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Revisiting a Minsky Crisis

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1. Economic Growth
2. Stability
3. Development

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Abstract

The purpose of this IQP is to examine the financial instability of a firm that is created from borrowing and investment decisions. A firm's stability moves through three debt to income ratio levels as suggested by Hyman Minsky. There are many endogenous factors in the economy that affect a firm's expansion and contraction. I will examine a system dynamics model that illustrates some of the common behavioral patterns within a firm as suggested by Hyman Minsky.

Introduction

The production of producer goods (capital goods) runs ahead of the production of consumer goods. First a factory must be built. Then the factory can produce consumer items such as food, clothing or CD's. A business borrows from banks to invest in capital goods or build more factories. The business intends to repay the banks (interest and principle) with the cash flows from the sale of the products that they produce. The purpose of this credit is to bridge the gap between expenditure now and receipt later.

During this surplus expansion workers bring their wages back into the consumer market as they purchase food and clothing for their standard of living. There is an increased demand for consumer goods equal to the extent of the new factory construction. This new flow of money into the consumer goods market is captured as profit by business owners and entrepreneurs. Profits increase because surplus expansion is pure income for owners of consumer goods companies.

Since business is booming and there are profits everywhere stock market values increase. The increase in stock market values is a direct result of increased earnings and a speculative euphoria. But the economy is finite and it cannot increase indefinitely.

Eventually all the capital equipment is in place and there is no more surplus expansion. The increase in profits that comes from surplus expansion halts. The increase in earnings tapers off and flattens. Without an increase in earnings stock prices begin to fall. When it is time for the factory to sell their product to the consumer market a panic has already set in due to falling stock prices and a decrease in earnings. To maintain profit workers are usually laid off which decreases demand. Now the firm that owns the factory is not making the expected cash flows that it was predicting would repay their principle and interest payments. This cycle illustrates the boom and bust of a firm in the economy. Laying people off reduces demand and the products of the factory cannot be sold. Prices fall and there are further layoffs. It's a downward spiral. Perceived good loans for smart investments turn into bad loans for excess capacity. This is not only the fault of management within a firm. Banks become complacent during good times and make risky loans. Banks want to grow as institutions so the more loans they take on the riskier those loans become.

Why is System Dynamics a Useful Tool?

System dynamic techniques and software are the perfect tools for building this individual firm and illustrating the unstable behavior modes for the future. Theoretical models were a start but a mathematical representation using system dynamics is the next step in the process of understanding the financial instability of a firm. System dynamics software is able to produce visual graphs that show continuous behavior into the future. This is why system dynamics is so useful: it shows real life output that can be used to

make policy decisions in the real world by management. Mathematical parameters can easily be changed to show the differences in behavior.

Chapter 1

Minsky's Story – "The Financial Instability Hypothesis"

"The modern capitalist economy is an intensely financial system – money and finance are not neutral."

-Hyman P. Minsky

Minsky developed a financial instability hypothesis that states in a capitalist economy the economic structure is susceptible to financial crises. Minsky also says that a financial crisis is systematic and is due to endogenous factors rather than being an accidental event. The economy has financial regimes that are stable and ones that are unstable. According to Minsky the ratio of debt to income determines the stability of a firm. These debt ratios are created by a firm's decision to borrow money from a lender with the intentions of investing this money on expansion or future projects. The predicted demand or the expected future cash flows determine how much money the bank is willing to lend and how much debt the firm is willing to acquire. In order to validate a business debt the firm must have prices and outputs that ensure enough profit after labor and material costs to create a positive cash flow. Minsky defines cash flow as 'gross profits after out-of-pocket costs and taxes.' (Minsky, 23)The firm should expect to be able to pay off the entire principle as well as the interest payments with this cash flow. In other words the future value of the investment is greater than the money lent out. A firm

gets into trouble when the cash flows are not what were expected. Now a firm cannot make interest or principle repayments from their cash flows. This lack of cash profit forces a firm into refinancing. This is where the contraction of a company starts as it must borrow more and more to fulfill past financial obligations. There are different reasons for the beginning of this downward spiral such as mismanagement inside the firm or the complacency of the banks to make risky loans. A firm may overshoot on the prediction of its future demand or future cash flows and put itself in debt. An unforeseen increase in costs or chance rise in interest rates may also contribute to debt. On the bank side, as expansion continues both borrowers and lenders are willing to engage in activity with lower margins of risk. (Kregel) Banks become complacent and make bad loans to firms that may default.

Minsky believes in having a large government sector to generate enough income for firms during times when consumer demand is low. Government intervention can prevent serious financial crises. A large government deficit increases gross profits in the production of consumer and investment goods. In other words when business and consumer spending is in a lull the government takes over and provides the necessary income for firms to keep making money. The operations of the Federal Reserve can also prevent financial crises. The Fed is able to increase or decrease the money supply in the economy, which will have a direct effect on interest rates and borrowing. The Fed can also raise or lower the discount rate, which also affects borrowing. The only problem with these two sectors intervening is that it can lead to inflation.

Minsky states that the behavior of a capitalist economy depends on the pace of investment. There is a certain valuation placed on capital assets such as machinery and

factories. There is a prediction of what their future value will be and this determines how much a company is willing to invest. A company will invest keeping in mind that it needs to repay these contractual commitments at a later date in time. These financing decisions are a direct result of the pace of gross profits. This whole procedure of investment is dependent on expectation. The company is expecting to have the future cash flows to repay principle and make interest payments on its contractual commitments.

Minsky classifies three different debt to income ratio levels that a firm can move through: Hedge, Speculative and Ponzi. A Hedge firm is able to make interest rate payments and all principle debt repayments on its cash flows. A Hedge firm is stable and expanding. Speculative firms can meet interest rate payment obligations but cannot repay principle. A speculative firm must refinance or re-borrow in order to meet their payment commitments. Ponzi units cannot meet any of their payment commitments. They must sell their assets or borrow. Borrowing will lower the equity of a unit. A Ponzi unit usually declares bankruptcy.

Minsky says that most firms engage in speculative finance and they face three major problems when repaying debt. If there is a rise in interest rates then their payment commitments will rise relative to their cash receipts. This means that their cash receipts are staying the same but the rise in interest rates is driving up the interest payments that they owe. Also the firm's assets are long term and their liabilities are fixed in the short term. As the interest rates rise there will be a greater rise in their liabilities than in their assets. This means that in the long run their assets will be less than their debts. The third problem facing debt-financed institutions is that revaluation of firms can be sudden. If

anything goes wrong, such as less cash receipts relative to payment commitments, the fim's valuation can plumit. (Minsky, 25)

A hedge firm's financial stability decreases due to endogenous factors. Usually a speculative euphoria develops and the firm believes that it can expand more than it should. It borrows money and its cash flows are not sufficient to re-pay the loans. This increase in debt to income ratio is due to mismanagement and this is how a stable firm becomes an unstable firm.

What Others Have Contributed

Economic models of a firm have been built before but they have been strictly theoretical. Even if the models have included mathematical equations they have not demonstrated an understanding of how the system behaves under different parameters or changes in endogenous circumstances.

John Maynard Keynes

Minsky's financial instability hypothesis was built using theory previsouly argued by John Maynard Keynes. Keynes' "General Theory" is an explanation for "financial and output instability as the result of market behavior in the face of uncertainty." (Minksy, 21) The conditions of the financial market and other disequilibrating forces determine investment activity. This investment activity influences two sets of prices: capital and financial assets and current output and wages. Keynes refers to money as a veil between assets and wealth of the owner. (Minsky, 22) This means that people often

borrow money from a bank in order to buy real assets. These assets will then hopefully increase their wealth at some point in the future. But if it were not for the bank's ability to finance the borrowers they would never be able to own these assets.

Keynes' "General Theory" also deals with time and uncertainty. All business decisions and ventures are done without knowledge of the future behavior of the economy. "Changing views of the future affect the relative prices of various capital assets and financial instruments...[and] the relation between capital-assets price and the price of current output." (Minsky, 23) During a short period of calendar time lots of endogenous factors can quickly change that will affect the system greatly. These financial attributes are what contribute to the fragility of a firm.

Lance Taylor and Stephen A. O'Connell

Taylor and O'Connell tried to build upon Minsky's financial instability theories citing two key assumptions. The first assumption is that the value of a firm's assets are responsive to discounted rents on capital. The second assumption is that liabilities of a firm and money in the public's portfolio are substitutable. This means that as expected profits drop the public will shift their preferences towards money for their portfolios. This leads to a rise in interest rates that lowers expected profits even more. Taylor and O'Connell stress the negative relationship between interest rates and expected profit. This can be thought of as a panic: when interest rates rise investment decreases. As investment decreases the value of the firm's capital assets declines as well as their net

worth and expected profits. This is part of the debt deflation process that Minsky describes.

Taylor and O'Connell describe the problem of instability beginning with a boom. During a period of optimism a firm's net worth rises and it will borrow with this increase. When this expansion reaches its peak the ratio of debt to net worth (Minsky uses debt to income) rises. This starts the downward swing where net worth decreases and firms move through the three debt positions. Hedge firms become speculative firms and speculative firms become ponzi firms. The ponzi firms become bankrupt.

Martin Wolfson

Wolfson states that in a business cycle expansion period there is always an increase of debt. This increase in debt weakens corporate balance sheets. Debt increases in relation to equity and as that maturity of the debt is shortened the liquidity of the firm decreases. These events decrease corporate profit and discourage future investment. In terms of refinancing to meet new debt requirements banks are less likely to make new loans because they are already incurring losses on loans outstanding. Monetary Policy also factors in because they place restrictions on the banks lending power during times of expansion.

Chapter 2

Why Use System Dynamics?

System dynamics is a methodology that uses computer simulation processes to analyze mathematical systems modeled after real world systems. System dynamics models analyze how variables change dynamically – over time. These computer models are then translated into policy design for real life situations. Building models using system dynamics software is a beneficial way to avoid problems that may occur in real life. If a certain policy does not work in a computer model then it can be avoided in a real system. System dynamics models also save time because of the quick computer simulations.

Brief Background

System dynamics was developed at MIT by professor John Forrester to help corporate managers run their firms more efficiently. One of the first models that was built by professor Forrester was 'Urban Dynamics', which modeled the city of Boston. A book and new model 'World Dynamics' followed that analyzed the problems facing earth in the future. Professor Forrester's conclusions were very controversial because according to the model a population increase led to too much pollution and natural resource usage. He predicted that if the world did not use more population control

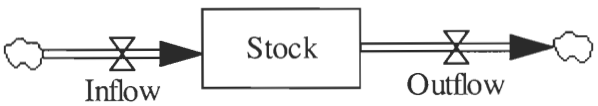
techniques and stop using natural resources at such a rapid pace then earth would be in serious trouble.

Simple Structures

Flow

Valve (Regulates Flows)

Source or Sink (Stock outside of model)



This is an example of a stock with an inflow and outflow. The stock can be thought of as a level and the inflow and outflow is the rate of change of that level. Another way of picturing this is a bathtub (stock) and a faucet (inflow, outflow) that can fill the bathtub or drain it. The value of the Stock = +Inflow – Outflow. If the inflow is greater than the outflow the stock will increase. If the outflow is greater than the inflow

the stock will decrease. If the inflow is equal to the outflow the stock will not change. This value is called equilibrium. The sources and sinks in a system dynamics model represent stocks that are exogenous. The purpose of the sources and sinks are to allow endless supply and absorption. They have infinite capacity.

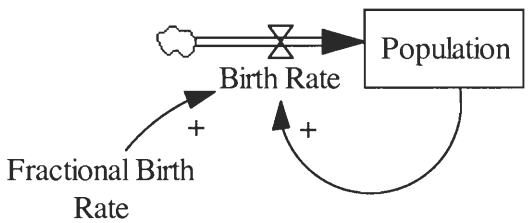
Stocks make four important contributions to system dynamics models. First, Stocks characterize the system and provide information for decision-making. The second contribution from stocks is that they provide the system with inertia and memory. Past events add up in the stocks. The content within the stocks only changes with increases or decreases in the flows. Thirdly, stocks are the source of delays. A delay means that the output of a process lags behind the input. The difference between the input and output accumulates in the stock. All delays involve a stock. There are different types of delays that are incorporated in system dynamics models. There is a time delay involved between the first day of constructing a building and the point when it is ready for occupancy. There is a perception delay between the desired shipping rate of a company and its actual shipping rate. This is also called a reporting delay. Finally, stocks decouple rates of flow and create disequilibrium dynamics. The inflow and outflow to a particular stock are ruled by different equations thus making them differ in value. This means that stocks are rarely ever in equilibrium. (Sterman, 195)

Differentiating between stocks and flows is often a confusing task. In mathematical terms stocks are integrals and flows are derivatives. In economics stocks are levels and flows are rates. A method for distinguishing what variables in the system are stocks is the snapshot test. If you froze the system at a certain point in time the stocks

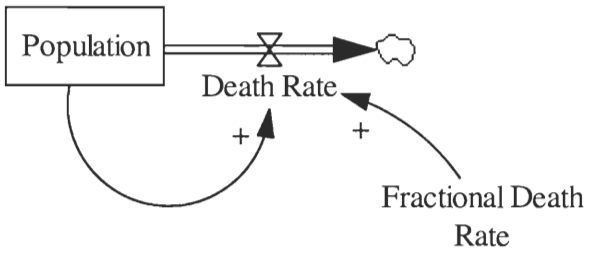
would be the variables that you can count or measure. The flows in the system are the variables that are changing the stocks.

In the above example Inventory is the stock. Inventory is increased by the inflow of deliveries and it is reduced by the outflow of sales. If this company is selling soda the units of the stock Inventory would be 'cases of soda.' The units of the flows Deliveries and Sales would be 'cases of soda per week.'

The simplest structure in system dynamics modeling is called a first-order system. First-order systems are linear, which means that rate equations are linear combinations of all the variables.

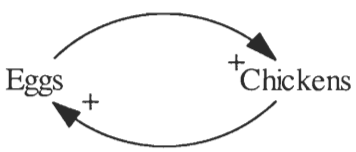


The above example is a First-order, linear positive feedback system. The Birth Rate = Population * Fractional Birth Rate. This system exhibits exponential growth.



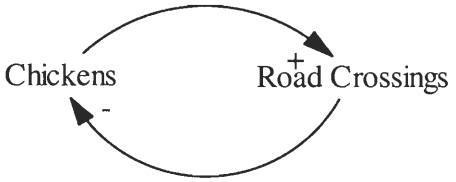
The above example is a First-order, linear negative feedback system. This system exhibits exponential decay. (Sterman)

Feedback loops are illustrated by using causal loop diagrams. A positive feedback loop is also referred to as self-reinforcing. These loops reinforce or amplify the system.



Eggs lead to more chickens, which in turn lead to more eggs. This system is amplifying. The opposite is also true. Fewer eggs mean fewer chickens, which leads to fewer eggs. Even though the behavior is decaying it is still reinforcing behavior.

A negative feedback loops is a balancing system. Negative loops oppose change and seek balance and equilibrium. They are self-limiting.



An increase in the number of chickens means there will be more road crossings. But as the chickens cross the roads more they will die and their population will decrease. But now as the chicken population decreases there will be fewer chickens trying to cross the roads so more of them will live and increase the population again.

It is important to determine the correct polarity of the loop, whether it is positive or negative. One method for determining polarity is counting the number of negative links in the loop. If the number of negative links is even the loop is positive. If the number of negative links is odd the loop is negative. This method can be confusing though if the loop is extremely complex. An alternative, and usually more acceptable method of determining polarity, is to trace the effect of each change around the loop. If the last variable of the loop opposes the original change then it is a negative loop.

There are five steps that complete the modeling process. To ensure that the model is credible each one of these steps should be considered. (Sterman, 86)

1. Problem articulation

   The main problem that the model is attempting to solve needs to be identified. The key variables that need to be included in the system must be picked and the proper time horizon for examining the model should be estimated. A model builder must

find the historical behavior modes (reference modes) so that they know how the model should act.

2. Formulation of dynamic hypothesis

   The model builder needs to know the current theories of the problematic behavior. The dynamic hypothesis needs to include all of the endogenous variables that are drivers for the feedback system. Then it is necessary to map the causal structure of the system using causal loop diagrams and stock flow maps.

3. Formulation of a simulation model.

   When building a model there are certain parameters that need to be thoroughly thought out to make the model behave correctly. Also the equations for all the variables are the decision rules that are going to drive the system. These boundaries need to be realistic in order to simulate a real life system.

4. Testing

   In the testing stage, the behavior that the model produces needs to be compared to the original reference modes. The model should be tested against extreme conditions and under a variety of different parameters to see which variables are most important.

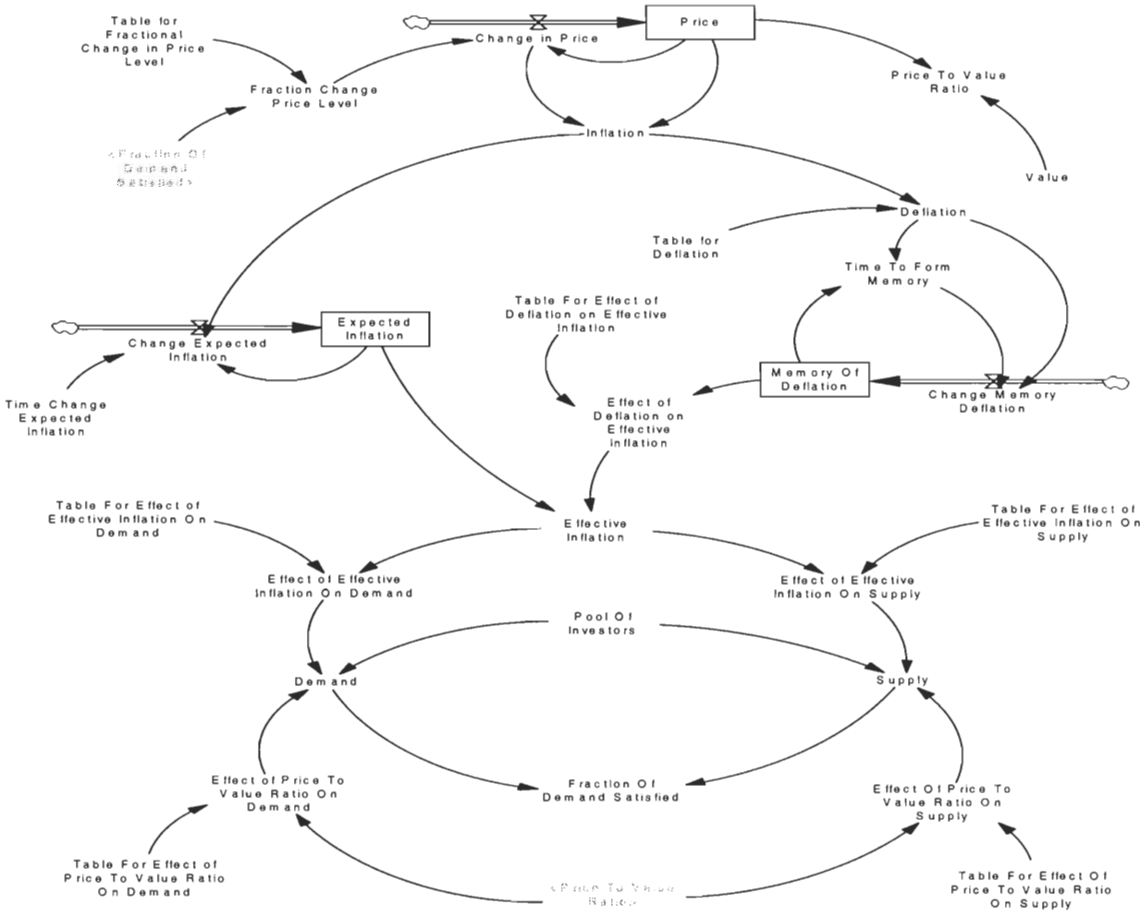
5. Policy design and evaluation

   The final stage of building a system dynamics model is comparing your results to what might actually happen in the real world. Certain policies can be taken from the results of the model and applied to real life situations. But a model builder must be aware of unforeseen circumstances and ever changing conditions of businesses when making policy recommendations. That is why it is so important to use different sensitivity analyses on system dynamics models.

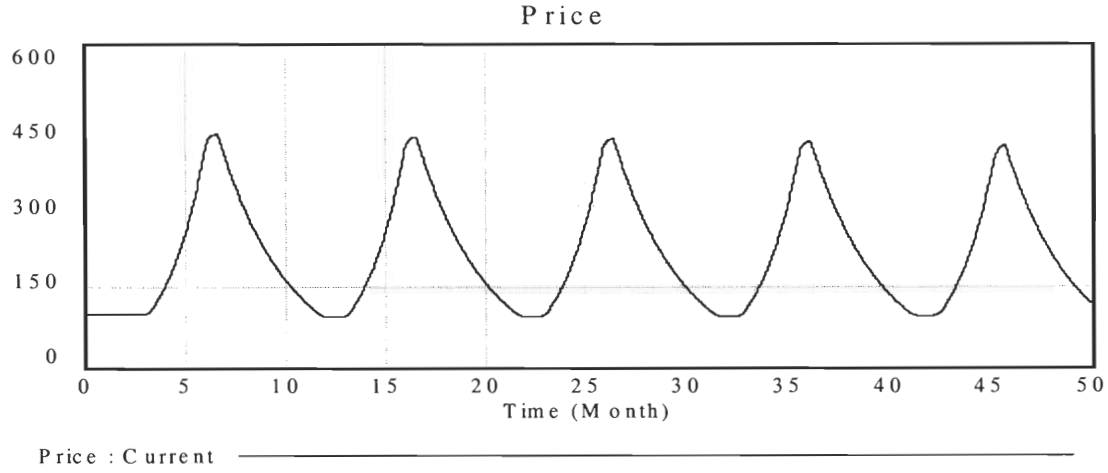
Chapter 3

Speculation Model

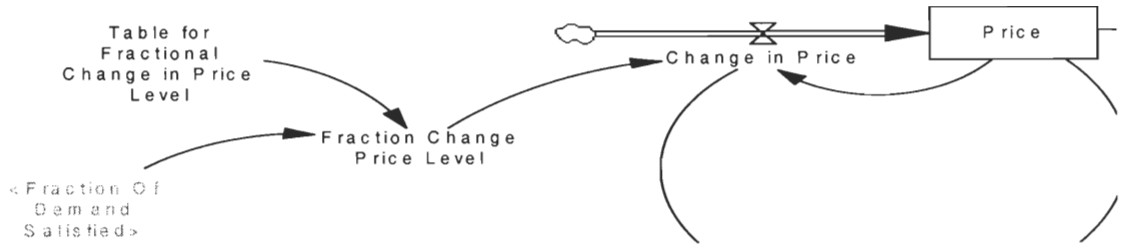
Speculative Euphoria is a major factor in the debt to income levels that a firm moves through. The following system dynamics model, built by Michael J. Radzicki Ph.D., shows the oscillations that a firm's output exhibits based on price of goods and the governing rules of supply and demand.



The following graphs demonstrate some of the behavior cycles that a firm encounters during different stages of speculation.

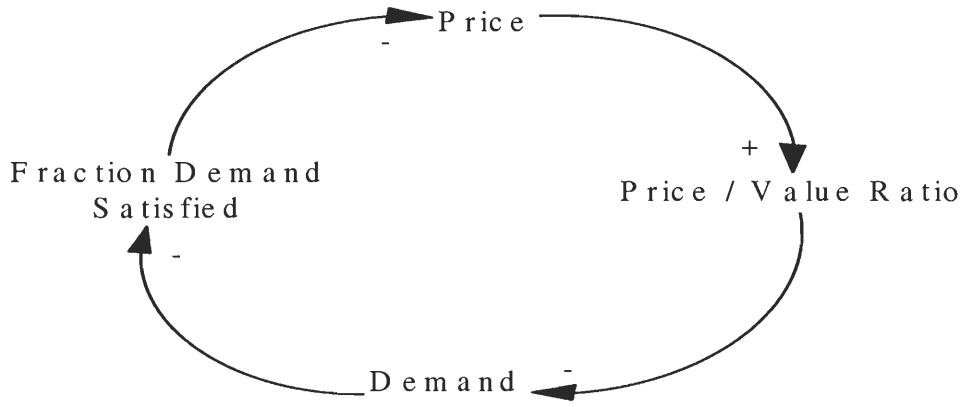


The price of the product that the firm is producing oscillates over time. The price changes are driven by supply and demand. As the 'fraction of demand satisfied' increases the price is driven down. In other words, if the supply is much greater than the demand the price of the product needs to be lowered in order to entice people into buying it. As the 'fraction of demand satisfied' decreases the price of the product is raised. People are willing to spend more money to buy the product if there is a large demand for it and not a bountiful supply. The vensim piece of this model looks as follows:



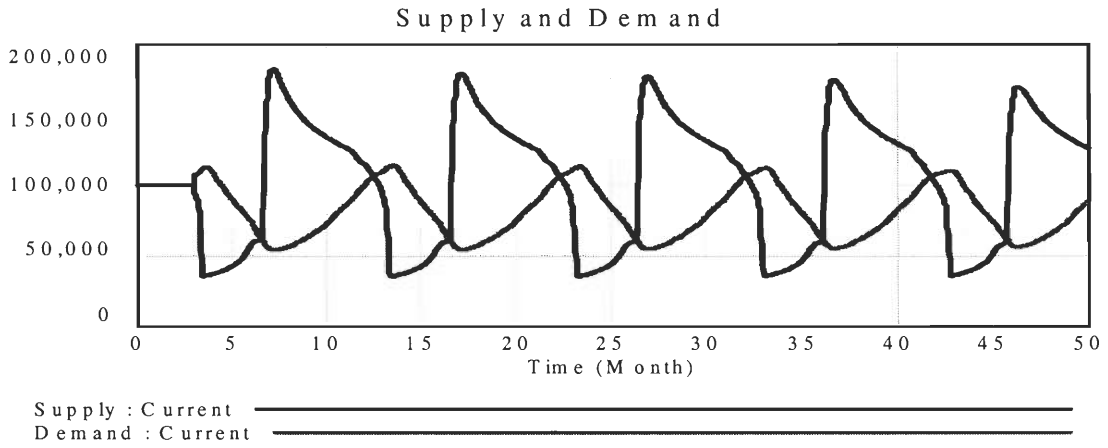
The flow 'Change in Price' drives the stock 'Price'. 'Change in Price' is the 'Price' * 'Fraction Change Price Level'. And the 'Fraction Change Price Level' is driven by a graphical function that basically states high supply and low demand leads to a falling price and low supply and high demand leads to a rising price. The reason that price oscillates is that a euphoria in the product develops and people want to buy it. When the product has lost its appeal people stop caring about it and the price drops. The stock 'Price' can also be taken to mean the public opinion of the value of a specific firm. The euphoria phenomenon works the same way. If people value a company highly then the value of their stock increases for no reason other than public opinion.

Here is a causal loop diagram of how the price is being driven in the system dynamics model:

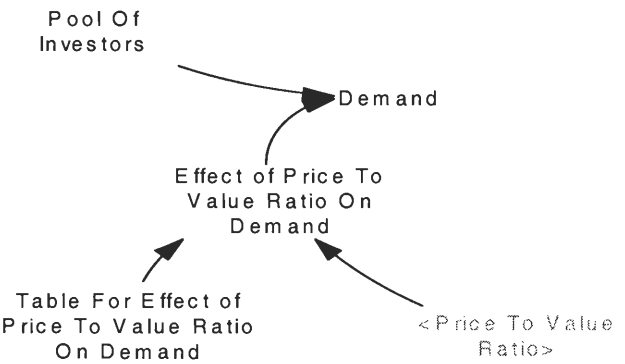


As the price increases the price to value ratio increases because they are positively correlated. The formula for the price / value ratio is simply 'Price' / 'Value'. As the price to value ratio increases there is a decrease in demand. This makes sense if you consider that as price increases the denominator, 'Value', does not increase. The product is increasing in price and not increasing in value. Over time consumers figure out that they are not getting the "bang for their buck." As the demand decreases the 'Fraction Demand Satisfied' increases. This is because the formula for this function is 'Supply' / 'Demand'. The denominator is decreasing thus giving the fraction a greater value. Finally, as 'Fraction Demand Satisfied' increases the price decreases. The formula for 'Fraction Demand Satisfied' = 'Supply' / 'Demand'. Supply is increasing and there is not a great demand for the product so the price drops. This causal loop is a balancing loop. As you first trace the effects around the loop price is increasing but when you end the loop you find that price is decreasing. This opposition is the reason that the price oscillates in the working vensim model.

The following graph illustrates the behavior modes of supply and demand in this system.

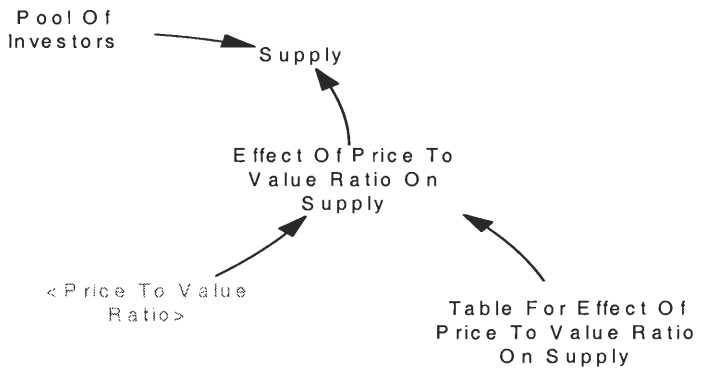


Supply and demand oscillate in the same manner that price does. It is also evident from the graph that as supply goes up demand goes down and vice versa. Examining the vensim model tells us why this is so:



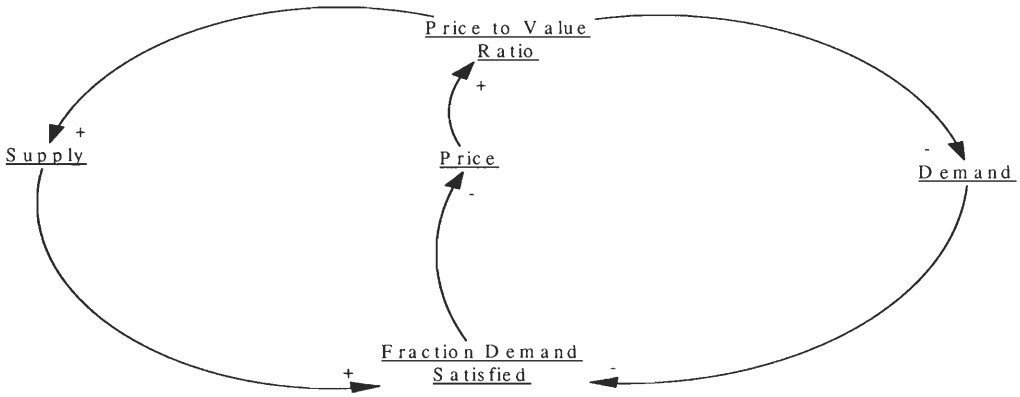
Demand is governed by a graphical function, which is determined by the price to value ratio. The rule says as the price to value ratio goes up demand goes down. This was touched on before: As price gets high relative to value consumers do not want to buy. This graphical function is multiplied by 'Pool of Investors' to get 'Demand'. 'Pool

of Investors' is simply a parameter that can be adjusted depending on how many bodies you want in the system.



Supply is governed by the exact same set of rules. The only difference is that when the price to value ratio goes up the supply also goes up because consumers are less willing to buy. The graphical function is then multiplied by 'Pool of Investors' to get 'Supply'.

Now we can look at supply and demand in a causal loop structure:



These two feedback loops are both balancing, which produces the oscillatory behavior. **Right Loop:** As the price to value ratio increases the demand goes down which in turn makes the fraction demand satisfied increase. This makes the price drop so the price to value ratio is decreasing. **Left Loop:** As the price to value ratio increases the supply increases also. That makes the fraction demand satisfied increase. This means there is a drop in price and the price to value ratio is decreasing.

Conclusion

The expansions and contractions in economic cycles are not just a random phenomenon. Oscillatory behavior is due to the effects of endogenous variables within the system. There is always a negative feedback loop involved, which makes the system seek balance. Balance seeking behavior is what produces the overshooting and undershooting of oscillations. From the writing of Hyman Minsky we learn that varying

debt and income levels are due to mismanagement. This bad decision-making is from speculative euphoria and a misunderstanding about the strength of investments and cash flows. The speculation model that we examined showed that the rise and fall of price and output levels are due to governing rules of supply, demand and value ratios. The balancing causal loop structures showed that the system was always seeking equilibrium. Oscillations in a financial or economic cycle are caused endogenous relationships and governing rules within the system.

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