Application of Actuarial Science to Systemic Risks

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Acknowledgements

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Executive Summary

This paper examines the circumstances that lead to systemic risk and proposes a new definition: *A systemic risk to a financial system is manifest when changes in conditions, internal and/or external, lead to major disruptions beyond the collective tolerance level of the participants in the system, thereby causing the participants to change behavior in a way that inhibits the ongoing functioning of the system.*

Systemic risk differs significantly from individual risk, and needs to be analyzed from a system-wide perspective. A study of systemic risk requires a focus on the system as a whole, by examining the policies, incentives and behaviors that drive people flows, resource flows and money flows, as well as their influence on the activities in various sectors of the system.

Mark-to-Market (MTM) valuations are meaningful for valuing individual risks at a specific point in time. However, from a system-wide perspective, MTM valuations are pro-cyclical and exhibit self-reinforcing momentum, with booms inviting more speculation and busts creating a downward spiral of price depreciation. When a regime-change of the market occurs, some widely-held beliefs, assumptions and behavioral patterns under the old regime may break down and change unexpectedly. As a result, policy decisions made by relying on MTM alone can be misleading or even damaging for the system.

Effective management of systemic risk requires the utilization of multiple valuation methodologies and understanding of the relationships between different valuations. This paper proposes using an actuarial valuation method for assets and liabilities based on long-term intrinsic value that is more sustainable than market values at a point in time. Actuaries regularly perform appraisals for long-term assets and liabilities based on long-term average trends, without being unduly influenced by market volatilities. An actuarial valuation approach can equip regulators with counter-cyclical metrics and tools to manage systemic risk.

For the U.S. housing market, the current housing appraisal methods are based on market values of comparable sales, which is pro-cyclical. Over the past few years (2008-2012), downward pressures caused by massive foreclosures and strategic defaults have been preventing the U.S. housing market from returning to its long-term intrinsic value. This paper advocates using an actuarial appraisal method that references construction costs and controls the rate of appreciation within a reasonable range to derive appraisal values more related to intrinsic values. The paper also proposes a strategy for reviving the U.S. housing market, through voluntary mortgage debt reduction by lenders in exchange for the rights to benefit from the future appreciation of the housing unit.

It is a widely held view that the majority of insurance companies following traditional insurance business models are not a source of systemic risk. There is an exception to the rule for some non-

traditional insurance operations such as AIG Financial Products and mono-line bond insurers. This study concurs with the view that insurance companies by themselves do not generate systemic risk for the whole economy. The genesis of systemic risk requires a collective set of factors and players at work. Major contributors to the recent financial crisis include the U.S. government's housing policies, which helped create the macro-environment for the housing finance bubble. Some insurance holding companies also contributed to the housing finance bubble by expanding their business activities to insuring mortgage-backed securities (MBS) and credit default swaps (CDS). Among many players in the financial system, the insurance industry shares responsibility for proactively monitoring imbalances in the financial system and refraining from activities that exacerbate such imbalances.

The paper notes that the government either explicitly or implicitly provides "insurance" or "guarantees" to some sectors of the economy (e.g. government-sponsored enterprises (GSE) and the banking system); this type of insurance, unlike traditional insurance products, can generate systemic risk. Similarly, non-insurance activities by insurance groups can be a source of systemic risk.

The monetary and fiscal policies of the major world economies are by far the most dominant sources of systemic risk. These policies influence future interest rates and can have profound impacts on all financial institutions, including insurance companies.

As an example, this paper discusses China's housing market bubble. Based on the interactions of people flow, resource flow and money flow, an analogy can be made to the late 1980s Japanese real estate boom. If the Japanese boom and bust experience is repeated in China, the burst of China's real estate bubble can destroy trillions of dollars of market value and pose significant challenges to the Chinese economy and to the countries relying on China's construction boom.

The paper identifies the need for innovative methods and approaches for measuring and managing systemic risk. Actuaries have long been modeling complex systems involving changes in conditions and policyholder behavior. Moreover, actuaries are experienced in analyzing the impacts of government policies and regulatory changes on financial systems. Actuarial models of complex systems, when applied in connection with the Actuarial Control Cycle and actuarial appraisal methods, can provide useful indicators for policy makers and businesses in managing systemic risk.

Chapter 1 Definitions of Systemic Risk

In the wake of the 2008 financial crisis, policy makers and regulators have come to the realization that they did not have a grasp on the events that led to the crisis (near collapse of the financial system). Subsequently, the issue of how to define systemic risk, and then how to manage it, has emerged as the single most important issue among policymakers and regulators.

In this chapter we review some widely cited definitions of systemic risk.

1.1 Review of Definition of Systemic Risk

Attention to systemic risk has dramatically increased following the 2008 global financial crisis, and there are several proposed definitions of systemic risk. However, there is no consensus on the definition.

Billio, Getmansky, Lo, and Pelizzon (2010) give a definition of systemic risk as "any set of circumstances that threatens the stability of or public confidence in the financial system." The European Central Bank (2010) defines it as a risk of financial instability so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially. Others have focused on more specific mechanisms, including imbalances (Caballero, 2009), correlated exposures (Acharya, Pedersen, Philippon, and Richardson, 2010), spillovers to the real economy (Group of Ten, 2001), information disruptions (Mishkin, 2007), feedback behavior (Kapadia, Drehmann, Elliott, and Sterne, 2009), asset bubbles (Rosengren, 2010), contagion (Moussa, 2011), and negative externalities (Financial Stability Board, 2009).

Darryll Hendricks[1] (2009) defines systemic risk by event trigger and phase transition. He defines it as the risk that an event will trigger a loss of confidence in a substantial portion of the financial system that is serious enough to have adverse consequences for the real economy. Alternatively, Hendricks defines systemic risk as the risk of a phase transition from one equilibrium to another (much less optimal) equilibrium, characterized by multiple self-reinforcing feedback mechanisms making it difficult to reverse. The Property Casualty Insurers Association of America (PCIAA)[2] defines systemic risk as the likelihood and degree of negative consequences to the larger body.

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[1] Darryll Hendricks, Defining Systemic Risk,
http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Economic_Mobility/PTF-Note-1-Defining-Systemic-Risk.pdf?n=3489, Financial Reform Project Paper, 2009.
[2] Source: Property Casualty Insurers Association of America. Systemic Risk Defined.
http://www.pciaa.net/web/sitehome.nsf/lcpublic/392/$file/PCI_Systemic_Risk_Definition.pdf, 2009.

According to Borio and Drehmann (2009), most definitions of financial stability share three useful elements. First, they focus on the financial system as a whole, as opposed to individual institutions. Second, they do not consider the financial system in isolation, but ultimately measure the economic (welfare) benefits and costs in terms of the "real economy" (economic activity). Third, they make an explicit reference to financial instability, the converse of stability, which is more concrete and observable.

At the international level, G20 finance ministers and Central Bank governors established the Financial Stability Board (FSB) to coordinate the work of national financial authorities and international standard setting bodies (SSBs) in order to develop and promote the implementation of effective regulatory, supervisory and other financial sector policies. In collaboration with the international financial institutions, the FSB will address vulnerabilities affecting financial systems in the interest of global financial stability.

The Financial Stability Board (FSB) and the International Monetary Fund (IMF) define systemic risk as "the risk of disruption to the flow of financial services that is (1) caused by an impairment of all or parts of the financial system; and (2) has the potential to have serious negative consequences for the real economy." The FSB has set out some criteria—size, interconnectedness and substitutability—by which the relevance of particular institutions to systemic risk may be assessed. The FSB specified criteria for those companies so identified that potentially increase the vulnerability of these institutions to financial failure, namely complexity, leverage and liquidity risk and large mismatches of assets and liabilities. However, most G20 countries do not yet have a formal definition of systemic risk and different countries have differing views on what systemic risk is, even on an informal level[3].

Domestically, the U.S. Dodd-Frank Act created a Financial Stability Oversight Council (FSOC), which is made up of the heads of various federal financial regulators. The FSOC describes systemic risk as follows[4]: "Although there is no one way to define systemic risk, all definitions attempt to capture risks to the stability of the financial system as a whole, as opposed to the risk facing individual financial institutions or market participants."

Ben Bernanke[5] echoes the FSB definition of systemic risks. He pointed out that systemic risks are developments that threaten the stability of the financial system as a whole, not just that of one

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[3] International Monetary Fund, Assessing the Systemic Implications of Financial Linkages, 2009.
[4] Financial Stability Oversight Council, 2012 Annual Report,
http://www.treasury.gov/initiatives/fsoc/Pages/annual-report.aspx, July 26, 2011, pp 3.
[5] Corey Boles, Bernanke Offers Broad Definition of Systemic Risk, *Wall Street Journal,*
http://blogs.wsj.com/economics/2009/11/18/bernanke-offers-broad-definition-of-systemic-risk/, November 18, 2009.

or two institutions. As a result, the broader task of monitoring and identifying systemic risk that might arise from the interactions of different types of financial institutions and markets – both regulated and unregulated – may exceed the capacity of any individual supervisor.

1.2 Putting Systemic Risk in Context

Normal Functioning of a Financial System

The financial system is at the heart of an economic system, since it supplies the essential life blood to various parts of the general economy, channeling savings into investment and allocating capital to various economic activities. The financial system brings together market participants, providing businesses with the capital they need, while at the same time providing households with an opportunity to hold their savings in a secure form, where it grows over time with the economy. The financial system facilitates price discoveries by market participants and thus the proper functioning of market forces (the invisible hand according to Adam Smith). Using cotton as an example, when there is an excess supply of cotton, it is expected that prices fall, people grow less cotton, people consume more cotton and the market seeks a new equilibrium. Of course, the market may never reach an absolute equilibrium as assumed in academic theory; instead, investment speculation changes the expected equilibrium and thus the market is constantly in the process of seeking a new equilibrium.

Breakdown of the Normal Conditions

The process of obtaining a new equilibrium can be overwhelmed by endogenous and/or exogenous forces. John Maynard Keynes was credited with describing such vicious market forces. Larry Summers (2009) described a number of self-reinforcing market forces in discussing the recent financial crisis: "Consider some of the vicious cycles we've seen in the last few years:

- a liquidation squeeze where financial assets fall in value, which forces their sale by those on margin, which pushes the prices even lower;
- fire sales of assets where lower prices on assets cause institutions to have less capital, which leads to less lending and even more asset devaluation, continuing the downward spiral;
- a credit-crunch in which a weakening economy leads to a weaker financial system, which leads to less lending, which leads to an even weaker economy;
- a Keynesian vicious cycle, in which lower spending leads to lower employment, which leads to lower incomes, which leads to lower spending, further continuing the cycle;
- A panic run on the bank, in which individuals see financial institutions in trouble, rush to withdraw their funds, putting those institutions in more trouble and causing others to withdraw funds."

Identify the System and Its Sub-Systems

We recognize that the financial system has many sub-systems, and it interacts with many other systems. For instance, a human body has its own systems and its internal organs are the sub-systems. The body also interacts with the external physical environment. An automobile has its own mechanical reference systems, such as the transmission. The car interacts with the external environment (gas supply, traffic), too. In order to define systemic risk, we need to clearly identify the reference "system," and its relationships with other systems.

When studying the systemic risk for the U.S. financial system, the entire U.S. financial system is identified as the reference system. Firstly, the U.S. financial system is part of the global financial system. Secondly, the U.S. financial system has many of its own sub-systems, including the capital markets, the banking system, the shadow banking system, the insurance industry, government agencies (GSEs) and the government security net (Social Security and Medicare). All these sub-systems are somehow inter-connected and they all have different characteristics. Not all sub-systems have equal influence on the U.S. economy; the influence they do have depends on their specific functions and sizes at any particular time.

Sources of Systemic Risk

DeNicolò et al. (2012) argue that important sources of systemic risk are the risk externalities across financial institutions and between the financial sector and the real economy. Examples of externalities include herding behavior of market participants, fire sales of financial assets causing a decline in asset prices and a deterioration of the balance sheets of intermediaries, and the risk of contagion caused by the propagation of shocks from systemic institutions or through financial networks.

There is widespread agreement that financial systemic risk is characterized by both cross-sectional and time-related dimensions: see, for example, Hartmann, de Bandt, and Alcalde (2009). The cross-sectional dimension concerns how risks are correlated across financial institutions at a given point in time due to direct and indirect linkages across institutions and prevailing default conditions. The time series dimension concerns the evolution of systemic risk over time due to changes in the default cycle, changes in financial market conditions, and the potential buildup of financial imbalances such as asset and credit market bubbles.

Goodhart, Sunirand, and Tsomocos (2006) argue that systemic risk arises from (i) spillover dynamics at the financial industry level, (ii) shocks to the macroeconomic and financial markets environment, and implicitly (iii) the potential unraveling of widespread financial imbalances.

We postulate that the objective of an economic system is to provide individuals and enterprises (as major players in an economic system) with an operating environment for them to attain their objectives, respectively.

Macro-prudential regulation must be charged with ensuring the normal functioning of the financial system. It may be unrealistic to avoid any form of cyclicality and have a zero risk of contagion in the financial system. A recent IMF study (DeNicolò et al., 2012) articulates that the objective of macro-prudential regulation must be to address market failures, rather than to smooth financial cycles.

The Time Dimension of Systemic Risks: Conditions versus Events

From the perspective of the time sequence of events, we can differentiate "conditions" for systemic risk from the systemic risk "event triggers." A financial system always exists in its current state or condition but this state and condition evolves over time. A given systemic risk condition may exist or accumulate for a long time before a systemic event is triggered. A systemic risk event trigger, in turn, may cause rapid or abrupt changes in the conditions of the system.

For example, the enormous size of the U.S. government deficit and the unfunded long-term liabilities (Social Security benefits and Medicare deficits) represents a "condition" of fiscal imbalance. This issue is an elephant in the room over the long term (over decades). Current market participants tend to be concerned with more pressing current events and thus ignore this long-term imbalance. Meanwhile, this imbalance of out-sized government debt is accumulating and getting worse by the day. Over a period of years or decades, the accumulation of imbalance, if not managed properly by the administration, may trigger a major crisis or dislocations in the U.S. financial system.

As another example, before the Greek sovereign debt crisis erupted, Greece had for many years as a systemic risk condition its unfriendly business environment. Greece ranked 100th out of 183 countries in "ease of doing business," which was an indication of a poor business environment.

When studying systemic risk, we need to analyze both the conditions for systemic risk and the systemic risk events that can bring rapid changes to the conditions of the system.

Influences of Government Policies

The actions or behaviors of the players are the most important aspects of the "conditions" of systemic risk, or even the "triggers" of systemic risk. Government policies are often influenced by political pressures. For instance, prudential policies that restrict credit availability (and possibly bank profits) may encounter political challenges.

The environment created by government cannot be ignored in the triggering of systemic risk.

In our view, the official definition of systemic risk by FSB is incomplete by omitting the huge impact of government policies. Government policies for the housing and the financial sectors, and the very actions of the Federal Reserve Board and other central banks, are among the chief drivers of systemic risk and should be included in the definition of systemic risk. Indeed, U.S. government policies to increase housing ownership were among the chief drivers that led to the 2008 financial crisis. At the onset of the 2008 financial crisis, the heroic actions of the Federal Reserve Board in rescuing the financial system by injecting trillions of dollars of liquidity was essential in restoring order in the financial system.[6]

Dynamic Evolution of Financial Systems

From an international and a historical perspective, we recognize that different systems have different operating rules and exhibit different behaviors.

In ancient societies, some tribes or regions operated based on a bartering system (where no official currency is used). Before the fiat monetary system, there were time periods when gold and silver were used as the medium of exchange. The current financial system and the fiat monetary system are only phenomena of recent history.

Modern financial systems are subject to the forces of rapid transformation, namely,

   i.   Innovations in financial products, rapid growth of derivatives and capital markets.
   ii. Technological breakthroughs that change the way information is being processed and how financial transactions are taking place.
   iii. Deepening of globalization along with the increased prominence of emerging markets
   iv. Changes in accounting rules and regulations

Indeed, recognition of this fast changing nature of the modern financial system underscores the importance of studying systemic risk.

Characteristics of a Healthy Financial System

Given the sheer size and enormous complexity and fast-changing nature of the financial system, we identify some elements essential to well-functioning capital markets:

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[6] Forbes, Ben Bernanke's Paper Dollar Embodies Systemic Risk,
http://www.forbes.com/sites/charleskadlec/2012/04/02/ben-bernankes-paper-dollar-embodies-systemic-risk/,
April 4, 2012.

i. Stability in the currency of the financial system
ii. Sustainability of economic growth and viable business models
iii. Clear rules, enforced fairly
iv. Free information flows
v. Risks priced fairly across the spectrum of business activities
vi. Feedback mechanisms in place to maintain or restore balance

Absence of any of the above factors may cause distortions in the normal functioning of the market; accumulation of such distortions over time may lead to a systemic event trigger that causes major disruptions to the system.

In diagnosing the health of a financial system, there are many indicators:

i. Whether the price of risk is within reasonable bounds (the price of risk directly impacts allocation of capital).
ii. Whether the size and functioning of various sectors are effective (establishing reasonable ranges and boundaries so that disruptions in one part of the economy would not severely affect people in other parts of the system).
iii. Whether feed-back mechanisms and feedback loops are functioning properly to allow the system to re-balance to within reasonable ranges.
iv. Whether development is sustainable in the long run; consider, for instance, consumption of fossil energy resources, water, and agricultural products.

In summary of our discussions, we propose the following definition of systemic risk:

A systemic risk to a financial system is manifest when changes in conditions, internal and/or external, lead to major disruptions beyond the collective tolerance level of the participants in the system, thereby causing the participants to change behavior in a way that inhibits the ongoing functioning of the system.

1.3 The "Systemic" Viewpoint

Any discussion of systemic risk must start with the recognition that the subject matter refers to the risk of a "system," rather than an individual. For an individual risk, one is most concerned about making the right bets (e.g. bet on the direction of commodity prices). However, for a system, the balance between buyers and sellers is the dominant concern. When too many speculative investors are betting on "one–way" trades, it represents a systemic risk of imbalance.

In a system, it is normal to have a spectrum of views (even opposing views), since each view represents a balancing factor. When studying systemic risks there is an analogy to ecology (the science of the study of ecosystems). Ecological balance has been defined as "a state of dynamic equilibrium within a community of organisms in which genetic, species and ecosystem diversity remain relatively stable, subject to gradual changes through natural succession" and "a stable balance in the numbers of each species in an ecosystem."

Adopting a "systemic" viewpoint can help explain certain phenomena. For instance, on August 6, 2011, S&P announced an unprecedented downgrade of U.S. credit from AAA to AA+. Contrary to what a downgrade would do for a company, the U.S. 10-year Treasury-bill yield dropped below 2% -- a record low in 50 years. If we treated the U.S. as an individual risk, a downgrade would have driven the yields higher. However, the S&P downgrade created uncertainty in the global markets, and relatively speaking, the U.S. was the strongest relative to other countries in the new environment. Thus, from a systemic point of view, the decline in rates made perfect sense.

Most systemic risks are imbalances accumulated over time. At an individual risk level, the housing risk was perceived to be very low. Indeed, one can easily extrapolate the housing price appreciation trend into the future. On the other hand, by looking at the system as a whole, one could see more clearly the accumulated imbalances (affordability index, housing start units, and speculative investment).

1.4 Needs for Different Approaches to Modeling Systemic Risks

Individual risk pricing models are subject to the pressure of market sentiment at the time and thus may not be able to fully capture changes in regimes. On the other hand, measurement of systemic risks can capture a full cycle of different regimes (normal, anxious and panicked markets). The pricing model focuses on profitability in the next reporting period while systemic risk measurement focuses on what may trigger the next crisis or recession over a longer period of time. Consequently, individual risk pricing models and systemic risk models use different amounts of data and focus on different explanatory variables. The market has short memories, and most pricing models use relatively recent data and carry little weight of historical rare events.

Losses may be independent of one another under normal market conditions but may exhibit high correlations under anxious or panic markets. Absent a systemic event, home loan defaults are normally associated with deaths, job loss, or divorce—which are generally random and independent events. On the other hand, a region-wide house price decline may trigger many homeowners (whose property is worth less than the outstanding loan balance) to default on their mortgage payments.

In order to capture systemic risks, we must go beyond a balance sheet focus. Presently corporate risk analysis has largely focused on a firm's balance sheet. Over a short-term horizon the balance sheet perspective may be the most important from a solvency perspective. However, over longer time horizons the current balance sheet may not adequately capture the key risks to the business or its solvency. For example, at early 2007 (before the onset of the financial crisis), AIG and Lehman Brothers had outstanding balance-sheet numbers. However, their business models were heavily exposed to the risk of a housing market downturn. With too much focus on balance-sheet numbers, the simple question of "what if the housing market takes a downturn" never made it to the analysis of their disclosure of risk to shareholders.

Interplay between Multiple Systems

The behaviors of multiple interacting systems differ fundamentally from that of a single system. For instance, Greece was able to obtain cheap financing after it joined the European Monetary Union. The European Monetary Union also helps make German products very competitive. After the 2008 Financial Crisis, the UK imposed more strict regulation and taxes on financial institutions. Such measures had unintended consequences since some financial institutions could move their operations to other countries with more lax requirements.

Chapter 2 Valuation Methods

2.1 Following the Flows in an Economic System

The foundation of any economic system is the people and the environments in which they live. It is people who ultimately make decisions in directing resource and money flows. It is people who communicate and process information. It is people who make rules and regulations. The global economic systemic consists of over seven billion individuals today; they constitute many vast markets.

To facilitate deeper understanding of systemic risks, we see an economic system as a network of *flows*, including people flows, resource flows, and money flows.

People flows
Over a long-term time horizon, demographic trends/shifts have a huge impact on labor supply as well as consumption; the various stages of life cycles and inter-generational wealth transfer are at the foundation of any economic system. Ultimately, it is people who are the agents behind the decisions on all economic transactions. Over a more intermediate time horizon, the herding behavior represents an important aspect of the people flow, and can impact a specific sector of the economic system.

Resource flows
With people as the main agents of an economic system, resources are needed to satisfy people's needs (and desires): raw materials, goods and services are changing hands in an economic system.

Money flows
Money flow refers to flows of financial resources, including capital markets transactions, savings and investment activities, loans, and credit flows. All businesses require essential resources, and financing is one of them.

Money flows are influenced by market valuations, as well as by rules and regulation.

2.2 Channels of Flows

A deeper understanding of the how the financial system works requires a study of the major channel of people flows, resource flows and money flows.

Firstly, individuals are behind all decisions and actions on the resource flows and money flows. Individuals make decisions based on information, emotion, and incentives and are constrained by rules and regulations and the external environment.

Information: Economic activities are directed by people (economic agents) who make decisions based on the information available to them. *Misinformation*, mostly *beliefs and assumptions* that reflect market sentiments, is an important source of systemic risk since it influences the decision-making by many market participants.

Incentives: Incentives for economic agents are the local driving forces for many financial transactions. Misaligned incentives may disrupt the channels for the money flows and result in wasteful allocation of resources.

Valuation Differentials: Gaps in the levels of valuation have a powerful influence on money flows and resource flows. Capital market valuations, cross-border comparisons, accounting and tax treatment can all have an impact on money flows and resource flows.

Rules and Regulation: Rules and regulations direct the channel of the flows.

Central Bank and Government intervention: the central banks and governments can exert huge influences on the financial system.

All these factors help to determine economic activities.

The state of the economy, particularly perceived future growth rates, affects individuals' economic decisions.

2.3 The Impact of People Flow on the Financial System

Actuaries have long analyzed demographic trends and their impacts on the financial system. In this research, we have noticed the significant influence of demographic trends on the economic system.

Demographic trends explain the Japanese miracle of the 1980s and the lost decades since the 1990s. According to Fred Pearce,[7] "Japan used to be young. When it was the poster child of Asia's economies, it profited from a huge population of young adults, and not many old dependents. Those young adults became so busy working that they almost gave up on having babies. Then they grew old. Result: the land of the rising sun has become the land of the setting sun. … Japan now has the world's oldest people – average female life expectancy is 86 years – and it has among the world's lowest fertility rates. At just 1.2 children per woman, it has not much more than half what it needs to maintain population numbers. Meanwhile, the average age is well over 40, and one in four people are over 65."

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[7] Fred Pearce, The population crash will kill our economy—good news for the environment, http://www.guardian.co.uk/environment/2011/oct/26/population-crash-economy-good-planet/print, 2011.

Figure 2.1 Japan Population Pyramid between 1990 and 2010
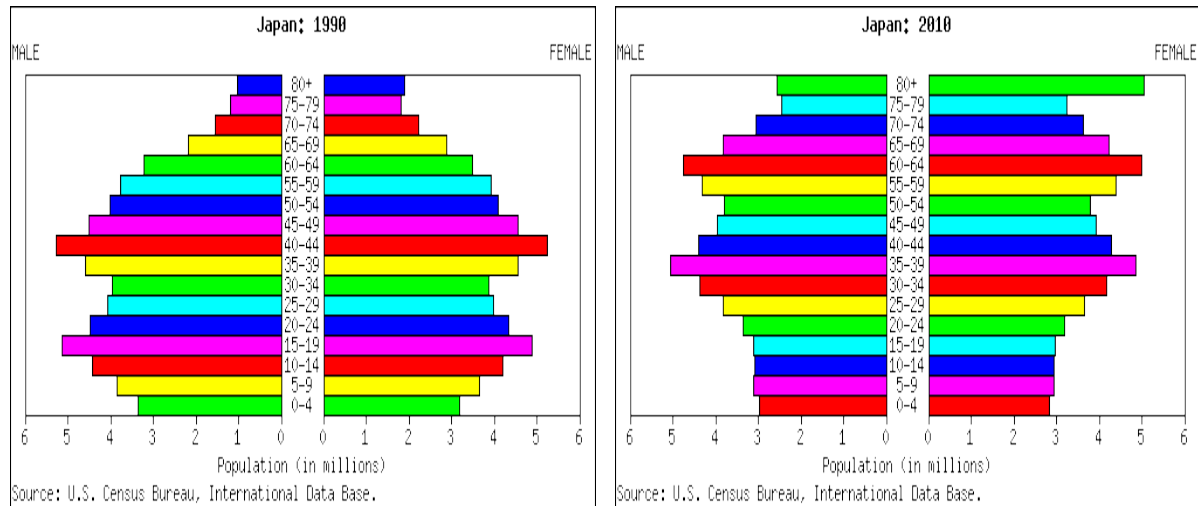
The above population pyramids provide a graphical representation of Japan's age distribution between 1990 and 2010. From the pyramids, it can be observed that the Japanese population is dominated by two major age groups. In 1990, the two major groups were aged 15-19 (pink) and 40-44 (red). The population in the remaining age groups seems to be high only when they are around the two major peaks. This characteristic implies a burst in birth rates in the 1970s and after 1946 (due to post WWII recovery years). As time progresses, the aging process of these two major population groups is evident as the two peaks move up the age scale. However, since 1990, the newly emerged population groups were consistently lower in numbers relative to the previous years, signifying a constant decline in Japanese birth rate.

Table 2.1: Percentage Breakdown of Japan Total Population by Age

Year	Total Population (in Thousands)	Population Aged 0 – 14 (%)	Population Aged 15 – 64 (%)	Population Aged 65+ (%)
1990	123,611	18.2	69.5	12.0
1995	125,570	15.9	69.4	14.5
2000	126,962	14.6	67.9	17.3
2005	127,768	13.7	65.8	20.1
2010	128,058	13.2	63.7	23.1

Source: US Census Bureau, International Data Base

As a result of the declining birth rate, the Japanese population is aging overall. An increasing portion of the total population is occupied by older citizens. The percentage breakdown of the

Japanese population demonstrates this situation. While the young population (aged 0 – 14) declined from 18.2% of the total population to 13.2%, the elder population (aged 65+) increased from 12.0% to 23.1%. Thus, the aging demographic trend is clearly evident in Japan.

Figure 2.2: Nikkei 225 from 1990 to 2011 (Source: Yahoo! Finance)

From 1990 to 2011, the Nikkei index dropped significantly from over 35,000 to less than 10,000. The decline in the index, which signifies a decline in economic conditions, may be a result of the aging population in Japan. As the country's major workforce retires, Japanese production capability decreases which results in the declining economic condition.

The Japanese example offers some guide for other Western developed countries which are experiencing both an aging population and an economic decline (e.g., Italy).

Young populations could be driving everything from the Arab spring to China's economic miracle. The Middle East and Egypt are experiencing a bulge of young adults in their population pyramid. However, governments have failed to harness this demographic potential for economic growth. Arguably those young adults took to the streets (the Arab spring). Figure 2.3 shows the rapid increase of youth (age 15-30) in Egypt. This growth fueled increasing demand for employment and consumption. The Egyptian economy failed to respond with appropriate opportunities for the young people.

Figure 2.3 Egypt Population Pyramid in Year 2008
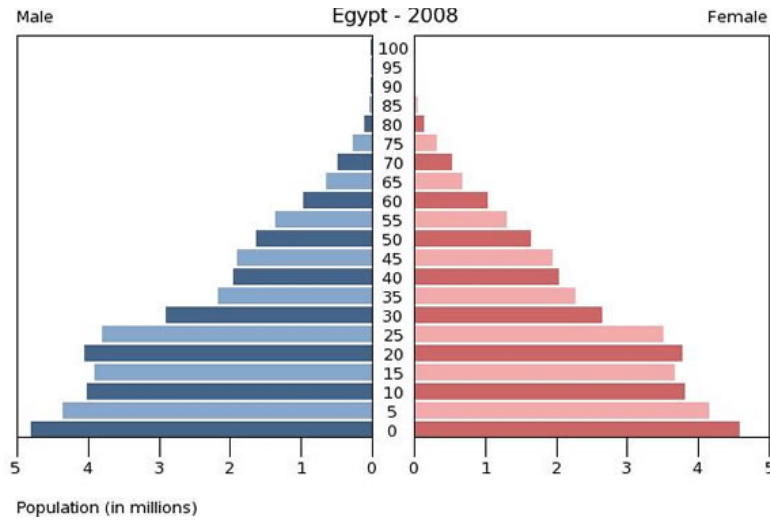
Source: US Census Bureau, International Data Base.

Economists have been discussing the unprecedented economic development of China, again, thanks to the large youthful population who filled factories at low costs. On the other hand, economists are sounding alarms for the declining fertility rates due to the Chinese government's one-child policy and the rising cost of raising a child (Figure 2.4).

Figure 2.4 Population Pyramid of China in Year 2010
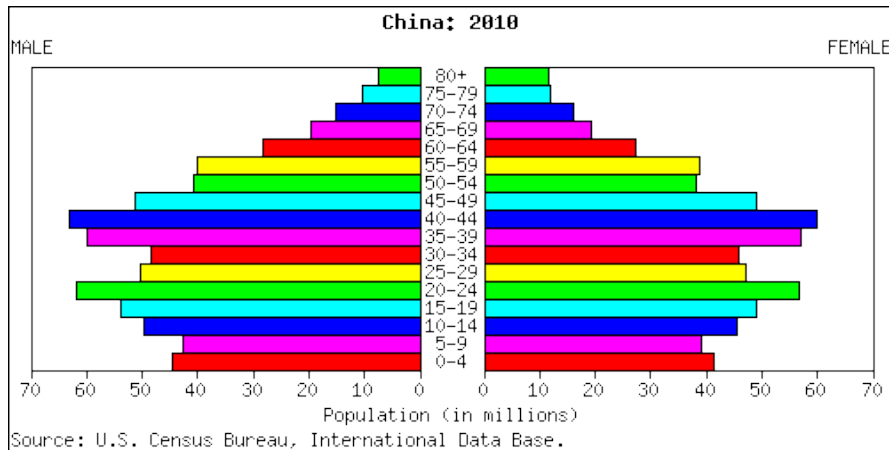
Figure 2.5 Population Pyramid of the United States in Year 2010
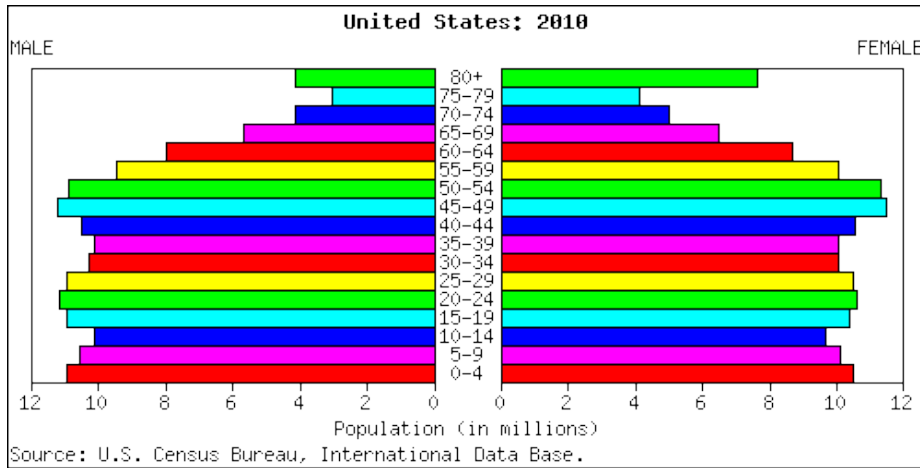
Based on the demographic trends in Figure 2.5, we can see that the United States has a steady demographic trend without significant decline in youth population (thanks to both healthy birth rates and immigration). With this demographic profile, the U.S. will likely continue to command a leadership position among the developed countries, and has a huge advantage over Western developed countries.

When it comes to demographic trends, it is not only fertility rates that count, but also migration trends. For instance, although Germany is experiencing an aging population, it is attracting immigration of workers from other European countries with high unemployment rates (e.g. Spain).

2.4 The Impact of Money Flows on the Financial System

Most financial collapses originate from the same cause: an explosion of credit.

The amount of money that flowed into the real-estate sector in the early 2000s can be used to explain the drivers of the U.S. housing boom. As shown in Figure 2.6, the amount of non-agency mortgage-backed securities (MBS) grew rapidly, indicating significant money flow into the real-estate sector.

Figure 2.6 Non-agency MBS Issuance & Type of Mortgage Loans
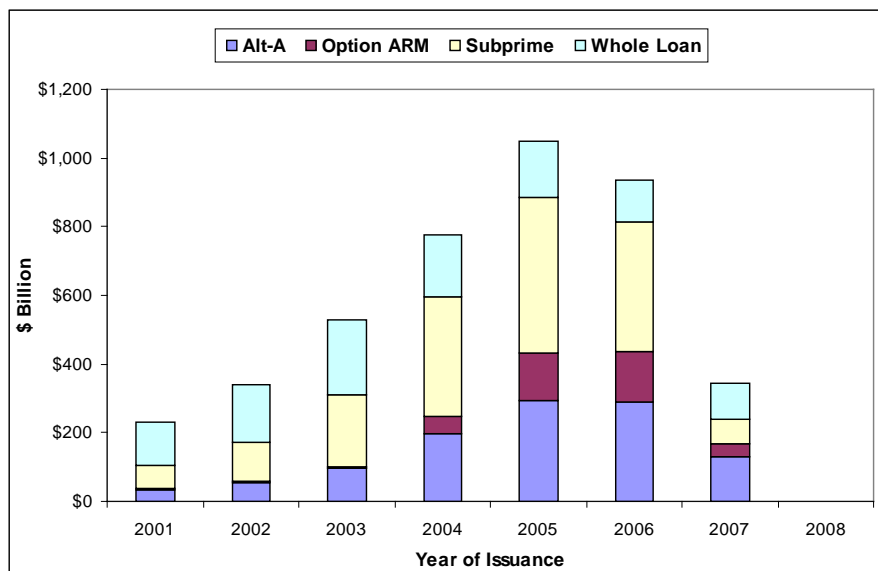
Increased levels of valuation can be the result of "uneven" money flows, which can also be the cause of massive money flows. A rising stock market can have a positive impact on an economy. On the other hand, an unsustainable (out of balance) high stock market valuation may damage an economy, primarily by distorting incentives. During stock market bubbles, many business people (owners and employees) stop regular business activity and "play" the stock market to get rich.

Until 1997, Asia attracted almost half of the total capital inflow into developing countries. The economies of Southeast Asia in particular maintained high interest rates attractive to foreign investors looking for a high rate of return. As a result the region's economies received a large inflow of money and experienced a dramatic run-up in asset prices. At the same time, the regional economies of Thailand, Malaysia, Indonesia, Singapore, and South Korea experienced high growth rates, +8 to 12% in GDP, in the late 1980s and early 1990s. This achievement was widely acclaimed by financial institutions including the IMF and World Bank, and was known as part of the "Asian economic miracle." The large inflow of money channeled large quantities of credit that became available, which in turn generated a highly leveraged economic climate, and pushed up asset prices to an unsustainable level.

The 1997-1998 Asian Financial Crisis was triggered by corrections in the asset prices which resulted in defaults on loans. The resulting panic among lenders led to a reversal of money flow out of the Southeast Asia countries and caused further credit crunch and more bankruptcies. As

foreign investors attempted to withdraw their money, the exchange market was flooded with the currencies of the crisis countries, causing abrupt depreciation of currencies in those countries.

Impact of the FDI Flows

Foreign Direct Investments (FDI) represents the money flows across borders, and can have a huge impact on economic activities. We can use the recent China experience as an example.

As reported by the Royal Bank of Scotland, China attracted the most foreign direct investment (FDI) in absolute terms in the past decade 2002-2011 (around $1.3 trillion or almost half the $2.1 trillion flows to the 21 leading emerging markets).

Figure 2.7 Cumulative FDI inflows to China and other emerging countries

Source: Sujata Rao, Where will the FDI flow? *Reuters*

Cumulative FDI inflows over the last 10 years (USDbn, 2002-2011)
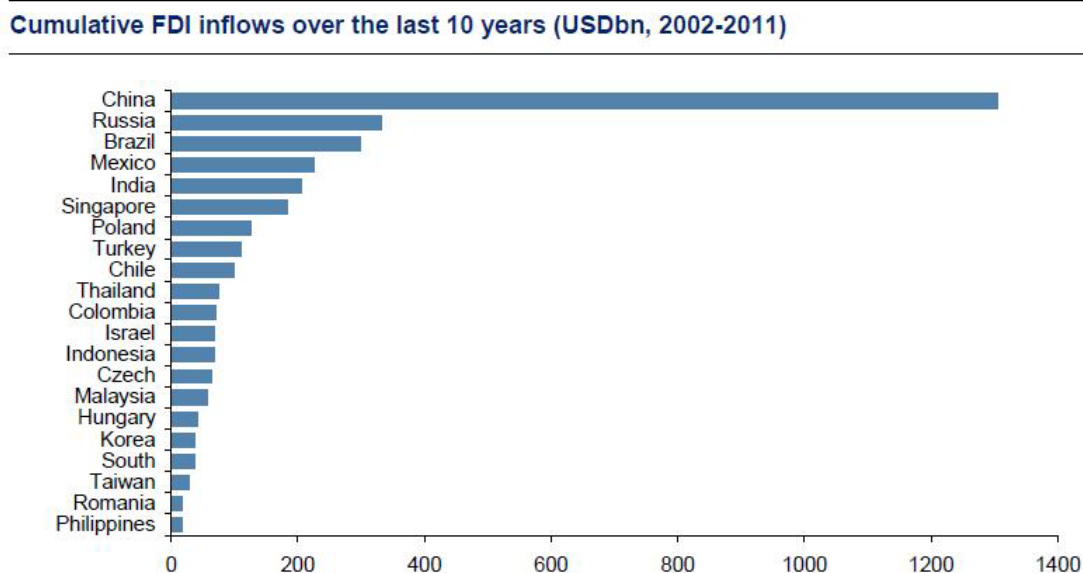
But this FDI to China is slowing. This is because China's low-value manufacturing base is becoming less competitive relative to the rest of Asia, and because stringent restrictions remain in place in many sectors. RBS notes that China is at risk of suffering a decrease in FDI inflows in coming years.[8] The bank also notes that the nature of FDI in China is changing: half the 2011 flows went to real estate.

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[8] Sujata Rao, Where will the FDI flow? *Reuters,* http://blogs.reuters.com/globalinvesting/2012/04/27/where-will-the-fdi-flow/, April 27, 2012.

As reported by Bloomberg,[9] FDI in China dropped for a fifth straight month in March 2012 on a slowing economy, limited prospects for gains in the Yuan, and renewed concerns that Europe's debt crisis will worsen. There are also reports of an acceleration of cash exiting China. These reports may be reinforcing the downward pressure. A reversal of FDI flow - out of China - may pose a severe downside risk for China's economy and the world's economy.

2.5 Mark to Market Accounting Valuation

Mark-to-Market (MTM) rules require that financial institutions holding financial instruments available for sale (such as mortgage-backed securities, preferred stock, and bonds) must mark those assets to market.

MTM can be very appealing to the financial industry during times of market boom. MTM helps to recognize the profits more quickly during times of market boom. MTM profits can generate momentum and invite more speculation and make it difficult for regulators to "spoil the party". Conversely, during a market downturn, MTM will feed into a downward spiral of fire sales. In summary, MTM accounting is pro-cyclical (amplifying the cycle swing) and makes the financial system suffer increased volatility.

William M. Isaac testified:[10] "MTM accounting has destroyed well over $500 billion of capital in our financial system. Because banks are able to lend up to ten times their capital, MTM accounting has also destroyed over $5 trillion of lending capacity, contributing significantly to a severe credit contraction and an economic downturn that has cost millions of jobs and wiped out vast amounts of retirement savings on which millions of people were counting."

"Below is an example of the distortion that occurs when using mark to market (MTM) accounting. This example involves an actual case study from an anonymous bank that made loans and securitized them as a mortgage backed security (MBS). Expected losses and expected cash flows for the MBS differ dramatically from MTM write downs. The Bank is required to record MTM losses of $913 million as opposed to the maximum expected lifetime losses of $100 million, resulting in a significant overstatement of losses and having a negative impact on tangible common equity."

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[9] Bloomberg, China's Foreign Direct Investment Declines a Fifth Month, http://www.bloomberg.com/news/2012-04-17/china-s-foreign-direct-investment-declines-for-fifth-month-1-.html, April 17, 2012.

[10] before the U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON FINANCIAL SERVICES on March 12, 2009

Figure 2.8 The Magnified Losses by MTM Accounting
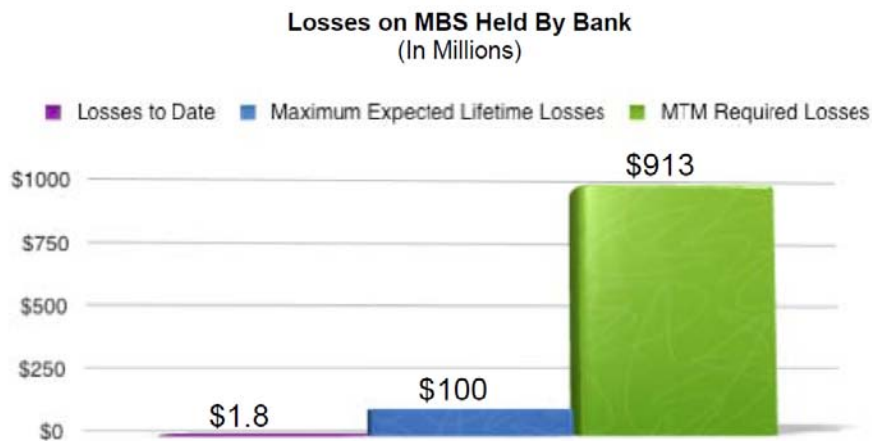
Source: William Isaac's Testimony before US House of Representatives Committee on Financial Services

"It is extremely important that bank regulation be counter-cyclical, not pro-cyclical. The time for banks to create reserves for losses is when the sun is shining, not in the middle of a hurricane."

This calls for alternative valuation approaches to MTM valuation. One promising approach is to resort to actuarial valuations.

2.6 Actuarial Valuations

Actuarial science is an applied discipline which evolves to meet the challenges of evaluating insurance/financial products in today's complex economic, regulatory and technological environments. Insurance plays an important part in the financial system in serving individuals', corporations', and societies' need for financial security and risk sharing. Actuarial science offers guidance, with methodology and measurements, for not only product design, but also risk-based pricing to ensure optimal sharing of risks and, as a result, to facilitate efficient allocation of financial resources.

Distinct from other natural and social sciences, actuarial science has the following unique features:

    i.   Actuarial methods are developed from the specific social contexts of risks, combining both the financial mathematics and the social/behavioral aspects. Actuarial science lies in between natural sciences and social sciences.

ii. Actuarial science is rooted in empirical evidence and practical applications. A foundation of actuarial science is the study of life cycles of individuals and the financial security needs at different stages of those life cycles. This foundation is invaluable for understanding systemic risk.

iii. Actuarial valuations adopt very long-term time horizons. For instance, life and annuity contracts may cover several decades. Property-casualty insurance deals with insurance market cycles that can last for several years. In contrast, financial engineering approaches focus almost exclusively on current market data. The long-term perspective of actuarial science is an advantage in the study of systemic risks, which often accumulate over a long period before erupting. Actuarial valuations complement other valuations (e.g., capital market valuations, regulatory and accounting rules). This puts actuaries in a unique position to analyze the multiple forces interacting with the financial system.

Historically, actuarial science has evolved over time in response to changes in the landscape of financial and insurance markets. The recent financial crisis is in part brought to us by financial engineering approaches, with an obsession with market values. Actuarial science is uniquely positioned to help in the management of systemic risk. If financial engineering brought us the crisis, it is new thinking (actuarial) that will get us a better future. Or, actuarial science can provide new tools in dealing with systemic risks.

Chapter 3 Actuarial Analysis of Systemic Risk

3.1 Regime Change of the Financial Market

According to the insights of Keynes, there are two different modes of the financial system: (i) normal functioning of a financial system where the market is able to re-adjust to long-term equilibrium in response to market forces, and (ii) the financial system fails to re-equilibrate and requires intervention (to re-start or even re-set the system).

The financial market exhibits different behaviors under different regimes. For instance, Fostel and Geanakoplo (2008) define three regimes:
  i.   The *normal* market, when the liquidity wedge is small and leverage is high;
  ii.   The *anxious* market, when the liquidity wedge is big and leverage is curtailed, and the general public is anxiously selling risky assets to more confident natural buyers; and,
  iii. The *crisis* or *panicked* market, when many formerly leveraged natural buyers are forced to liquidate or sell off their positions to a reluctant public, often going bankrupt in the process.

A discussion of systemic risks requires separate treatments of the financial system depending upon the specific regime (mode) of the market. The vicious market cycle represents a case where smart regulation by policy makers and government intervention can fail. One objective of the study of systemic risks is to identify signals and metrics to counter such vicious cycles to help policy makers and regulators.

3.2 Key Assumptions Breakdown under Changes of Regime

An important lesson learned from the financial crisis is that when there is a significant change in condition, some of the previous assumptions do not hold, and very different behavior patterns emerge. We see this in the historical relationship between mortgage rates and applications.

Figure 3.1 Historical Relationships between Mortgage Rates and Applications

Source: Business Insider

Historical Relationships Between Mortgage Rates And Applications

"The charts below show the relationship between mortgage rates and mortgage purchase applications. As the first chart shows, historically this relationship has been negatively correlated which is proper (as rates fall, mortgage applications for purchase rise). In the second chart what you see is that recently this relationship has completely reversed and it's positively correlated. In other words, potential homebuyers are not presently responsive historically low mortgage rates."

—Tom Porcelli, Chief Economist at RBC Capital Markets

1990 to mid-2006
R = -85%

mortgage apps for purchase

30-year effective mortgage rate

mid-2006 to current
R = +89%

mortgage apps for purchase

30-year effective mortgage rate
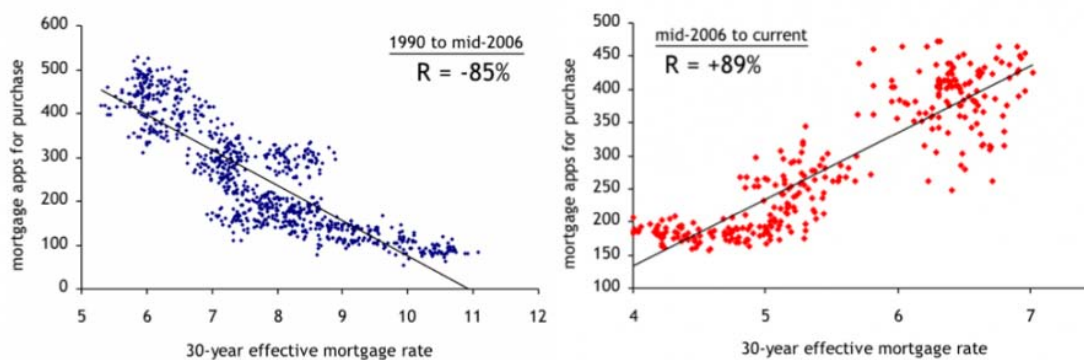
We also see this changing assumption in the variable annuity business. According to a Wall Street Journal report,[11] Dutch financial-services company ING Group took a hit in earnings in the fourth-quarter of 2011, up to €1.1 billion ($1.48 billion) from the company's U.S. annuities business. ING said the charge is needed to cover guaranteed payouts from the annuities *as investors are now more likely to stay put* because of the financial crisis. ING sold 500,000 of its U.S. variable annuity products from 2003 to 2009 before calling a halt to new investment, giving it total funds of $45 billion. Assumptions for the U.S. closed block variable annuity business have been updated to take into account a number of changing factors, such as mortality rates, but ING said its most significant revision was for the number of expected lapses.

A point needs to be made that systemic risks involve changes in conditions and thus changes in assumptions. Research work on systemic risks should focus on the calibration of key

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[11] Wall Street Journal, ING takes US annuities hit, http://online.wsj.com/article/SB10001424052970203413304577083652727129504.html, December 7, 2011.

assumptions under changing conditions, rather than re-calibrating the risk model to existing market conditions. It is well known that financial engineers calibrate their models to market values. In contrast, actuaries have a long tradition of calibrating valuations based on long-term trends and sustainable values.

3.3 Counter-Cyclical Measures

IAA (2009) publication,[12] "Dealing with Predictable Irrationality – Actuarial Ideas to Strengthen Global Financial Risk Management," recommended more counter-cyclical regulatory arrangements.

"Existing prudential regulatory arrangements need to become more dynamic and counter-cyclical rather than pro-cyclical. This would include developing approaches that would see regulators transparently changing capital requirements for market participants (not just interest rates) when early warnings appear of market "bubbles" emerging. For example, capital "shock-absorbers" could be put in place to gradually deflate market bubbles before they burst. This would provide the capacity to allow "drawdowns" of such capital during periods of subsequent market stress rather than having to enforce tougher capital requirements at such times. Australia provides an example of counter-cyclical approaches. The Australian Prudential Regulation Authority (APRA) in 2003/4 requested to stress test the ability of all banks to withstand a 30% fall in housing values."

"During the housing market boom in the U.S., under the then market assumptions of continuing housing price appreciation, the Collateralized Debt Obligations (CDOs) were severely underpriced, which was a major contributor to the current crisis." Here an actuarial re-evaluation of the correlation assumptions, taking into consideration the stress scenario similar to the APRA exercise, would have helped supplement the irrational market assumptions.

Most regulators have realized the need for counter-cyclical measures. However, very few tools are available to regulators to embolden counter-cyclical actions.

From our analysis of systemic risks in the housing market, we advocate using actuarial appraisal values as a counter-cyclical measure.

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[12] International Actuarial Association, Dealing with Predictable Irrationality – Actuarial Ideas to Strengthen Global Financial Risk Management,
http://www.actuaries.org/CTTEES_TFRISKCRISIS/Documents/IAA_Financial_Risk_Management_EN.pdf

3.4 Actuarial Control Cycle

The actuarial profession has long developed the concept of a "control cycle" especially when managing long term risks that are not actively traded. This "Actuarial Control Cycle" concept involves a feedback-loop:

i.   modeling of expected results,
ii.   measurement of actual results,
iii. determination, in both quantitative and qualitative terms, of an understandable explanation of the differences between the expected and actual results, and
iv.   Use of those findings to recalibrate and strengthen the model.

In studying systemic risks, this type of feedback loop helps to learn the behavior of the "system" or to detect changes of the "conditions of the system." Adopting an Actuarial Control Cycle approach can improve the capacity to take action before a financial disaster.

The IAA publication recommends the Actuarial Control Cycle in light of the limitation of current approaches. "All too often, current capital markets activity is based on daily procedures that can lose sight of the bigger picture involving the longer term, whole market risks, shifts in fundamental risk parameters, systemic risks and/or unexpected correlations between events, whether extreme or not."

The concept of an Actuarial Control Cycle is especially useful when we monitor several indicators of the system and when combined with actuarial valuation as a complement to market valuation.

3.5 Where to Look for Systemic Risk indicators?

Brunnermeier, Dong, and Palia (2012) documents that banks with higher non-interest income (noncore activities like investment banking, venture capital and trading activities) have a higher contribution to systemic risk than traditional banking (deposit taking and lending). The paper also finds that banks with higher trading income one year prior to the recession earned lower returns during the recession period.

Figure 3.2 Average non-interest income to interest income ratio over 1986-2008
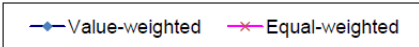
Source: Brunnermeier et al (2012)
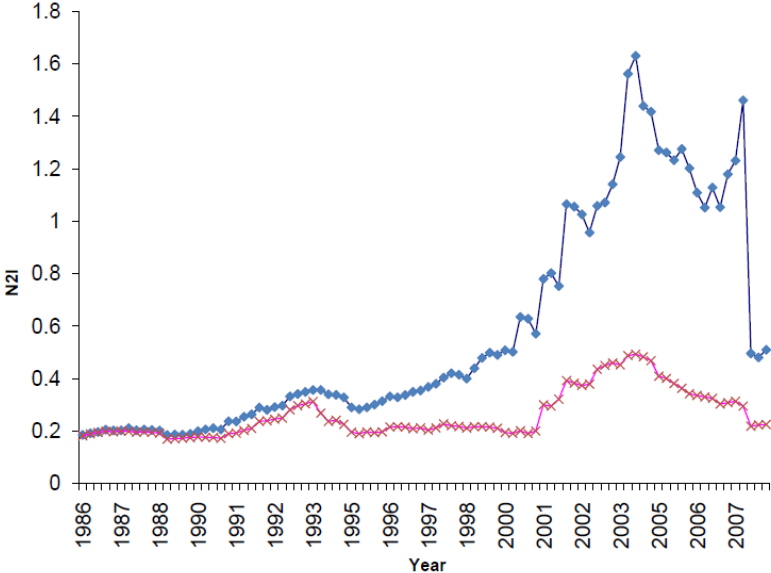
Chapter 4 Systemic Risk for the U.S. Housing Market

4.1 The U.S. Housing Market

The housing sector plays an integral role in the U.S. economy. Residential homes are the greatest source of wealth and savings for many Americans. The U.S. housing prices had several years of run up during 2001-2006 before it tipped over in a plunge during 2007-2011(see Figure 4.1). About $9.2 trillion of wealth were created in the 2001-2006 period due to housing price appreciation, and then over $6.7 trillion were lost during the subsequent 2007-2011 downturn. This wealth effect was borne firstly by households and secondly by businesses.

Figure 4.1 U.S. Residential Real Estate Market (Source: Federal Reserve Board, Flow of Funds)

Homeowner Equity = Market Value – Mortgage Liability
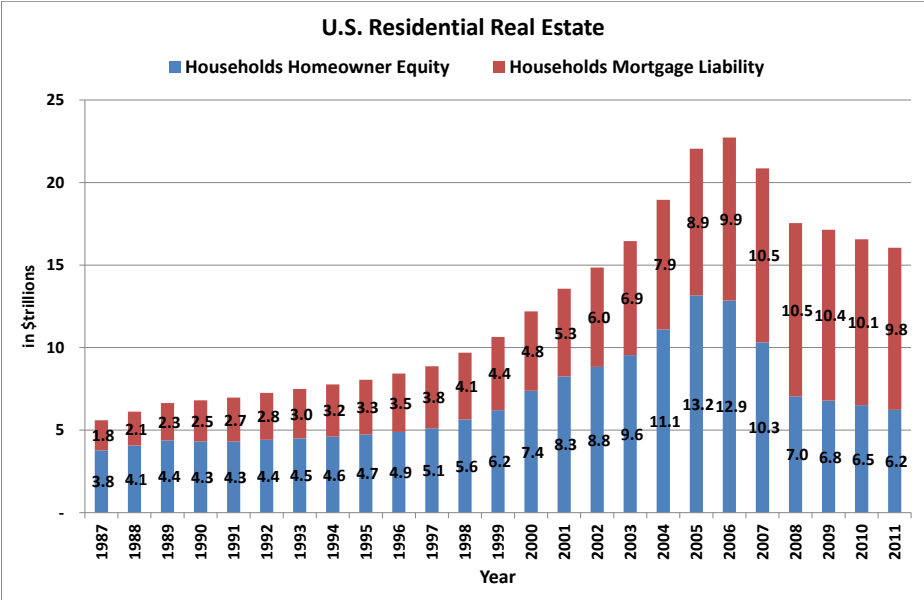
We were able to track indicators of money flow behind the formation of the U.S. housing bubble. In Figure 4.2, we can see that the size of non-agency Mortgaged-Backed Securities (MBS) issuance increased rapidly from year 2001 through 2005. A large majority of the non-agency residential mortgage-backed securities (RMBS) are of Subprime, Alt-A and Option ARM loans.

Figure 4.2 Non-Agency MBS Issuance[13]
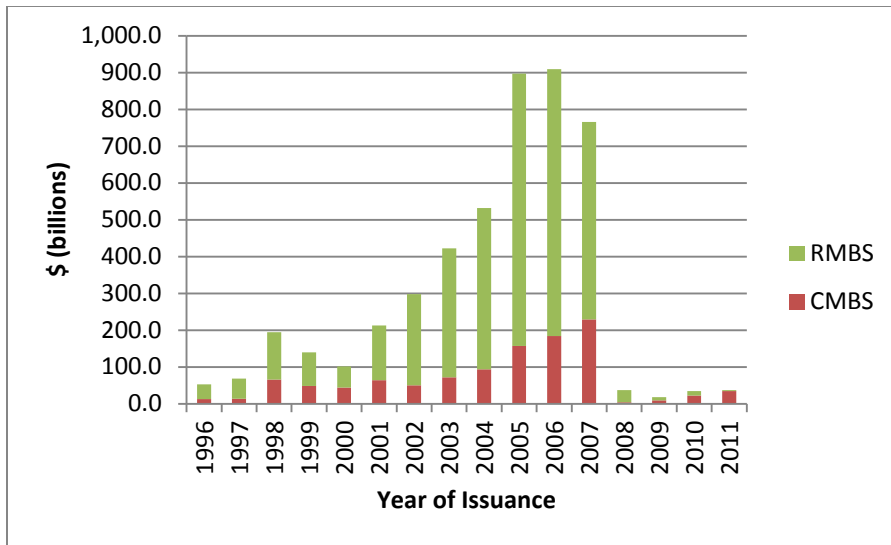
The housing market affects a larger segment of the population than the stock market, and has a big impact on consumer spending. In a research article,[14] Karl E. Case, John M. Quigley, and Robert J. Shiller examined the link between increases in housing wealth, financial wealth, and consumer spending. They studied a panel of 14 countries observed annually for various periods during the past 25 years and a panel of U.S. states observed quarterly during the 1980s and 1990s. They found strong evidence that variations in housing market wealth have important effects upon consumption. For example, in one model specification, a ten percent increase in housing wealth increases consumption by roughly 1.1 percent for the international panel, while a ten percent increase in stock market wealth had virtually no effect upon consumption.

Figure 4.3 shows how the U.S. home equity channeled credit flows in and out of the households sector.

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[13] Source: Securities Industry and Financial Markets Association
[14] "Comparing Wealth Effects: The Stock Market versus the Housing Market"

Figure 4.3 Housing Equity Withdrawal since the financial crisis

Source: Kate Reinold[15]
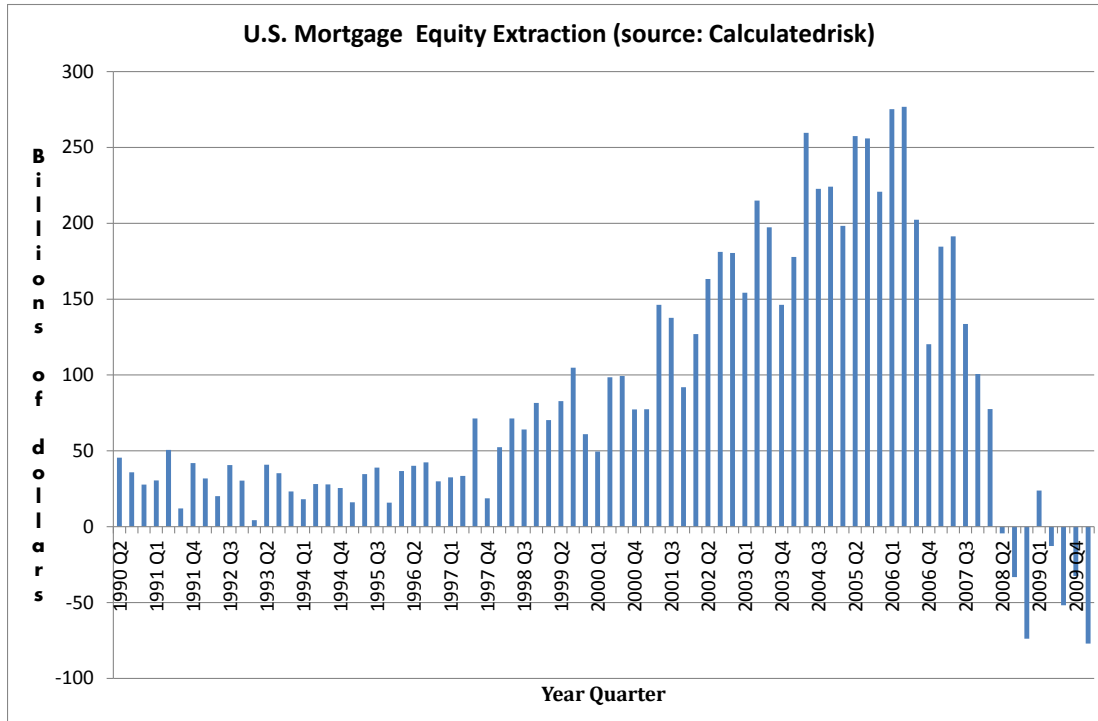
As shown in Figure 4.4, the homeowner equity as a percentage of real estate market value remained relatively flat from 2001 to 2005, and then dropped by 3% in 2006. The 3% drop in 2006 may be a result of increased use of non-conventional (such as Alt-A) mortgage loans. Figure 4.4 provides further evidence that when the market value appreciated from 2001 to 2006, real estate served as an ATM machine for households to take out the money for consumer spending. The subsequent drop of homeowners' equity as a percentage of real estate market value for the years 2007-2011 is predominantly due to the housing price depreciation.

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[15] Calculated Risk, http://www.calculatedriskblog.com/2012/05/mortgage-equity-withdrawal-update.html

Figure 4.4 U.S. Residential Homeowner's Equity

Source: Edward Pinto[16]
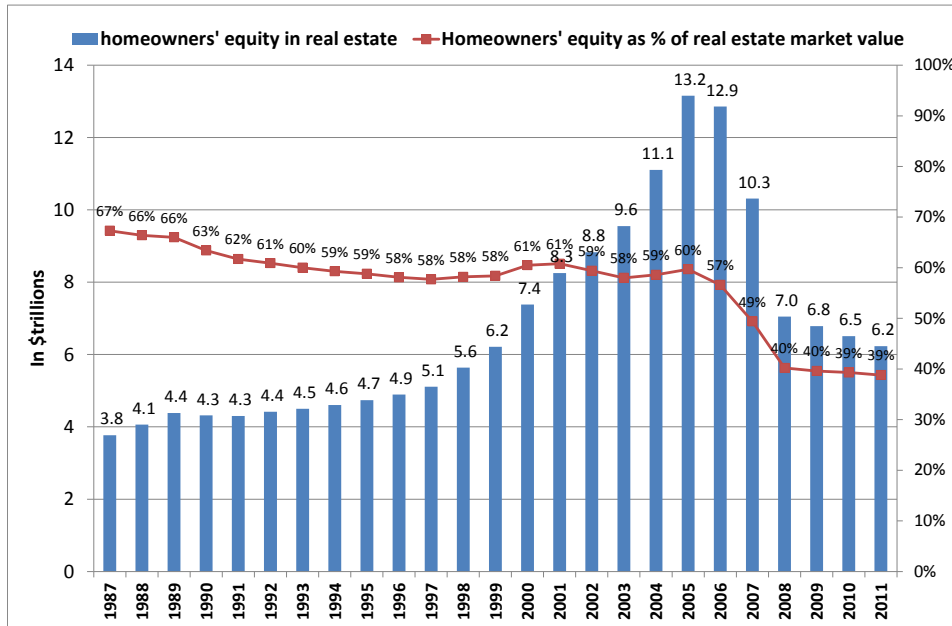
4.2 Indicators of Housing Financing Leverage

Earned equity is the combination of a down payment and scheduled amortization. It is also known as "skin in the game." For the house purchase, a measure of leverage is the size of the down payment as percentage of the house value.

Edward Pinto gives a contrast of housing financing leverage between the 1990s and the first half of 2000s. He tracked the leverage for the bottom 50% of purchase loans in terms of size of down payment. For Fannie Mae loans, the average equity in year 1990 was 12% (7:1 buyer leverage), as compared to only 1.5% equity in 2006 (66:1 buyer leverage). For Subprime loans, the average equity in year 1990 was 25% down (3:1 buyer leverage), as compared to only 2.7% equity in 2006 (36:1 buyer leverage).

Figures 4.5 and 4.6 show the trend of increased leverage for Agency loans and Non-Agency loans, respectively.

Figure 4.5 Housing Leverage for Agency Loans
Source: Edward Pinto[17]
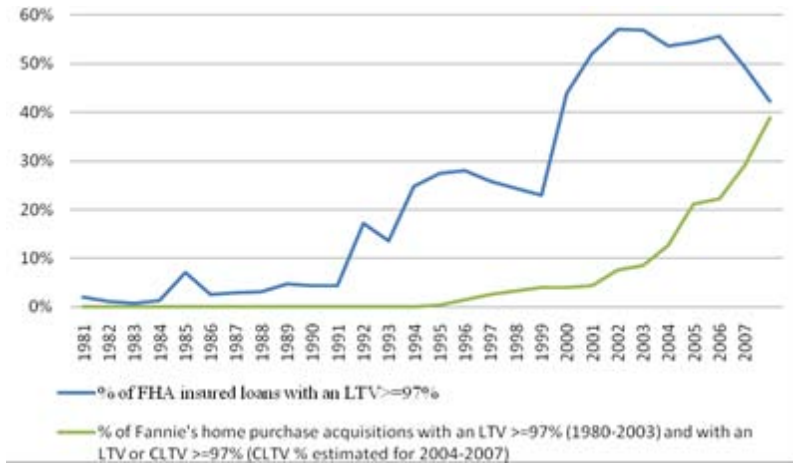
Figure 4.6 Housing Leverage for Non-Agency subprime and Alt-A loans
Source: Edward Pinto[18]
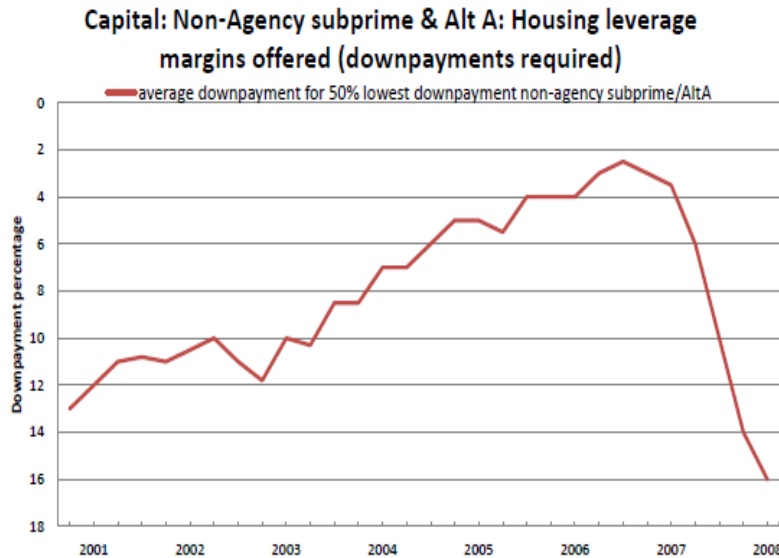
Edward Pinto also pointed out that there were plenty of warning signs of potential overvaluation in the housing market:

    i.   Widening gap between prices and fundamentals (rents and construction costs).

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[17] American Enterprise Institute conference, "Reengineering the Appraisal," August 8, 2012
[18] American Enterprise Institute conference, "Reengineering the Appraisal," August 8, 2012

ii.   Rapid credit growth and proliferation of innovative mortgage products.
iii.   Unusually high level of construction.
iv.   Strong speculative interest in real estate.

Unfortunately, during the years 2001-2006, market participants and regulators relied too heavily on the ever increasing market prices of housing and ignored those other signals and indicators. There were no counter-cyclical mechanisms that were put into place to provide a damper to the formed bubble. This almost exclusive reliance on "market" valuations also plagued the housing appraisal industry.

4.3 The Role of Appraisers in the Housing Market

Appraisals played an important role in both the housing bubble formation in 2001-2006 and the sluggish recovery in 2007-2011. This is due to the underwriting approval of mortgage loans depending upon the loan-to-value ratio, which is the loan amount relative to the home appraisal value. Home appraisals are supposed to be objective (unbiased) assessments of a property's value. For decades, home appraisals were done primarily by independent professionals who were experts in their local markets, based largely on selling prices of comparable homes.

The housing bubble that burst a few years ago was inflated, in part, by overly generous appraisals, which were fueled by the momentum of housing price appreciation. This helped to support widespread market optimism with the belief that the housing price appreciation trend would continue into the future.

Since the subprime mortgage crisis in 2007, the appraisal system has been reformed in recent years to put a stop to the high estimates of property values that even appraisers admit helped inflate the housing bubble. As an adjustment from past mistakes, appraisers are under pressure to come in with lower estimates, and valuations are being heavily influenced by distressed sales which are priced at a discount to the rest of the market. Many industry watchers argue the new regime has caused the pendulum to swing too far to the other side, inadvertently causing the opposite problem: artificially low appraisals. In a research paper, [19] economist Leonard Nakamura at the Philadelphia Federal Reserve cited a downward bias in appraisals.

One indicator of the bias in appraisals is the increasing number of disputes over appraisal values. The National Association of Realtors said that 16% of realtors surveyed in 2011 reported a cancellation of home sale in June of this year. Chief economist Lawrence Yun blamed the

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[19] "How Much Is That Home Really Worth?"

unusually large number on low appraisals. In June of 2010, only 9% of those surveyed reported a cancellation.[20]

Lower appraisal is another form of tightening the credit flow, thus exacerbating the housing problem. Thus, appraisal value serves as a hidden "control" that can loosen or tighten the credit flows.

4.4 Housing Appraisal Methodologies

The Federal Housing Authority (FHA) requires the use of multiple approaches to valuation. FHA methodology is based on three principles (see McMichael's Appraising Manual, 4th Edition (1951)):

  i.   The Principle of Replacement (Cost Approach)
  ii.   The Principle of Substitution (Market Comparable Approach)
  iii. The Principle of Income Capitalization (Income Approach)

However, the Principle of Replacement Cost Approach was discouraged by federal agencies when the Market Comparable Approach was given predominance. Fannie Mae[21] took a position that

  i.   Appraisals that rely solely on the cost approach as an indicator of market value are unacceptable.
  ii.   Fannie Mae does not require the cost approach to value except in the valuation of manufactured homes.

Construction costs can serve as a barometer of long-term intrinsic value for houses. The figures[22] below show comparisons of market price and construction costs, for the United States and Phoenix, respectively.

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[20]S Kalita and C. Mollenkamp, Judgment Call: Appraisals Weigh Down Housing Sales, Wall Street Journal, http://online.wsj.com/article/SB10001424053111904006104576500170808091148.html, August 11, 2011.

[21] According to Appraisal Report Review: Cost Approach to Value (04/01/2009, B4-1.4-19,)

[22] Scott Andrew, Approaches to value – construction costs, American Enterprise Institute conference, "Reengineering the Appraisal," August 8, 2012.

Figure 4.7

Market Price divergence from construction costs – United States
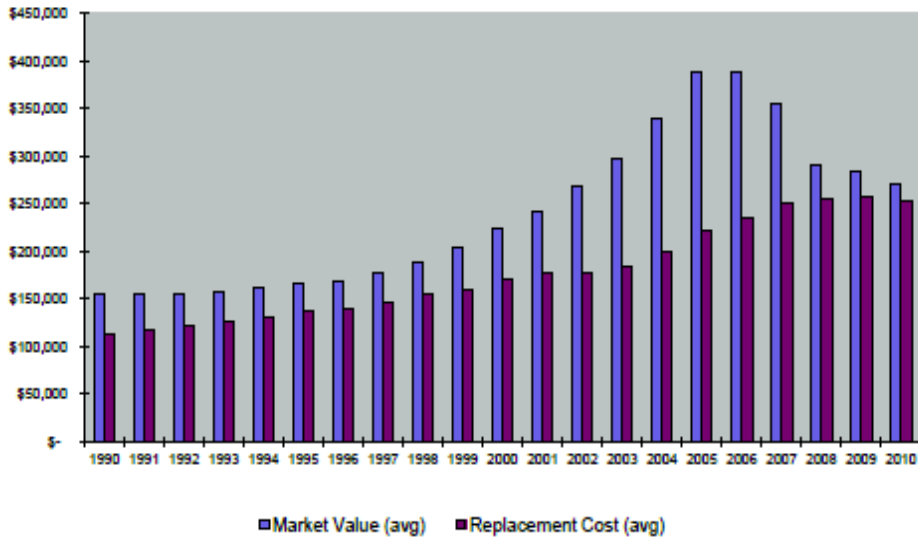
Figure 4.8

Market Price divergence from construction costs– Phoenix
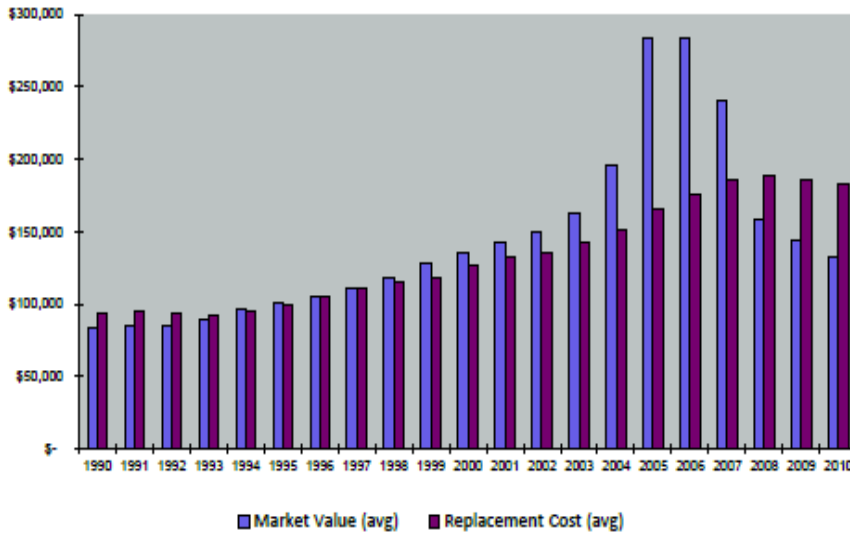
Source: Scott Andrew[23]

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[23] American Enterprise Institute conference, "Reengineering the Appraisal," August 8, 2012.

Separate Appraisal of Land and Structure

Recently, researchers are advocating that a house is a bundle of structures and land, and thus appraisal should be done separately for the land and structure. Morris A. Davis (2012) argues that

  i.   Structures are elastically supplied and construction costs are roughly flat.
  ii.   Land supply is inelastic - changes to demand more likely lead to changes to price.
  iii. "Deviations from fundamentals" in housing will appear in land prices and construction quantities.

Historically, land prices have demonstrated higher volatility than the housing prices.

Figure 4.9 Volatilities of Land Prices versus Housing Prices

Land prices moved up and down much more than house prices.
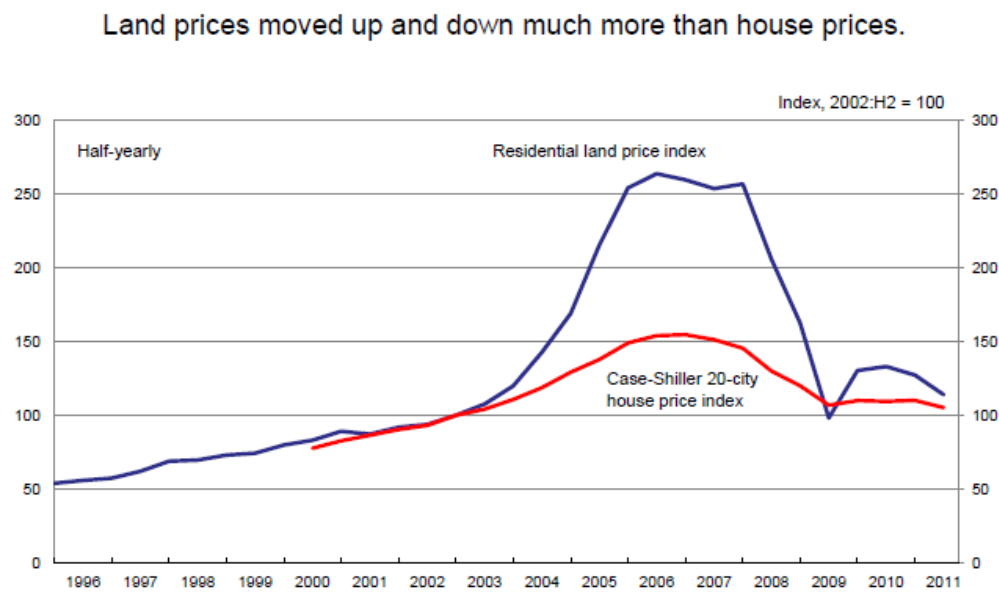
Source: Nichols, Oliner, and Mulhall (2012).

Land is the key element in housing cycles. This is because land prices are more volatile than structure prices. For metro areas, a larger share of house price is due to land price, and metro areas are more susceptible to run-ups and collapses in housing prices. Lenders should be conservative in lending against land value, especially after large increases in land prices. This would help to instill counter-cyclical discipline into real estate lending.

Actuarial Appraisal Value

Here we advocate for an actuarial appraisal methodology, reflecting not only current market values, but also the long-term trend of housing prices. The key aspect of the actuarial appraisal methodology involves the selection of a reasonable range (with floor and cap) of the rate of housing price appreciation. Once this rate of housing appreciation falls outside the reasonable range, a housing appreciation beta is applied to control it.

Here we present an example of an actuarial appraisal methodology applied to the Case-Shiller Index. The actuarial appraisal value is based on *a controlled rate of price appreciation.*

  i.   Select a reasonable range for the house price appreciation with a Floor and a Cap.
 ii.   If Quarterly Appreciation is within the range [Floor, Cap], no adjustment is needed, and Controlled Rate of Appreciation = Observed Rate of Appreciation
iii.   If Quarterly Appreciation is greater than the Cap
        Controlled Rate of Appreciation = Cap + Housing Appreciation Beta * (Observed Rate of Appreciation – Cap)
 iv.   If Quarterly Appreciation is lower than the Floor
        Controlled Rate of Appreciation = Floor + Housing Appreciation Beta * (Observed Rate of Appreciation – Floor)

Using the Case-Shiller U.S. housing price index, by minimizing the sum of squared error (distance between actual and appraisal values), we calibrated the following parameters for an actuarial appraisal formula: Floor = 0.008591, Cap = 0.016864, and Housing Appreciation Beta = 0.3. Figure 4.10 shows a comparison of the Case-Shiller housing price index and the actuarial appraisal value.

Using this specific calibration, the actuarial appraisal value of the Case-Shiller index for 2012 Q1 is 158.30, as compared to the actual Case-Shiller index value of 127.32. The actuarial appraisal value represents a price level that is 24.3% higher than the current market value. Admittedly, this does not mean that the housing value should be 24.3% higher across the board, as there are variations across regions.

Furthermore, instead of presenting one actuarial appraisal value, we can come up with a range for the actuarial appraisal values, with a low estimate and a high estimate.

Figure 4.10 Actuarial Appraisal Value for the U.S. Housing Price Index

Case Shiller U.S. Housing Price Index (Seasonally Adjusted)
COMPOSITE-US-SA — Actuarial Appraisal Value
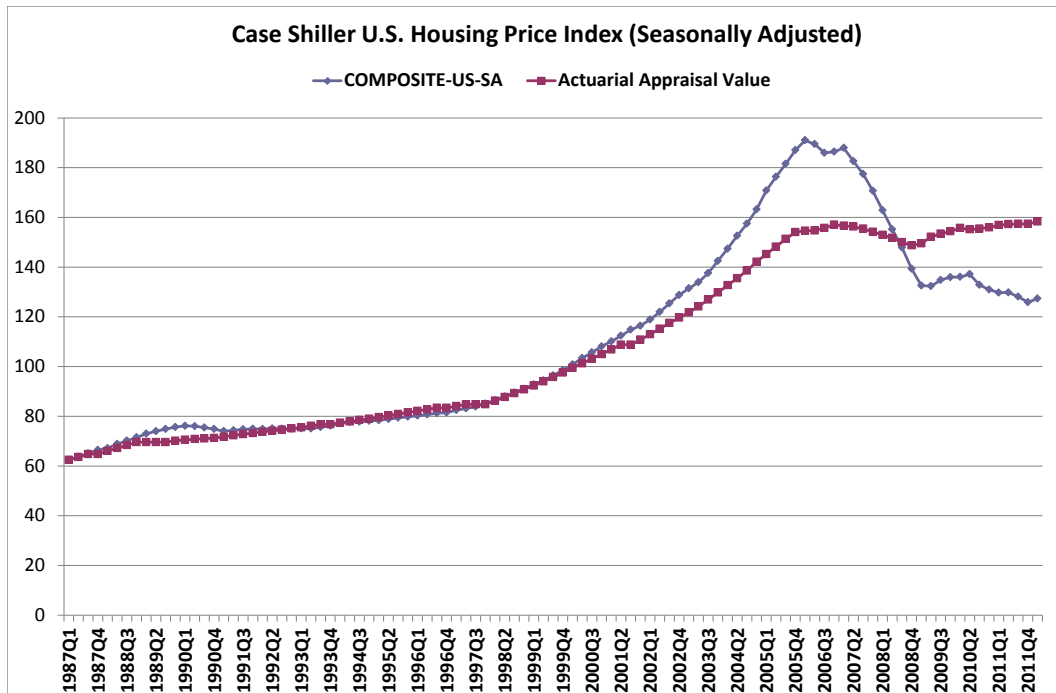
4.5 Economic Incentives and Strategic Default

In the recent housing market down turn, there was empirical evidence of two types of mortgage defaults:

i. Default due to an Income Issue: the family income is insufficient to pay mortgage payments. Unemployment and lost income may contribute to this type of default. On the other hand, a sustained low interest environment may have already reduced the interest cost of mortgage loans.

ii. Default due to a Balance Sheet Issue: many homeowners can afford the mortgage payment but make a rational decision to default, because the homeowner has negative equity in their home. Negative equity, which is also referred to as "underwater" or "upside down," means that borrowers owe more on their mortgages than their homes are worth. In the case of "underwater" mortgages, the homeowner may choose to default as a rational economic decision, which is also called "strategic default".

According to data provider CoreLogic, at the end of year 2011, 11.1 million residential properties with a mortgage were in negative equity, accounting for 22.8% of all residential properties with a mortgage. An additional 2.5 million borrowers had less than five percent equity, referred to as near-negative equity. Together, negative equity and near-negative equity

mortgages accounted for 27.8 percent of all residential properties with a mortgage nationwide, and the total mortgage debt outstanding on properties in negative equity was $2.8 trillion in the fourth quarter of 2011.

CoreLogic data includes 48 million properties with a mortgage, which accounts for over 85 percent of all mortgages in the U.S. CoreLogic used its public record data as the source of the mortgage debt outstanding (MDO) and it includes both first mortgage liens and second liens and is adjusted for amortization and home equity utilization in order to capture the true level of mortgage debt outstanding for each property.

Figure 4.11 National Distribution of Home Equity Q4 2011

Source: First American CoreLogic
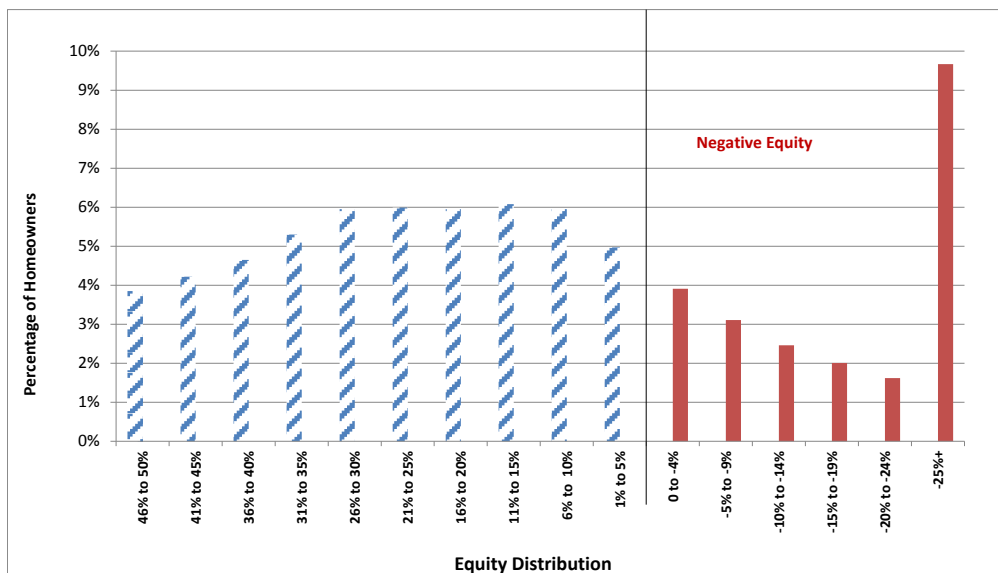
A Wall Street Journal article[24] by Professor Stan Liebowitz (University of Texas, Dallas) states, "The analysis indicates that, by far, the most important factor related to foreclosures is the extent to which the homeowner now has or ever had positive equity in a home." Figure 4.12 shows "how important negative equity or a high Loan-To-Value ratio is in explaining foreclosures (homes in foreclosure during December of 2008 generally entered foreclosure in the second half of 2008). A simple statistic can help make the point: although only 12% of homes had negative equity, they comprised 47% of all foreclosures."

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[24] "New Evidence on the Foreclosure Crisis", 7/5/09

Figure 4.12 Some Statistics on Causes of Foreclosure[25]

No Skin in the Game

Causes of mortgage foreclosures, 2nd half of 2008

Negative Equity*	285,305
Downpayment of less than 3%**	130,014
Mortgage Rate Reset Upward**	60,942
Subprime FICO Score (<620)	148,697
Unemployment Increase in 2008	183,447

*Factors based on Equity

** Complex Subprime Products

Source: Author's regression analysis of loan-level data in 30 million mortgages compiled by McDash Analytics

Figure 4.13 Monthly Mortgage Default Rate[26]

Monthly Mortgage Default Rate
(BASED ON PERFORMANCE OF ALL LOANS PACKAGED INTO SECURITIES IN 2006)

Value of Home Exceeds Loan
● MEDIAN CURRENT LOAN-TO-VALUE

PRIME
ALTERNATIVE-A
SUBPRIME
OPTION ADJUSTABLE-RATE

Loan Exceeds Value of Home

COMBINED CURRENT LOAN-TO-VALUE RATIO
(AMOUNT OWED ON ALL MORTGAGES ON A HOME DIVIDED BY CURRENT VALUE OF HOME)

DEFAULT PERCENTAGE PER MONTH

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[25] Source: "New Evidence on the Foreclosure Crisis", Stan Liebowitz, WSJ, 7/5/09

[26] Based on performance of all loans packaged into security in 2006. Source: http://www.nytimes.com/2009/03/05/opinion/05geanokoplos.html?pagewanted=all

Professors John Geanakoplos and Susan Koniak ("Matters of Principal", A New York Times Op-Ed, 3/5/2009) analyzed monthly mortgage default rates. As shown in Figure 4.13, the monthly default rates are very sensitive to whether or not a homeowner has an ownership stake in his home. For instance, for subprime mortgages, when the loan amount is 160% of the current value of their house, the monthly default (and delinquent) rate is 8%. When loan amount is 60% of the current value of their house, the monthly default (and delinquent) rate is only 1%. Based on these data points for the subprime mortgage, we can use an actuarial model to describe how the force of default increases when the home equity decreases:

$$\mu(t) = \left(\frac{LoanAmount(t)}{0.8 \cdot Home\,Value(t)}\right)^{2.15} \mu_{baseline}(t), \qquad \text{(Equation 4.1)}$$

Where $\mu_{baseline}(t) = 0.2256$ represents the force of default rate (per annum) for the baseline case -- that the loan amount equals 80% of the current home value.

It is noted that the Loan to Value Ratio is a key indicator of incentive for strategic default. Geanakoplos and Koniak (2009) stated, "Despite all the job losses and economic uncertainty, almost all owners with real equity in their homes, are finding a way to pay off their loans. It is those "underwater" on their mortgages — with homes worth less than their loans — who are defaulting, but who, given equity in their homes, will find a way to pay."

For homeowners, it is the anticipated home price that determines the likelihood of strategic defaults. The time horizon of anticipated future price can range from a few months to a couple of years. Based on the simple actuarial model of the force of default in Equation 4.1, we have the following table of estimated reduction in default rates.

Table 4.1 Estimated strategic default rates as a function of anticipated home price appreciation

Anticipated Home Price Appreciation	Reduction (-) in default rate
+10%	-19%
+15%	-26%
+20%	-32%
+25%	-38%
+30%	-43%

Publication of actuarial appraisal value, to the extent that it can influence the anticipated home price appreciation, can help reduce strategic default rates.

4.6 Debt Reduction in Exchange for Equity

As an attempt to stem the tide of strategic defaults, we propose a debt-for-equity conversion. This will involve homeowners and lenders (mortgage loan holders) agreeing on a debt-for-equity swap. To facilitate such a program, a government agency is appointed (created) to serve as a *trust, pool, or exchange* for equity ownership by the lenders (other than the homeowners). Here we discuss a specific (perhaps overly simplified) Debt-for-Equity Conversion Program.

   i.   Lenders offer a *20% Debt Reduction in exchange for 20% Equity in the home.*
  ii.   After the debt-for-equity conversion, the lenders (financial institutions or other agencies) can deposit the minority shares in the home with the government agency, for an ask price.
 iii.   Investors (individuals, insurance companies and pension funds) can offer to purchase such minority shares from the government agency, for a bid price.
  iv.   When there are sufficient buyers and sellers of the minority shares, the government agency serves as market-maker (or a clearing house) with a 2-3% bid-ask spread.
   v.   When there are insufficient buyers and sellers of the minority shares, the government agency can itself engage in the buying or selling of minority shares of homes, guided by the going market value and the actuarial appraisal values.

Lenders are allowed to take over the property only after the lender offers the debt-for-equity conversion option; that is, the lenders cannot take over the home before a debt-for-equity conversion was offered to the home owner.

We present an analysis of this Debt-for-Equity Conversion Program.

LTHV represents the loan-to-house-value ratio for a home.

   i.   When the LTHV is 100%, this Debt-for-Equity Conversion will help homeowners to restore an 80% LTHV ratio.
  ii.   When the LTHV is between 100% and 125%, the Debt-for-Equity Conversion will help homeowners to return to a positive equity position.

A 20% debt reduction will result in a 20% reduction of loan to value ratio, which is equivalent to a 25% home price appreciation. According to Table 4.1, there will be an estimated 38% reduction in the default rates.

In summary, publishing actuarial appraisal values in conjunction with a Debt-for-Equity conversion program, we can expect a dramatic reduction in the strategic default rates.

This will help the housing market to recover, and get the total home equity back to a more reasonable level, as illustrated in Figure 4.14.

Figure 4.14 Projected effect of debt-for-equity conversion and a recovery of housing market
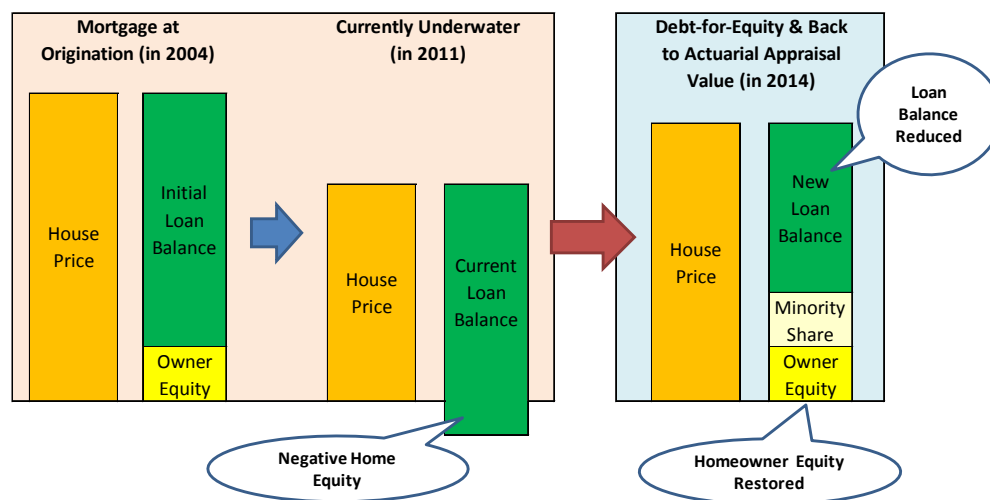
There are remaining practical issues related to the program. Particularly, the rights and obligations of the minority share ownership in the homes needs to be well defined, from operational and legal aspects:

  i.   How to allocate housing-related expenses (property taxes, home improvements, home association fees, etc.)
 ii.   What if the home value has depreciated? Will the minority share have a first claim on the land (its value is more durable than the house itself)?
iii.   What if there is a fire or liability claim on the property? How will insurance be handled?
 iv.   When will the minority shares in the homes be liquidated? Is there a time limit for such liquidation?
  v.   The homeowner may need to pay off minority shares before taking out any home equity in a refinancing transaction or a sale of the home.
 vi.   How to prevent anti-selection or moral hazard?

4.7 Housing Market Recovery and the U.S. Economy

Since 2008, the U.S. government has poured trillions of dollars into the U.S. financial system. However, the stimulus effect on the economy is weak, with sustained high unemployment and a depressed housing market. Banks are still repairing their balance sheets which were damaged by the non-performing mortgage loans (due to foreclosures and short-sales). Banks have tightened their lending standards which, in effect, have reduced the credit available to businesses and households. On the other hand, corporations and businesses are facing sluggish demand by households and are reluctant to borrow to expand their businesses and hire more employees.

In the full circle of credit flows, the housing market plays a "leader" role. When households have more money to spend, it generates demand for products and services, thus driving the growth of the corporate sector, which in turn drives up demand for bank loans. As a result, employment and household incomes rise and the whole economy grows. When a majority of American households are suffering significant losses of wealth due to a housing slump, stimulating the housing market is more effective in restoring economic activities than injecting money into the banking system (where money is trapped in the banking system and does not flow immediately into businesses).

The high level of negative equity and the inability to pay contribute to a significant foreclosure pipeline. Professors John Geanakoplos and Susan Koniak (2009) have discussed their findings in the context of the best government policy for rescuing the housing market:

> "For subprime and other non-prime loans, which account for more than half of all foreclosures, the best thing to do for the homeowners and for the bondholders is to write down principal far enough so that each homeowner will have equity in his house and thus an incentive to pay and not default again down the line. This is also best for taxpayers, who now effectively guarantee the securities linked to these mortgages because of the various deals we've made to support the banks.

> For these non-prime mortgages, there is room to make generous principal reductions, without hurting bondholders and without spending a dime of taxpayer money, because the bond markets expect so little out of foreclosures. Typically, a homeowner fights off eviction for 18 months, making no mortgage or tax payments and no repairs. Abandoned homes are often stripped and vandalized. Foreclosure and reselling expenses are so high the subprime bond market trades now as if it expects only 25 percent back on a loan when there is a foreclosure."

Without Debt-for-Equity Conversion, a debt reduction by a financial institution will result in an immediate loss on its balance sheet. With the Debt-for-Equity conversion, financial institutions will not have to realize a big loss since part of the losses is offset by the value of the asset (minority shares in the home).

Wang (2009) proposed a good asset purchase plan where he advocated that a U.S. government agency stimulate the housing sector by purchasing minority shares (up to 20%) of the house. In re-examining this plan, it becomes clear that the appraisal value plays a key role. A more refined actuarial appraisal system needs to reflect local market factors (such as school systems). Now most upside-down mortgages have been sold to government agencies or other entities. These mortgages are already deeply discounted. In order to establish better values on these distressed mortgages or foreclosed homes, we need innovation in the appraisal value system.

Chapter 5 Systemic Risk for the Insurance Industry

In this chapter we first address the question of whether the insurance industry poses systemic risks.

We then discuss some systemic risks that the insurance industry is exposed to in the current economic environment. Specifically we discuss the insurance industry's exposure to (i) interest rate changes and (ii) the European debt crisis.

5.1 Does the Insurance Industry Pose Systemic Risk?

Regarding the question whether insurance companies can generate systemic risks, most research reports take the position that the majority of insurance companies following traditional insurance business models do not currently pose systemic risks, with the exception that the insurance industry can cause systemic risk when assuming other functions (e.g., non-traditional insurance operations such as AIG Financial Products and bond insurers).

The research publication by economists Peter J. Wallison and Edward J. Pinto at the American Enterprise Institute sheds light on the issue.

> *"The affordable housing goals imposed on Fannie Mae and Freddie Mac in 1992 were the major contributors to both the deterioration in underwriting standards between 1992 and 2008 and the growth of an unprecedented ten-year housing bubble that suppressed delinquencies and stimulated the growth of a private securitization market for subprime loans."*

> *"In less than twenty-five years, "affordable housing" and other housing policies have turned a healthy market into a financial ruin. In 1989, for example, only 1 in 230 homebuyers made a down payment of 3 percent or less; by 2007, it was 1 in 3. Meanwhile, average home equity plunged from 45 percent to 7 percent."*

> *"Government housing policies did more than increase the numbers of subprime and other weak mortgages in the US financial system; they also encouraged Americans to reduce the equity in their homes, built a massive ten-year bubble that obscured growing risks in the mortgage market, forfeited the support of insurance companies and private pension funds—both natural sources of mortgage funding—and tended to degrade the quality of the peripheral elements, such as appraisals, necessary for a well-functioning housing finance system."*

While some analysis of the recent financial crisis laid blame on AIG Financial Products as a main source of systemic risks, we should not lose sight of the bigger picture that the U.S. government housing policies created an environment for housing bubble. Insurance holding companies became a conduit and contributed to the bubble by selling underpriced CDS.

The genesis of systemic risks requires a collective set of factors and players at work. Among various factors and players, U.S. government policies tend to have a major influence on various other players. If AIG Financial Products did not offer the CDS, some other players could have done so.

At the time (2002-2006), the underlying assumption was that housing prices will continue to go up. Under such an assumption, even the models developed by financial engineers seemed to "justify" the underwriting of CDS sold by AIG.

5.2 Interest Rate Risks and Potential Impact on the Insurance Industry

We discuss two scenarios of future interest rates and how they may impact insurance companies.

Scenario 1: Consistently Low Interest Rate Environment in the U.S.
Since the 1980s, the 10-year Treasury note yield has decreased dramatically from over 8% to 4.29% in 2005, 3.66% in 2008, 3.22% in 2010 and 1.97% in 2012 (Appendix A). Since the 2008 financial crisis, the U.S. Federal Reserve Board has implemented numerous monetary policies to keep short-term interest rates low and to obtain lower long-term interest rates and flatter yield curves; these are measures trying to avoid deflation, reduce the unemployment rate, lower mortgage rates, and stimulate the economy with lower borrowing costs.

Despite the low probability of any further cuts in the interest rate, the current global environment seems to support low interest rates. Investors still view the U.S. dollar as one of the safest investment options especially given the European debt crisis and nervous Asian economies. Relatively speaking, there is still a strong appetite for investing in U.S. treasury bonds which helps maintain the low interest rate level.

In mid-2012, industrial production continues to drop in many economies in the Euro zone. Countries such as Greece, Spain and Italy face significant debt crises despite the repeated

bailouts from the IMF and European Central Bank.[27] Due in part to the possibility of a Euro currency breakup, there is an increase in flight to the safe haven of U.S. Treasuries. The worsening conditions in Europe have also affected the Asian economies. Facing significant reduction in export revenues from Europe, key countries in Asia such as China, India, and South Korea are experiencing weakening growth rates. Since December 2011, China has cut its bank reserve requirements from 27.9% to 20.5% in order to stimulate growth and counter the side effects of the European debt crisis.[28]

Unfavorable economic conditions in both Europe and Asia may actually increase money flow to the United States because the U.S. market is still the most reliable place for investment, and as a result, the interest rates may be sustained at a low level for a longer period of time. Conversely, there are inherent risks to the U.S. dollar given the ever-growing public debt and the widening budget deficit, both of which may make the ultra-low interest rate environment not sustainable in the long run.

Effects of Low Interest Rates on the Insurance Industry

It can be said that the prolonged low interest rate environment has adversely impacted the life insurance industry. As interest rates continue to decline, interest rate risks are being elevated for interest sensitive products.

Figure 5.1: Interest Rate Sensitivity Spectrum of life Insurance Products
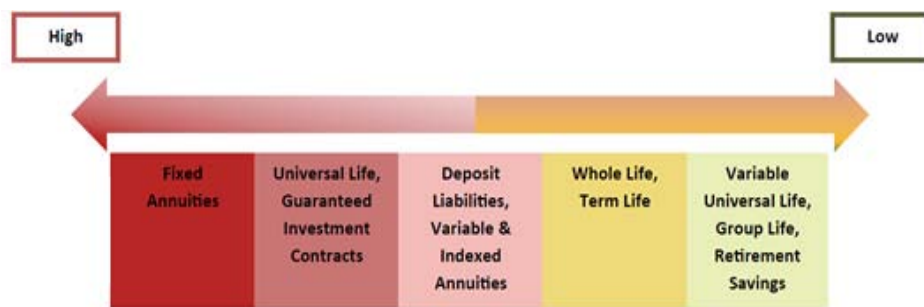
Source: Bruning et al., 2012.

Depending on the type of insurance policy, the product's exposure to interest rate risk differs. Fixed annuity policies tend to be most sensitive to changes in interest rates because the policy guarantees the payout amount regardless of the market interest rate. At the same time, Universal Life policies are relatively insensitive to interest rate fluctuations due to the built-in non-

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[27] Brian Blackstone, Europe's Economy Weakens, Adding to Fears, *The Wall Street Journal*, http://online.wsj.com/article/SB10001424052970204190504577038132275675596.html, November 15, 2011.
[28] Esther Fung, Aaron Back, and Tom Orlik, China Eases Bank Reserve Requirement, *The Wall Street Journal*, http://online.wsj.com/article/SB10001424052970204131004577232933776226326.html, Feb 2012.

guaranteed elements in the forms of fees and additional charges. [29] Figure 5.1 provides a spectrum of life insurance policies based on their sensitivity to interest rate risk.

Having persistent low interest rates affects the life insurers' earnings and liquidity. A prolonged period of low interest rates would reduce the insurers' investment income and compress the insurers' earnings spreads, forcing insurers to increase their reserves (Bruning et al., 2012). During times of economic downturn when interest rates are very low, cash flow between an insurer's assets and liabilities can be significantly mismatched. To fulfill the cash demands from current obligations, insurers may be forced to make unfavorable sales of more solid investments. At the same time, it would also be extremely hard to find long-term, high yield, and low risk new investments to replace these investments. This in turn would cause problems in future liquidity and future matching of asset and liability cash flows (Bruning et al., 2012).

Scenario 2: Rising Interest Rates in the U.S. and their Effects on U.S. Government Debt

Since interest rates are currently so low in the United States, the likelihood of an interest rate spike is significant. If the foreign demand for U.S. currency and U.S. bonds declines, bond prices will decrease, and the U.S. will be forced to increase yields to make the securities more attractive.

On June 1st, 2012, Japan and China established a direct currency trade agreement between the Yuan and Yen, bypassing the U.S. Dollar and reducing both countries' reliance on the U.S. currency. Bilateral trade between the two countries totaled $344.9 billion in 2011 with 50% to 60% of the trade settled in U.S. dollars.[30] This may be the start of a trend of decreasing influence of the U.S. dollar over trade between these two major Asian countries, which may heighten the interest rate risk in the United States. Most importantly, a rising interest rate would considerably increase the financing cost of the United States' huge government debt, which may trigger a snowballing effect.

Along with decreasing borrowing costs, the United States government has consistently increased its government debt over the past decade. As shown below, total U.S. debt has never declined since reaching nearly $6 trillion in 2001. By the end of 2011, the total government debt more than doubled to over $15 trillion, which was also over 100% of the U.S. GDP in 2011 (Appendix

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29 Larry Bruning, Shanique Hall, and Dimitris Karapiperis, Low Interest Rates and the Implications on Life Insurers, National Association of Insurance Commissioners,
http://www.naic.org/cipr_newsletter_archive/vol3_low_interest_rates.htm, Apr. 2012.

[30] Kosuke Takahashi, Japan and China Bypass US in Direct Currency Trade, *The Asia-Pacific Journal 10*, 24, (2012), http://japanfocus.org/-Kosuke-TAKAHASHI/3769

B). In addition, the 10-year government bond yield declined dramatically during this period.[31] Between 2010 and 2011, the 10-year yield decreased from 3.609% to only 1.879% (Appendix C). With the low interest rates, the interest payment for 2011 was just $454 billion, which is only around 3% of the country's GDP. The debt burden does not seem significant at all under the low yield conditions. However, if the interest rates were to increase, borrowing costs would increase significantly.

Figure 5.2 U.S. Government Debt for years 2001-2011
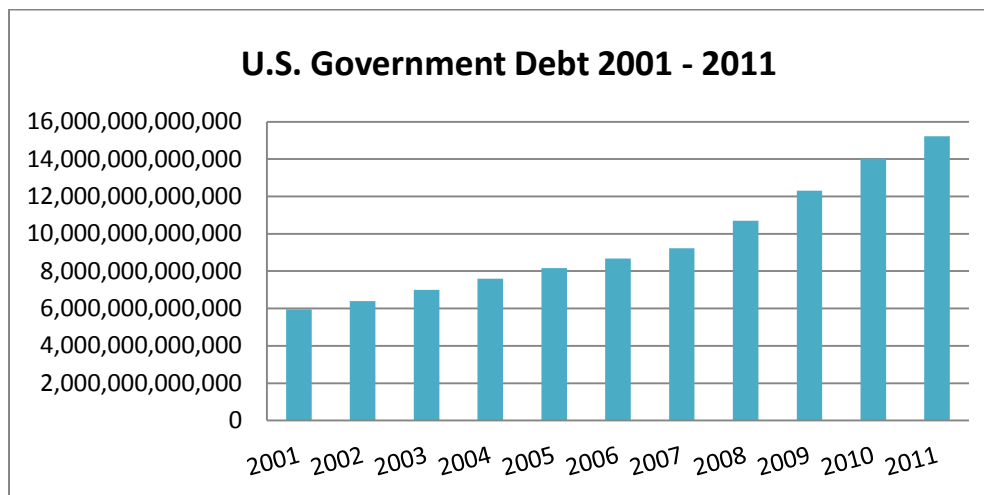
Source: Bureau of Economic Analysis

The disastrous effects of interest rate increases are fully demonstrated in the on-going European debt crisis. The crisis occurred because some member countries in the European Union are unable to fulfill their government debt obligations due to excessive borrowing and increased interest rates. For example, Italy and Spain are both suffering from debt repayment issues. By 2011, Spanish government debt was worth around 70% of its GDP while Italian government debt was worth over 120% of its GDP.[32] The debt as a percentage of GDP for these two countries is not much different from that of the U.S. However, Italy and Spain had much higher interest rates which ultimately caused the unbearable debt payment burden. Between January 31st, 2010 and July 11th, 2011, 10-year government yield rose from 4.080% to 5.800% for Spain and from 4.109% to 6.546% for Italy. It is the increased borrowing costs that seriously threaten the European economy (Appendix C).

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[31] After comparing the absolute interest payment against total outstanding debt, it was concluded that the 10-year U.S. government bond yield corresponded most closely to the interest payment rate (Appendix B)

[32] General Government Gross Debt - Percentage of GDP, Eurostat, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table, July 2012.

To demonstrate the severity of the U.S. debt condition, the relative movements of the Italian and Spanish 10-year government bond yields are compared to the U.S. 10-year bond yield. The model estimates that within two years, the U.S. 10-year yield would increase from 3.609% to 5.749% under the Spanish conditions and to 5.130% under the Italian conditions (Appendix D). This means that if a similar interest rate trend occurs in the United States, the interest payment can be expected to increase by 159% or 142% in less than two years. Such an increase in yield would also increase the government's borrowing cost proportionally and result in a significant increase in interest payment as a percentage of GDP. The rising interest rate would create a significant budget shortfall, and bring down the U.S. economy. The graph below depicts the two hypothetical interest rate scenarios:

Figure 5.3 Government Bond Yields: U.S., Spain and Italy
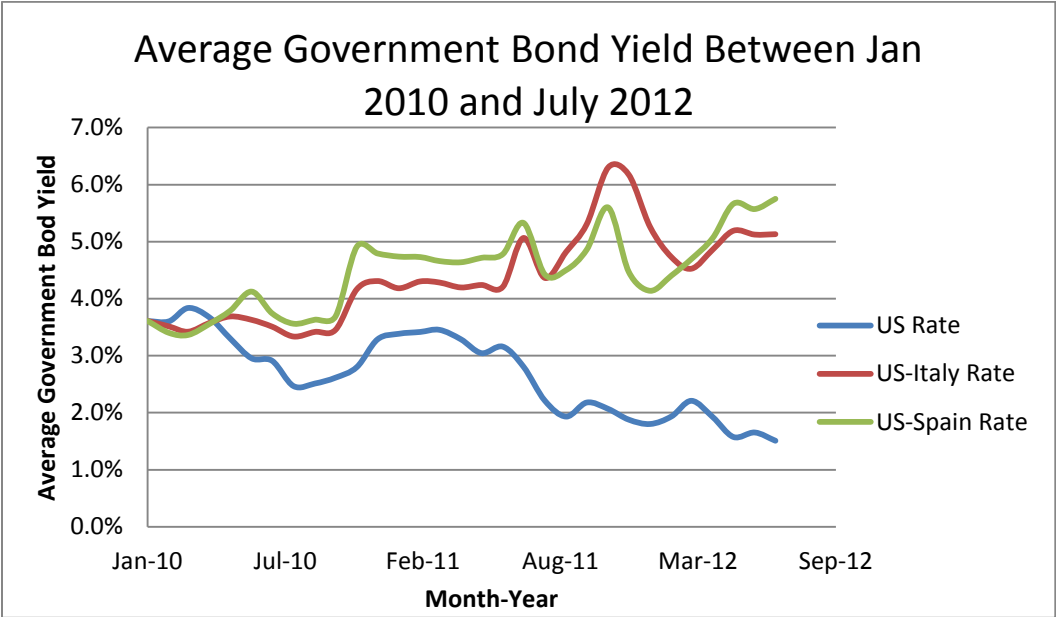
Effects on the Insurance Industry – an Abrupt Increase in Interest Rate
In the late 1970s and early 1980s, dramatic increases in interest rates significantly affected the insurance industry.[33] A similar situation may have the same effects in the current economy.

If the interest rate increases faster than insurers' credit rates such that the advantage of surrendering surpasses the penalty for withdrawing from existing policies, the number of surrenders will increase dramatically. Policyholders would "cash out" and go for new

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[33] Frank Sabatini, Rising Interest Rates: How Big a Threat? SOA Risk Management Newsletter, Nov. 2004.

investments that provide higher returns. Furthermore, bond prices would decrease as a result of higher interest rates. As insurers are forced to liquidate some of their bond holdings to satisfy the surrender demands, these transactions would result in financial losses as well as negatively impact their capital position (see Sabatini, 2004).

Therefore, if the interest rate rises rapidly, the insurer would have to credit higher rates and obtain equivalent higher investment returns. Unfortunately, changing the insurers' investment portfolio to higher yield assets cannot be achieved in a short period of time. The insurers will be faced with a hard choice to make: subsidize credit rates or lose their customers (Sabatini, 2004). In the short-term, insurers will not be able to obtain asset portfolios that match the subsidized credit rates, resulting in financial losses. At the same time, new customers that replace the surrenders will get policies with higher credit rates (Sabatini, 2004). Because these liabilities are still backed by lower-yielding assets, insurers will also realize financial losses.

Projected U.S. Interest Payments as Percentage of Revenue

Byron Wien, Vice Chairman at Blackstone Group says that "if we keep on accruing $1+ trillion in debt annually and interest rates go from 2.16% to 3%, the cost of servicing the US debt will rise from 7% of tax revenues to over 20% by 2020 crowding out Social Security, healthcare and defense expenditures."

Figure 5.4 US Interest Payments/ Revenue (Source: Business Insider)
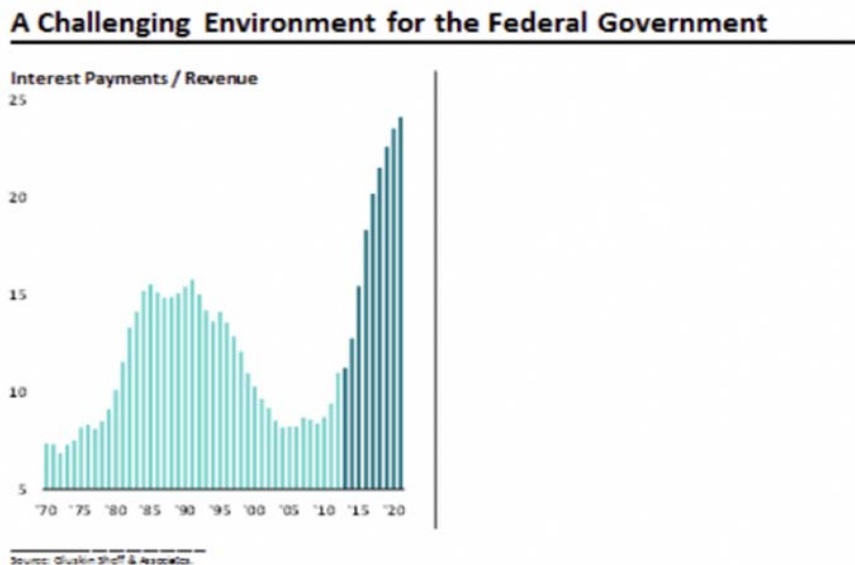
Countering Changing Interest Rates

To mitigate the risks associated with a volatile interest rate environment, insurers take several approaches. Insurers increase the duration of their assets to better match with liabilities and improve immunization against interest rate changes (Bruning, 2012). Insurers also diversify their product mix and investment portfolio to reduce the overall sensitivity to interest rate risks. Furthermore, by adjusting pricing and other features of new policies, for example by lowering guaranteed rates; insurers lower their liabilities and reduce the compression in earning spreads (Bruning, 2012). Finally, insurers employ financial derivative tools such as interest rate swaps to hedge against changes in interest rate and keep the hedged effective interest rate at constant and preferable levels.

5.3 The Insurance Industry's Exposure to Euro-Zone Sovereign Debt

In the past year (2011), sovereign debt exposure has become a key issue for insurers as Portugal, Ireland and Greece have sought bailouts while Italy and Spain may soon follow suit. Insurers are exposed directly through investments in sovereign debt and indirectly via non-sovereign banks that are themselves exposed to sovereign debt. Once sovereign banks default, the bond values held by insurers plummet, and the bondholders book large financial losses. With the exception of a few companies that may be vulnerable in the event of Italian and Spanish defaults, the European insurance sector as a whole appears sufficiently capitalized to withstand losses from its exposures. The US insurance sector has minimal exposure to sovereign debt and faces even less risk from the European debt crisis.

European Insurance Sector

Several companies in the European insurance sector took significant losses on Greek sovereign debt. However, in general, European insurers were not significantly impacted and suffered a substantially smaller hit than their banking counterparts. Over the last couple of years, many insurers have taken steps to greatly reduce their exposures to sovereign debt and have moved away from providing CDSs on European sovereign debt, positioning themselves to withstand even potential default scenarios. In addition, most exposure lies within life insurance operations, where losses may be shared with policyholders under participating policies.

The major European insurers do not hold large amounts of Portuguese, Irish and Greek sovereign bonds. These holdings only account for 1% of their investment portfolios. Thus, rating agencies suggest that even in the event of orderly defaults of Portugal, Ireland and Greece, the European

insurance sector would only be marginally affected.[34] For example, as of June 2011, companies whose gross exposure to Greek sovereign debt was large relative to capital included Ageas (15.8%), Mapfre (5.9%), Munich Re (3.5%), ING (3%), Generali (Italy) (2.9%) and Allianz (2.9%). All the exposures appear to be manageable with Ageas being the exception.[35]

However, the amount of Spanish and Italian sovereign debt held in the industry may represent a material level of risk, both directly and through contagion. As can be seen in the table below, certain insurance groups like MapFre, Allianz, Groupama, and Generalli hold significant amounts of Spanish and Italian sovereign debt. In the event of a wider sovereign crisis that leads to Spanish or Italian defaults, such companies may face sizeable losses.[36] In fact, MapFre and Generalli have already experienced notable downgrades from Fitch.

Table 5.1. Major Insurance Groups –Publicly Reported Direct Exposures to Peripheral Sovereigns

Source: Willis Market Security

Group Consolidated Data (Millions)	Ccy	Shareholders' Equity		Basis	Direct Sovereign Exposure - Government Bonds (As reported at Sep 30, 2011) [1]								
		30-Sep-11	30-Jun-11		Greece	Ireland	Portugal	Spain	Italy	Total GIIPS	GIIPS as % of Sep 30 SHE [2]	Total Sovereign Exposure	GIIPS as % of Total Sov. Exposure
AIG [4]	USD	86,031	92,681	Gross & Net	0	0	7	294	114	415	0.50%	25,697	1.60%
Ace [3]	USD	23,750	24,113	Gross						< 165	< 0.7%	5,585	< 3.0%
Allianz	EUR	43,564	42,615	Gross	497	486	629	5,034	25,608	32,254	74.00%	144,725	22.30%
Aviva [2]	GBP	-	15,861	Gross	100	600	200	1,100	7,100	9,100	57.40%	-	-
Aviva [2]	GBP	-	15,861	Participating Fund Assets	100	400	200	700	6,300	7,700	48.50%	-	-
Aviva [2]	GBP	-	15,861	Shareholder Assets	0	200	0	400	800	1,400	8.80%	-	-
Axa [2)(3]	EUR	-	46,416	Gross	900	900	1,500	10,200	17,100	30,600	65.90%	187,000	16.40%
Axa [2)(3]	EUR	-	46,416	Net	300	300	400	4,100	5,300	10,400	22.40%	-	-
Generali	EUR	15,846	17,231	Gross	1,143	1,563	1,823	5,403	46,235	56,168	354.50%	125,569	44.70%
Generali	EUR	15,846	17,231	Net	200	300	500	2,200	-	-	-	-	-
Groupama [2)(3]	EUR	-	4,289	Gross	2,075	55	755	2,934	7,228	13,047	304.20%	-	-
Groupama [2)(3]	EUR	-	4,289	Net	540	13	217	671	1,542	2,983	69.60%	-	-
Hannover Re	EUR	4,699	4,325	Gross	0	38	19	319	25	402	8.50%	5,266	7.60%
Mapfre [3]	EUR	7,062	6,837	Gross	225	354	399	7,373	835	9,186	130.10%	12,165	75.50%
Munich Re	EUR	21,972	20,058	Gross	582	1,747	416	1,913	3,577	8,236	37.50%	83,190	9.90%
Munich Re	EUR	21,972	20,058	Without P/H participation [5]	83	499	0	666	2,413	3,660	16.70%	-	-
Munich Re	EUR	21,972	20,058	With P/H participation [5]	499	1,248	416	1,248	1,165	4,575	20.80%	-	-
QBE [2)(3]	USD	-	11,209	Net	0	0	0	0	0	0	0.00%	-	-
Scor [3]	EUR	4,217	4,002	Net	0	0	0	0	0	0	0.00%	-	-
Swiss Re [3]	USD	27,772	24,818	Net	0	5	32	34	3	74	0.30%	58,454	0.10%
Travelers	USD	25,172	25,008	Net	0	0	0	8	0	8	0.03%	-	-
XL Capital	USD	9,940	9,626	Gross	0	0	0	1	27	28	0.30%	-	-
Zurich	USD	31,874	31,153	Gross	0	500	500	5,000	5,700	11,700	36.70%	61,000	19.20%

Notes:

(1) All figures are disclosed on a group consolidated basis and are stated as reported in denoted currencies, millions. Exposures may not be directly comparable due to inconsistencies in reporting basis (i.e. Gross or Net) and accounting value basis (i.e. Market Value, Fair Value, etc).

(2) Where Shareholders' Equity as at Sep 30, 2011 is not available Jun 30, 2011 has been utilised in the calculation for GIIPS as % of SHE.

(3) Exposure figures for Sep 30, 2011 unavailable Jun 30, 2011 have been disclosed here.

(4) Majority of GIIPS exposure is assumed to be housed within the Chartis' segment of AIG. As at Sep 30, 2011 Chartis Shareholders' Equity was USD 44,863m.

(5) P/H denotes; Policyholder. Policyholder participation relates to insurance contracts whereby the policyholders bear the majority of the investment risks and reward, with shareholders typically only exposed to a residual proportion of investment risk.

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[34] Willis, Impact of the Eurozone Crisis on Insurer Solvency, http://www.willis.com/documents/publications/Services/Market_Security/Special_Eurozone_Report_December_14_2011.pdf, December 14, 2011.

[35] UBS, The debt crisis: Greece and our equity and bond views on financials, http://www.farmlandinvestmentpartnership.com/attachments/128_58092542-UBS-the-Debt-Crisis.pdf, June 17, 2011.

[36] Willis

According to Fitch Ratings, in the case of a Greek exit from the Eurozone, Italian and Spanish insurers are the most vulnerable out of all the European companies due to the contagion effects on their respective sovereign and bank debts. Italian insurers, in general, have extensive exposure to their own sovereign bank while Spanish insurers, albeit being less exposed to their sovereign bank, are more exposed to domestic banks, some of which rely on the Spanish sovereign bank for support.[37]

Additionally, despite the overall strength of the European sector to weather a general sovereign debt crisis, the high degree of interconnectedness between non-sovereign banks and insurers is a cause for concern, according to Moody's. Insurers often have substantial credit exposures to banks through bond portfolios and derivative contracts. They may also depend on banks for credit lines or work alongside banks as joint venture partners.[38]

The US Insurance Sector

US insurers hold much less GIIPS (Greek, Irish, Italian, Portuguese, Spanish) sovereign debt exposure than their European counterparts and thus are practically immune from the sovereign debt crisis. As a result, the US insurance industry has not experienced any rating downgrades due to the latest crisis. Although direct US insurance industry exposure to both financial sector and sovereign debt of the EU was almost $229 billion as of June 30, 2011, only 3% of this total was sovereign debt exposure. Exposure to heavily indebted countries (Portugal, Ireland, Italy, Greece, and Spain) was minute in comparison, totaling about $2.7 billion, which is approximately 0.05% of the industry's cash and invested assets. In addition, in the year prior to June 30, 2011, US insurers have responded to the deteriorating European situation by decreasing their exposure to GIIPS nations by $241 million.[39]

Table 5.2 is the breakdown of the US insurance industry's exposures to the GIIPS nations, by the type of exposure. Even though US insurers are not likely to be directly affected by the Eurozone's sovereign debt problems, further developments in the debt crisis may have a considerable impact on the US insurance sector. For example, investors moving away from European government bonds could increase demand for US Treasury bonds and push low

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[37] Fitch Ratings, Italian, Spanish Insurers Most Exposed to a Greek Exit,
http://www.fitchratings.com/web/en/dynamic/articles/Italian-Spanish-Insurers-Most-Exposed-to-a-Greek-Exit.jsp,
May 16, 2012.

[38] Willis
[39] NAIC, European Bailout Mechanisms: What They Are, the Agencies Involved and Affected Exposure within the
U.S. Insurance Industry, http://www.naic.org/capital_markets_archive/111202.htm, 2011.

interest rates even lower, thereby lowering returns on investment portfolios. US insurers could also come under increased regulatory scrutiny when they experience such investment losses.[40]

Table 5.2: GIIPS and European Union Bond Holdings as of June 30, 2011 ($000).
Source: NAIC Capital Markets Bureau

	Financial	Sovereign	Other	Grand Total
Greece		1,111,143.20	40,181.10	1,151,324.30
Ireland	1,896,607.80	5,900.50	9,388,106.30	11,290,614.50
Italy	412,663.30	824,278.90	1,174,375.20	2,411,317.40
Portugal		30,540.60	110,973.00	141,513.60
Spain	802,481.90	770,046.10	4,881,971.00	6,454,498.90
Total GIIPS	3,111,753.00	2,741,909.30	15,595,606.60	21,449,268.70
Total Euro Participants	30,886,931.60	4,468,505.80	97,246,738.00	132,602,175.40
Total Other EU Countries	29,275,449.10	2,416,480.70	64,665,951.50	96,357,881.30
Grand Total	60,162,380.70	6,884,986.50	161,912,689.40	228,960,056.60

These evidences support the position that insurance companies have actually been taking actions to manage their exposure to systemic risk.

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[40] Mark Hofmann, Will European financial crisis hit U.S. insurers?, *Business Insurance,*
http://www.businessinsurance.com/article/20120205/NEWS04/302059978

Chapter 6 Systemic Risks on the Horizon

6.1 Monetary and Fiscal Policies as Sources of Systemic Risk

Central bank actions can exert tremendous influence on the general economic condition (for better or worse). In a Financial Times article "Brave and Bloated", Monday April 29, 2012, Claire Jones, Ralph Atkins and Robin Harding stated -- "Since the onset of the crisis, the world's monetary authorities have been forced to ditch their inherent conservatism and embrace extreme measures on an unprecedented scale to stave off financial and economic collapse. Central banks have repeatedly been called on to step in, providing exceptional levels of support to the financial system, when governments have been unable or unwilling to act. Along the way, central bankers – traditionally seen as a reserved and cerebral bunch – have assumed the role of firefighting saviors. But their actions have in some respects compromised their credibility and revealed the limitations of their independence from politics."

Figure 6.1 Ballooning of Central Bank's Balance Sheet
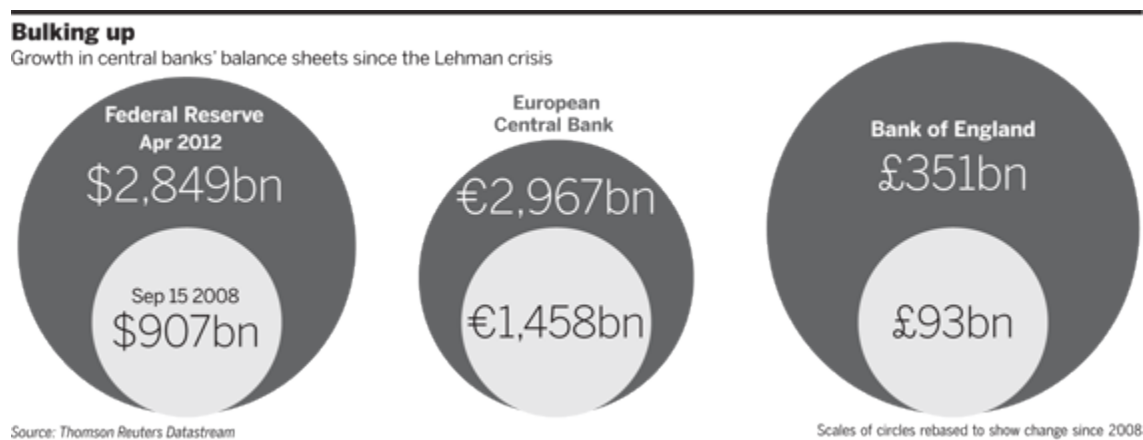
Usually, a central bank will conduct open market operations by buying short-term government bonds or foreign currency. However, during a financial crisis, the central bank may buy other types of financial assets as well. The central bank may buy long-term government bonds, company bonds, asset backed securities, stocks, or even extend commercial loans. The intent is to stimulate the economy by increasing liquidity and promoting bank lending, even when interest

rates cannot be pushed any lower. Quantitative easing is usually used when lowering the discount rate is no longer effective because interest rates are already close to or at zero. In such a case, normal monetary policy cannot further lower interest rates, and the economy is in a liquidity trap.

In addition to central bank actions, various governments can resort to economic stimulus packages. Both the United States and China have implemented massive stimulus packages in the magnitudes of trillions of dollars.

Some of the crisis-hit European countries are facing unique challenges in dealing with the debt crisis. Unlike the U.S. or China, these European countries are not able to roll out fiscal stimulus packages (restricted by creditors) and they cannot have their own monetary policy (decisions are up to the ECB).

6.2 Derivative Concentration

During the 2008 financial crisis, a hotly discussed issue was too-big-to-fail institutions - those institutions whose disorderly dissolution may cause havoc in the economy (using the bankruptcy of Lehman Brothers as an example).

As Tyler Durden notes (in Amount and Concentration of Derivatives still Threaten Global Economy, dated September 25, 2011), "The latest quarterly report from the Office Of the Currency Comptroller shows that the top 4 banks in the US now account for a massively disproportionate amount of the derivative risk in the financial system. Specifically, of the $250 trillion in gross notional amount of derivative contracts outstanding (consisting of Interest Rate, FX, Equity Contracts, Commodity and CDS) among the Top 25 commercial banks (a number that swells to $333 trillion when looking at the Top 25 Bank Holding Companies), a mere 5 banks (and really 4) account for 95.9% of all derivative exposure …. The top 4 banks: JPM with $78.1 trillion in exposure, Citi with $56 trillion, Bank of America with $53 trillion and Goldman with $48 trillion, account for 94.4% of total exposure."

6.3 China's Real Estate Bubble

China's real-estate market boom has generated trillions of dollars of wealth by reaching an unsustainable level.

Figure 6.2 Home Price Index for China from 2000 Q1 to 2010Q1[41]
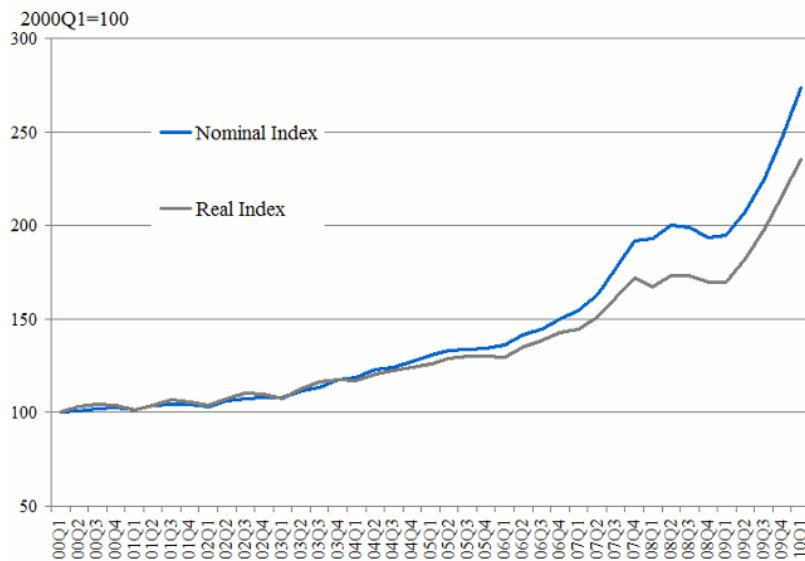
There are both malignant bubbles and benign ones. Indeed, not all property bubbles lead to financial crises, and not all financial crises are preceded by property bubbles. "International panel studies have shown that two-thirds of 46 systemic banking crises were preceded by house price boom-bust patterns, while 35 out of 51 house price-bust episodes were followed by a crisis."

6.4 So is China's Real Estate Bubble Benign or Malign?

Mr. Kiyohiko Nishimura[42] presented figures (Figures 6.3 and 6.4) to show the following three variables:

   i.   The inverse dependency ratio, that is, the ratio of working-age population to the rest,
   ii. The real property price index, and
   iii. Total loans in real terms.

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[41] Source: Wu, Gyourko and Deng (2010). Using data source of the Institute of Real Estate Studies, Tsinghua University.

[42] Kiyohiko Nishimura, How to detect and respond to property bubbles - challenges for policy-makers, Reserve Bank of Australia-BIS Research Conference "Property markets and financial stability," August 2012.

Figure 6.3

Population Change, Credit Expansion and Asset Price: Japan
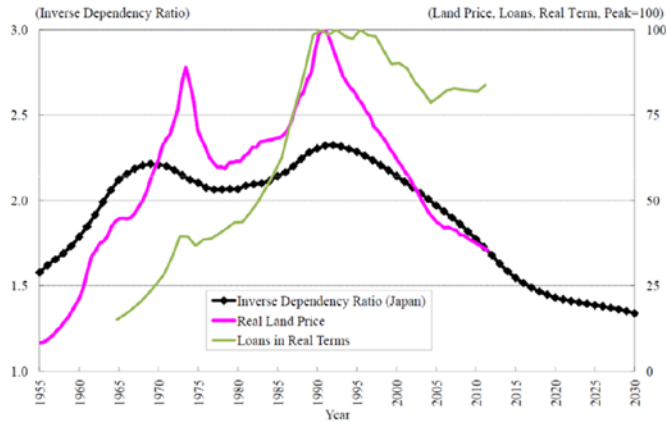
Source: United Nations; Japan Real Estate Institute; Japan Ministry of Internal Affairs and Communications; Bank of Japan

Figure 6.4

Population Change, Credit Expansion and Asset Price: China
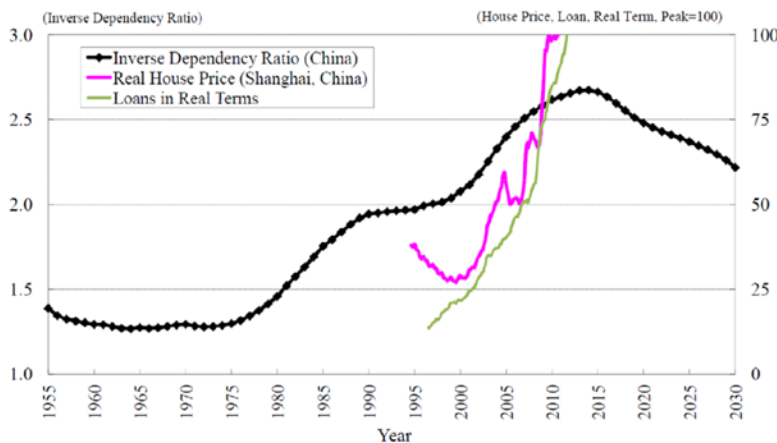
Source: United Nations; Zhongfang Shanghai Real Estate Index Office, National Bureau of Statistics, People's Bank of China

Mr. Nishimura compared that the surge in Chinese home prices and loan growth over the past five years has surpassed extremes seen in Japan before the Nikkei bubble popped in 1990. The construction reached 12 percent of GDP in China in 2011, as compared to the peak of 10 percent

that Japan has ever reached. Based on these comparisons, he warns that China is now entering the 'danger zone'.

The credit and housing booms can remain "benign" so long as the workforce is young and growing. They turn "malignant" once the ratio of working age people to dependents rolls over as it did in Japan. China's ratio will peak at around 2.7 over the next couple of years as the aging crunch arrives. It will then go into a sharp descent, compounded by the delayed effects of the one-child policy. With a combination of aging demographic, an extreme property price bubble and a steep increase in loans, the probability of a major correction has increased to a dangerous level.

The scenario of China's real estate bubble burst can generate ripple effects to the global economy, from Australia's commodity-driven market to Latin America's exports.

Chapter 7 Government Policies and Regulation

There are macro-prudential policy tools for managing systemic risks (DeNicolò et al., 2012). For instance, the externalities associated with fire sales arise because banks fail to internalize the consequences of not taking precautionary measures in booming times; to address this externality, counter-cyclical capital surcharges can restrain banks from increasing exposures in booming times. Other tools include systemic risk-based capital surcharges, dynamic provisioning, liquidity regulation, lending limits (caps on loan to value and debt to income ratios), and the separation of investment banking and commercial banking (Volcker rule). A combination of policy tools is likely to provide a better solution to the problem of correcting the same externality, since each tool has different advantages and limitations.

DeNicolò et al. (2012) and Dell Ariccia et al. (2012) identify that a major challenge in the implementation of macro- prudential policy is in the calibration of instruments. Despite recent evidence on the effectiveness of some tools, little is known quantitatively. For example, it is far from clear how high capital surcharges should be or what should be the optimal loan-to-value ratio. Further fundamental and applied research on the optimal choice and calibration of macro-prudential policy tools is required to justify policy intervention.

The roles of government may change depending on the mode of the market:

  i.   during normal markets the government acts primarily as a "referee," to promulgate and enforce rules for market practices, and
  ii.   during capital market breakdowns or severe economic recession, the government acts as lender of last resort, restoring market confidence and bolstering economic activity.

Some argue that regulation and government policies are often reactive, rather than proactive. Government policies and regulatory changes tend to react to the boom-and-bust cycle and frequently have unintended (negative) consequences. A past example is the enactment of the Sarbanes Oxley Act created after the Enron and WorldCom accounting scandals. There were unknown increased compliance costs of the Sarbanes Oxley Act and now the Dodd-Frank Act. A coherent framework for regulatory responses requires a deeper understanding of the financial "system," how government actions interact with other forces of the financial system, and how they impact the broader economy.

7.1 Regulatory Approaches to Systemic Risks

The financial system is becoming increasingly complex and such complexity often masks structural issues. The financial system consists of numerous sub-systems that interact with each other in many dimensions. Each individual is a decision-making unit, with different knowledge, perceptions, and incentives. Firms vary in size, products and services, history and culture. Industry sectors and market segments behave like independent sub-systems in some aspects, and interconnected in other aspects. The interactions among many parts of the financial system have many uncertain elements. The information contained in accounting statements has much uncertainty. Individuals speculate on other people's sentiments and future actions. As a result, capital markets sometimes exhibit herd behavior and volatile sentiments.

In dealing with complex systems, regulators and policymakers have limited time and resources, so they must resort to higher intelligence and understanding to gain insights and knowledge about the system. We advocate a risk intelligence approach to assist regulators and policymakers. It requires screening and prioritizing various economic sectors, institutions, and activities, based on the level of potential threats to the financial system.

A systemic risk regulator is like a doctor and is charged with attending to the health of the financial system as a whole. To diagnose a patient, the doctor needs to use his/her medical training, medical instruments, and experiential knowledge and judgment. We would suggest that the systemic risk regulators have the following roles and responsibilities: 1) Facilitate data gathering and information analysis of systemic risk exposures; 2) Develop tools to identify and mitigate risk arising from price distortions (using natural stabilizers and formulae driven adaptive capital rules or collateral requirements); 3) Identify potential problem areas, quantify them in terms of their likelihood and severities and recommend possible policy solutions; and 4) Examine current regulations for gaps in supervision, coordinate data collection and information sharing among regulators.

The tasks of managing systemic risks are enormously challenging for regulators and supervisors. These tasks also include:
  i.   Improve transparency (from a risk perspective) of the financial markets;
  ii.   Examine the shadow banking, hedge fund, private equity, off-balance sheet vehicles and over-the-counter derivatives markets for risks they present to the financial markets/economy;
  iii. Examine other specific issues such as "too big to fail," highly inter-connected institutions and how to regulate or wind them down; and
  iv.   Move more products to exchanges to reduce counterparty risk/increase transparency/lower costs/increase liquidity.

With such a broad scope including all sectors of the economy, systemic risk regulators need to coordinate with various functional regulators. Systemic risk regulators need to supplement, rather than replace, the activities of existing regulators.

7.2 Identification of Structural Issues

Most systemic risks are manifestations of structural issues which have been accumulating over time. For instance, the availability of "no income no document" types of loan created structural vulnerability of mortgage finance; and the lack of skin in the game for mortgage brokers presented the wrong incentives for producing more subprime loans. Some firms may actively seek to take advantage of structural issues (e.g. the mortgage lenders such as Countrywide and investment banks such as Lehmann Brothers) which may cause rapid accumulation of imbalances and, if unchecked, may endanger the system. The business models of firms are inter-connected, which can make a local imbalance travel and magnify throughout the system in unexpected ways.

Various structural forces and imbalances may accumulate and eventually lead to broader changes of the system. In order to arrest the buildup of structural imbalances, the systemic risk regulators must look for such structural imbalances before they grow out of control and endanger the whole system. We advocate developing metrics and tools for identification of imbalances in various segments of the economy, such as the level of public debt as percentage of GDP, the percentage of income spent on medical costs and college tuitions.

We must have early identification of potential regime changes. Uncertainty in the evolution of these different regimes necessitates flexible and adaptive policy responses, rather than relying upon static capital rules. This calls for early recognition of pending regime changes (e.g. boiling points of a booming stock market, and freezing points of a credit market), so as to enable appropriate policy responses. Flexibility in policy responses is imperative for dealing with a complex and hard-to-predict financial system.

7.3 Articulating Ranges of Tolerances

Market cycles are natural processes of structural re-formations though creative destruction of obsolete business models. Government policy should help articulate the risk appetite (tolerance level) for the whole system, and put mechanisms in place to help rein in wild swings in the tolerance levels.

During different regimes of the market, the priority of systemic regulation may shift. For instance, during the recent economic downturn, the government on the one hand is pressing banks to increase lending, and on the other hand, raising capital requirements and underwriting standards. These conflicting demands put banks in a bind. We believe that the government can accomplish both through encouraging re-formation of new business models as a way of coming out the recession.

7.4 Simplify the Basel III Rules

Andy Haldane,[43] executive director for financial stability at the Bank of England, warned that the complexity of current regulation is preventing authorities from spotting and averting financial crises. He argues that the Basel III rules now rely heavily on banks' internal models to make millions of calculations about the risk levels of individual loans, making it almost impossible to compare banks with their peers. Investors have also grown increasingly skeptical of bankers' ability to measure risk in the wake of the financial crisis and JPMorgan Chase's recent multibillion-dollar trading loss.

"With thousands of parameters calibrated from short samples, these models are unlikely to be robust for many decades," he said, calling for regulators to consider "simplified, standardised approaches to measuring credit and market risk, on a broad asset class basis."

Here we agree with Mr. Hadane's points and suggest that actuarial science can help develop "simple yet effective" metrics that can help regulators manage systemic risks by developing actuarial benchmarks for various sectors including market risk, credit risk, real-estate risk, and commodities risk.

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[43] Andy Haldane, The dog and the Frisbee, Federal Reserve Bank of Kansas City's 36th economic policy symposium, "The Changing Policy Landscape," August 2012.

Summary and Conclusion

Systemic risk differs significantly from individual risk, and needs to be analyzed from a system-wide perspective. A study of systemic risk requires a focus on the system as a whole, by examining the policies, incentives and behaviors that drive people flows, resource flows and money flows, as well as their influence on the activities in various sectors of the system.

Effective management of systemic risk requires the utilization of multiple valuation methodologies and understanding of the relationships between different valuations. This paper proposes using an actuarial valuation method for assets and liabilities based on long-term intrinsic value that is more sustainable than market values at a point in time. Actuaries regularly perform appraisals for long-term assets and liabilities based on long-term average trends, without being unduly influenced by market volatilities. An actuarial valuation approach can equip regulators with counter-cyclical metrics and tools to manage systemic risk.

For the U.S. housing market, the current housing appraisal methods are based on market values of comparable sales, which is pro-cyclical. This paper advocates using an actuarial appraisal method that references construction costs and controls the rate of appreciation within a reasonable range to derive appraisal values more related to intrinsic values. The paper also proposes a strategy for reviving the U.S. housing market, through voluntary mortgage debt reduction by lenders in exchange for the rights to benefit from the future appreciation of the housing unit.

This study supports the view that insurance companies by themselves do not generate systemic risk for the whole economy. The genesis of systemic risk requires a collective set of factors and players at work. Nevertheless, the insurance industry has its share of responsibility to proactively monitor imbalances in the financial system and not engage in activities to exacerbate such imbalances.

The monetary and fiscal policies of the major world economies are by far the most dominant sources of systemic risk. These policies influence future interest rates and can have profound impacts on all financial institutions, including insurance companies.

The paper identifies the need for innovative methods and approaches for measuring and managing systemic risk. Actuaries have long been modeling complex systems involving changes in conditions and policyholder behavior. Moreover, actuaries are experienced in analyzing the impacts of government policies and regulatory changes on financial systems. Actuarial models of complex systems, when applied in connection with the Actuarial Control Cycle and actuarial appraisal methods, can provide useful indicators for policy makers and businesses in managing systemic risk.

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Appendix A U.S. Interest Rates

(Source: http://research.stlouisfed.org/fred2/series/DGS10/downloaddata?cid=115)

Table A1: Annual Interest 1970 – 2010

Year	Rate
1970	7.35%
1971	6.16%
1972	6.21%
1973	6.85%
1974	7.56%
1975	7.99%
1976	7.61%
1977	7.42%
1978	8.41%
1979	9.43%
1980	11.43%
1981	13.92%
1982	13.01%
1983	11.10%
1984	12.46%
1985	10.62%
1986	7.67%
1987	8.39%
1988	8.85%
1989	8.49%
1990	8.55%
1991	7.86%
1992	7.01%
1993	5.87%
1994	7.09%
1995	6.57%
1996	6.44%
1997	6.35%
1998	5.26%
1999	5.65%
2000	6.03%
2001	5.02%
2002	4.61%
2003	4.01%

Graph A1: 10-Year Treasury Rate 1970–2012
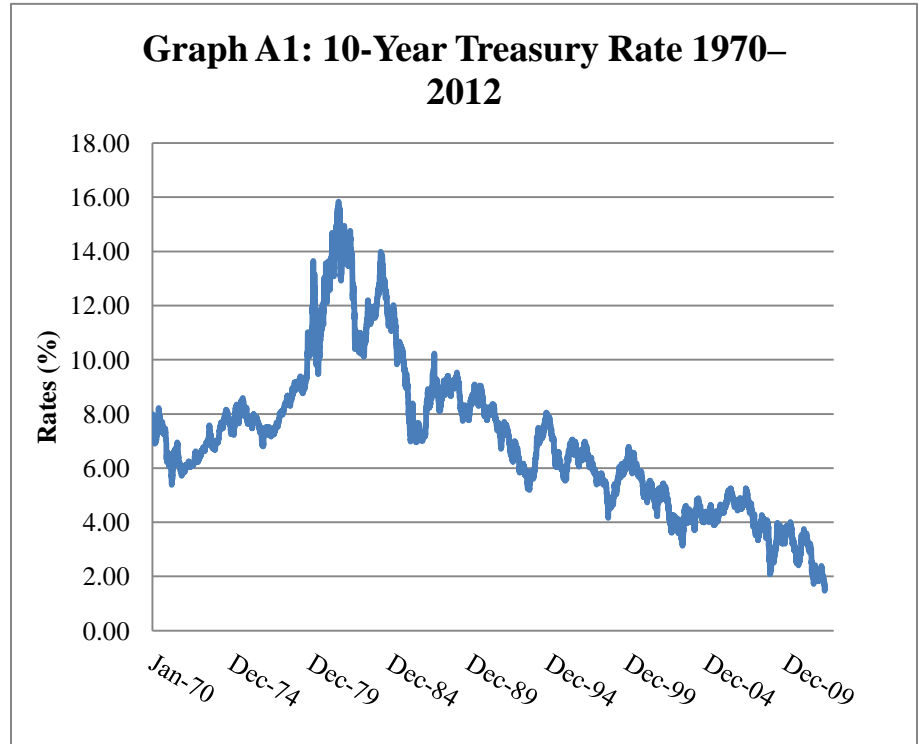
2004	4.27%
2005	4.29%
2006	4.80%
2007	4.63%
2008	3.66%
2009	3.26%
2010	3.22%
2011	2.78%
2012	1.97%

Appendix B The U.S. Total Outstanding Debt and Interest Payment

Table B1: U.S. Total Outstanding Debt, Interest Payment, and Interest as % of Debt between 2001 and 2011

Year	Interest Payment	Total Debt	Int. as % of Debt
2001	$359,507,635,242	5,943,438,563,436	6.048%
2002	$332,536,958,599	6,405,707,456,848	5.191%
2003	$318,148,529,152	6,997,964,247,818	4.546%
2004	$321,566,323,971	7,596,142,802,424	4.233%
2005	$352,350,252,508	8,170,424,541,314	4.312%
2006	$405,872,109,316	8,680,224,380,086	4.675%
2007	$429,977,998,108	9,229,172,659,218	4.658%
2008	$451,154,049,951	10,699,804,864,612	4.216%
2009	$383,071,060,815	12,311,349,677,512	3.111%
2010	$413,954,825,362	14,025,215,218,708	2.951%
2011	$454,393,280,417	15,222,940,045,451	2.985%

Table B2: Average Annual U.S. Treasury Yield 2010-11

	2-year	5-year	10-year	Average
2010	0.658%	1.867%	3.132%	1.886%
2011	0.434%	1.487%	2.736%	1.552%

The 10-Year Treasury Rate best models the interest payment for total outstanding debt.

Source: http://www.treasurydirect.gov/NP/BPDLogin?application=np

Appendix C 10-Year Bond Yields – U.S., Italy and Spain

Jan 2010 – May 2011 10-Year Bond Yield U.S., Italy and Spain			
	US	**Italy**	**Spain**
Jan-10	3.609%	3.609%	3.609%
Feb-10	3.604%	3.513%	3.401%
Mar-10	3.839%	3.421%	3.364%
Apr-10	3.672%	3.575%	3.558%
May-10	3.303%	3.688%	3.788%
Jun-10	2.956%	3.628%	4.124%
Jul-10	2.911%	3.508%	3.741%
Aug-10	2.468%	3.336%	3.561%
Sep-10	2.513%	3.417%	3.631%
Oct-10	2.616%	3.453%	3.689%
Nov-10	2.802%	4.165%	4.912%
Dec-10	3.288%	4.309%	4.792%
Jan-11	3.386%	4.182%	4.737%
Feb-11	3.418%	4.302%	4.729%
Mar-11	3.455%	4.283%	4.659%
Apr-11	3.290%	4.196%	4.638%
May-11	3.046%	4.240%	4.716%
Jun-11	3.160%	4.207%	4.780%
Jul-11	2.809%	5.064%	5.328%
Aug-11	2.213%	4.364%	4.423%
Sep-11	1.933%	4.821%	4.500%
Oct-11	2.180%	5.308%	4.860%
Nov-11	2.068%	6.300%	5.598%
Dec-11	1.879%	6.173%	4.468%
Jan-12	1.803%	5.256%	4.138%
Feb-12	1.936%	4.727%	4.406%
Mar-12	2.210%	4.525%	4.695%
Apr-12	1.924%	4.862%	5.064%
May-12	1.575%	5.191%	5.663%
Jun-12	1.654%	5.123%	5.570%
Jul-12	1.509%	5.130%	5.749%