The Impact of Mortgage Securitization on Housing Bubble and Subprime Mortgage Crisis: Self-organization Perspective

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This paper is prepared for the KDI Journal of Economic Policy conference, August 9, 2011
Theme: Globalization, Growth and Inequality
1. Introduction

Mortgage financing model:

The originate and hold model:
Before 1980

The originate and distribute model:
After 1990
2. Securitization of Mortgages: Its Complexity and Impact

Transformation of mortgage financing:
From the originate and hold model to the originate and distribute model

Securitization:
The theory of asset demand: determinants
- Wealth
- Expected return on mortgages relative to alternative assets
- Risk of mortgages relative to alternative assets
- Liquidity of mortgages relative to alternative assets

\[ \text{Securitization} \rightarrow \text{liquidity} \uparrow \quad \text{mortgage rate} \downarrow \]

housing price \uparrow
Historic development of securitization of mortgages

Secondary market, full faith and credit

1980: Government sponsored enterprises (GSE)
The Federal National Mortgage Association (Fannie Mae) and Freddie Mac
prime mortgage and zero default risk

1984: Private sector financial institutions:
prime mortgage

1995: Subprime and Alt A mortgages:
NINJA Loans: No Income, No Job and No Assets
## Appendix A: Outstanding Mortgage Securities and Securitization Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>(1) GSE</th>
<th>(2) Non-agency</th>
<th>(3) Total Security</th>
<th>(4) Total Mortgage</th>
<th>(5) Securitization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>111,086</td>
<td></td>
<td>$111,086</td>
<td>$957,900</td>
<td>11.59%</td>
</tr>
<tr>
<td>1981</td>
<td>126,186</td>
<td></td>
<td>126,187</td>
<td>1,030,200</td>
<td>12.25</td>
</tr>
<tr>
<td>1982</td>
<td>162,829</td>
<td></td>
<td>162,892</td>
<td>1,070,200</td>
<td>15.22</td>
</tr>
<tr>
<td>1983</td>
<td>219,201</td>
<td></td>
<td>219,201</td>
<td>1,186,100</td>
<td>18.48</td>
</tr>
<tr>
<td>1984</td>
<td>252,007</td>
<td>11,000</td>
<td>263,007</td>
<td>1,132,100</td>
<td>19.91</td>
</tr>
<tr>
<td>1985</td>
<td>314,554</td>
<td>24,000</td>
<td>338,554</td>
<td>1,518,600</td>
<td>22.29</td>
</tr>
<tr>
<td>1986</td>
<td>434,884</td>
<td>16,600</td>
<td>451,484</td>
<td>1,722,000</td>
<td>26.22</td>
</tr>
<tr>
<td>1987</td>
<td>531,867</td>
<td>27,800</td>
<td>559,667</td>
<td>1,920,500</td>
<td>29.14</td>
</tr>
<tr>
<td>1988</td>
<td>570,733</td>
<td>34,900</td>
<td>605,633</td>
<td>2,154,100</td>
<td>28.12</td>
</tr>
<tr>
<td>1989</td>
<td>646,759</td>
<td>43,300</td>
<td>690,057</td>
<td>2,378,900</td>
<td>29.01</td>
</tr>
<tr>
<td>1990</td>
<td>1,013,920</td>
<td>55,000</td>
<td>1,068,920</td>
<td>2,614,700</td>
<td>40.88</td>
</tr>
<tr>
<td>1991</td>
<td>1,152,453</td>
<td>96,700</td>
<td>1,249,153</td>
<td>2,781,700</td>
<td>44.91</td>
</tr>
<tr>
<td>1992</td>
<td>1,268,777</td>
<td>142,300</td>
<td>1,411,077</td>
<td>2,947,300</td>
<td>47.88</td>
</tr>
<tr>
<td>1993</td>
<td>1,354,638</td>
<td>167,900</td>
<td>1,522,538</td>
<td>3,106,200</td>
<td>49.02</td>
</tr>
<tr>
<td>1994</td>
<td>1,461,376</td>
<td>183,000</td>
<td>1,644,376</td>
<td>3,283,200</td>
<td>50.08</td>
</tr>
<tr>
<td>1995</td>
<td>1,554,901</td>
<td>193,800</td>
<td>1,748,701</td>
<td>3,451,200</td>
<td>50.67</td>
</tr>
<tr>
<td>1996</td>
<td>1,691,357</td>
<td>215,400</td>
<td>1,906,757</td>
<td>3,674,700</td>
<td>51.88</td>
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<tr>
<td>1997</td>
<td>1,801,319</td>
<td>253,500</td>
<td>2,054,819</td>
<td>3,900,600</td>
<td>52.56</td>
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<tr>
<td>1998</td>
<td>1,985,873</td>
<td>321,500</td>
<td>2,307,373</td>
<td>4,258,500</td>
<td>54.18</td>
</tr>
<tr>
<td>1999</td>
<td>2,255,520</td>
<td>353,200</td>
<td>2,608,720</td>
<td>4,674,200</td>
<td>55.81</td>
</tr>
<tr>
<td>2000</td>
<td>2,449,956</td>
<td>377,500</td>
<td>2,827,456</td>
<td>5,110,300</td>
<td>55.33</td>
</tr>
<tr>
<td>2001</td>
<td>2,791,287</td>
<td>463,200</td>
<td>3,254,487</td>
<td>5,678,000</td>
<td>57.32</td>
</tr>
<tr>
<td>2002</td>
<td>3,087,430</td>
<td>544,100</td>
<td>3,631,530</td>
<td>6,437,400</td>
<td>56.41</td>
</tr>
<tr>
<td>2003</td>
<td>3,394,021</td>
<td>664,000</td>
<td>4,058,021</td>
<td>7,227,800</td>
<td>56.14</td>
</tr>
<tr>
<td>2004</td>
<td>3,467,047</td>
<td>1,049,800</td>
<td>4,516,847</td>
<td>8,270,500</td>
<td>54.61</td>
</tr>
<tr>
<td>2005</td>
<td>3,607,558</td>
<td>1,536,600</td>
<td>5,144,158</td>
<td>9,374,300</td>
<td>54.87</td>
</tr>
<tr>
<td>2006</td>
<td>3,904,911</td>
<td>1,991,500</td>
<td>5,896,411</td>
<td>10,421,400</td>
<td>56.58</td>
</tr>
<tr>
<td>2008</td>
<td>4,518,871</td>
<td>2,116,600</td>
<td>6,635,471</td>
<td>11,135,800</td>
<td>59.59</td>
</tr>
</tbody>
</table>

Sources: Columns (1), (2), (3), (4) are from the 2008 Mortgage Finance Market Statistical Annual Vol. I, II (Inside Mortgage Finance); column (5) is calculated by the author.
Appendix B: Non-agency MBS issuance by type

<table>
<thead>
<tr>
<th>Year</th>
<th>Prime</th>
<th>Subprime</th>
<th>Alt A</th>
<th>Total</th>
<th>[(2) + (3)]/(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>25,837.7</td>
<td>17,771.4</td>
<td>498.3</td>
<td>44,107.4</td>
<td>41.42%</td>
</tr>
<tr>
<td>1996</td>
<td>31,418.7</td>
<td>30,769.4</td>
<td>1,802.6</td>
<td>63,990.7</td>
<td>50.90</td>
</tr>
<tr>
<td>1997</td>
<td>49,974.9</td>
<td>56,920.7</td>
<td>6,518.0</td>
<td>113,413.7</td>
<td>55.93</td>
</tr>
<tr>
<td>1998</td>
<td>97,365.2</td>
<td>75,829.9</td>
<td>21,235.5</td>
<td>194,430.6</td>
<td>49.92</td>
</tr>
<tr>
<td>1999</td>
<td>74,630.9</td>
<td>55,851.5</td>
<td>12,022.8</td>
<td>142,505.2</td>
<td>47.63</td>
</tr>
<tr>
<td>2000</td>
<td>53,584.9</td>
<td>52,467.4</td>
<td>16,443.6</td>
<td>122,495.9</td>
<td>56.25</td>
</tr>
<tr>
<td>2001</td>
<td>142,202.5</td>
<td>87,052.9</td>
<td>11,373.6</td>
<td>240,629.0</td>
<td>40.90</td>
</tr>
<tr>
<td>2002</td>
<td>171,534.4</td>
<td>122,680.9</td>
<td>53,462.7</td>
<td>347,678.0</td>
<td>50.66</td>
</tr>
<tr>
<td>2003</td>
<td>237,454.6</td>
<td>194,958.5</td>
<td>74,151.0</td>
<td>506,564.1</td>
<td>53.12</td>
</tr>
<tr>
<td>2004</td>
<td>233,378.1</td>
<td>362,549.3</td>
<td>158,585.8</td>
<td>754,513.2</td>
<td>69.07</td>
</tr>
<tr>
<td>2005</td>
<td>280,703.7</td>
<td>465,036.3</td>
<td>332,323.2</td>
<td>1,078,063.2</td>
<td>73.96</td>
</tr>
<tr>
<td>2006</td>
<td>219,037.4</td>
<td>448,599.6</td>
<td>365,675.8</td>
<td>1,033,312.8</td>
<td>78.80</td>
</tr>
<tr>
<td>2008</td>
<td>180,462.4</td>
<td>201,546.7</td>
<td>249,610.0</td>
<td>631,619.1</td>
<td>71.42</td>
</tr>
</tbody>
</table>

Sources: Columns (1), (2), (3), (4) are from the 2008 Mortgage Finance Market Statistical Annual, Vol. I, II (Inside Mortgage Finance). Column (5) is calculated by the author.
2007

Ginnie Mae: 4% of Mortgage Backed Securities (MBSs)

The GSE: 40% of MBSs
Private sector financial institutions: 56%
The share of total mortgage debt outstanding: 56%
The non-MBSs share: 44%

MBSs: a kind of asset-backed securities (ABSs)
Complexity

Private sector financial institutions established various special purpose vehicles (SPVs) from complex mixtures of residential MBSs, credit card and other debt receivables: these were treated as off-balance items to avoid banks’ capital requirements.

Three tranches: senior mezzanine equity loan

Created the collateralized debt obligations (CDOs), CDOs of CDOs and CDOs-cubed.
The originate and distribute model: Asymmetry of information and opacity of the system:

- Predatory lending and borrowing
- Moral hazard
- Adverse selection
- Principal-agent
- Globalization of mortgage market

These problems led to rent-seeking behavior and transfer of wealth from inferior information holders to superior information holders.
A credit default swap (CDS) is utilized for management of credit risk.

The CDS is a credit derivative contract between two counter parties:

The buyer—pays premiums to the seller and receives a payoff in case of any underlying financial instrument defaults during the term of the CDS contract.

Reportedly an estimate of $62.2 trillion worth of CDS’s contracts outstanding worldwide in 2008.
3. Securitization of mortgages, mortgage rates and housing bubble
   • Securitization and mortgage rates

   *Figure 1: Securitization and Mortgage Prices*
• Securitization and the housing bubble

Responses to stimuli

Keynes (1936): Animal spirits

Self-organization (Camazine, et al., 2003: Kauffman, 1993; Prigogine and Stenger, 1984)

Newton: Linear relationship between inputs and outputs and ergodic equilibrium

Self-organization: Nonlinear relationship: non-ergodic equilibrium (attractor)

Example: a school of fish

Bifurcation
Positive feedback
Negative feedback
Camazine et al. (2003) explains the relationship between feedback and change.

Feedback can have two basic values: positive or negative. Feedback is positive if the recurrent influence reinforces or amplifies the initial change. The snowballing effect of positive feedback takes an initial change in a system and reinforces that change in the same direction as the initial deviation. Self-enhancement, amplification, facilitation, and autocatalysis are all terms used in positive feedback. (Camazine et al., 2003, p.17)

*Implosion*
Figure 2: A Scatter plot of nominal housing prices and mortgage securitization

Scatterplot of Nominal housing price index vs Securitization ratio

Nominal housing price index vs Securitization ratio

- Nominal housing price index
- Securitization ratio
Hypotheses

Hypothesis 1: Securitization of mortgage credit lowers mortgage rates.

Hypothesis 2: Securitization of subprime mortgages helps trigger the housing bubble.

Hypothesis 3: Self-organization of actors in financial systems amplifies the housing bubble.
We specified our models to reflect these theories and models as follows:

\[
\text{MRT} = f(\text{INF}, \text{MSR}, \text{RGDPG})
\]  
\[
\text{HPI} = f(\text{MSR}, \text{RGDOG}, \text{BCI}, \text{SUBP})
\]  

Where,  
MRT: the 10 year mortgage yield rate  
INF: the inflation rate  
MSR: the mortgage securitization ratio (the ratio of securitized mortgages to total mortgage outstanding)  
RGDPG: the real GDP growth rate  
HPI: the housing price index  
BCI: the building construction cost index  
SUBP: the dummy variable for securitization of subprime mortgages  
(SUBP=0 before 1995 and SUBP=1 after 1995)
Table 1: Estimation Results

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRT</td>
<td>16.20 - 0.157 MSR - 0.1972 RGDPG - 0.0547 INF</td>
<td>(0.08) (0.00) (0.05) (0.58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R^2 = .90</td>
<td>R^2 (adj) = .89</td>
<td>F (3, 24) = 76.16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPI</td>
<td>- 503.29 + 275.40 MSR - 3.7625 RGDPG + 5.832 BCI + 28.389 SUB</td>
<td>(0.06) (0.02) (0.26) (0.04) (0.16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R^2 = .63</td>
<td>R^2 (adj) = .62</td>
<td>F (4, 23) = 15.19</td>
<td></td>
</tr>
</tbody>
</table>

Structural Change Test for Subprime Mortgage

<table>
<thead>
<tr>
<th>Test</th>
<th>Break Point</th>
<th>Num DF</th>
<th>Den DF</th>
<th>F Value</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chow</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>14.16</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The numbers in parentheses are p-values.
Solutions to the Subprime Mortgage Crisis

Does the market self-regulate?
Optimal mix of market and regulation.

• Self-organization perspective: Negative feedback with time lag
  Mortgagor
  Banks
  Insurance Company
  Regulatory agency

• Alternative to self-organization
  1. The Federal Reserve
     Easy monetary policy
     Stress Test
2. The U.S. Government

The U.S. Congress passed the Troubled Assets Recovery Program (TARP) and designated $750 billion:
   a. To purchase toxic assets from banks and financial institutions
   b. To provide relief to homeowners
   c. To encourage banks to resume lending to each other and consumers and businesses.

3. The U.S. Congress adopted the $787 billion stimulus and recovery package.

Regulatory agencies
   Proposals
   1. Financial product consumer protection act (Stility)
   2. Democratization of financial system
   3. Independent financial advisory systems
   4. Transparency
Conclusion:

We therefore conclude that due diligences are required by all actors in the market while a bubble is forming and expanding in our economic system because all bubbles eventually pop as Shiller noted. Although economic bubbles are recurring frequently and impose enormous adverse effects on millions of people as the economic bubble collapses there are not enough studies on economic bubbles. There is a need for more research on economic bubbles to manage them effectively and the self-organization perspective offers a good analytical framework for the study of economic bubbles.

Thank you.

Questions?
The Impact of Mortgage Securitization on the Housing Bubble and Subprime Mortgage Crisis: A Self-organization Perspective

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This paper is prepared for the 2011 KDI- Journal of Economic Policy conference.
The Impact of Mortgage Securitization on the Housing Bubble and Subprime Mortgage Crisis: A Self-organization Perspective

Abstract

The subprime mortgage crisis has been analyzed from many different perspectives. The securitization of subprime mortgages has emerged as the leading cause of the subprime mortgage crisis. This securitization is a complex process that involves a number of different players (Ashcraft and Schuerman, 2008).

Securitization of subprime mortgages, which are a part of mortgage-backed securities (MBSs) also led to further complexity by the introduction of collateralized debt obligations (CDOs) and credit default swaps (CDSs). MBSs, CDOs and CDSs became sources of adverse selection and moral hazard which have contributed significantly to the current subprime mortgage crisis. Our study investigates the impact of securitization of mortgages on mortgage rates, the housing bubble and the subprime mortgage crisis.

The study found that securitization of mortgages has an inverse relationship with mortgage rates and that securitization of subprime mortgages triggered the housing bubble in 1995. The housing bubble contributed to the construction boom and economic growth while it was expanding, but it caused catastrophic adverse effects on the U.S and global economies when it popped.

We found that an application of the self-organization principle in biology and thermodynamics to the analysis of the current housing bubble provides insight in the current subprime mortgage crisis and other bubbles in general. This study may offer a fresh new perspective for policy makers.

JEL classification: B52, G14, G21
Key words: subprime mortgage crisis, housing bubble, complexity, securitization of subprime mortgages, self-organization, opacity of mortgage financing, mispricing of risk, TARP, MBS, CDO, CDS

1. Introduction

The subprime mortgage crisis caused a major slowdown in the U.S. economy and economies around the world, imposing severe adverse effects on millions of people (Wu and Yang 2008). Numerous economists have analyzed the nature of the subprime mortgage crisis and offered solutions to the crisis. Shiller (2008) argues that the housing bubble, caused by irrational exuberance, led to the dangerous over-expansion of credit, which resulted in a global credit crunch. In a similar vein, Morris (2008) points out that the expansion of credit generated by home equity credit fueled high consumption and strong economic performances. During the housing bubble, credit was extended for “ninja” loans—no income, no job, no assets—and ninja loans became a part of subprime mortgage loans.
Some writers argue that the subprime mortgage crisis was caused by the housing bubble; others seek the origin of the crisis in the securitization of mortgages. It is likely that the housing bubble is related to the securitization of mortgages; thus treating the housing bubble and securitization of mortgages independently may not give a full picture of the current subprime mortgage crisis.

Securitization of mortgages increases the liquidity of mortgages by creating secondary markets for them. As the improved liquidity of mortgages becomes a more desirable asset, demand for the asset increases. As demand increases, prices of housing increase and mortgage rates decline. The resulting housing prices and positive feedback of higher housing prices reinforce the housing bubble, demonstrating the relationship between the housing bubble and the securitization of mortgages.

The securitization of mortgages transformed the “originate and hold” mortgage model to the “originate and distribute” model (Mizen, 2008, p. 538). This model has, however, contributed to mispricing of risk (Mizen, 2008), moral hazard and adverse selection (Ashcraft and Schuermann, 2008). The collapse of the housing bubble and mispricing of risk appear to be key culprits of the subprime mortgage crisis. This paper, therefore, examines the process of the transformation of the originate and hold model to the originate and distribute model, and the relationship between the housing bubble and the securitization of mortgage credit.

We can draw an analogy between the formation of the housing bubble and the self-organization principle in biology and thermodynamics. Self-organization in biological systems refers to a broad range of pattern-formation processes in both physical and biological systems (Camazine et al., 2003). The formation of the bubble pattern in the housing industry can be analyzed from this self-organization perspective, which provides a useful analytical framework to explain the housing bubble pattern and offer a solution to the subprime mortgage crisis.

The paper examines the origin and evolution of mortgage securitization and the impact of securitization of mortgages on the housing bubble and subprime mortgage crisis. We also discuss
solutions to the subprime mortgage crisis from a self-organization perspective and an alternative to self-organization.

2. Securitization of Mortgages: Its Complexity and Impact

2.1 Transformation to the originate and distribute model

Securitization of subprime mortgages is a result of the transformation of mortgage financing from the originate and hold model to the originate and distribute model. The complexity of this model grew over the years as financial institutions attempted to solve problems stemming from mortgage securitization.

This history may be traced to 1968, when the Government National Mortgage Association (Ginnie Mae) securitized Federal Housing Administration and Veterans Administration (FHA/VA) mortgages backed by the “full faith and credit” of the U.S. government for resale in the secondary market (Mizen, 2008, p. 536). Mizen (2008) indicates that government sponsored enterprises (GSE) such as the Federal National Mortgage Association (Fannie Mae) and Freddie Mac then began to securitize prime mortgages in 1980. Ginnie Mae is a government agent and Fannie Mae and Freddie Mac are government sponsored enterprises (GSEs). Securitization by a government agent and the GSEs meant that prime mortgage products and securitized prime mortgage products were subject to almost zero default risk. In contrast, private sector financial institutions’ involvement in securitization, including high quality (prime) loans, subprime loans and Alt-A loans and their MBSs, are subject to significant default risk (Mizen, 2008). In 1984 securitization of prime mortgage loans by private sector financial institutions emerged and in 1995 private financial institutions began to securitize subprime and Alt A mortgages (see Appendix A and B).

By 2006 according to Rosen (2007), Ginnie Mae’s guaranteed mortgages accounted for 4% of all mortgage backed securities (MBSs) issued. The GSEs involved 40% of MBSs; the remaining 56% were repackaged by private sector financial institutions. The mortgage backed securities (MBSs) share of total mortgage debt outstanding was about 56%, the non-MBSs share about 44%. MBSs, a kind of asset-
backed securities (ABS), became more complex as private sector financial institutions issued more complicated new products, and pools of MBS were collected and securitized. Various special purpose vehicles (SPVs) were established to create new asset-backed securities from complex mixtures of residential MBSs, credit card and other debt receivables; to avoid banks’ capital requirements, special purpose vehicles (SPVs) were treated as off-balance sheet items. Most MBSs included securities backed by prime loans, subprime loans or Alt-A loans, which are “issued to borrowers that appear to have good credit, but these loans do not meet the definition of prime or conforming” (Rosen, 2007, p. 2).

In this process, private financial institutions categorized asset-backed securities (ABS) into three tranches: senior, mezzanine, and equity levels based on the priority of the claim that holders of these financial instruments can make in case of bankruptcy. Bonds that are themselves backed by pools of bonds are referred to as collateralized debt obligations (Rosen, 2007); a number of the collateralized debt obligations (CDOs) purchased MBSs and securities of other CDOs. Banks hold asset-backed securities in warehouses before intermediating credit to end investors. Securitization gets complex as financial institutions develop a market for collateralized debt obligations, and Mizen’s (2008) statement on the complexity of securitization illustrates the process of complexity in mortgage securitization:

Some tranches of CDOs were then pooled and resold as CDOs of CDOs (the so-called CDOs-squared); CDOs-squared were even repackaged into CDOs-cubed. (Mizen, 2008, p. 538)

These CDOs were distributed to final investors and various entities including primary lenders, mortgage brokers, bond insurers and credit rating agencies (OECD, 2008), all of whom participated in this process at various stages from origination to final distribution. Unlike the originate and hold model, which does not involve these stages and thus generates less credit risk, the originate and distribute model involves credit risk at each stage, and this mispricing of credit risk has been a key element in the current subprime mortgage crisis.

2.2 Problems in the originate and distribute model
What are the sources of credit risk? Economists contribute the mispricing of risk to information
asymmetry and frictions stemming from it. According to Ashcraft and Scheurmann (2008), the
securitization process is subject to seven key frictions:

(1) Frictions between the mortgagor and the originator: predatory lending because subprime borrowers
can be financially unsophisticated.

(2) Friction between the originator and the arranger: predatory borrowing and lending; the originator
has an information advantage over the arranger with regard to the quality of the borrower.

(3) Frictions between the arranger and third-parties: adverse selection; the arranger has more
information about the quality of the mortgage loans, which creates an adverse selection problem:
the arranger can securitize bad loans (the lemon) and keep the good ones.

(4) Frictions between the servicer and the mortgagor: moral hazard.

(5) Frictions between the servicer and third-parties: moral hazard.

(6) Frictions between the asset manager and investor: principal-agent.

(7) Frictions between the investor and credit rating agencies: model error (Ashcraft and Scheurman,
2008, pp. i and ii).

Because of these frictions, the originate and distribute model of mortgage lending creates
opportunities for multiple problems: predatory lending and borrowing, moral hazard, adverse selection,
principal-agent problem, and model error in credit rating. These problems led to mispricing of risk,
which together with the housing bubble, caused the subprime mortgage crisis (Ashcraft and
Scheurmann, 2008; Mizen, 2008; Morris, 2008; Rosen, 2007; Schiller, 2008). Since a significant portion
of banks’ revenues are generated by fees on originating mortgages, servicing mortgages and issuing
MBSs, these fee-generating activities have changed the nature of banking. Banks began to engage in
more fee-generating activities as they serviced mortgages and issued MBS. Therefore, securitization of
mortgages likely fostered changes in banking practice to fee-generating banking. Banks continued to involve in various fee generating activities such as ATMs and automatic loans.

Furthermore, the originate and distribute model creates a larger number of steps and opacity of the financial system between the originator and the final holder of mortgages. Mizen cites comments from Alexander Lamfalussy and William Buiter, the former general manager of the Bank for International Settlements and former chief economist of the European Bank for Reconstruction and Development, respectively, who note that “banks have replaced the ‘originate and hold’ model of lending long and borrowing short, with an ‘originate and distribute’ model in which they lend and then sell the claims to someone else” (Mizen, 550). The originate and distribute model was designed to solve problems stemming from lending long and borrowing short in the originate and hold model. However, this model has accompanied problems which were not solved during its development. Mizen argues that a larger number of steps between the originator and holder added greater opacity to the process and contributed to the mispricing of risk that was not properly appraised. He further points out that the extension of originate and distribute banking to subprime mortgage securities created an asset class with an opaque ownership structure, and is ultimately responsible for the subprime mortgage crisis, as banks created an asset class of special purpose vehicles (SPVs) and put them on the off-balance sheet to avoid their capital requirements. According to Mishkin (2010), avoiding regulation is a typical behavior of financial institutions, but the consequences are often overlooked.

2.3 Problems in managing mortgage credit risk

A further complexity is added to the originate and distribute model (Mizen, 2008) in management of mortgage credit risk: a credit default swap (CDS) is utilized for management of credit risk. The CDS is a credit derivative contract between two counterparties: the buyer makes periodic payments (premiums) to the seller, and in return receives a payoff (protection) if any underlying financial instrument defaults during the term of the CDS contract. CDSs can be bought by most institutional investors, but it is not
necessary for the buyer to own any CDO. The cost of insurance to cover default risk using CDSs had become much more expensive as subprime mortgage default increased and the ABX declined during 2008. The ABX index launched in January 2007, and used as an indicator of default risk. The ABX index serves as a benchmark of the market for securities backed by home loans issued to borrowers with weak credit. The ABX index tracks the performance of a basket of credit default swaps (CDSs) based on U.S. subprime loans, and traders and investors are allowed to take positions without actually holding CDSs (Wong, 2008). Sellers of CDS were not anticipating the collapse of the housing bubble and there were also misleading or fraudulent opportunistic positions taken by financial institutions. Financial institutions on the wrong sides of positions and sellers of CDS became insolvent as the housing bubble popped. These financial institutions were bailed out by the government. According to the Bank for International settlements report, there were an estimated $62.2 trillion worth of CDSs contracts outstanding worldwide in 2008 (Morgensen, 2008-02-17, New York Times, ISDA market survey).

The originate and distribute model was designed to solve the problems in the originate and hold model of high interest rate risk and low liquidity in lending long and borrowing short. However, the illiquidity and high interest rate risk of the originate and hold model led to high mortgage rates, which reduced housing demands. The problems of interest rate risk of lending long and borrowing short became more severe in the early 1980s because of wide swings in short-term interest rates. However, the new solution came with new problems, such as increased opacity and mispricing of risk in the financial system. Problems generated by this new model have still not been adequately addressed. Popper’s (1982) fundamental evolutionary sequence of events illustrates that solutions eliminate errors, but also generate new problems that need to be solved. Therefore, “all organisms are constantly, day and night, engaged in problem-solving” (Popper, p. 110). Policy makers might be advised to adopt Popper’s constant problem-solving framework throughout their entire evolution of any new lending model.
3. Securitization of Mortgages, Mortgage Rates and Housing Bubble

3.1 Securitization of mortgages and mortgage rates

Models such as Figure 1 demonstrate how securitization influenced mortgage rates and the housing bubble. Prices of an asset are determined by the demand and supply of the asset. Determining factors of the demand for mortgages are relative expected returns, taxes, liquidity and wealth (Mishkin, 2010). Securitization of mortgage credit increases the liquidity of mortgages and shifts the demand for mortgage to the right. As the demand for mortgages increases, the price will go up and mortgage rates will decline, due to an inverse relationship between prices of bonds and interest rates (Mishkin, 2010). The prices of mortgages will rise from $P_0$ to $P_1$ in Figure 1 due to mortgage securitization, and mortgage rates will decline as a result of an increase in the price of mortgages. Based on the effect of liquidity on mortgage rates, we can formulate the following hypothesis:

Hypothesis 1: Securitization of mortgage credit lowers mortgage rates.

![Figure 1: Securitization and Mortgage Prices](image)

3.2 Securitization of Subprime Mortgages and the Housing Bubble
The housing bubble can be further explained by the spontaneous responses of actors in the mortgage market. What was the triggering or tuning mechanism of the housing bubble? Based on the model used above, securitization of subprime mortgages was the likely source. Questions are what comes after the triggering or tipping point in bubble or how a bubble forms. Shiller’s (2008) irrational exuberance and Keynes’ animal spirit (1936) attempt to answer the question. We argue that the self-organization theory in biology and thermodynamics (Kauffman, 1993; Prigogine and Stenger, 1984) help explain the formation of bubble.

Shiller’s home price index shows that the current nominal housing bubble started in 1995 and ended in 2006 (Shiller, 2008). He argues that the housing bubble was caused by irrational exuberance and the social contagion of boom thinking. He stresses the feedback effect in producing speculative bubbles:

Psychological, epidemiological, and economic theory all point to an environment in which feedback of enthusiasm for speculative assets, or feedback of price increases into further price increases, can be expected to produce speculative bubbles from time to time. They make clear that these bubbles can have complicated—sometimes random and unpredictable—dynamics. (Shiller, 2008, p. 47)

Akerlof and Shiller (2009) argue a similar point in their newly published book, Animal Spirits. They point out that a key to address the current problem is to recover Keynes’s (1936) insight about “animal spirits”—the spontaneous attitudes and ideas that guide economic action:

Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many years to come, can only be taken as a result of animal spirits of a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities. (Keynes, 1936, p. 161)

The guiding principles of animal spirits are relatively simple and spontaneous. The self-organization theory is similar to animal spirits in terms of responding to information only in area immediately around you. We argue that the self-organization perspective (Kauffman, 1993; Prigogine and Stenger, 1984) can explain the formation and expansion of the housing bubble.
well. Self-organization refers to a broad range of pattern formation processes in both physical and biological systems (Camazine et al., 2003). Camazine et al. define self-organization:

Self-organization is a process in which a pattern at the global level of a system emerges safely from numerous interactions among the lower-level components of the system. Moreover, the rules specifying interactions among the system’s components are executed with only local information, without reference to the global pattern. (Camazine et al., 2003, p. 8)

Furthermore, “The multiplicity of interactions that characterizes self-organization systems emphasizes that such systems are dynamic and require continual interactions among lower-level components to produce and maintain structure” (Camazine et al., 2003 p. 8). Home buyers, banks and regulators react to information on increasing housing prices; home buyers buy houses anticipating the appreciation of housing prices; and banks make mortgage loans with the expectation that mortgage loans are secured because home values will exceed mortgage values. These spontaneous interactions and cascades of events form a housing bubble, which expands until the bubble reaches its maximum.

The concept of feedback in biological and physical systems (Kauffman, 1993; Prigogine and Stenger, 1984) can add more insight to analysis of the housing bubble pattern. Camazine et al. (2003) explain the relationship between feedback and change.

Feedback can have two basic values: positive or negative. Feedback is positive if the recurrent influence reinforces or amplifies the initial change. The snowballing effect of positive feedback takes an initial change in a system and reinforces that change in the same direction as the initial deviation. Self-enhancement, amplification, facilitation, and autocatalysis are all terms used in positive feedback. (Camazine et al., 2003, p.17)

The amplifying nature of positive feedback means that it has the potential to produce destructive explosions or implosions in any process where it plays a role. How can such snowballing be kept under control? This is where negative feedback plays a critical role, providing inhibition to offset the amplification and helping to shape it into a particular pattern. (Camazine et al., 2003, p. 19)

Camazine et al. (2003) illustrate self-organization phenomena using a school of fish and a herd of reindeer. A school of fish maneuvers gracefully, with all its members moving in parallel in the same direction. The reason that fish do not run into each other is due to a negative feedback, which helps
maintain equilibrium for a school of fish. Similarly, a housing bubble moves upward, with all home buyers moving in the same direction. In other words, the housing bubble can be explained by persistent housing price increases due to an extended duration of positive feedback.

This raises a question: What triggered the initial change in the housing bubble? We believe that the initiation of private financial institutions’ involvement in subprime mortgage credit securitization was a tipping point in the current housing bubble. As stated before, the subprime MBSs by private financial institutions grew rapidly after their inception in 1995. The increasing MBSs by private financial institutions made credit available to subprime mortgagors and created high demands for housing, thus increasing housing prices. Home buyers then responded to the appreciation of housing prices, and financial institutions responded to opportunities for generating fees in mortgage origination, servicing, issuing MBSs and CDOs, and underwriting mortgages and MBSs. Both home buyers and financial institutions reacted based on their local information, and the positive feedback of the initial change formed and amplified the housing price bubble. Thus we can observe that the housing bubble pattern emerged from numerous interactions among the lower level of components, as seen in the self-organization of biology and physics (Camazine et al., 2003; Haken, 1977; Kauffman, 1993; Prigogine and Stengers, 1984).

What then made the housing bubble collapse and reverse itself? There are two factors: the housing bubble exhausted credit availability and household debts reached capacity limits (Morris, 2008). To maintain equilibrium negative feedback is required (Kauffman, 1993). Positive feedback accompanies negative feedback and all bubbles, therefore, eventually collapse (Schiller, 2008). Negative feedback offers an opportunity for error elimination (Plotkin, 1982; Popper, 1982). Errors in the securitization and housing bubble were mispricing of risk and lack of due diligence in all actors in the originate and distribute model, including government regulatory agents. As housing prices decreased, speculative
downward demand reinforced a decline in housing prices, creating a gap between the value of the mortgage and the value of a house.

Based on the impact of securitization and self-organization on the housing bubble, we can draw the following hypothesis:

Hypothesis 2: Securitization of subprime mortgages helps trigger a housing bubble.
Hypothesis 3: Positive feedback in securitization of subprime amplifies the housing bubble and negative feedback reverses the housing bubble: Positive and negative feedback make the pattern of the housing bubble sigmoidal.

4. Model and Empirical Results

4.1 Model

We can test these hypotheses with models. In the mortgage rate model (equation 1), we include the mortgage securitization ratio to test hypothesis 1; the inflation rate variable is included based on the Fisher effect on nominal interest rates. The GDP growth rate variable is used to capture the relationship between the demand for an asset and income. We expect that there is an inverse relationship between the mortgage rate and securitization ratio, and the inflation rate and GDP growth rate variables are expected to show a positive relationship with the mortgage rate variable.

The housing price model (equation 2) is specified to test hypothesis 2 and 3, as well as four theories that have been frequently cited as an explanations for the current housing bubble. The housing price model includes the mortgage yield rate, mortgage securitization, real GDP growth rate, building cost index, and a dummy variable for subprime mortgage securitization. Except for the building cost index variable, these variables are determining factors of the demand for housing.

Models include the following elements to reflect theories of the mortgage rate and housing price:
1. Securitization of subprime and Alt A mortgage loans: This securitization started in 1995, the current housing bubble started at the same time. Subprime mortgage securitization increased housing demand by offering mortgages to less qualified home buyers.

2. The irrational exuberance hypothesis (Robert Shiller, 2008)

3. The low mortgage rate (interest rate) hypothesis: The Fed Chairman, Greenspan, maintained lower interest rates, which led to lower mortgage rates during the housing bubble. There is an inverse relationship between housing prices and mortgage rates.

4. Securitization of mortgages: Securitization of mortgages provides more funds for home buyers; mortgage-backed securities (MBSs) were sold all over the world and drew savings from the U.S. as well as other countries. Securitization may also lower mortgage rates.

We specified our models to reflect these theories and models as follows:

\[ MRT = f(INF, MSR, RGDPG) \]  \hspace{1cm} (1)

\[ HPI = f(MSR, RGDPG, BCI, SUBP) \]  \hspace{1cm} (2)

Where,  

- MRT: the 10 year mortgage yield rate
- INF: the inflation rate
- MSR: the mortgage securitization ratio (the ratio of securitized mortgages to total mortgage outstanding)
- RGDPG: the real GDP growth rate
- HPI: the housing price index
- BCI: the building construction cost index
- SUBP: the dummy variable for securitization of subprime mortgages (SUBP=0 before 1995 and SUBP=1 after 1995)

### 4.2 Data and empirical results
Data used in estimation of models are from Shiller (2008), the 2008 Presidential Report and the 2008 mortgage market statistical annual (Inside Mortgage Finance Publication). Detailed sources of each variable are as follows:


MRT, INF, RGDPG: the 2008 Presidential report

MSR: estimated by the author based on the 2008 mortgage market statistical annual (Inside Mortgage Finance Publication)

**Table 1: Estimation Results**

\[
\text{MRT} = 16.20 - 0.157 \text{MSR} - 0.1972 \text{RGDPG} - 0.0547 \text{INF} \\
\text{(0.08)} \quad \text{(0.00)} \quad \text{(0.05)} \quad \text{(0.58)}
\]

\[
R^2 = .90 \quad R^2 \text{ (adj)} = .89 \quad F (3, 24) = 76.16
\]

\[
\text{HPI} = -503.29 + 275.40 \text{MSR} - 3.7625 \text{RGDPG} + 5.832 \text{BCI} + 28.389 \text{SUB} \\
\text{(0.06)} \quad \text{(0.02)} \quad \text{(0.26)} \quad \text{(0.04)} \quad \text{(0.16)}
\]

\[
R^2 = .63 \quad R^2 \text{ (adj)} = .62 \quad F (4, 23) = 15.19
\]

**Structural Change Test for Subprime Mortgage**

<table>
<thead>
<tr>
<th>Test</th>
<th>Break Point</th>
<th>Num DF</th>
<th>Den DF</th>
<th>F Value</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chow</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>14.16</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The numbers in parentheses are p-values.

These data are time series data from 1980 to 2007. We employed both a multiple regression estimation method and the SAS statistical package to estimate regression coefficients and Chow test statistics.

Regression coefficients and p-values are presented in Table 1. The mortgage rate variable is deleted from the housing price model because of a strong correlation between the mortgage rate and the securitization of mortgage. The mortgage securitization variable reveals a statistically significant inverse association with the mortgage rate and a statistically significant positive association with the housing
price variable. These results support the main thrust of our investigation on the subprime mortgage crisis. Detailed discussions are presented in the following section.

5. Empirical Analysis and Discussion

5.1 Securitization and the Mortgage Rate

We specified the mortgage rate model to find the impact of mortgage securitization on the mortgage yield rate. Independent variables included in the model are mortgage securitization ratio, the real GDP growth rate, and the inflation rate. Securitization reveals a statistically significant inverse association with the mortgage rate, which conforms to the expectation and supports hypothesis 1 that mortgage securitization has an inverse association with the mortgage rate. However, the real GDP variable has a statistically significant negative association with the mortgage rate, and the inflation variable does not show a statistically significant association with the mortgage rate variable. Signs of these two variables do not conform to the expectations of the theoretical model.

5.2 Subprime Mortgage Securitization, the Housing Bubble and Self-organization

Model (2) tests whether the subprime mortgage securitization was a triggering factor in the U.S. housing bubble; regression coefficients are estimated based on data from 1980 to 2008. We included additional variables such as the building construction cost index and real GDP growth rate variables in this model. The real GDP growth rate variable is not statistically significant and does not demonstrate the expected positive relationship with the housing price. The building cost index variable is statistically significant with the expected positive sign.

The mortgage securitization variable shows an expected sign and is statistically significant. The dummy variable representing securitization of subprime mortgages reveals a positive sign, although it is not statistically significant at the conventional α level. To find out whether subprime mortgage securitization led to a structural change in the housing price, we conducted a Chow test. The Chow statistics show that the break point is the 15th observation (1995), which is the year that subprime
mortgage securitization started. The Chow test statistics are statistically significant and the test results suggest that subprime mortgage securitization was a trigger point for the current U.S. housing bubble. Figure 2 conforms the breaking point for the structural change.

When we examined data from 1980 to 2007, we found that the current housing bubble started in 1995. The mortgage securitization ratio started to rise significantly in 1990 due to a sharp increase in both government sponsored enterprises (GSEs) and non-agency mortgage securities. Securitization of non-agency mortgage securities (private sector financial institutions) had started in 1984 with a securitization ratio of 19.91%; by 2007 the securitization ratio was 59.59%. The non-government agency mortgage securities were only 4.2% in 1984, but rose to 31.98% in 2007, which can be calculated from columns (2) and (3) in Appendix B. Securitization of mortgages increases the liquidity of mortgages and reduces the interest rate risk of lending long and borrowing short. The problem of lending long and borrowing short became more apparent in the early ‘80s because of the wilder swing of the short-term interest rates. The securitization rate of mortgages, a parameter which changes between 0 and 1, is comparable to a tunable parameter in biology (Camazine et al., 2003). There is no securitization of mortgage when the parameter is 0 and 100 percent securitization when it is 1. Changes in the securitization parameters result in changes in housing prices. Securitization is a strategic or policy variable in management or economics.

What did trigger the current housing bubble? One answer may be securitization of subprime mortgage credits. Securitization of mortgage credit by Ginnie Mae started in 1968; other GSEs became involved in securitization in 1980. Securitization of subprime mortgages by private financial institutions started in the mid-1990s and increased rapidly. We argue that this is a tipping point. When a person raises the temperature, water does not boil until the temperature reaches the threshold point. Although securitization began earlier, the housing bubble did not start until the sharp increase in securitization of subprime mortgages in 1995. In thermodynamics and biology, the tipping point is referred to as the
threshold point of bifurcation (Heylighen, 2008; Kauffman, 1993; Prigogine and Stengers, 1984). The snowballing effect of positive feedback takes an initial change in a system and reinforces that change in the same direction as the initial deviation (Camazine, et al., 2003, p. 17). In the same way, the initial housing bubble triggered by initial external subprime mortgage securitization in 1995 amplified the housing bubble and the pattern of housing price changed in 1995.

To test the impact of subprime mortgage securitization on the housing bubble, we used a dummy variable for the year that the securitization of subprime mortgages was introduced. Empirical results show that this variable had a positive impact on the housing bubble. The downward snowballing effect of negative feedback can provide inhibition to offset the amplification. The onset of the decline in housing prices triggered by the subprime crisis (unsustainable debt) can be amplified as time passes; home buyers act on information about increasing housing prices, they interact with each other, and they also interact with financial institutions. Consequently, the pattern of the housing bubble becomes nonlinear (see Figure 2).

The pattern of this housing bubble forms a sigmoidal curve. Kauffman’s (1993) explanation of a sigmoidal curve in self-organization can be applicable to the sigmoidal curve of the housing bubble pattern:

The sigmoidal function is initially below the proportional response. Here a given output levels to an output that is less than the input. Were that reduced output fed back as the next input, then the subsequent response would be even less. Over iterations, the response would dwindle to zero. The sigmoidal response becomes steep in its midrange, however, and crosses above the proportional response. An input above this critical crossing point leads to an output that is greater than the proportional-response output. In turn, were that output fed back as a next input, the output would be still greater than input. Over iterations the response would climb to a maximum. (Kauffman, 1993, p. 184)

As discussed earlier, the pattern of the housing bubble was formed by numerous interactions of home buyers, financial institutions and credit rating agencies. As long as a housing bubble continues to expand, MBSs are secured debts because they are asset-backed securities (ABSs). Securitization of subprime
mortgages offers more mortgage loans to home buyers, and housing prices increase as a result of increased demand. As the housing price climbed to a maximum in 2006, the housing bubble reversed itself due to constraint of household debt capacity. These behaviors of housing prices make the pattern of the housing bubble sigmoidal, as we can see in Figure 2. Camazine et al. (2003) have shown how a small change in a system parameter can result in a large change in the overall behavior of the system (p. 35). Figure 2 shows that a change in securitization caused by subprime mortgage securitization resulted in large changes in housing prices. This also confirms the butterfly effect, the analogy that a butterfly flapping its wings could cause hurricanes in another part of the world (Lorenz, 1963; Rosser, 2000). Miller and Page (2007) also illustrate how systems of interacting agents can lead to emergent phenomena. Their linking individually based micro processes to macrosocial outcomes is a useful analogy to the formation of housing bubble phenomena.

Figure 2: A Scatter plot of nominal housing prices and mortgage securitization

![Scatterplot of Nominal housing price index vs Securitization ratio](image)
Securitization of home mortgages has continued to increase by adding more institutions, such as the government agency (Ginnie Mae), government sponsored enterprises (Fannie Mae and Freddie Mac) and private sector financial institutions. Securitization of private financial institutions includes prime mortgages, subprime mortgages and Alt A mortgages. The pattern of the housing bubble changes as securitization of mortgages increased. Figure 2 also illustrates the nature of the relationship between self-organization and housing prices. This relationship is supporting evidence for hypothesis 3.

The maximum point is another bifurcation point where negative feedback reinforces the downward change or amplifies the initial change. In the case of a school of fish, positive feedback and negative feedback work with little time lag, so that each fish maintains its distance with neighboring fish and equilibrium (Camazine et al., 2003). However, the housing bubble pattern shows that positive feedback amplifies a housing bubble and controlling or negative feedback operates with a significant time lag. The housing bubble started in 1995 and lasted until 2006. Although operating rules for home buyers and financial institutions are simple, the global pattern of spontaneous interactions of home buyers and financial institutions became complex. This complex global pattern of spontaneous interactions led to the crisis. Data for Figure 2 are from Shiller (2008) and the authors’ estimation based on the Inside Mortgage Finance Report (2008).

5.3 Securitization of Subprime Mortgages and Subprime Mortgage Crisis

Column (5) in Appendix B shows the share of the subprime and Alt A out of total non-agency issuance (private financial institutions). The share of the subprime and Alt A has been growing since 1995 and peaked in 2006, with 78.8% of the total MBS issuance amount by private financial institutions.

When securitization of subprime and Alt A loans by private sector financial institutions started in 1995, mortgage backed securities became a significant part of the collateralized debt obligations (CDOs). Resecuritization of CDOs and a derivative of CDOs, credit default swaps (CDSs), further complicated the subprime mortgage problem. As stated before, there were an estimated $62.2 trillion worth of CDSs
contracts outstanding worldwide in 2006 (Morgensen, 2008). Private sector financial institutions’ involvement in subprime mortgage securitization caused subprime loans and Alt A loans to increase due to the transferability of risk in the originate and distribute model. Thus, securitization of subprime loans and Alt A loans became a main source of the current subprime mortgage crisis. MBS involves three risks: interest rate risk, prepayment risk and default risk (Rosen 2007). Securitization of subprime mortgages increases the default risk. A recourse clause (in the representations and warranties) that obligates originators (lenders) to buy back loans that are later discovered not to have originated with proper due diligence became ineffective at reducing the risk because so many originators became insolvent.

6. Solutions to the Subprime Mortgage Crisis

6.1 A Self-organization Perspective

One self-organization solution to the current financial crisis is to envisage the solution from the perspective of an individual financial institution, home buyer, regulation agency and investors in the financial system. A collapse of the housing bubble can be seen as the operation of negative feedback (Camazine, 2003), which offers an opportunity for error elimination (Plotkin, 1982; Popper, 1982). Individual financial institutions will react to the financial crisis based on their local information regarding the financial crisis. They are likely to scrutinize mortgage loans and to require a higher percentage of down payments. They will also interact with other actors in the system such as loan applicants, savers, other financial institutions and regulatory agencies, based on their local information. Financial institutions will exercise more due diligence in dealing with loan applicants and with mortgage-backed security issuers such as MBS and CDO issuers. They will pay special attention to CDSs. Investors will also scrutinize these financial instruments before they invest in them.

A general characteristic of a self-organizing system is robustness or resiliency (Camazine et al., 2003; Heylighen, 2008; Kauffman, 1993; Prigogine and Stengers, 1984). Self-organization in biology states that living organisms react to changes in environment, and their reactions lead to a global order
(Camazine et al., 2003). The current perturbation will push financial systems into a better state or equilibrium, a state where individual financial institutions, consumers and regulators mutually adapt. Foster (1992, 2000) argues that the firm, as a complex adoptive system with self-organizational qualities, can develop a range of forward looking contractual arrangements in the context of transaction cost economics. The same can be said about the current changes in the financial environment. Financial firms will develop a range of new financial arrangements in dealing with the mispricing of risk and the opacity created by the originate and distribute mortgage financing model. Financial systems will establish a new global order stemming from the current perturbations.

As Kauffman (1993) argues, “evolution is a complex combinatorial optimization process in each of the coevolving species in a linked ecosystem, where the landscape of each actor deforms as the other actors move” (p. 644). Financial institutions securitized subprime mortgages and made mortgage loans available to low income home buyers, which made home buyers buy more homes. The result deformed the final holders of CDOs and led to the current crisis. The crisis, a stimulus to the financial system and a complex combinatorial optimization process in each of the coevolving home buyers, financial institutions, final investors (holders) and regulatory agencies, will help create new systems. The mutual interactions of these actors help generate more healthy and efficient financial intermediaries. Kauffman (1993) also points out that evolution is an emergent order honored and honed by selection. Emergence of a new financial system likewise will have the order honed by selection, and the new order will show how order emerges from the chaos. Moreover, the situation can become worse before it gets better, and the U.S. financial systems will go through the rugged landscape until it reaches an equilibrium or attractor. The experience on the 1997 Korean economic crisis provides an evidence of the self-organization perspective solution. However, alternative solutions may be required to reduce pain in the short-run and to trigger economic recovery.

6.2 Alternative Solutions to Self-organization
Alternative solutions to self-organization perspectives include central authorities, blueprints, templates and leadership. The U.S. government and the Federal Reserve are central authorities; they are working to solve problems created by the housing bubble formed by positive feedback of self-organization. The collapse of the housing bubble has created enormous adverse effects on the U.S and world economies. This negative feedback is a step in the process of reaching a new equilibrium from the collapse of the housing bubble. Camazine et al. (2003) point out that the “individual acquires and processes information that elicits a negative feedback response: A small perturbation applied to the system triggers an opposing response that counteracts the perturbation” (p. 16). In a biological system this negative feedback prevents an implosion. An ideal solution to problems in the housing bubble might have been due diligence exercised by the regulatory agencies while the housing bubble was forming and expanding. Can regulatory agencies play this role? This may be a challenging task, because non-linear dynamic self-organization models are capable of generating catastrophic discontinuities, chaotic dynamics and a variety of other complex dynamics, as noted by Rosser (2000). Home buyers and financial institutions were interacting with each other based on local information. Home buyers responded to increasing housing prices, and financial institutions responded to opportunities for fee generation from mortgage origination, servicing mortgages, issuing MBSs and CDOs and underwriting mortgages and MBSs. They did not see problems stemming from the global pattern, group characteristics and complexity. Regulatory agencies thought that actors in markets are smart and control themselves to maintain balance. However, markets failed to self-regulate and negative feedback did not operate until the housing bubble reached a maximum. Therefore, a new regulatory regime may be required to prevent problems of bubbles from recurring.

Today almost all large financial institutions in the U.S. and the world are involved in securitization as MBS and CDO issuers and underwriters. They actively participate in CDSs to manage their risk on CDOs. Consequently, problems faced by financial institutions, the U.S. economy and other
economies in the world are severe and widespread. The crisis involved trillions of dollars worldwide, thus the problem requires massive coordinated efforts by governments in the world. To address this problem the U.S. Congress passed the Troubled Assets Recovery Program (TARP) and has designated $750 billion to purchase assets and equity from financial institutions. TARP, designed to strengthen the financial sector, allows the U.S. Department of Treasury to buy illiquid, toxic assets from banks and other financial institutions and to provide relief to homeowners who are facing mortgage bankruptcies. TARP also encourages banks to resume lending both to each other and to consumers and businesses. Interbank lending will restore financial market stability and make bank loans available to consumers and businesses, which will help increase consumer spending on durable goods such as automobiles, housing and furniture. However, toxic assets are likely to rise unless policy makers take measures to stop and reverse the trend. The U.S. government is taking steps to stem the foreclosure trend; it is planning to spend $75 billion for home owners who are facing home mortgage foreclosures and to offer subsidies to new home buyers to boost new home construction.

However, the costs of stabilizing financial systems is expected to rise significantly higher than the currently appropriated dollar amounts. U.S. policy makers may draw lessons from the Japanese real estate crisis in the 1990s. According to the New York Times (February 13, 2009: Hiroko Tabuchi, B 1), the Japanese economy endured a “lost decade” of economic stagnation as Japanese banks and policy makers were slow to recognize the magnitude of their banking problems and wasted trillions of Yen on half-measures. U.S. policy makers and banks need to confront the issues directly and should take effective steps fast. When the Korean government, banks and business firms took bold measures as they faced the 1997 financial crisis, they recovered relatively quickly (Park, 2008). Therefore, the timing and implementation of appropriate policy measures are crucially important in recovery of the U.S. economy from the current crisis. Current policy debates and institutional interventions on problems of self-organization have the same familiar tone of Keynesian and classical policy debates (Rosser, 1999).
However, hindsight on the current financial crisis offers some clues for government interventions in the future. Since design of the originate and distribute model, the development of off-balance sheet special purpose vehicles (SPVs) and the securitization of subprime mortgages have contributed to the current financial crisis, these developments should have been properly monitored as they were developing. Are government agencies capable of doing the job? Scholars continue to debate this question.

The self-organizational policy prescription would further suggest that policy makers study the evolving nature of patterns (Colander, 2000) and address problems as they arise.

Rather than bounding after the unknowable, and try to deduce analytically models that hold for all times, economics has reduced its search to what it believes is knowable. New Millennium economists search for patterns in data, try to find temporary models that fit the patterns, and study the changing nature of those patterns as institutions change. (Colander, 2000, p. 131)

Economists could not have known all potential problems when they designed and implemented the originate and distribute mortgage model. Problems emerged in the process of evolution in the new model. The securitization of subprime mortgage accompanied the cascade of events and a complex system has emerged as agents in financial institutions managed their credit risks and consumers acted on their local information of subprime mortgage securitization. The complexity of subprime mortgages led to catastrophic adverse effects on the global economy because the securitized subprime mortgages were sold to savers all over the world. Asymmetry of information between the originators of subprime mortgages and its final holders in other countries was more pronounced than other securities because of the complexity of subprime mortgage securitization. Therefore, government interventions require better understanding of the global patterns of bubbles (Rosser, 1999) and mechanisms for selecting a solution among tentative solutions (Popper, 1982), to reduce policy errors in mortgage financing changes. Policy makers need to develop a process to mobilize knowledge from all knowledgeable people because people working in the field have concrete experience and knowledge that the new system is experiencing and its future direction.
When the Federal Reserve and the new administration began to take more aggressive steps, the Fed made over one trillion dollars of loans to financial intuitions in 2008, the Fed also purchased subprime mortgages and it is likely to maintain an easy monetary policy until early 2011. The new administration and Congress in 2009 worked out massive fiscal policy stimulus measures to boost the U.S. economy. The previous administration had implemented tax cuts, but the amount of the cuts might not have been sufficiently large enough to trigger economic stimulation. The new administration had taken more aggressive stimulus fiscal policy measures. They proposed over $800 billion of recovery and reinvestment programs, and the U.S. Congress actually adopted the $787 billion stimulus and recovery package.

Regulatory agencies are also scrutinizing financial institutions and their transactions more closely. Financial regulatory agencies are criticized for their lack of regulations and due diligence. The increasing tendency of deregulation and strong belief in a free market system in the past two decades created an environment for less stringent regulatory implementation. However, these trends are reversing now and some economists are proposing a financial product consumer protection act, equivalent to the current consumer protection act. Opaqueness stemming from information asymmetry among actors in securitization of mortgage credit created moral hazard, adverse selection and conflict of interest. These problems may have contributed to the current subprime mortgage crisis. New or existing regulations need to reduce or eliminate the opacity of the system and increase transparency of the securitization process. The system should encourage the originator to take more risk rather than transferring it. Securitization of subprime mortgages and new issuances of CDOs and CDSs need to be monitored with due diligence. Shiller (2008) has proposed that rather than more regulatory measures, we should have more democratization of financial systems to provide independent advice and information to financial consumers, so that consumers can make informed financial decisions. He also points out that the collapse of the housing bubble makes housing more affordable to home buyers.
Ultimately, it is important to design an efficient regulatory system, and the current subprime mortgage crisis presents an opportunity for decision makers to create efficient new orders for the U.S. and the global financial systems. The U.S. Congress actually passed a financial consumer protection act to protect financial consumers and to prevent recurring future financial problems.

7. Summary and Conclusion

The originate and distribute model was originated to increase the liquidity of mortgages (lower mortgage rates) and to address interest rate risk stemming from lending long and borrowing short in mortgage financing. The new model facilitated the securitization of mortgages. However, it has been created new problems of opacity, mispricing of risk and complexity in mortgage financing, as Popper (1982) predicted. Regulatory agencies need to understand these sources of opacity, mispricing of risk and complexity which developed underneath the housing bubble.

The pattern of the housing bubble or any bubble for that matter can be analyzed from a self-organization perspective. The current housing bubble was triggered by the securitization of subprime and Alt A mortgage loans by private financial institutions in 1995. The subprime mortgage crisis arose as the housing bubble popped, and the current crisis provides a good lesson why due diligence is required in new mechanism design (Maskin, 2008). Since no one would know all potential problems stemming from the emerging complexity of a new originate and distribute model at the time of its adoption, monitoring in a new model needs to be flexible and ongoing throughout the development of complexity in the model. Characteristics of complexity in self-organization are not universal and therefore controlling any bubble needs to be case-specific (Colander, 2000; Rosser, 1999).

Although economic bubbles recur frequently and impose enormous adverse effects on millions of people as an economic bubble collapses, not enough studies have been conducted on economic bubbles. There is a need for more research to address problems effectively, and the self-organization
perspective provides an appropriate framework for both the analysis and policy prescriptions of economic bubbles.
References


Foster, J., 2000, “Is there a role for transaction cost economics if we view firms as complex adaptive system?” Contemporary Economic Policy, 18(4), 369-385.


Morgensen, 2008-02-17, New York Times, ISDA market survey.


### Appendix A: Outstanding Mortgage Securities and Securitization Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>GSE 1</th>
<th>Non-agency 2</th>
<th>Total Security 3</th>
<th>Total Mortgage 4</th>
<th>Securitization Rate 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>111,086</td>
<td>$111,086</td>
<td>$957,900</td>
<td>11.59%</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>126,186</td>
<td>126,187</td>
<td>1,030,200</td>
<td>12.25</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>162,829</td>
<td>162,892</td>
<td>1,070,200</td>
<td>15.22</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>219,201</td>
<td>219,201</td>
<td>1,186,100</td>
<td>18.48</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>252,007</td>
<td>11,000</td>
<td>263,007</td>
<td>1,132,100</td>
<td>19.91</td>
</tr>
<tr>
<td>1985</td>
<td>314,554</td>
<td>24,000</td>
<td>338,554</td>
<td>1,518,600</td>
<td>22.29</td>
</tr>
<tr>
<td>1986</td>
<td>434,884</td>
<td>16,600</td>
<td>451,484</td>
<td>1,722,000</td>
<td>26.22</td>
</tr>
<tr>
<td>1987</td>
<td>531,867</td>
<td>27,800</td>
<td>559,667</td>
<td>1,920,500</td>
<td>29.14</td>
</tr>
<tr>
<td>1988</td>
<td>570,733</td>
<td>34,900</td>
<td>605,633</td>
<td>2,154,100</td>
<td>28.12</td>
</tr>
<tr>
<td>1989</td>
<td>646,759</td>
<td>43,300</td>
<td>690,057</td>
<td>2,378,900</td>
<td>29.01</td>
</tr>
<tr>
<td>1990</td>
<td>1,013,920</td>
<td>55,000</td>
<td>1,068,920</td>
<td>2,614,700</td>
<td>40.88</td>
</tr>
<tr>
<td>1991</td>
<td>1,152,453</td>
<td>96,700</td>
<td>1,249,153</td>
<td>2,781,700</td>
<td>44.91</td>
</tr>
<tr>
<td>1992</td>
<td>1,268,777</td>
<td>142,300</td>
<td>1,411,077</td>
<td>2,947,300</td>
<td>47.88</td>
</tr>
<tr>
<td>1993</td>
<td>1,354,638</td>
<td>167,900</td>
<td>1,522,538</td>
<td>3,106,200</td>
<td>49.02</td>
</tr>
<tr>
<td>1994</td>
<td>1,461,376</td>
<td>183,000</td>
<td>1,644,376</td>
<td>3,283,200</td>
<td>50.08</td>
</tr>
<tr>
<td>1995</td>
<td>1,554,901</td>
<td>193,800</td>
<td>1,748,701</td>
<td>3,451,200</td>
<td>50.67</td>
</tr>
<tr>
<td>1996</td>
<td>1,691,357</td>
<td>215,400</td>
<td>1,906,757</td>
<td>3,674,700</td>
<td>51.88</td>
</tr>
<tr>
<td>1997</td>
<td>1,801,319</td>
<td>253,500</td>
<td>2,054,819</td>
<td>3,900,600</td>
<td>52.56</td>
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<tr>
<td>1998</td>
<td>1,985,873</td>
<td>321,500</td>
<td>2,307,373</td>
<td>4,258,500</td>
<td>54.18</td>
</tr>
<tr>
<td>1999</td>
<td>2,255,520</td>
<td>353,200</td>
<td>2,608,720</td>
<td>4,674,200</td>
<td>55.81</td>
</tr>
<tr>
<td>2000</td>
<td>2,449,956</td>
<td>377,500</td>
<td>2,827,456</td>
<td>5,110,300</td>
<td>55.33</td>
</tr>
<tr>
<td>2001</td>
<td>2,791,287</td>
<td>463,200</td>
<td>3,254,487</td>
<td>5,678,000</td>
<td>57.32</td>
</tr>
<tr>
<td>2002</td>
<td>3,087,430</td>
<td>544,100</td>
<td>3,631,530</td>
<td>6,437,400</td>
<td>56.41</td>
</tr>
<tr>
<td>2003</td>
<td>3,394,021</td>
<td>664,000</td>
<td>4,058,021</td>
<td>7,227,800</td>
<td>56.14</td>
</tr>
<tr>
<td>2004</td>
<td>3,467,047</td>
<td>1,049,800</td>
<td>4,516,847</td>
<td>8,270,500</td>
<td>54.61</td>
</tr>
<tr>
<td>2005</td>
<td>3,607,558</td>
<td>1,536,600</td>
<td>5,144,158</td>
<td>9,374,300</td>
<td>54.87</td>
</tr>
<tr>
<td>2006</td>
<td>3,904,911</td>
<td>1,991,500</td>
<td>5,896,411</td>
<td>10,421,400</td>
<td>56.58</td>
</tr>
<tr>
<td>2007</td>
<td>4,518,871</td>
<td>2,116,600</td>
<td>6,635,471</td>
<td>11,135,800</td>
<td>59.59</td>
</tr>
</tbody>
</table>

Sources: Columns (1), (2), (3), (4) are from the 2008 Mortgage Finance Market Statistical Annual Vol. I, II (Inside Mortgage Finance); column (5) is calculated by the author.
### Appendix B: Non-agency MBS issuance by type

<table>
<thead>
<tr>
<th>Year</th>
<th>Prime</th>
<th>Subprime</th>
<th>Alt A</th>
<th>Total</th>
<th>[(2) + (3)]/(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>25,837.7</td>
<td>17,771.4</td>
<td>498.3</td>
<td>44,107.4</td>
<td>41.42%</td>
</tr>
<tr>
<td>1996</td>
<td>31,418.7</td>
<td>30,769.4</td>
<td>1,802.6</td>
<td>63,990.7</td>
<td>50.90%</td>
</tr>
<tr>
<td>1997</td>
<td>49,974.9</td>
<td>56,920.7</td>
<td>6,518.0</td>
<td>113,413.7</td>
<td>55.93%</td>
</tr>
<tr>
<td>1998</td>
<td>97,365.2</td>
<td>75,829.9</td>
<td>21,235.5</td>
<td>194,430.6</td>
<td>49.92%</td>
</tr>
<tr>
<td>1999</td>
<td>74,630.9</td>
<td>55,851.5</td>
<td>12,022.8</td>
<td>142,505.2</td>
<td>47.63%</td>
</tr>
<tr>
<td>2000</td>
<td>53,584.9</td>
<td>52,467.4</td>
<td>16,443.6</td>
<td>122,495.9</td>
<td>56.25%</td>
</tr>
<tr>
<td>2001</td>
<td>142,202.5</td>
<td>87,052.9</td>
<td>11,373.6</td>
<td>240,629.0</td>
<td>40.90%</td>
</tr>
<tr>
<td>2002</td>
<td>171,534.4</td>
<td>122,680.9</td>
<td>53,462.7</td>
<td>347,678.0</td>
<td>50.66%</td>
</tr>
<tr>
<td>2003</td>
<td>237,454.6</td>
<td>194,958.5</td>
<td>74,151.0</td>
<td>506,564.1</td>
<td>53.12%</td>
</tr>
<tr>
<td>2004</td>
<td>233,378.1</td>
<td>362,549.3</td>
<td>158,585.8</td>
<td>754,513.2</td>
<td>69.07%</td>
</tr>
<tr>
<td>2005</td>
<td>280,703.7</td>
<td>465,036.3</td>
<td>332,323.2</td>
<td>1,078,063.2</td>
<td>73.96%</td>
</tr>
<tr>
<td>2006</td>
<td>219,037.4</td>
<td>448,599.6</td>
<td>365,675.8</td>
<td>1,033,312.8</td>
<td>78.80%</td>
</tr>
<tr>
<td>2007</td>
<td>180,462.4</td>
<td>201,546.7</td>
<td>249,610.0</td>
<td>631,619.1</td>
<td>71.42%</td>
</tr>
</tbody>
</table>

Sources: Columns (1), (2), (3), (4) are from the 2008 Mortgage Finance Market Statistical Annual, Vol. I, II (Inside Mortgage Finance). Column (5) is calculated by the author.