.13288644 \; h^3 + 417.8682254 \; h^4 - 987.874776 \; h^5 + 1287.949482 \; h^6 \\
- 867.5700384 \; h^7 + 235.8018617 \; h^8 \bigg|_{0}^{1}
\] (5)

4.3.2 Exponential regression, adequate fit – used in model

Figure 2 black line.

\[ P + 0.2655 \cdot e^{2.88 \cdot h} \] (6)

Figure 2 blue dashed line.

\[ P - 1.55 + 0.2655 \cdot e^{2.88 \cdot h} \] (7)

where \( P \) is the average return of the venture capital (VC) portfolio.
4.3.2.1 Integral of alternate exponential regression – used in model

\[ \int_{0}^{1} P - 1.55 + 0.2655 \cdot e^{2.88 \cdot h} \, dh = 0.000 \quad (8) \]

Indefinite integral of alternate exponential with a portfolio factor to raise or lower VC portfolio return.

4.3.3 Solution of the \( h \) intercepts and boundaries

Alternate exponential solved for \( h \) can give us the 1 (one) and 0 (zero) intercepts. To do this, create a variable that is the \( h \) axis outcome, \( y \), separate from the \( h \). For both equations, set \( h \) to 0.

\[ y = P - 1.55 + 0.2655 \cdot e^{2.88 \cdot h} \Rightarrow \frac{y - P + 1.55}{0.2655} = e^{2.88 \cdot h} \Rightarrow \ln(\frac{y - P + 1.55}{0.2655}) = 2.88 \cdot h \Rightarrow \frac{\ln(\frac{y - P + 1.55}{0.2655})}{2.88} = h \]

(9)

\[ y = 1 \Rightarrow \frac{\ln(\frac{1 - P + 1.55}{0.2655})}{2.88} \quad (10) \]

\[ y = 0 \Rightarrow \frac{\ln(\frac{1.55 - P}{0.2655})}{2.88} \quad (11) \]

Solve both of the above equations for \( P \) when \( h = 0 \) and 1, to get the limits of the functions. Referring back to figure 2, we see that 0 and 1 are our limits.

\[ \ln(\frac{2.55 - P}{0.2655}) \frac{2.88}{2.88} \rightarrow P = 2.55 - 0.2655 \cdot e^{2.88 \cdot 0} = 2.2845 = 1 \text{ intercept max.} \]

\[ 2.55 - 0.2655 \cdot e^{2.88 \cdot 1} = -2.179689529 = 1 \text{ intercept min.} \]

\[ \ln(\frac{1.55 - P}{0.2655}) \frac{2.88}{2.88} \rightarrow P = 1.55 - 0.2655 \cdot e^{2.88 \cdot 0} = 1.2845 \rightarrow P = 0 \text{ intercept max.} \]

\[ 1.55 - 0.2655 \cdot e^{2.88 \cdot 1} = -3.179689529 = 0 \text{ intercept min.} \]

These functions are named ProcIntercept1 and ProcInterceptZero respectively in the equations that follow. They have a parameter of \( P \).

The graph verifying the results of these functions is in the appendix.

4.3.4 Revised 2 part equation for exponential fitted curve returns

\[ \int_{0}^{1} P - 1.55 + 0.2655 \cdot e^{2.88 \cdot h} \, dh - \int_{0}^{\text{ProcInterceptZero}(P)} P - 1.55 + 0.2655 \cdot e^{2.88 \cdot h} \, dh \]

(12)

This equation gives us the net. This is the shaded blue area of figure 3.
4.4 DIN PAYOUTS

The losses integral (eq. 13 & 14) gives us the total amount that the investment returns are below 1 for the region from 0 to the $y=1$ intercept. These are the Venture Bank losses, which are the same as the insurance payouts. This formula assumes that the underwriter will accept the assessed valuation of the investment equity turned over by the venture bank. This assessed valuation will lower the insurance payout by the assessed valuation.

Note that a second reasonable scenario is that the underwriter takes over the equity and waits until some $n$ year hold time is complete. This latter requires somewhat different accounting. But then, the final exit equity value on the back end goes to the underwriter. However, I think that most underwriters would move to sell rapidly.

4.4.1 Definite form of losses integral

Venture bank deal losses = Underwriter payouts

$$\int_{ProcInterceptsZero(P)}^{ProcIntercepts1(P)} 1 - (P - 1.55 + 0.2655(e^{2.88h})) \, dh$$

(13)

When $P = 1.55$, function = 0.2054307077

4.4.2 Definite form of losses integral for underwriters

$$(1 + Intrsti)^{-1} \int_{ProcInterceptsZero(P)}^{ProcIntercepts1(P)} 1 - (P - 1.55 + 0.2655(e^{2.88h})) \, dh$$

(14)

When $P = 1.55$, function = 0.2279261069
4.5 CLAWBACK LIEN

The clawback lien is on the back end after the underwriter pays off the DIN. It is a fraction of the net DIN payout. (e.g. a fraction of shortfall between the loan amount insured and the valuation of the equity accepted by the underwriter.) 77% appears to be an optimum. See following discussion: Choosing a clawback lien fraction.

4.5.1 Definite form of clawback integral

\[ \text{Clawback} = 0.77 \ (77\%) \]

\[
\text{Clawback} \cdot \int_{\text{ProcInterceptZero}(P)}^{\text{ProcIntercept}(P)} 1 - (P - 1.55 + 0.2655 (e^{2.88h}) \ (e^{2.88h})) dh 
\]

When \( P = 1.55 \), function = 0.1581816449

4.5.2 Choosing a clawback lien fraction

The purposes of a clawback lien are:

First, to make it feasible to determine on the back end if the bank is gaming the underwriter. The clawback allows a back-end claims process after the fact.

Second, to ensure that there is a smoothly rising curve of profitability for venture banks that receive insurance payoffs. Since these are derivatives they are enforced immediately, underwriters cannot implement a claims process prior to payment. So, as seen in figure 4, without a clawback there is a strong motivation to commit fraud on the underwriter, and intentionally crash investments to make more money. Profitability curves with clawback liens that are zero or too low create higher earnings at zero than when investments have the Kauffman portfolio returns.

Fully 89% of the Kauffman VC funds returned 0.5 or better. Consequently I have chosen 0.5 (which is zero on the VC portfolio adjustment scale) as the lower end of normal operations that an underwriter should be dealing with. The normal high end is a bit below 1.875, as there is an example of a large pension portfolio without internal data that has returns of 1.5. Divided by 80%, this is 1.875, which establishes a reasonable maximum.

In the selection graph of figure 4, we see a set of curves with different clawback values, as the VC portfolio return (P) factor varies. To pick a clawback fraction, decide what the lowest reasonable total portfolio return is. Then pick a value that has a minimum at that portfolio value.

I chose 77% as optimum, to prevent Venture Bank jackpotting temptation while being fair to bankers.

The caution is that fiduciaries will be quite good at figuring out how to maximize for their own account, and any degree of improvement by damaging some of their portfolio investments is a perverse incentive to play to lose in order to make a little bit more off the insurance. I suggest great caution in lowering the clawback fraction.

Figure 11 graphs in 3 dimensions what the effect of having no clawback would be on venture bank earnings.
4.6 PREMIUMS PAID TO UNDERWRITER BY VENTURE BANK

This summation is simplified by an assumption that all payouts occur in year 5, and all investment exits occur in year 10. So, we calculate the 5 and 10 year elements, and then multiply by the fraction of investments that apply to each.

*\( DINrate \) is the DIN yearly insurance rate.

\[ Intrst = 0.02 \]

\[ DINrate = 0.05 \]

4.6.1 Underwriter side

5 year term gross

Total premiums if all insurance was for a 5 year term.

5 Year term = 0.25

\[ ProcYintercept 1(P) \cdot DINrate \cdot 5 \]

When \( P = 1.55 \), 5 year payments total = 0.1151163575

10 year term gross

Total premiums if all insurance was paid for the full 10 year term.

10 Year term = 0.50

\[ (1 - ProcYintercept 1(P)) \cdot DINrate \cdot 10 \]

When \( P = 1.55 \), 10 year payments total = 0.2697672850
Total payments = 5yr + 10yr (Underwriter side)  
Payments = 0.1151163575 + 0.2697672850 = 0.3848836425

4.6.2 Venture bank side

Venture bank’s version includes cost of money to carry.

\[ \text{ProcYintercept } 1(P) \cdot \text{DINrate} \cdot \int_{0}^{5} (1 + \text{Intrst})^{(5-x)} dx \quad + \\
\text{ProcYintercept } 1(P) \cdot \text{DINrate} \cdot \int_{0}^{10} (1 + \text{Intrst})^{(10-x)} dx \quad (18) \]

When P = 1.55, premiums & carry cost for 5 + 10 years is:
0.1210082154 + 0.2983317780 = 0.4193399934

4.7 EQUITY FRACTION OWED TO UNDERWRITERS

This is the fraction of the final equity of 1.55 that the underwriters have claim on. Since the underwriters have already taken the equity for all the companies with losses, the underwriters are only owed for the money making investments. So, the equity integral (eq. 19 & 20) lower bound is where the earnings function crosses 1 (e.g. where it crosses break even). Then the underwriter's fraction is multiplied by that fraction of total earnings.

I can see the possibility that underwriters may be tempted to lower their equity fraction in order to close sales to venture banks for VC portfolio deals. Given that the overall performance of underwriter DIN policies depends on the top end compensating for the low end, underwriters need to model the outcome.

A safe method of price cutting in a competitive underwriter market for Venture Bank business would be to set a formula for equity fraction to slide based on value of a pool at exit. Such a formula should have a running accounting for the cost of insurance payouts for the investment pool. This algorithm could be modeled such that it has good predictability. The only limitation is that when a payout or exit is triggered, the calculation must be executable in a transparent manner without giving rise to questions that might allow challenge to the status of DIN instruments as derivatives. Consequently, making provisions for back end givebacks to venture banks that meet certain performance targets is the proper way to structure such negotiations.

4.8.1 Definite integral of equity fraction owed to underwriter

\[ \text{DINEquityFraction} = 0.5 \]

\[ \text{DINEquityFraction} = \int_{\text{ProcYintercept } 1(P)}^{1} P - 1.55 + .2655 \cdot e^{(2.88-h)} dh \quad (19) \]

When P = 1.55, underwriter equity = 0.6475155435

4.8.2 Definite integral of equity fraction remainder for venture bank
Mathematical model of Venture Banking

\[(1 - DINEquityFraction) \cdot \int_{\text{Proc}/\text{Intercept}}^{1} P - 1.55 + 0.2655 \cdot e^{(2.88-h)} \, dh \tag{20}\]

When \( P = 1.55 \), Venture Bank equity = \( 0.6475155435 \)

4.8.3 Results for a VC portfolio of 1.55 (Kauffman's)

**Venture bankers per multiple of capital**
- 0.6475155435 Venture Bank equity
- + 0.2054307077 DIN insurance payouts
- - 0.419399934 Total DIN premiums plus carrying cost
- - 0.1581816449 Clawback
- \[0.275424613\] Gain

\[\text{Venture bank equity} - (\text{Total DIN premiums} + \text{carrying cost}) - \text{Clawback} = \text{VC earnings}\]

\[\text{VC earnings} \cdot \text{MOC} = \text{Venture bank ROI} \tag{21, detail of 1}\]

**Underwriters per subset portfolio**
- 0.6475155435 Underwriter's equity
- - 0.2279261069 DIN insurance payouts total carrying cost
- + 0.3848836425 Total DIN payments
- + 0.1581816449 Clawback
- \[0.962654724\] Gain

**Underwriter's ROI**

\[
\frac{\text{Underwriter’s equity} + \text{Total DIN premiums} + \text{Clawback}}{\text{Insurance payouts} + \text{carrying cost}} = \text{ROI} \tag{22, detail of 2}\]

\[
\frac{0.6475155435 + 0.3848836425 + 0.1581816449}{0.2279261069} = 5.2235
\]

4.8.4 Results for a VC portfolio of zero (-3 on these graphs)

**Venture bank**
We repeat the above calculation with a portfolio adjustment of -3.

Total earnings for venture bankers per multiple of capital
- 0.0 Venture Bank equity
- + 0.9987995023 DIN insurance payouts
- - 0.2627954404 Total DIN payments and carrying cost
- - 0.7690756168 Clawback
- \[0.095811246\] Loss

**Underwriters**
- 0.0 Underwriter's equity
Mathematical model of Venture Banking

- 1.108171629  DIN insurance payouts total carrying cost
+ 0.25  Total DIN payment income
+ 0.7690756168  Clawback

(0.089096012)  Loss

5

6  GRAPHS OF SYSTEM BEHAVIOR

7  VENTURE BANK SYSTEM BEHAVIOR

7.1 WHEN ZERO ISN’T ZERO: THIS ZERO IS AN ADJUSTMENT FACTOR

The graph of the venture bank results when the average VC portfolio return = 0 needs discussion. It would seem that a miracle occurs here, since you cannot squeeze something from nothing. And in the graphs below, you will see VC portfolio values down to -3. So why is this?

When the portfolio adjustment is zero, this would be a true zero portfolio if there was no floor on losses and investments could go negative without limit. In this model, investments can go to zero, but not past zero. (See figure 3.) Because of this, when the portfolio adjustment is at 0, the actual VC portfolio return is 0.5 (50%), a 50% loss of invested capital. (See figure 5 for detail of behavior below the 0 portfolio adjustment factor.) To get to an actual return for a portfolio that equals zero, it is necessary to have a -3.17 portfolio adjustment². However, here I have used -3 as the lowest value because it is zero out to 3 decimal places, and any venture bank that actually manages this feat has other problems.

I think we are mostly interested in the region from 0 to 1.875, because this shows behavior for those large portfolios that should be most common. A portfolio factor of 0 is a 50% loss portfolio, and yet both parties can still make money at this level. I assume very large portfolios, and a VC portfolio that averages losses of 50% is quite poor. In the Kauffman dataset, 0.5 is in the bottom octile. Similarly, 1.875 is about as good as any large VC portfolio is likely to get with current VC selection approaches. One might then ask, why I show up to a +3 VC portfolio return. The reason is that Mulcahy noted that VC firms have a correlation between past performance and future results that is not seen in the stock market. So, it is plausible to think it may be possible to achieve large portfolio VC results greater than 1.875.

Remember that the purpose of a venture bank is to create money for the venture bank to loan to themselves. This, and the fact that the investment equity remains the asset of the bank is key to how venture banking returns work.

² While it is possible to create a function that would take a value of 0 and turn it into a -3 internally, so that the graph scale shows the true VC portfolio return on the horizontal axis, this creates extra complexity internally. At this stage, I decided to avoid that. It also would increase the computing cost of each graph.
I show the system of equations behavior down to -3. Be aware that -3 is not quite a 100% loss VC portfolio, and 0 is a 50% loss VC portfolio. However, a breakeven portfolio of 1.0 is correct, as is everything larger. The function is non-linear, and converges to be correct near 1. I chose not to correct this non-linear element of the model at this time to prevent complicating its internals.
7.2 VENTURE BANK GRAPH RESULTS

Venture Bank ROI =
(Venture Bank equity + Insurance payouts – Premium payments cost – Clawback) · MOC

(23, restatement of 21)

Figures 6 through 10 are views of the same results, rotated.

Figure 6: Venture bank returns. Blue plane is at 1, which is breakeven for the bank.

Figure 7: Top view. Blue plane is breakeven for the bank.

Figure 8: Side view along VC portfolio axis

Figure 9: Side view along MOC axis. Blue line at 1 is breakeven.
Figure 10: Venture bank returns. Red cut plane at zero marks returns that correspond to a 50% loss VC portfolio. Green cut plane correctly shows 1.875 VC portfolio return. Blue horizontal cut plane at 1 is breakeven.

Figure 11 A & B: Behavior with 0% clawback versus 77% clawback. This figure shows why it is necessary to have clawbacks. Otherwise, there is a valley in the region where most of the VC portfolios are. Most venture capital portfolios should be in the region between 0 and 1.875 bounded by the red and green cut planes. The red cut plane at zero corresponds to VC portfolio returns of 0.5 (50% loss). The green cut plane at 1.875 correctly identifies a VC portfolio return of 1.875 (187.5%).
7.3 UNDERWRITER SYSTEM BEHAVIOR

For the underwriter, MOC is not meaningful relative to ROI. Instead, MOC is related to the total volume of business that can be done with the bank. Let us step through the basic business of the underwriters.

Earnings are:
Total premiums to underwriter + DIN Equity share + Clawback – (Payout + Carry cost).

There are four ways of figuring the return on investment.
1. Investment is the cost of payout plus the cost of money to pay for it carried over 5 years.
   Payout + Carry cost.
   Earnings are: DIN premiums + Equity + Clawback
2. Investment is Payout + Carry cost - Discounted clawback bond sales.
   In this scenario, clawbacks, or some fraction of them, are sold, to defray costs for Payout + Carry.
   The discount rate of clawbacks will be set at 1.5 x USA 12 month LIBOR.
3. Investment is Payout + Carry cost - Sales of up to 70% of discounted equity futures.
   DIN Equity future shares for this model are discounted at 1.5 x (USA 12 month LIBOR) from the average portfolio valuation at exit.
   Note: Delivery of DIN equity shares will be the responsibility of the underwriter at closeout, or an alternative exercise competent entity that takes over 30% or greater majority position (Hanley 2017b). (Underwriter cannot drop responsibility for being exercise competent entity without another shareholder with 30% or more agreeing to become one.) With an exercise competent entity taking over equity futures, the underwriter can sell 100% of DIN equity futures, but that is not modeled here.
4. Combination of sales of clawbacks at discount and sales of equity futures.
   Here, investment is:
   Payout + Carry cost - Discounted clawback - Discounted equity futures sales.

Figure 12 shows behavior of components of ROI for underwriters.
7.3.1

7.3.2  **Simple underwriter ROI**

Underwriter ROI = \[
\frac{\text{InsNetDINPremiumTotal} + \text{InsEquityShare} + \text{InsNetClawbackLien}}{\text{InsLossPayoutTotal}}
\] (24)

Figure 13 shows the ROI if the underwriter does not sell equity futures or clawbacks at a discount.

Underwriters losses begin at -1.4525, which corresponds to a VC portfolio return of 0.125975915 (~12.6%, or a portfolio loss of 87.4%).
7.3.3 2. Underwriter ROI when selling off clawback bonds

Underwriter ROI =
\[
\frac{\text{InsNetDINPremiumTotal} + \text{InsEquityShare} + \text{Remainder InsNet Clawback Lien}}{\text{InsLossPayoutTotal} - \text{Discounted Ins Clawback Lien Sales}}
\]  

The idea here is that shares in clawback liens would be sold off as fixed maturity bonds.

Figure 14 shows the changes in ROI as the fraction of discounted clawbacks sold changes for a selected set of portfolio adjustments. Note that with clawback bond sales, the portfolio adjustment break-even point of -1.425 in the previous simple accounting is only stable at approximately -0.25.

Figure 13: Detail view of simple underwriter earnings without sales of clawbacks or equity futures. ROI becomes meaningless where VC portfolio scale is above 2. Breakeven is at -1.425
Figure 15 shows how ROI varies with both clawback bond sales and adjustments of the portfolio returns for individual deals. The blue plane is at 1, which is break even. The zero clawback sales graph in gray is shown together with the color shading sales graph. When the color shaded graph ends while ascending, ROI becomes meaningless due to zero net cost of insurance payouts.

Figure 14: VC portfolio adjustment numbers are shown next to the lines on the right. Note that here, a portfolio adjustment of -0.25 (black line) is flat. Everything below this, ROI trends down the larger the clawbacks fraction sold. Everything above it, the ROI rises the more are sold. Compare with figure 23.
7.3.4 3. Underwriter ROI with sales of equity futures

Underwriter ROI =

\[
\frac{\text{InsNetDINPremiumTotal} + \text{InsNetClawbackLien} + \text{RemainderDiscountedInsEquitySales}}{\text{InsLossPayoutTotal} - \text{DiscountedInsEquitySales}}
\]  

(26)

Figures 16 and 17 show how ROI varies with equity futures sales while the VC portfolio adjustment goes from -3 to 3. In the region of higher VC portfolio return in figure 16 beyond the spikes, there is no cost, only earnings.
Figure 16: Comparison of sales of equity futures with no sales (in gray). The significance of this graph is, again, that ROI rises faster above the critical transition, and below it, drops more quickly.

Figure 17: Detail of discounted equity futures sales. Here we see the transition region more clearly as the color shaded sales graph dips dips below the gray non-sales graph.
7.3.5 4. Underwriter ROI with sales of both clawback bonds and equity futures

Underwriter ROI =
\[
\frac{\text{InsNetDINPremiumTotal} + \text{RemainderInsNetClawbackLien} + \text{RemainderDiscountedInsEquitySales}}{\text{InsLossPayoutTotal} - \text{DiscountedInsClawbackLienSales} - \text{DiscountedInsEquitySales}}
\] (27)

Figures 18-23 vary the VC portfolio adjustment from -3 (zero return) to +2. Above 2.14 there is no graph, which means there is no net cost to the business.

The region past where the graph spikes end is all earnings and ROI is meaningless. Remember that a VC portfolio adjustment of 1 is 1, and everything above that is likewise correct. But below 1, the portfolio adjustment becomes inaccurate. A portfolio adjustment of 0 is a VC portfolio return of -0.5, or a 50% loss. A portfolio adjustment of -3, is a VC portfolio of zero.

Figure 18: VC portfolio adjustment = -3 to -1.5. Blue cut plan at breakeven.

Figure 19: VC portfolio adjustment = -1.5 to 0.0.

Figure 20: VC portfolio adjustment = 0.0 to 0.8. Blue cut plane at breakeven.

Figure 21: VC portfolio adjustment = 0.8 to 1.4.
7.3.6 Combined graphs for underwriter sales of both clawback bonds and equity futures

Figures 22 and 23 show how ROI varies based on cash flow as affected by sales of clawback bonds and discounted equity futures at selected VC portfolio adjustments together in one graph.

Figure 22: VC portfolio adjustment = 0.2 to 2.0

Figure 23: VC portfolio adjustment = -3 to 0.2
8 CONCLUDING REMARKS

In a reasonably normal operating environment, the optimum strategy for the underwriters will be to sell equity futures off early. This will generate revenue, and insulate the underwriter from markets over time. There is plenty of time to do this, so underwriters should be in a good position to establish a market for new issues. Because of this, I would expect that equity futures should usually fetch a significantly better price than the perfect fore-knowledge calculation of this model.

A further benefit of sales of equity futures is that these can be used to establish a surrogate pricing for the underlying investments. If this can be established, it may be usable for creating alternative exits, such as leveraged buy outs for those small number of investments that are not ready to retire at 10 years. Such transactions would have to be done outside of the venture banking system.

If all the clawbacks are sold off then the underwriter loses transparency into the venture bank’s records relative to that investment. If there is any reason to want to maintain transparency, then that should be avoided. Like the equity futures, this should significantly improve ROI, and provide an earlier conversion to an effectively zero cost business.

I expect that payoff occurrences will exhibit clustering, and should skew toward early payoffs for three reasons.

• First, Kauffman's data shows that funds exhibiting losses are concentrated in a rough quartile, and that past performance of a fund's managers was a good predictor of future performance.
• Second, when insurance is held, VC managers will have less incentive to hold investments that they think won't get to break even because it is costing them the insurance premium to maintain the investment.
• Third, my assumption that VCs only take the 20% carry on their positive gain portfolios is a conservative assumption. The true venture capital performance internally may be significantly higher.

There will be performance impact for individual investment returns on venture bank portfolios due to paying for insurance on investments. Against the incentive to cut losses earlier due to maintenance of insurance, the venture bank will want to maximize the value of that investment in order to minimize losses because of the clawback lien credits. I think that for the venture banks, this will probably improve performance relative to current VC firms.

It may be desirable for an underwriter to set minimum insurance terms, for instance 5 years, to prevent dumping early. I could see the possibility that underwriters could get hit with some of their clients paying 1 year of insurance and dumping investments in order to minimize their insurance costs while maximizing payoffs on bankrupted investments. This scenario would damage underwriter's position somewhat, and has potential to undermine the stability of the venture-bank system. Against this, if underwriters maintain a back end claims process, such activity can be treated as a violation of fiduciary trust, and result in a higher clawback up to 100%, and possibly including penalties above and beyond the clawback amount.
9 APPENDIX

9.1 KAUFFMAN DATASET

Octiles marked with shading.

\[
\text{Vector}([0.04, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 0.99, 1.00, 1.05, 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60, 1.65, 1.70, 1.75, 1.80, 1.85, 1.90, 1.95, 2.00, 2.05, 2.10, 2.15, 2.20, 2.25, 2.30, 2.35, 2.40, 2.45, 2.50, 2.55, 2.60, 2.65, 2.70, 2.75, 2.80, 2.85, 2.90, 2.95, 3.00, 3.05, 3.10, 3.15, 3.20, 3.25, 3.30, 3.35, 3.40, 3.45, 3.50, 3.55, 3.60, 3.65, 3.70, 3.75, 3.80, 3.85, 3.90, 3.95, 4.00, 4.05, 4.10, 4.15, 4.20, 4.25, 4.30, 4.35, 4.40, 4.45, 4.50, 4.55, 4.60, 4.65, 4.70, 4.75, 4.80, 4.85, 4.90, 4.95, 5.00, 5.05, 5.10, 5.15, 5.20, 5.25, 5.30, 5.35, 5.40, 5.45, 5.50, 5.55, 5.60, 5.65, 5.70, 5.75, 5.80, 5.85, 5.90, 5.95, 6.00, 6.05, 6.10, 6.15, 6.20, 6.25, 6.30, 6.35, 6.40, 6.45, 6.50, 6.55, 6.60, 6.65, 6.70, 6.75, 6.80, 6.85, 6.90, 6.95, 7.00, 7.05, 7.10, 7.15, 7.20, 7.25, 7.30, 7.35, 7.40, 7.45, 7.50, 7.55, 7.60, 7.65, 7.70, 7.75, 7.80, 7.85, 7.90, 7.95, 8.00]) \text{, datatype } = \text{ float}\]
\]

Mean average = 1.31

| Octile mean | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |
|-------------|----|----|----|----|----|----|----|----|
|             | 0.24 | 0.65 | 0.79 | 0.92 | 1.17 | 1.38 | 1.84 | 3.41 |

Quartile mean: 0.452, 0.857, 1.276, 2.656

9.2 KAUFFMAN REVISED DATASET

Values are identical until they are greater than or equal to 1. Values above 1 are divided by 0.8. Octiles marked with shading.

\[
\text{Vector}([0.04, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 0.99, 1.05, 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60, 1.65, 1.70, 1.75, 1.80, 1.85, 1.90, 1.95, 2.00, 2.05, 2.10, 2.15, 2.20, 2.25, 2.30, 2.35, 2.40, 2.45, 2.50, 2.55, 2.60, 2.65, 2.70, 2.75, 2.80, 2.85, 2.90, 2.95, 3.00, 3.05, 3.10, 3.15, 3.20, 3.25, 3.30, 3.35, 3.40, 3.45, 3.50, 3.55, 3.60, 3.65, 3.70, 3.75, 3.80, 3.85, 3.90, 3.95, 4.00, 4.05, 4.10, 4.15, 4.20, 4.25, 4.30, 4.35, 4.40, 4.45, 4.50, 4.55, 4.60, 4.65, 4.70, 4.75, 4.80, 4.85, 4.90, 4.95, 5.00, 5.05, 5.10, 5.15, 5.20, 5.25, 5.30, 5.35, 5.40, 5.45, 5.50, 5.55, 5.60, 5.65, 5.70, 5.75, 5.80, 5.85, 5.90, 5.95, 6.00, 6.05, 6.10, 6.15, 6.20, 6.25, 6.30, 6.35, 6.40, 6.45, 6.50, 6.55, 6.60, 6.65, 6.70, 6.75, 6.80, 6.85, 6.90, 6.95, 7.00, 7.05, 7.10, 7.15, 7.20, 7.25, 7.30, 7.35, 7.40, 7.45, 7.50, 7.55, 7.60, 7.65, 7.70, 7.75, 7.80, 7.85, 7.90, 7.95, 8.00]) \text{, datatype } = \text{ float}\]
\]

Mean average = 1.555725

| Octile mean | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |
|-------------|----|----|----|----|----|----|----|----|
|             | 0.24 | 0.65 | 0.79 | 0.92 | 1.46 | 1.72 | 2.30 | 4.26 |

Quartile mean: 0.452, 0.857, 1.595, 3.32

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