Likely Causes of the US Housing Market Crisis: A System Dynamics Investigation

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ABSTRACT

This paper attempts to take a fresh look at some of the major causes of the US housing market crisis as cited in the literature. In particular it investigates the effect of loosening of bank capital requirements, the government's push to increase home ownership, increase in homeowners' equity due to the housing boom, loose monetary policy, and change in bankruptcy rules. The paper performs controlled experiments with a system dynamics model to understand the fundamental and reinforcing causes of the crisis. The system dynamics approach allows for studying each cause in isolation as well in consort with the other causes, helping to assess whether they work as posited in the literature. Our findings indicate that with the exception of loose bank capital requirements the other reasons provide at best only a partial explanation of the crisis. Interestingly loose monetary policy actually prevents the boom from becoming too large. However on the downside, it discourages household savings and causes the bust to be worse, due to weak household finances that result from low savings.

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1. Introduction

The aim of this paper is to understand the impact of some of the main causes that have been hypothesized to have led to the financial crisis that started with the collapse of the housing market in the US in August 2007. A system dynamics model of the personal finance process of households is constructed to experiment with the impact of each cause. This framework allows us to analyze which of the hypothesized causes could potentially lead to crisis causing situations. In addition we attempt to understand how these multiple causes, working simultaneously, might impact the economy. In particular, whether they might magnify or dampen each other's effect when implemented simultaneously in our model.

The most common causes of the housing crisis cited in the literature emanate from two basic sources: financial regulation and availability of "cheap" money. Financial regulations are said to have impaired households' ability to service mortgage debt through the bankruptcy reform enacted in 2005. They are also blamed for the inordinate importance that credit rating agencies acquired in determining the success of issuing of securities, which led to the corruption of the process of credit rating. And finally financial regulations have been blamed for lax capital requirements for banks leading them to lend too much. "Cheap" money is believed to have been available to households due to rising savings abroad, rising equity in homes, and the government's mandate to increase home ownership. Rising savings abroad meant cheaper loans in the US as foreigners invested in low yield US assets. An example is the Chinese Central Bank investing proceeds of China's large current account surplus in US Treasury bills. Rising home prices meant that households' equity rose automatically without any need for additional savings. The government's mandate to extend homeownership meant additional availability of easy credit (Levine, 2010).

We present a model of personal finance that incorporates the micro-level decision structure for determination of income, expenditure, savings and asset prices. To this model we add a source of cheap money to supplement income for households. Asset prices are modeled to be backward looking and self-fulfilling to mimic the real life rise in housing prices. In addition these asset prices are allowed to determine the household's decision to invest, which helps to create the feedback loop of high home prices fueling increased buying which in turn feeds further home buying. Finally the normal fraction of assets that households could borrow is made a function of banks' rising capacity to lend due to lax capital requirements and various financial innovations in packaging and reselling loans.

We conduct four experiments with this model, each representing a different hypothesized cause of the crisis. The experiments are ordered chronologically to mimic the actual timeline of events as they unfolded leading up to the crisis. Experiment 1 represents loosening of bank capital requirements which started around the middle of the 1990s, experiment 2 represents cheap money influx coming predominantly from large current account surpluses that followed in Asian economies in the wake of the Asian crisis in 1997-98, experiment 3 represents the lowering of interest rates by the Federal Reserve starting 2001 and experiment 4 represents bankruptcy reform in 2005.

Our findings indicate that each tested cause contributes to the crisis in a unique way. The loosening of bank capital requirements and bankruptcy reform contribute to both the increase as well as eventual decline of housing prices. Cheap money influx contributes to the increase in house prices, however it actually cushions the fall in prices. In contrast, the lowering of the interest rate by the Federal Reserve while contributing to the fall in prices actually dampens the initial price increase. Each experiment is overlaid on previous ones to see the cumulative impact

as time progresses. Lax banking capital requirements and cheap money reinforce each other and cause the bubble to become larger. Bankruptcy reform reinforces these two causes of crisis even further.

Interestingly our experiment representing the Federal Reserve lowering interest rate has an impact on home prices predominantly through lowering households' incentive to save. This results in a smaller bubble due to households' reduced savings. However when the bubble bursts it makes the crisis much worse because households are ill-equipped to handle the downturn due to low savings. This somewhat vindicates the Federal Reserve's stand that lower interest rates did not feed the bubble. At the same time it draws attention to household savings as the route through which this policy played a role in the crisis.

The rest of the paper is organized as follows. Section 2 presents a literature review to highlight some of the commonly cited reasons for the crisis. Section 3 presents our model. Section 4 presents our experiments and findings. Section 5 concludes.

2. Literature Review

Levine (2010) contends that due to NSRO (Nationally recognized statistical rating organization) designation granted to credit rating agencies by the SEC, these agencies transformed their business model from selling credit rating to subscribers to practically selling "licenses" to issuers of securities. Regulators, official agencies and private institutions came to rely on the NSRO ratings for capital adequacy and portfolio guidelines.

In the area of bank capital requirements, Levine (2010) draws attention to the Federal Reserve allowing banks to use CDS (Credit Default Swaps – derivative securities that pay the holder if there is a default on a loan) to reduce capital requirements - since 1996. These were widely used

and some issuers of CDSs for example, AIG developed huge exposure to them relative to their capital base. Thus in effect banks were taking excessive risks without actual insurance backing those moves. In addition, the SEC in 2004 permitted the 5 largest investment banks to determine their own capital levels based on their own models of asset and portfolio risk. There was even limited oversight on these models as the investment banks sometime failed to satisfy their self-determined capital adequacy.

In addition, there is literature that links liberalization of banking sector to increasing levels of competition and bank failures. It has been posited that competition leads to lowering of the value of a bank's franchise that is primarily determined by its expected earnings. This goads banks on to take risks that they would otherwise avoid. There is an extensive literature on the US that finds an inverse relationship between bank scale and bank failure, which indicates that competition leads to banking sector instability (Calomiris, 2000; Calomiris and Mason, 2000) Weder (2009) contends that time inconsistency in financial regulation inflated the bubble. Regulators have an incentive to announce a no-bailout policy in order to ensure prudent risk taking by banks, however when crisis strikes the optimal strategy is to bailout struggling banks. Banks anticipate this and take on more risk. In addition, according to Weder (2009), regulators have little at stake in terms of the capital of the regulators own institution and also have an incentive to hide losses since it demonstrates their own failures.

Finally Levine (2010) discusses the role of the Government Sponsored Entities (GSEs): Federal National Mortgage Association (Fannie Mae) & Federal Home Loan Mortgage Corporation (Freddie Mac), which are implicitly backed by the government. They therefore could raise money cheaply. Their primary function was creating a secondary market for mortgages: they purchase mortgages from banks and other primary mortgage lenders and hold them or package

them into Mortgage Backed Securities (MBS) guaranteeing timely payment of interest and principle and sell to investors. There were two policies that expanded mortgage markets and encouraged GSEs to accept lower quality mortgages and thus encouraged upstream primary mortgage lenders to lower their lending standards as well. These were the expansion of the affordable housing mission of the GSEs and the Community Reinvestment Act (CRA).

Laibson and Mollerstrom (2010) counter the conventional argument that savings glut in developing Asia led to the trade deficits and availability of cheap capital in the US by providing a model that demonstrates an alternative where it is the asset price bubbles in equity and residential real estate in the US that leads US consumers to spend their new wealth. They contend their model is representative of reality since capital imports in the US were consumed and not invested which is counter to what would be expected if foreign savings were responsible for the cheap capital in the US.

Li, et al. (2010) blame the limited funds available to serve mortgage debt which households had at their disposal even after filing for bankruptcy. Bankruptcy reform of 2005 reduced the amount of debt discharged and raised the cost of filling. Previously debt discharge loosened the homeowners' budget constraint and allowed them to use bankruptcy to continue making payments on their home. This option was limited by the bankruptcy reform.

The hypothesized causes cited in the literature thus fall into a four broad categories. The first category is the role of changing financial regulations for households. Mortgage reform of 2005 reduced the ability of households to use bankruptcy protection to help pay for their mortgage. The second category is the role of credit rating agencies that changed from information provision to virtual licensing. The third is the loosening of banking sector capital requirements. The fourth

is cheap money that became available to households due to government policies encouraging home ownership and the rising equity from home price increases. The current paper takes each of these causes in turn and conducts experiments to estimate the individual and cumulative impact of each. This is useful to clarify the precise role of each cause and also to check whether the arguments in the literature stand the test of economic modeling.

3. The Model

In this section we present the model of a system that describes the behavior of households with respect to their investment and debt choices and the price of real estate assets. An aggregate view of the model appears in Figure 1 showing feedback between the major sectors of the model. Asset volume and price are related through a control process, both directly and through changes in indebtedness and cash. Cash available for investment and indebtedness can, however, grow concomitantly since when price goes up, expected value of assets goes up too and the equity rise so achieved can lead to more borrowing. Indebtedness and cash are connected through a control process and cash will reduce indebtedness through debt service, while borrowing increases it. Each sector in Figure 1 is described below while model equations are placed in the Appendix.

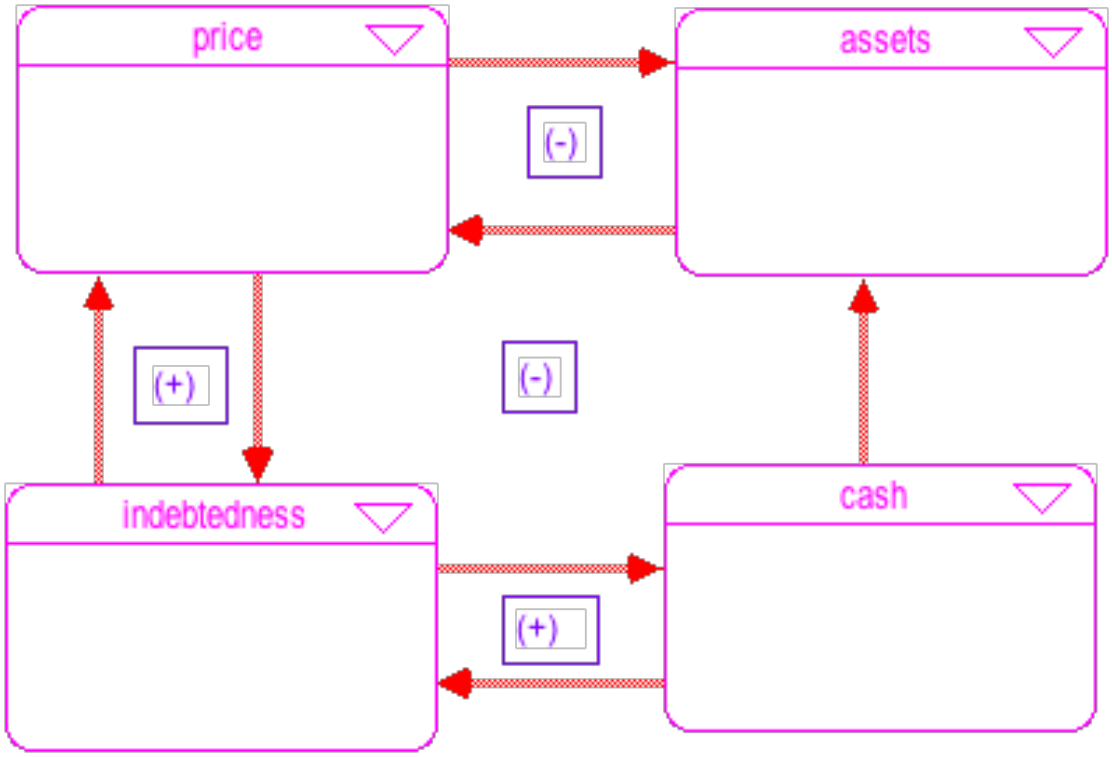

Figure 1: Aggregate relationships in the model

3.1 The Household's Investment Decision

Figure 2 describes the growth of real estate. The household's investment in real estate assets is determined by the fraction of available cash that is invested, which varies depending on trends in real estate prices. This formulation implies that the fraction is greater when real-estate prices are trending upward. Intuitively, households are willing to buy more expensive homes when they feel that the price of their home is likely to rise in the future based on the current upward trend in prices. The recent real estate bubble in the US was inflated in part by this willingness of households to continue buying homes in the face of rising prices. This may be attributed to the hypothesis that confidence tends to build on itself (Akerlof and Shiller, 2009).

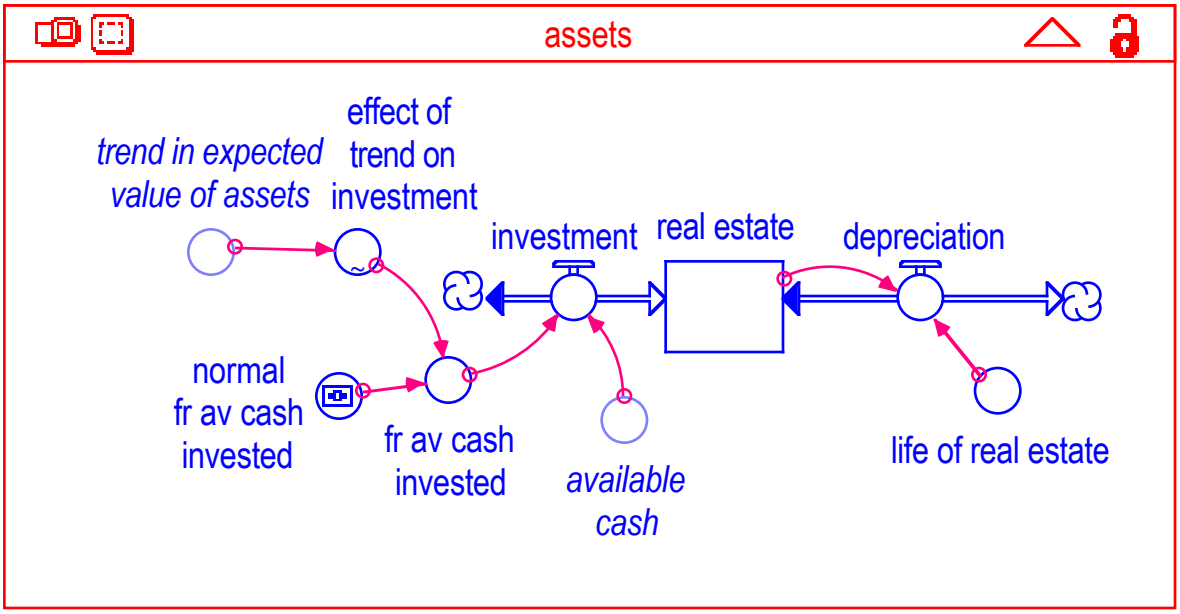

Figure 2: The assets market

3.2. Household savings

Figure 3 shows household saving decisions. The cash available for the households to spend or save/invest in each time period consists of their earnings, previous savings and borrowings less the debt served. Besides these standard components, available cash also consists in the current model of "extra" cash that becomes available to households due to government policies designed to encourage home ownership, e.g., the expansion of affordable housing mission of the GSEs and the Community Reinvestment Act (CRA) (Levine, 2010). Another source of the "extra" cash arises as the price of the real estate assets of households rises and this creates new wealth for households which they spend. (Laibson and Mollerstrom, 2010).

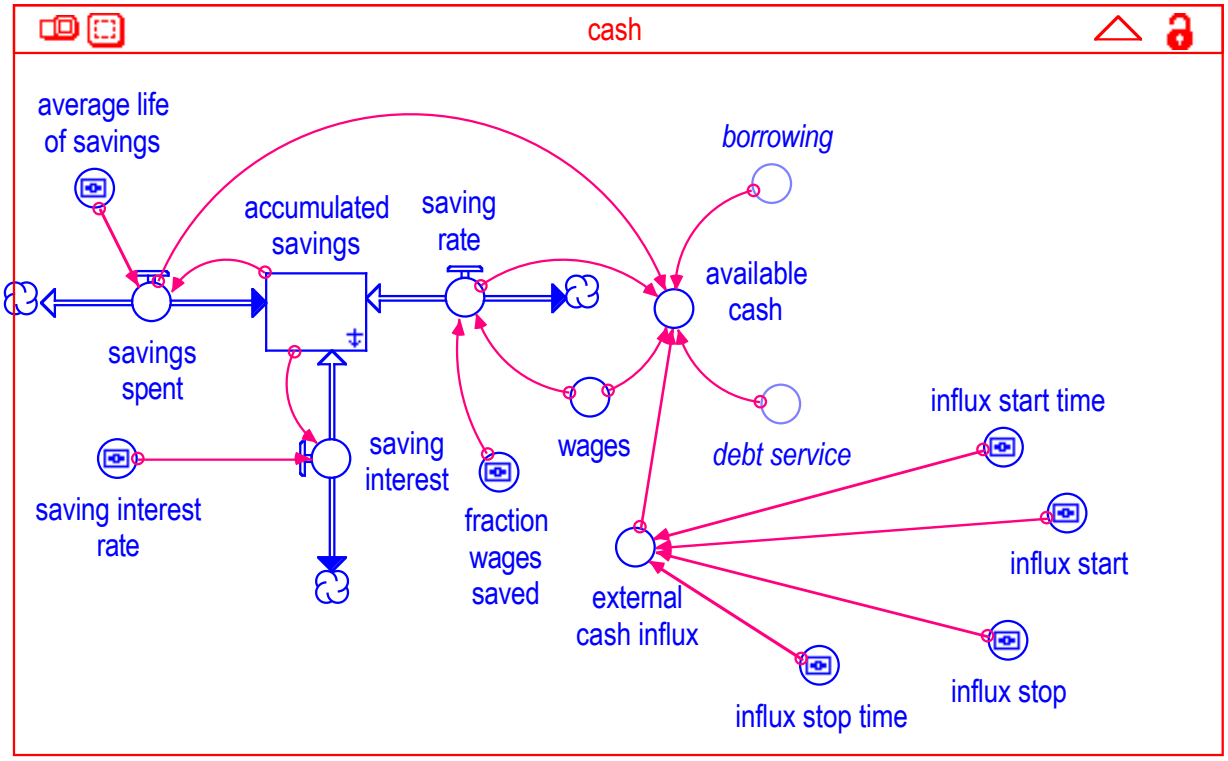

Figure 3: Cash for investment

3.2 The Evolution of Household Debt

The decisions leading to the evolution of household debt are shown in Figure 4. Households borrow a fraction of their total assets in each period. Total household assets consist of accumulated savings and the expected value of their real estate asset holdings.

The fraction of total assets borrowed by a household depends on the level of their existing debt to asset ratio which determines their borrowing capacity, the normal fraction of assets borrowed and the interest paid on the loan. The normal fraction of assets that a household could borrow

had been rising before the housing market collapse. This was in part the result of loosening constraints on the banking sector's capital requirements. Various regulatory concessions such as allowing banks to use credit default swaps to reduce capital requirements starting in 1996 and permitting the large investment banks to self-determine capital requirements allowed the lending capacity of banks to rise (Levine, 2010). This is because banks could lend out larger sums without having to maintain correspondingly high capital reserves and investment banks were a ready market for the packaged loans, particularly mortgages that the banks sold in the market. The latter activity further increased banks' lending capacity with the same amount of capital.

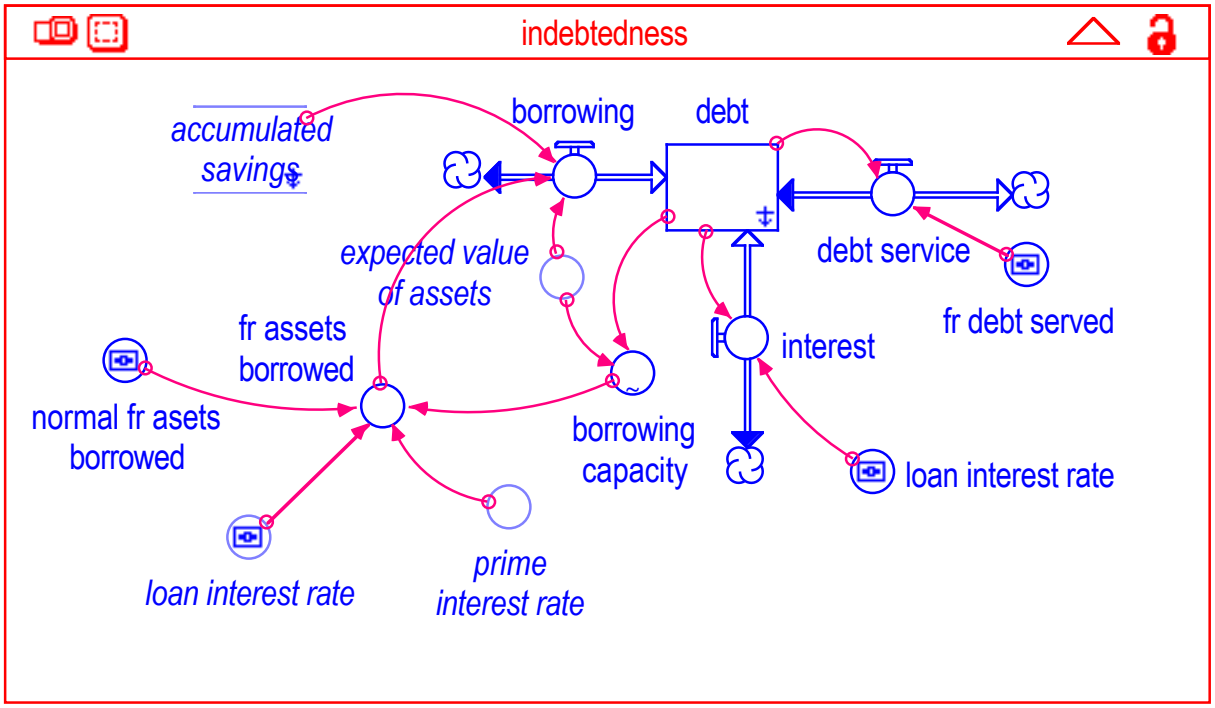

Figure 4: Indebtedness

Models of financial development and its role in mitigating excessive fluctuations in the economy are relevant here as well. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) demonstrate that in the presence of the need for collateral shocks to the net worth are persistent. This is because a negative shock that reduces net worth leads to lower collateral and lower capacity to borrow in subsequent periods leading in turn to lower investment and lower output. This lower output then continues the cycle that started with low net worth. In the present model lower collateral requirements unleash the same type of persistence in outcome through their effect on investment and housing prices.

3.3 The Real Estate Prices

Price expectations of real estate are backward looking and self-fulfilling. Specifically, expected price is directly related to the past observed trend of prices in addition to the interest rate and the relative price of these assets. This formulation is shown in Figure 5. It implies that an upward trend of home prices will generate future expectations of a continued rise. It is self-fulfilling as the price is assumed to move progressively in the direction of the expected price.

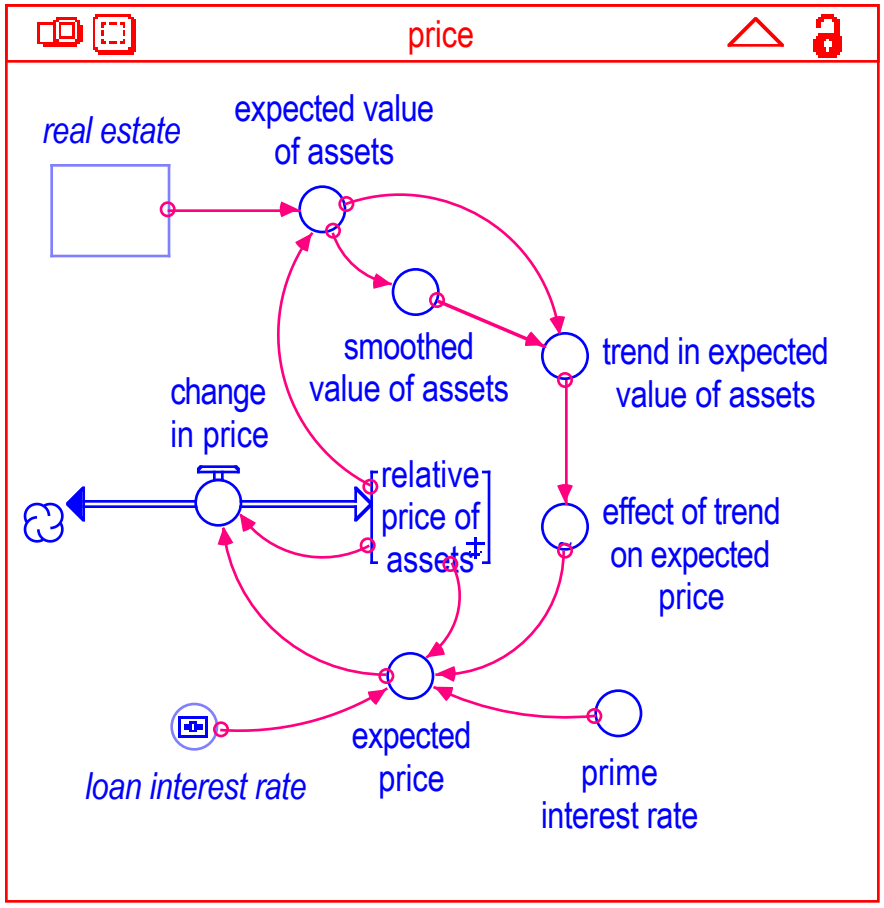

Figure 5: Price

4. The Experiments

For the experiments section of our analysis we will follow the chronological order of the actual events that have been hypothesized to be the causes of the crisis. Since they are chronological, we overlay one experiment atop the others that came before it as we move forward. Therefore at the time of conducting the second experiment, both the first and second are conducted together to get their cumulative impact and while conducting the third experiment the first and the second

are also conducted simultaneously and so on. In experiment 1 banking capital requirements are loosened, in experiment 2 cheap money comes in the form of foreign savings glut as well as due to the government's stated goal of increasing home ownership, in experiment 3 interest rates are lowered by the Fed and kept low for a prolonged period of time and finally in experiment 4 mortgage reforms forces households with financial troubles to be able to put a smaller fraction of their tight finances towards servicing their mortgage debt than they would earlier have.

We begin with the market clearing equilibrium simulated in Figure 6. This serves as a point of reference since all stocks are at steady state. The equilibrium is dynamic, flows occur in every time period in such a way as to maintain stocks at their steady state.

Figure 6: Market clearing equilibrium

4.1 Experiment 1: Loosening of capital requirements of banks

Our first experiment corresponds to the loosening of the capital requirements of banks. The causes of this loosening started as far back as 1975 when credit rating agencies were given

NSRO status. Although, the strong move towards this loosening really came in 1996 and was further reinforced in 2004 when CDSs were permitted in lieu of bank capital and investment banks were allowed to determine their own capital, respectively. In our model the loosening of capital requirements manifests itself in laxer rules for household borrowing, i.e., the normal fraction of assets borrowed by the household increases.

The fraction at steady state is 0.5 percent of total assets this is doubled in the experiment. The results are in Figure 7. Housing prices rise initially and after 18 time periods however they start falling. This decline is persistent and house prices fall at a faster pace as time passes.

This result arises from the extra available cash that results from the elevated fraction of assets borrowed by households due to the change in banks' lending policies. This extra available cash then elevates the investment level of households leading to overinvestment in real estate assets. The prices rise as the demand for real estate increases through this mechanism. As prices rise, this trend in self-reinforced as price changes are backward looking in our model. This bubble is further inflated by the fact that the fraction of available cash invested rises as real-estate prices rise.

House prices finally start falling as the household debt builds up and the debt service burden finally makes it harder for households to sustain ever higher levels of real estate investment. This puts brakes on real estate prices and finally leads to a fall in prices as demand evaporates and the price trend reinforces the fall in real estate prices.

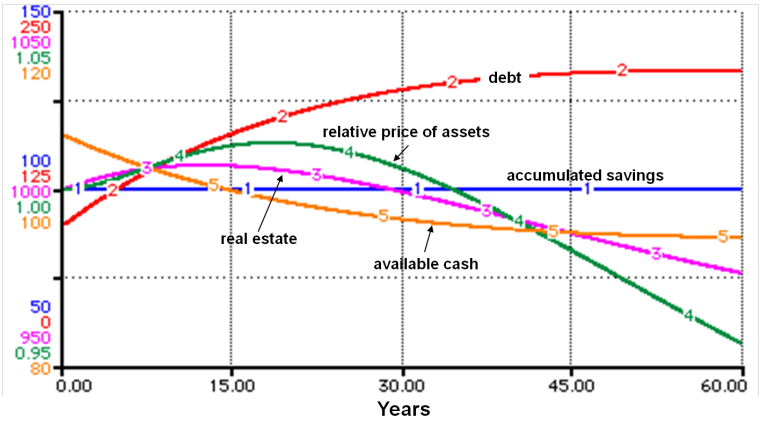

Figure 7: Experiment 1 – Reduction in Bank Capital Requirement

4.2 Experiment 2: Influx of cheap money

The second experiment corresponds to extra money that became available to households through two sources. One is the savings glut in developing countries particularly following the Asian crisis of 1997-98 (Bernanke 2005). Developing countries felt the need to insulate themselves from capital flight by running large current account surpluses; this automatically meant that developed countries, particularly the US, would run current account deficits as these savings were transferred from developing to developed countries. Developing countries, e.g. China, lent money to developed countries at exceptionally low rates of interest since they put their savings in government issued securities that pay very low interest.

The second source of this extra money was government policy geared towards encouraging home ownership through expansion of affordable housing mission of the GSEs and the Community Reinvestment Act.

In our model the savings glut and government's encouraging of home ownership manifest themselves through an influx of "cheap money" into the available cash pool of the household. The cheap money comes in through the channel of credit to households, however as soon as the crisis hits this money dries up as the entire economy's credit mechanism freezes. This is what happened in the US housing crisis as banks stopped lending and the credit crunch hit.

This experiment shown in the simulation of Figure 8 is conducted cumulatively with the first experiment: the normal fraction of assets borrowed is elevated and cheap money is made available at the same time. The cheap money in the model is termed "extra cash". We assume that the influx of extra cash starts at time period 0 and stops at time period 18. Recall that the housing prices started falling in time period 18 in the first experiment. Thus to replicate the real world situation where credit dried up as the housing crisis hit, we stop the influx at time period 18.

This result indicates that this extra cash helps households to invest even more in real estate assets. The prices rise even higher and remain elevated for longer period of time. The bust starts only at time period 22 or 23. This is when house prices start falling. The reasons for the fall are similar to the ones in experiment 1. Borrowing capacity of households falls as they take on increasing amounts of debt. This fall comes later as availability of cheap money helps to enhance the household's debt servicing capacity for longer in this experiment. House prices fall less than before. This is because cheap money provides a cushion to falling prices by supporting household finances.

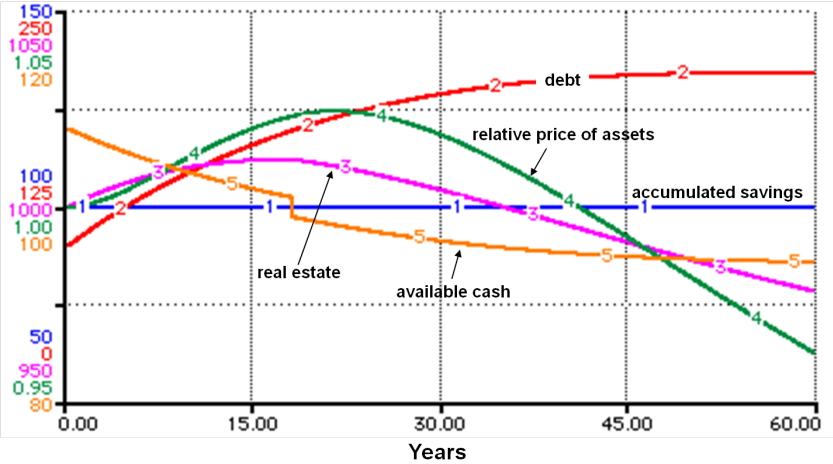

Figure 8: Experiment 2 - Cheap Money Inflow (and experiment 1)

4.3 Experiment 3: Lowering interest rates

The Federal Reserve lowered their target interest rate starting in the year 2001 in order to stabilize the economy in the face of the recession in the economy at that time. Following the September 11, 2001 terrorist attacks in New York, the Federal Reserve kept interest rates at that low level for most of the early part of the decade. Many have cited this as the cause for the housing bubble as low mortgage interest rates might have led households to borrow excessively and invest in real estate property that would have been out of their reach at higher interest rates. The steady state equilibrium interest rates in our model are 5% we decrease this to 2% in this experiment. As mentioned before, we conduct experiment 3 in conjunction with the conditions prevailing under experiment 1 and 2. Thus the normal fraction of assets borrowed is elevated and so is the cheap money influx to households up to period 18.

The results indicate that the boom in the housing market is comparable to the first experiment. The housing prices rise in similar fashion: at much the same rate and for about the same period

of time. However in the new experiment the fall is much more precipitous and house prices end up at a significantly lower level.

This experiment shown in the simulation of Figure 9 adds at least two substantive new results to the previous experiments. First, in spite of cheap money influx, the housing price boom is not as large as experiment two. The reason for this is the lower savings rate under this experiment arising out of lower interest rates. Thus while cheap money still exists, households' own accumulated savings take a dip. Second, the new result is the greater fall in house prices compared to earlier experiments, this too is due to weakened household finances due to lack of savings.

This is an interesting result in many ways. There has been much argument about the role of the Fed in creating the crisis and the Fed has vehemently defended its low interest rate stance in the early 2000s as not being the cause of the housing crisis (Bernanke, January 2010). The results of our experiment show a new dimension in this argument. It vindicates the Fed in its stance that low interest rates did not feed the bubble, we have seen in this experiment that housing prices actually grew at a slower pace and did not reach the highs that it would have reached in experiment 2. However interestingly this is only because the Fed's low interest rate policy makes household finances weak by reducing the incentive to save. In addition finally when once the crisis actually takes hold the Fed's low interest rate stance makes the crisis worse as housing prices fall further than they otherwise would have. The literature as well as the Fed's own energies have been concentrated in trying to explain the role of low interest rates as having encouraged home ownership and therefore inflated house prices. However the results of this experiment show that in the context of the previously existing lax bank capital requirements

(experiment 1) and availability of cheap money for households (experiment 2), the Fed's role was most important in reducing household savings.

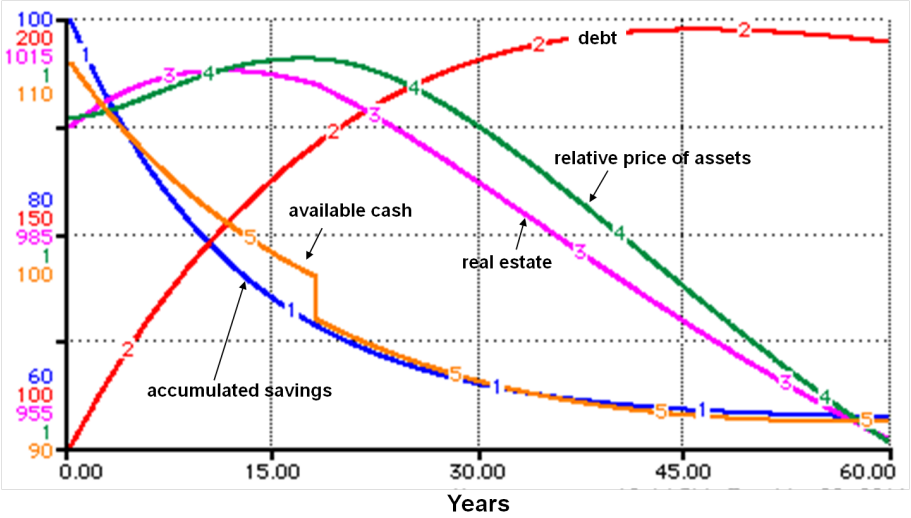

Figure 9: Adding impact of lowering interest rates to experiments 1 and 2

4.4 Experiment 4: Mortgage reform

Our final experiment simulated in Figure 10 attempts to demonstrate the impact of mortgage reform of 2005. This reform made it harder for households to apply for bankruptcy by raising the cost of filing. In addition it gave limited protection from creditors compared to before. This meant that where households could have chosen to concentrate their finances in servicing mortgage debt to keep their home, now they were forced to service other debt as well. This limited the amount of mortgage debt that could be served by them.

Since the only asset in our model is real estate, this experiment thus corresponds to a reduction in the fraction of debt served. The results indicate that initially the smaller fraction of debt served helps to shore up housing finances and make even more money available for investment. Thus

house prices rise is similar to experiment 2. However the fall is much greater than earlier experiments. The reasons are that recall that this is a cumulative experiments and thus all the conditions that led to housing price collapse earlier exist in this case too and in addition lower debt served means the borrowing capacity of households continues to be low leading to the self reinforcing cycle of lower investment in housing and falling housing prices.

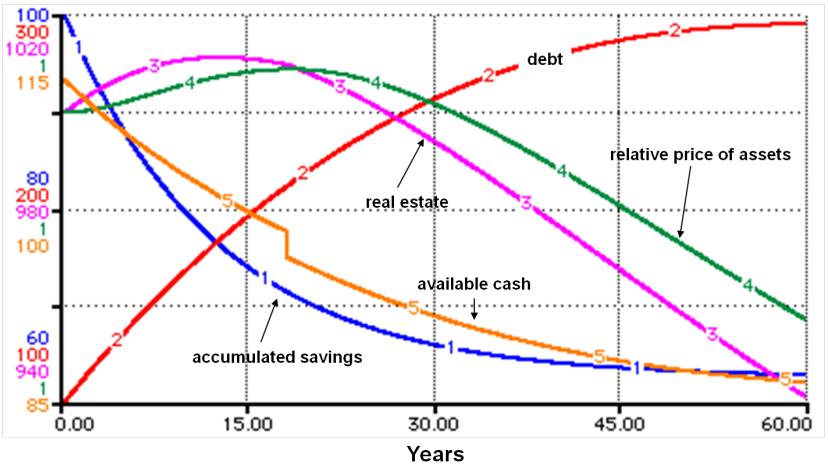

Figure 10: Experiment 4: Adding mortgage Reform to experiments 1, 2 and 3

4.5 Summing up the Experiments

Figure 11 presents a comparative graph of housing price in each experiment. It brings into focus the causes, cited in the literature, that explain the bubble in the housing market, i.e., the boom and then the bust in housing prices in the US market. We see that some of the causes fit neatly into the role of creating this boom and bust pattern of housing prices. Our first experiment that dealt with the loosening of bank capital requirements, for example, clearly leads to this outcome. There is an initial price rise followed by an accelerated price fall. The remaining three experiments, however, provide mixed results. The causes of crisis that they depict don't always

create the entire boom bust pattern. In experiment 2, the influx of cheap money, amplifies the boom, i.e., it leads to an even greater price rise that persists for a longer period of time, thus magnifying the bubble on the upswing. However it cushions the bust in prices, as house prices fall less. In experiment 3, the lowered interest rate, leads to a much more pronounced downturn in prices, however it actually dampens the initial price rise due to low household savings available for investment. Similar to the low interest rates of experiment 3, mortgage reform depicted in experiment 4 also leads to a more pronounced downturn. This is because mortgage reform reduces household capacity to service their debt.

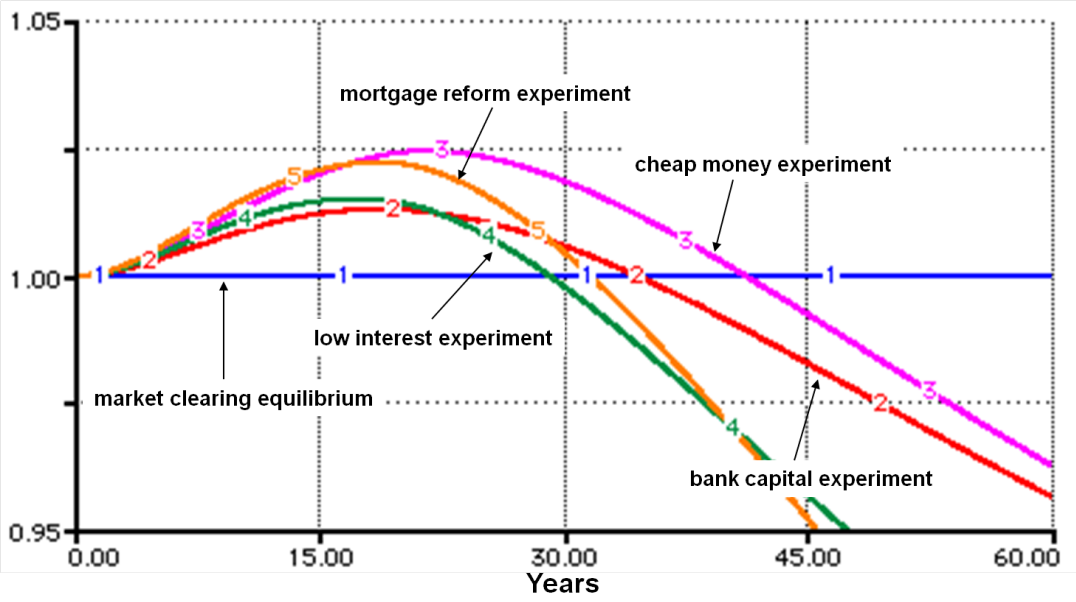

Figure 11: Comparison of Asset Price

5. Conclusion

In this paper we develop and experiment with a model of personal finance to study the impact of some of the potential reasons that have been cited in the literature to be responsible for the US housing market crisis that started in August 2007. Our findings indicate that most of the reasons posited in the literature do lead to the expected boom and bust cycle in home prices we have witnessed leading up to the crisis. However not all the causes have an equal impact the rise and fall in housing prices. In fact lower interest rates and cheap money amplify just one of either the boom, or the bust in house prices while dampening the other.

Interestingly our works puts forward a new dimension to the role of the Federal Reserve's loose monetary policy. We find that the Fed's intervention was indirect. It played out through household saving decisions and not home prices directly. We find that while low interest rates do not seem to feed the house price bubble, they do lead to worsening of the crisis as house prices collapse. This is because low household savings leave them ill-equipped to handle the crisis.

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