Thesis for Master Degree

Financial Innovation News, Collateral Constraint,

and Boom-Bust Dynamics in the Housing Market

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Contents

Financial Innovation News, Collateral Constraint, and Boom-Bust Dynamics in the Housing Market[*]

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1   Introduction

"But housing is housing; banks have been making mortgage loans for generations.Why was anyone willing to believe that all the rules had changed?...So a bit of financial engineering with no new technology, no reason to think that the fundamentals of housing had changed led to a gigantic financial bubble. Wow. I guess hype really does spring eternal."   Paul Krugman, "Mystery of the mortgage mess", New York Times, 11/17/2007

The recent U.S. financial crisis is originally characterized as a housing market boom and bust. As Figure 1 shows, the U.S. housing market experienced prolonged boom that started around 1999. After the peak of the price in early 2006, the price started to decline as the bad news about the housing market continued on arriving. In fact, home prices dropped 18% on December 30, 2008 compared with the level in the previous year.[1] This sharp drop came with the fact that there were tremendous

numbers of borrowers who could not repay the money for the housing loan. The increment of the foreclosure rates frightened the marketers, making the turmoil deeper and deeper.
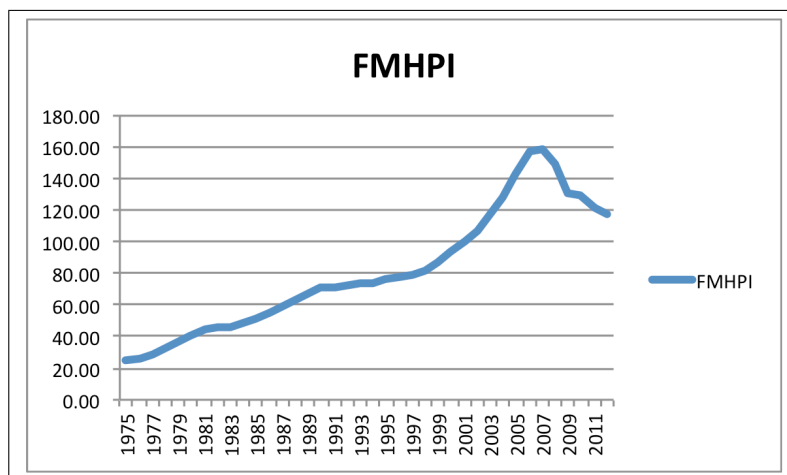
Figure 1: Source: Freddie Mac Housing Price Index, National

One of the key features of the crisis relates to the financial innovation. Before the U.S. boom ended, lots of new financial products and a set of policy reforms were introduced. For example, collateralized mortgage obligation(CMO) was introduced in the mid 1990s, credit default swap were first issued in the late 1990s, and so on. It is also valuable to refer to a set of legal reforms. For instance, the 1995 New Community Reinvestment Act is a ingredient of the financial innovation since it allowed Fannie Mae and Freddie Mac to take stronger role in the mortgage market, which resulted in the deepening of the mortgage market.

Figure 2 and Figure 3 represent one aspect of the proliferation of the financial technology. Figure 2 shows that the market of the securitization and CMO tranching grew during the housing boom, which in their peak amounted to trillions of dollars a year. Figure 3 presents the growing trend of the CDS market when the economy was booming. Data is from mid 2000s because it was the time that CDS technology were standardized for mortgages.

In this paper, the two facts shown in the previous discussion are connected. In other words, it is

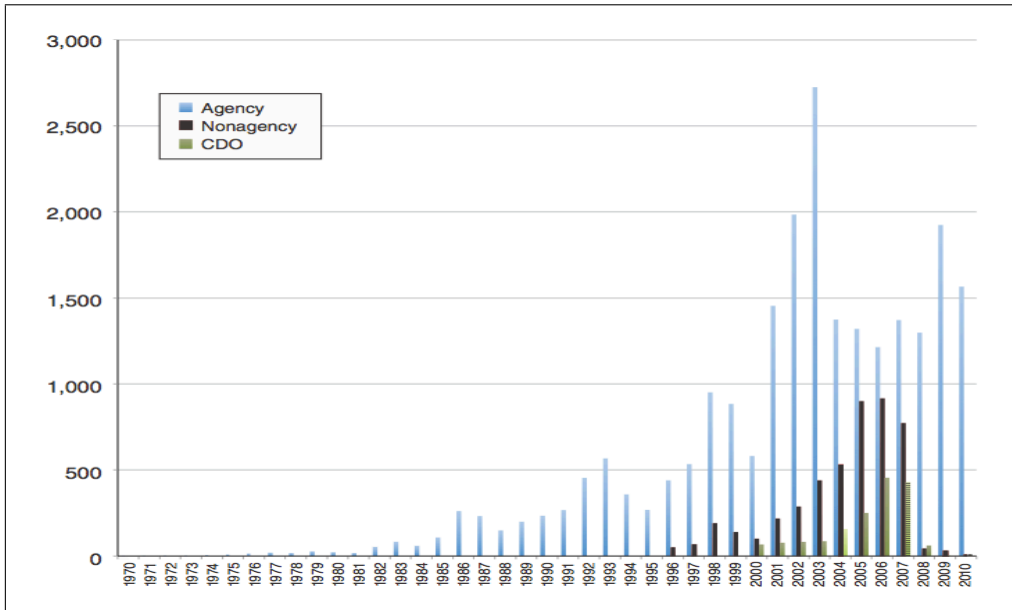Figure 2: Amount of securitization and tranching, Data Source:IBS OTC Derivatives Market Statistics, I borrow this graph from Geanakoplos(2012)
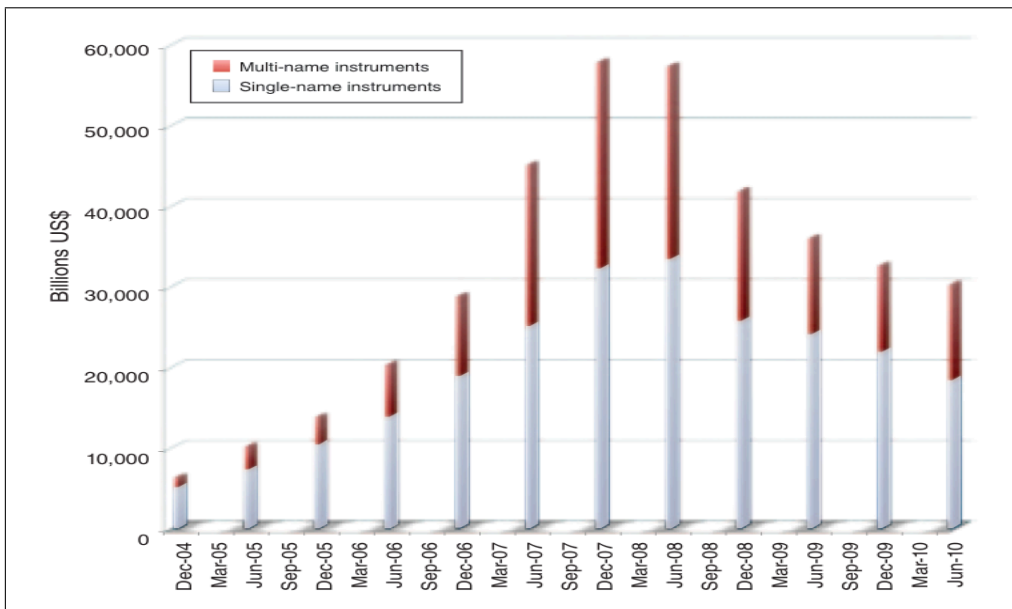

Figure 3: Outstanding National Amount of CDS Market, Data Source:IBS OTC Derivatives Market Statistics, I borrow this graph from Geanakoplos(2012)

shown that the financial innovation can be a cause of the housing boom and subsequent bust, which was typically observed in the recent U.S. housing market. The two specific information structures are assumed. The first is that the influence of the financial innovation is inherently so difficult to predict that people could misunderstand that a set of events that do not indicate the substantial improvement of the financial environment really matters. The second is that they believes that adaption to the new financial technology or environment takes time. These two assumptions make agents regard a current set of events, such as introduction of CMOs, CDSs, as well as new regulation acts, as the signal that in a few years the financial environment will improve. This paper proves that this type of information shock, named as news shock, can generate boom and bust in the housing market. The reason is as follows: In an economy where houses are used as a collateral to borrow, this shock induces the future housing price increase because the cost of borrowing decreases when the innovation occurs in the future. Anticipating the price increase, households can borrow more since the interaction of the price increment and the accumulation of the housing allows them to do so, which leads to the price hike even before the realization of the financial innovation. This mechanism generates the prolonged boom in the housing market as it was observed in the U.S. housing market. The boom will end when people realize the news was incorrect. At this time, borrowers hold housing so much that they become unwilling to possess them any more. This sudden disappearance of the demand collapses the housing market, making the price precipitate.

In the following section, I first survey the observed "financial innovation" before, and during the boom. Next, I qualitatively look through the movement of the attitude toward the innovation. Finally, I move on to explain the model showing the related literature, and close the discussion in the conclusion section.

1.1 Financial Innovation

The recent financial advance has occurred since around 1970. The government agencies Fannie Mae and Freddie Mac began the securitization of mortgage in earnest at that period. Salomon and First boston first made tranches by purchasing and slicing Fannie Mae and Freddie Mac pools in 1986. The issuance of the first collateralized debt obligations(CDOs) happened in 1987. By the mid 1990s, the investment bank Kidder Peabody, one of the greatest mortgage buyers, sliced tons of mortgage pools into tens of kinds of tranches called collateralized mortgage obligations(CMOs), named such as floater, inverse floater Pac, Tac and so on. Credit default swaps(CDSs), kinds of insurance on an asset or bond, were invented in 1997 by JP Morgan for corporate bonds and government bonds. This instrument was commonly used for mortgages in mid 2000s.

The financial innovation also refers to the several policy reform regarding the financial environment. Examples of the Acts introduced around the end of the 20th century were three: the 1995 New Community Reinvestment Act, the 1999 Gramm-Leach-Bliley Act, and the 2000 Commodity Futures Modernization Act according to the selection of Mendoza(2012). The first act was designed to empower Fannie and Freddie in mortgage market in order to activate the regional finance, leading the deepening of the securitization market . The second was created to partly abolish the Glass-Steagall Act that prohibited the bank holding companies to take charge of other types of banking roles, aiming at banning the excess risk taken by the financial sector. Commodity Futures Modernization Act mitigated the regulations on the over-the-counter derivatives like CDSs, clearly differentiating itself with the Commodity Exchange Act that stipulates the regulation of the trading of commodity futures.

Figure 4 provides the timeline of the selected financial innovations. On the basis of the strand of financial innovations, it must be no harm to assume that it induces the prediction that it actually reduces the transaction cost and risk itself. In the next section, I investigate the stance on those financial innovation upon which the marketers lean. From the survey it can be understood that the position is not always consistent along the period. Rather, the systematic alteration of the mode
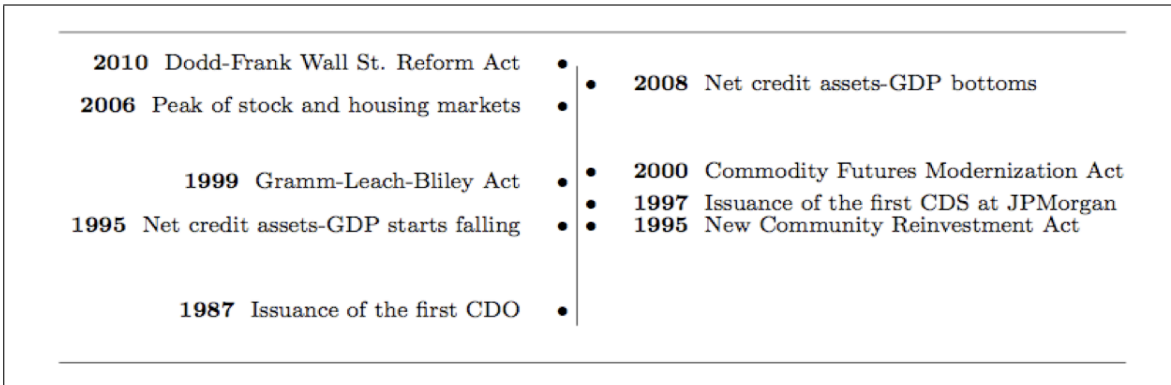
Figure 4: Chronicle of the selected financial innovation, timeline from Mendoza(2012)

exists: from optimism to the pessimism.

1.2 News: From Optimism to Pessimism

1.2.1 Optimism on the Financial Innovation

Here I survey the news pressed in the US and look through the time-varying attitude toward financial innovation. The investigation qualitatively clarifies movement of the mode from the optimistic one to the pessimistic. The story dates back around 20 years.

In the early 90s, the financial innovation was taken as a plausible advance that made the way to the complete financial market. Even though there were some worries regarding its possible role of amplification of the market stemming from the inherent difficulty and information asymmetry, the main attitude on the innovation was "optimistic". The statement by Professor Robert Cox Merton, the Nobel Prize winner in 1997, represented his positive viewing on the innovation at that time:

> "...the dramatic changes over the past two decades are consistent with development to-
> ward a more efficient financial market and intermediation system. Indeed, such changes
> can be seen as part of a financial innovation" spiral" that proceeds as follows: The prolif-
> eration of new trading markets in standardized securities such as futures makes possible the

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creation of new custom-designed financial products that improve" market completeness."
Next, volume in the new markets further expands as the producers themselves typically,
financial intermediaries trade simply to hedge their own exposures. Such increased volume
in turn reduces marginal transaction costs and thereby makes possible further implemen-
tation of new products and trading strategies which in turn leads to still more volume.
Success of these trading markets then encourages investment in creating additional mar-
kets, and so on it goes, spiraling toward the theoretically limiting case of zero marginal
transactions costs and dynamically complete markets." Robert C. Merton, "Financial
Innovation and Economic Performance", Journal of Applied Corporate Finance, 1992

This intriguingly strong positive stance continued, or even strengthened through the array of policy
reforms and invention of new seemingly favorable financial instruments such as CMO, and CDS by the
mid 2000s. The following sentences exist in the article that was written during the crisis, repenting
the past attitude of the economy.

"The apparent triumph of that (the transfer of risk)[2] process came after the technology
stock bubble burst and the American economy went into recession in 2001. A lot of money
was lost because of huge overinvestment in things like fiber optic cable, but the losses were
dispersed. No significant banks failed or even got into trouble.The system worked, the
regulators told themselves as they praised the financial advances brought on by the derivative
revolution.""Who ' s Going to Take the Financial Weight?", New York Times,10/26/2007

The interesting thing is the fact that in the early 2000s, US experienced the burst of the IT
bubble and Enron Scandal that were obviously related to the financial innovation. Nevertheless, the
interpretations of the events were against what would be expected first: the above news indicates
that the marketers in the US thought the burst was more modest than the case where there had not

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[2]Parenthesis added to mean the pronoun by the author of this paper.

been any financial innovation, and therefore regarded the observed size of shock as the proof of the winning of the financial innovation. Doubt might come that this view was singular at the time and was shown only in this article as the exaggeration during the crisis. However, it does not seem so. In fact, the mood observed in the next article also illuminates the intact optimism when the Enron scandal astonished the market :

> *"Home mortgages, car loans, credit card debt, student loans, equipment leases – all these assets, and more exotic ones like future receipts from British pubs and the box-office take for Steven Spielberg's future movies, have been remodeled into asset-backed securities. Those securities can now be found generating handsome returns for pension funds, mutual funds, banks, brokerage houses, insurance carriers, hedge funds and even some individual investors. A result, bond market experts say, has been the expansion of credit to consumers, greater liquidity and flexibility for lenders and the modulation of risk for corporations....Companies that want to use complicated structured-financing techniques should be prepared to explain them completely, he (Ronald Gilson, a law professor at both Stanford and Columbia)[3] said....But it would be a shame, he (Ronald Gilson) said, if the tools of structured finance came to be seen as the equivalent of skeleton keys and safe-cracking implements. Like electric jigsaws and battery-powered screwdrivers, they can be used to create shelter from hardships, safe exits from risky places, room to grow and a stable foundation. But like all tools, he (Ronald Gilson) said, they are only safe if used at arm's length in the daylight.","The Brick Stood Up Before. But Now?", New York Times, 2/10/2002*

That is, the cause the author of the article, or possibly the readers had recognized behind the latter scandal was neither the inherent weakness of financial market that were activated by financial innovation nor new financial instruments' possible role as the accelerator of the amplification; It was the misuse of the innocuous technology by the bad guys. This way of looking at the event led the

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[3]Parenthesis added to mean the pronoun by the author of this paper.

point in question toward the transparency and disclosure of the information. This "misspecification" allowed the notorious exotic financial product to be created, which dragged the world into the recent great depression.

1.2.2 Pessimism on the Financial Innovation

The doubt began to come with the weak indicators in the housing market. One is the stagnation of the housing price growth, in the comparison of that in the booming. Other is the news of the monetary tightening. Another is the slight increase of the delinquency rate in the housing market. It was, however, not enough for the market participants to turn over their belief on the underlying myth in the housing market: the prolonged belief that the risk sharing through the new financial product actually lessened the risk and therefore cost of borrowing, and that it was irrelevant to the potential vulnerability of the financial sector. Looking back from now, the recognized uncertainty was actually the symptom of the bust and should have more seriously examined as a omen of the coming crisis. It is worth noting that the following news clearly pointed out what actually happened after the two years from the publication.

> "At issue is whether financial innovations that have made it easier for Americans to buy homes have also made the system less stable and more subject to shocks that could drive many from their homes...For now, all the talk about bubbles may be just talk. In the late 1990's stock market, those who warned that prices were too high were discredited by the final huge rise in 1999 and early 2000. Only after most bears were silenced did they become right...THE housing bears now are anything but silent, and there is little sign of the economic news – soaring interest rates or recession or both – that would bring down home prices. But if and when a fall comes, watch the volume of home sales, particularly of existing homes. In the early 1980's recession, annual sales of existing homes fell 50 percent,

to two million homes....When that (prices do start to fall)[4] *does happen, watch the volume of sales of existing homes. If it falls rapidly, that will be an indication that not much has changed, and the damage is likely to be limited. But if sales volume stays high, that could indicate that the mortgage innovations are hurting. Then we could see rising numbers of foreclosures as homeowners discover they cannot sell their homes for what they owe but also cannot pay their suddenly higher monthly mortgage bills.",*"Easy Credit In Mortgages May Backfire.",New York Times, 8/26/2005

The sad thing is that this prediction actually turned out to be the prophecy: the housing bubble bursted due to the excess lending, securitization was nominated as one of the criminal of the crisis, the number of foreclosure rate skyrocketed, and the housing market collapsed two years after the publication. The news below pressed amid the turmoil of the crisis stated the confusion of the market stemming from the inherent difficulty of the identification of the location of the risk in the securities.

"If it was no longer the banks that would suffer when a financial crisis came around, who would? Could it be the insurance companies? Perhaps pension plans? Would hedge funds that gambled and lost be unable to meet their obligations and bring on a systemic failure?In this financial crisis, the one that started with subprime loans, we are learning the answer to that question. The risks that banks would have taken on under the old system   when banks made loans and profited only as they were paid back   had been transferred through a bewildering wilderness of options, swaps, swap options, specialized investment vehicles, collateralized debt obligations, variable interest entities and who knows how many other instruments.""Who's Going to Take the Financial Weight?", New York Times,10/26/2007

At this time, the myth on the financial innovation as the promising risk-reducing instruments completely collapsed; on the contrary, it was notoriously criticized as the origin of the crisis.

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[4]Parenthesis added to mean the pronoun by the author of this paper.

While it is impossible to tell what we viewed is all true and represent the general viewing at that time because these set of news is just a small fraction of the news pressed in the world, the strand of news at least indicates the movement of the attitude: from the optimistic toward the pessimistic with respect to the financial innovation. This finding rationalizes the first stage of the hypothesis that this boom-bust-style change of the viewing generated the housing bubble and its burst.

1.3   Related literature

In the next section, I start constructing the model. This part is allocated to show how the following discussion is related to other literatures. The structure of the model presented in this paper have three specific features: information on the financial innovation, collateral constraint and the news shock.

First of all, the model has many common features with Mendoza(2012). In the model of the mentioned article, agents know that the financial innovation comes and that possibly changes the borrowing cost. However, they do not know whether the good innovation actually happens since they do not have enough information or knowledge about the outcome on the new environment and new technology, so that they observe the realized data and update their prediction in the Baysian style. The clear difference is that my model assumes the news shock and Mendoza(2012) assumes the learning from the market. While learning can also explain the boom and bust, the clear optimism on the financial innovation that we see in the previous news survey provides a slight advantage on the news shock, for agents in the market already believe the innovation will reduce the transaction cost and allow household to borrow money much more easily.

It is profitable to compare with Adam and Marcet(2012a) and Marcet, et. al.(2012b) with regard to the focus on the information and asset pricing. These two papers examine, in a traditional consumption-based asset pricing model, how the adaptive learning from the observation of the data about the price growth generates boom and bust in the asset price. The similarity results from the feedback rule in their model. The key feature of them is that the shock on the belief immediately

induces current price increase. This data feedbacks into their belief, strengthens it, and creates further price increase. This mechanism makes the amplification in the market. One of the difference regarding the amplification is that my model does not assume the backward feed back. Rather it clarifies other path of the amplification that the promised shock generate the prolonged boom in the market.

Moreover, my model relates the general role of the financial innovation in the US crisis. One of the important papers on this aspect is Geanakoplos (2012). He explains the boom comes with the technology that allows the asymmetric betting: optimistic agents can borrow money from the relatively pessimistic agents using assets as a collateral and buy the asset more while the pessimistic have no means to bet on their belief. The bust, as he has shown, also stems from the financial innovation that allows pessimistic agents to bet on the worse case using money as a collateral. The mechanism on his discussion crucially relies on the specific sequence of the innovation during the boom-bust period that makes the specific transition of the leverage: leverage by the optimistic agents followed with the one by the pessimistic. my model does not identify the specific role of the financial instrument. Furthermore, it identifies the information structure as the key role of the boom and bust, rather than the specific leverage as the cause of the dynamics.

The model also focuses on the change of the belief. More and more literatures start analyzing the relationship between belief dynamics and asset pricing. Eichenbaum et. al(2012) and Piazzesi and Schneider(2009) focus on the fact that during the US housing bubble the consumer sentiment comoves with the housing price, and show the belief dynamics regarding the housing fundamentals can generate boom and bust in the housing market. Shiller(2003) and Shiller(2007) empirically suggest the difficulty in the contributing the dynamics of the housing price to the change of the fundamentals and point out the importance of the phycological factor. The boom and bust in Eichenbaum et.al(2012) result from the dynamics of the number of the optimistic agents. The sequential increase of this number generates prolonged price rise. The two clear differences can be found: the first is they assume the belief dynamics on the housing fundamentals, and I will assume the dynamics on the financial innovation.

The second is that mechanism of the protracted boom is due to the gradual increase of the demand in Eichenbaum et.al(2012), and in my model it owes to the interaction between the collateral constraint and the news shock.

In the model the news shock is adopted as the shock of the economy. The news shock is the signal the agents get beforehand and believe some factors such as productivity will change in the future. The news shock was first introduced in Beaudry and Portier(2004).Beaudry and Portier(2004) showed this news shock can generate the consumption and investment boom at the same time even when the economy does not experience any observed fundamental shock. The important assumption is that all agents believe the news is true. If this news shock were to happen many times, it would be difficult to justify that every time agents should hold "incorrect" belief in the ex-post meaning. In this sense, this news shock and the learning is closely related.

2 The Model

In order to explore the hypothesis that news generates boom and bust, the model is basically constructed following the spirit of Iacoviello(2005). To be specific, the nominal structure observed in the original model is shaved off and the real housing system in the model is abstracted because the focus is on the role of the information on the housing price. The model considers a discrete time, infinite horizon production economy with three type of agents. The first type is the patient agents, who are relatively able to wait compared with the other agents. They work using their labor and obtain their wage. They can allocate the income into three: to consume, to buy houses, and to lend (or borrow). The second type is the impatient agents, who has less patience: that is, they have smaller discount rate than the patient agents. They also work, gain income, allocate them into the consumption goods, housing, and borrowing (or lending). The smaller discount rate naturally assures them to be borrowers. Let us assume the borrowing is limited by the amount of housing as a collateral. This feature is

consistent with Kiyotaki and Moore(1997) in that the collateral constraint is tied to the real estate value. The last type of the agents is entrepreneurs. They make use of the two types of the labor force and produce consumption goods, paying the wages for each households. In the model it is assumed that the supply of the housing is fixed. This assumption is consistent with the related literature such as Iacoviello(2005), and Eichenbaum et. al(2011). Below it is shown that this standard setting can generate the non-negligible amplification effect in the housing market.

2.1 Patient Households

The problem of the households is fairly standard. The only difference from the normal model is that it is assumed the housing improves the utility of the household. The households maximize the following discrete lifetime utility function given their budget constraint:

$$maxE_0\Sigma(\beta^p)^t(lnC_t^p + j_t lnh_t^p - \frac{(l_t^p)^\eta}{\eta}) \tag{1}$$

$$s.t. C_t^p + q_t(h_t^p - h_{t-1}^p) + (1 + r_{t-1})b_{t-1}^p = b_t^p + w_t^p l_t^p \tag{2}$$

E_0 represents the expectation operator given the information set at period 0, $\beta^p \in 1$ is the patients' discount factor, and C_t^p, h_t^p, l_t^p denoted as consumption, housing, and hours of working, respectively. The subscript p means the patients' variable. The housing is multiplied by j_t so as to distinguish the effect of housing from consumption. The structure of instant utility gain from the housing is different from the assumption on Eichenbaum et. al(2011) that assumes the housing provides the utility gain in the next period. η expresses the disutility of working. They can obtain money by working and borrowing (lending). The price of the house, the interest from the finance is denoted with q_t, r_t, respectively. The household maximize the utility given the prices by choosing consumption, housing, amount of borrowing, and hours of work. Let us assume that the house will not depreciate, so that

the households can fully carry the housing over to the next period. By solving this problem, three first order condition are obtained as follows:

$$\frac{q_t}{C_t^p} = \frac{j_t}{h_t^p} + E_t \beta^p \left(\frac{q_{t+1}}{C_{t+1}^p}\right) \tag{3}$$

$$\frac{1}{C_t^p} = E_t (1 + r_t) \beta^p \frac{1}{C_{t+1}^p} \tag{4}$$

$$\frac{w_t^p}{C_t^p} = (l_t^p)^{(\eta - 1)} \tag{5}$$

The first equation shows the marginal utility from the consumption at period t is the same with the expected marginal utility when they allocate money into the housing at period t and sell it and buy consumption goods in the next period. The second equation represents the case when the households allocate the consumption at period t into the bond market. The left hand side describes the marginal utility of consumption at t and the right hand side shows the expected marginal utility from the consumption at period $t + 1$ with the return from the bond. The third shows the intra-temporal relationship between the consumption and the working. The equation shows that the disutility from the work equates with the consumption using the wages from the work.

2.2 Impatient Households

The basic structure of the problem of the impatient households is the same with that of the patients':

$$max E_0 \Sigma (\beta^i)^t \left(ln C_t^i + j_t ln h_t^i - \frac{(l_t^i)^\eta}{\eta}\right) \tag{6}$$

$$s.t. C_t^i + q_t (h_t^i - h_{t-1}^i) + (1 + r_{t-1}) b_{t-1}^i = b_t^i + w_t^i l_t^i \tag{7}$$

$$b_t^i \leq m_t E_t \left(\frac{q_{t+1} h_t^i}{1 + r_t} \right) \tag{8}$$

The clear difference is that the problem contains the collateral constraint. The borrowing is limited to certain fraction of the expected discount value of the housing in the next period. m_t represents the degree of the financial development, which is the main target of the analysis in this paper. If the borrowers choose not to repay money, the lender can seize the housing that the borrowers hold as the collateral, paying the transaction cost $(1 - m_t) E_t (q_{t+1} h_t^i)$ to liquidate the collateral. In total, the lender can at least obtain $m_t E_t (q_{t+1} h_t^i)$ without risk, which makes the contract as the risk-free one.

In the setting, the financial innovation that results in the reduction of the transaction cost of financing is defined as the increment of m_t, so that impatient households are allowed to borrow more. In order to understand the setting suppose that all agents believe housing price will increase in the next period, even if the price today does not change. This belief change permits them to make more use of the financing. This stems from the description of the constraint that the decision of the lending in the housing market is forward-looking.

It is worth pointing out that this constraint is introduced into the household sector, not into the firms. This is because the impatient households is regarded as the ones that have less credibility in the financial market, such as sub-prime-layered people. They are not always allowed to borrow as much as they want due to the past experience of arrears, default, and so on. Since the financial innovation shown in the US amid 2000 mainly affected these people, introducing this constraint in the impatient households is plausible as the analysis of the US experience.

One assumption $\beta^p > \beta^i$ is made in order to represent the difference of the patience. This assumption makes the impatient as the borrowers. As it is observed later the case where this constraint is always binding is investigated in this paper.

The first order conditions consist of the three equations:

$$-\frac{q_t}{C_t^i} + \frac{j_t}{h_t^i} + m_t\lambda_t E_t\frac{q_{t+1}}{1+r_t} + \beta^i E_t\frac{q_{t+1}}{C_{t+1}^i} = 0 \tag{9}$$

$$\frac{1}{C_t^i} - \lambda_t - \beta^i E_t(1+r_t)\frac{1}{C_{t+1}^i} = 0 \tag{10}$$

$$\frac{w_t^i}{C_t^i} = (l_t^i)^{(\eta-1)} \tag{11}$$

$$\lambda_t \geq 0, \lambda_t(m_t E_t(\frac{q_{t+1}h_t^i}{1+r_t}) - b_t^i) = 0 \tag{12}$$

Here let us define λ_t as the Lagrange multiplier at period t. λ_t expresses the lifetime utility improvement from the borrowing: the gain derived from the increase of the consumption at period t or investment on the housing, subtracted by the repayment at period $t+1$. This multiplier makes the difference from the first order conditions of the patient households.

The first line equates the marginal utility of the consumption at period t with the utility from housing at period t and consumption at $t+1$ when the households sell the housing into consumption goods at period $t+1$. The second describes the equality of the consumption at period t with the one at period $t+1$ using the bond. The third line shows the disutility from working is the same with the utility gain from the consumption increment at period t. The last line describes KKT conditions.

The question is whether the inequality of the constraint will bind or not. For the case without uncertainty, it is proved it will. The steady-state Euler equation for patient households is arranged to be $1+r = \frac{1}{\beta^p}$. Substituting this into the steady-state Euler equation of the impatient households, $\lambda = \frac{(1-\beta^i(1+r))}{C^i} = \frac{(\beta^p-\beta^i)}{C^i\beta^i} > 0$ by the assumption that $\beta^p > \beta^i$. From this fact, KKT shows the constraint is binding at the steady state. In the following part, the situation around the steady state is investigated and the equations are log-linearized. While it is true that the it cannot be assumed the

constraint is globally binding, the analysis of the binding case is rationalized by assuming the shock is small enough to assure our focus.[5] Thus, the KKT conditions degenerate to be the following:

$$b_t^i = m_t E_t \left(\frac{q_{t+1} h_t^i}{1 + r_t} \right) \tag{13}$$

2.3 Entrepreneurs

The problem of the entrepreneurs is a standard RBC type model. The entrepreneurs have production technology that allows them to produce consumption goods using two type of the labor force.

$$max \pi_t^f = y_t - w_t^p l_t^p - w_t^i l_t^i \tag{14}$$

$$s.t \, y_t = A_t (l_t^p)^\alpha (l_t^i)^{1-\alpha} \tag{15}$$

The technology is Cobb-Douglas constant returns to scale one that uses two labor force as the input. A_t is the productivity parameter. They maximize their profit given the wage and technology, changing the inputs. One interpretation why the two labor forces are distinguished stems from the difference of the skill of the two. The patient households and the impatient households can be regarded as the wealthy people and the poor people, and they have different level of skill due to the heterogeneity stemming from various reasons such as education. This difference allows us to assume the two labor forces are in the imperfect substitution relationship in terms of the production of the goods.

$$\alpha \frac{y_t}{l_t^p} = w_t^p \tag{16}$$

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[5]Iacoviello(2005) also adopts the same assumption and ascertain the harmlessness by investigating the non-linear simulation.

$$(1 - \alpha)\frac{y_t}{l_t^i} = w_t^i \tag{17}$$

The two equations above are demand on the labor p and i, respectively. α represents the wage share of the patient households. Because of the form of the production function and the structure of the problem, the entrepreneurs naturally gain zero profit, so that it is not necessary to consider the owner of the firms.

2.4   Equilibrium

The equilibrium of the model is an allocation of quantities $(C_t^p, C_t^i, h_t^p, h_t^i, b_t^p, b_t^i, l_t^p, l_t^i, Y_t)_{t=0}^\infty$ and sequence of prices $(q_t, w_t^p, w_t^i, r_t, \lambda_t)$ where the agents maximize their object function under their specific constraints, and where the markets clear. In fact, in addition to the key equations that are discussed in the previous section, the market clearing conditions are needed:

$$C_t^i + C_t^p = Y_t \tag{18}$$

$$h_t^i + h_t^p = H \tag{19}$$

$$b_t^i + b_t^p = 0 \tag{20}$$

These market clearing conditions are for goods, housing, and loan market, respectively. It is assumed the Supply for housing is fixed. In order to examine the transition dynamics around the steady state, these equations are log-linearized using the methods described by Uhlig(1998). Let us denote the percent deviation from the steady state as the hatted variables: $\hat{x}_t \equiv lnx_t - lnx$, which makes the following systems:

$$\hat{y}_t = \hat{A}_t + \alpha \hat{l}_t^p + (1-\alpha)\hat{l}_t^i \tag{21}$$

$$\hat{w}_t^p + \hat{l}_t^p = \hat{y}_t \tag{22}$$

$$\hat{w}_t^i + \hat{l}_t^i = \hat{y}_t \tag{23}$$

$$\hat{q}_t - \hat{C}_t^p = \frac{jC^p}{h^p q}\hat{j}_t - \frac{jC^p}{h^p q}\hat{h}_t^p + \beta^p E_t \hat{q}_{t+1} - \beta^p E_t \hat{C}_{t+1}^p \tag{24}$$

$$\hat{C}_t^p = -\hat{r}_t + E_t \hat{C}_{t+1}^p \tag{25}$$

$$\hat{w}_t^p - \hat{C}_t^p = (\eta - 1)\hat{l}_t^p \tag{26}$$

$$\hat{q}_t = (\frac{m}{1+r} - \beta^i m)\hat{m}_t + (1 - \frac{m}{1+r})\hat{C}_t^i - \frac{jC^i}{h^i q}\hat{h}_t^i - \frac{m}{1+r}\hat{r}_t + (\frac{m}{1+r} - \beta^i m + \beta)E_t \hat{q}_{t+1} + \beta^i(m-1)E_t \hat{C}_{t+1}^i \tag{27}$$

$$\hat{b}_t^i = E_t \hat{q}_{t+1} + \hat{h}_t^i - \hat{r}_t + \hat{m}_t \tag{28}$$

$$\hat{w}_t^i - \hat{C}_t^i = (\eta - 1)\hat{l}_t^i \tag{29}$$

$$\hat{y}_t = \frac{C^p}{y}\hat{C}_t^p - \frac{C^i}{y}\hat{C}_t^i \tag{30}$$

$$\hat{b}_t^p = -\hat{b}_t^i \tag{31}$$

$$h^p\hat{h}_t^p = -h^i\hat{h}_t^i \tag{32}$$

$$C^p\hat{C}_t^p + qh^p(\hat{h}_t^p - \hat{h}_{t-1}^p) + b^p(1+r)\hat{r}_{t-1} + b^p(1+r)\hat{b}_{t-1}^p = -b^p\hat{b}_t^p + w^pl^p(\hat{w}_t{}^p + \hat{l}_t^p) \tag{33}$$

Equation (21) is the production function. Equation (22) and (23) describe the labor demand. Equation (24) is the Euler equation for the consumption and housing for the patient households. Equation (25) denotes the Euler equation for consumption using the loan. Equation (26) is the labor supply by the patient households. Equation (27) is the Euler equation for impatient households and equation (28), and equation (29) is the loan demand and labor supply by the impatient households. Equation (30),equation (31), and equation (32) are market clear conditions for consumption goods, loans, and housing, respectively. The final equation (33) expresses the flow of fund of the patient households.

2.5   Calibration

This section begins with the calibration of the model in order to understand the transition mechanism.[6] The values of the parameters in the model follow Iacoviello(2005). Especially the important thing is that it is assumed the patient households have larger discount factors than that of the impatient households. The specific value of the preference is derived from the analysis of Emily Lawrance(1991)

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[6]I denote the system of the steady state in the appendix.

for poor (or impatient) households and Samwick(1998) for patient (or wealthy) households, which allow us to set $\beta^p = 0.99$ and $\beta^i = 0.95$.

First the transition dynamics when the persistent financial innovation actually occurs now making use of these parameters is shown. Then the discussion moves on to the case where the news shock occurs now.

Table 1-Parameters in the model		
Description	Parameter	Value
Patient households	β^p	0.99
Impatient households	β^i	0.95
Weight on housing	j	0.1
Labor supply aversion	η	1.01
Productivity	A	1
Degree of financial development	m	0.55
Patient households wage share	α	0.64
Autocorrelation of financial innovation shock	ρ^m	0.99

2.5.1 Transition Dynamics: Current Financial Innovation

In the calibration one percent deviation shock on the degree of financial development m is introduced. The timing of perception and realization of the shock are both current period so that the role of the news shock in the economy can be clearly understood . Figure 5 and Figure 6 describe the response of each variables.

When the shock occurs at period zero, the housing price jumps to increase and returns to the steady state level as the effect of the financial innovation disappears as the time goes. The jump comes from the fact that the shock reduces the cost of borrowing, which leads the virtual price of housing to decrease from the impatient households' point of view. Thus, the demand of housing rises and therefore housing price increases when the shock realizes at period zero. While the amount of the housing that the impatient households holds decreases at first and it seems to contradict the discussion above, this is true because the housing price increases so much that it is beyond the hand of the impatient at first. However, after accumulating enough housing as collateral by reducing consumption and working
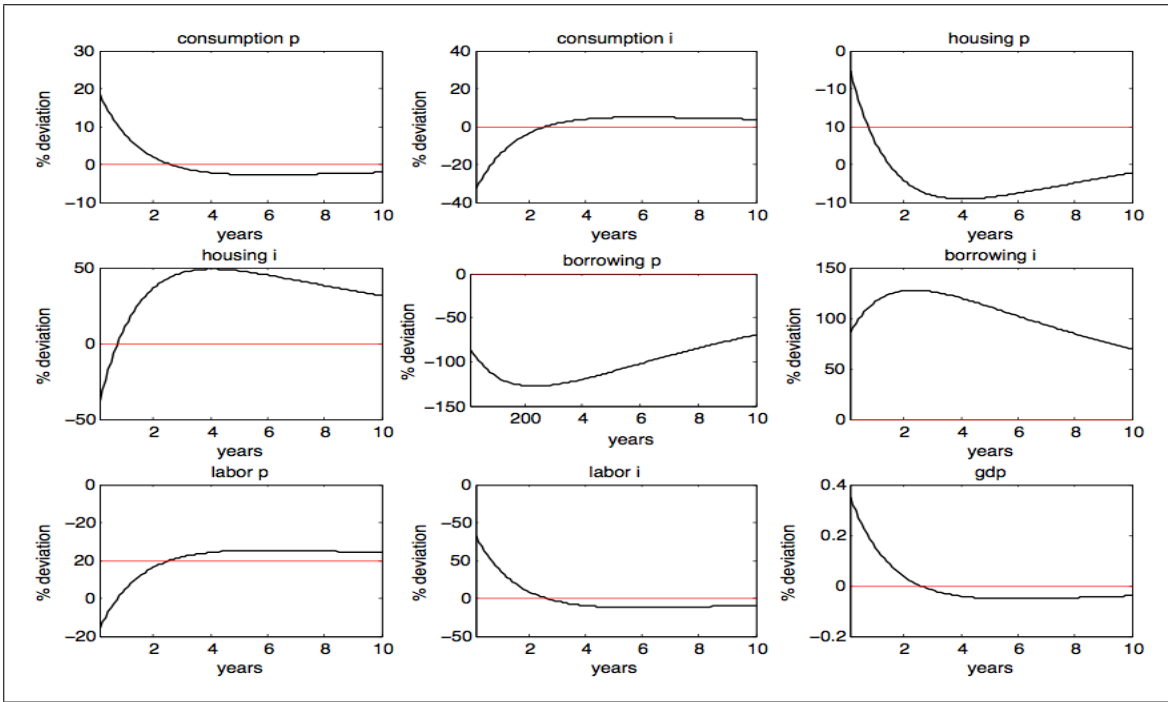
24

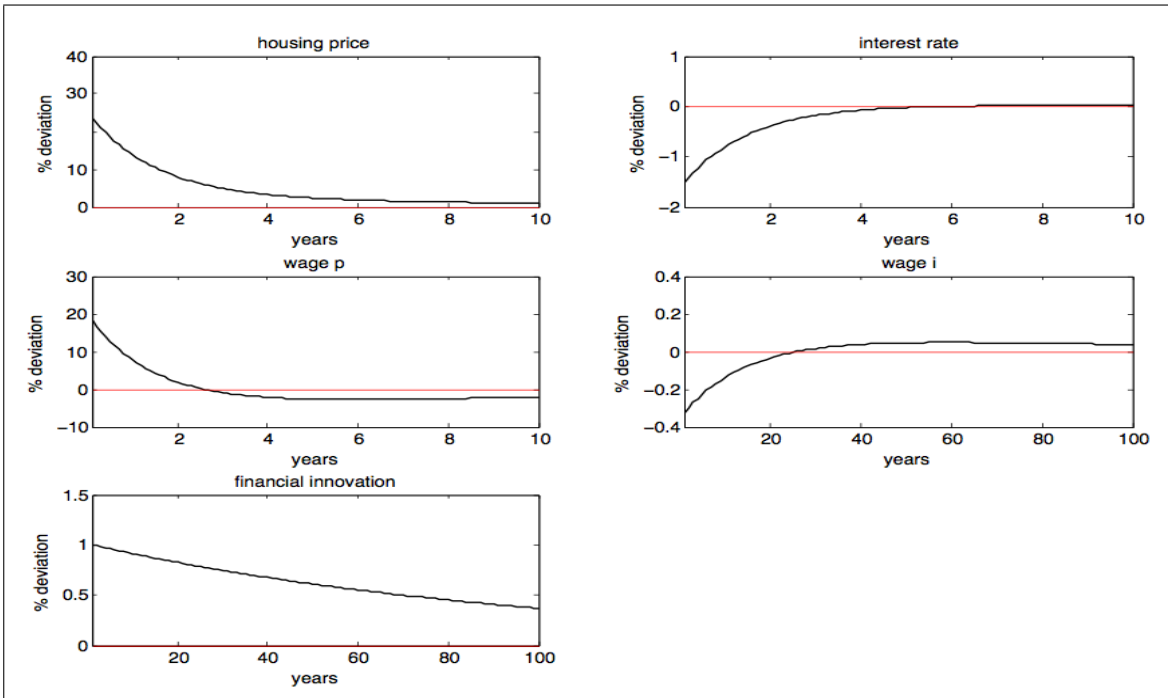Figure 5: Response to current financial innovation

Figure 6: Response to current financial innovation(cont.)

more, the amount of housing holding turns to be positive because the impatient can eventually borrow enough to finance the housing purchase. In fact, under the given parameters the consumption of the impatient households decreases and hours of work increases in order to finance the housing demand. Moreover, the amount of borrowing sharply increases after the shock. This increment is permitted by the construction of the collateral constraint in two ways: because of the accumulation of the collateral, and because of the housing price increase. These two paths simultaneously amplifies the economy.

A few things about the patient households and entrepreneurs are worth the attention. The changes of the actions come only through the movements of the prices and are straightforward to understand. The patient households increase their consumption because of the substitution from the increase of the housing price. They also increase the housing because they simply afford to purchase it.

2.5.2 News Shock: News is Incorrect

Now let us start investigating the effect of the news shock. To be specific, it is assumed that at period zero, the agents obtains the signal that in 5 years, the financial innovation will make fruits to reduce the borrowing cost. In setting the length of time by the realization from the acquisition of the shock, it is supposed implicitly that it was about 5 years from the set of the events that indicated the change of the regime to the occurrence of the crisis. The structure of the shock follows the spirit of Beaudry and Portier(2004):

$$lnm_t = \rho^m lnm_{t-1} + \epsilon_{t-n}^{news} + \epsilon_t \tag{34}$$

The degree of the financial development evolves according to the stationary AR(1) process in which the ρ^m is strictly smaller than 1. ϵ_{t-n}^{news} represents the news shock that agents in the economy acquire in period t and that indicates in n years the financial innovation happens. In our simulation let us set $n = 5$ to target the US experience. ϵ_t is the shock which could possibly reverse the news: that is, if the $\epsilon_{t-n}^{news} = 1$ and $\epsilon_t = -1$, the degree of the financial development m does not change at all

throughout the periods. However, this set of two shocks affect the economy because at time k where $t - n \leq k < t$, all agents believe that the financial innovation must occur at period t, so that they react and take actions optimally so as to adapt themselves to the "promised" shock.

In this paper, the focus is on the case where the news is incorrect. [7]This is because the key component of the optimism on the financial innovation stems from the risk sharing that at the same time reduces the risk of borrowing and lending, which was proved false by the harsh experience during the crisis. Figure 7 describes the transition of the economy when the news shock occurs and it turns out to be false.
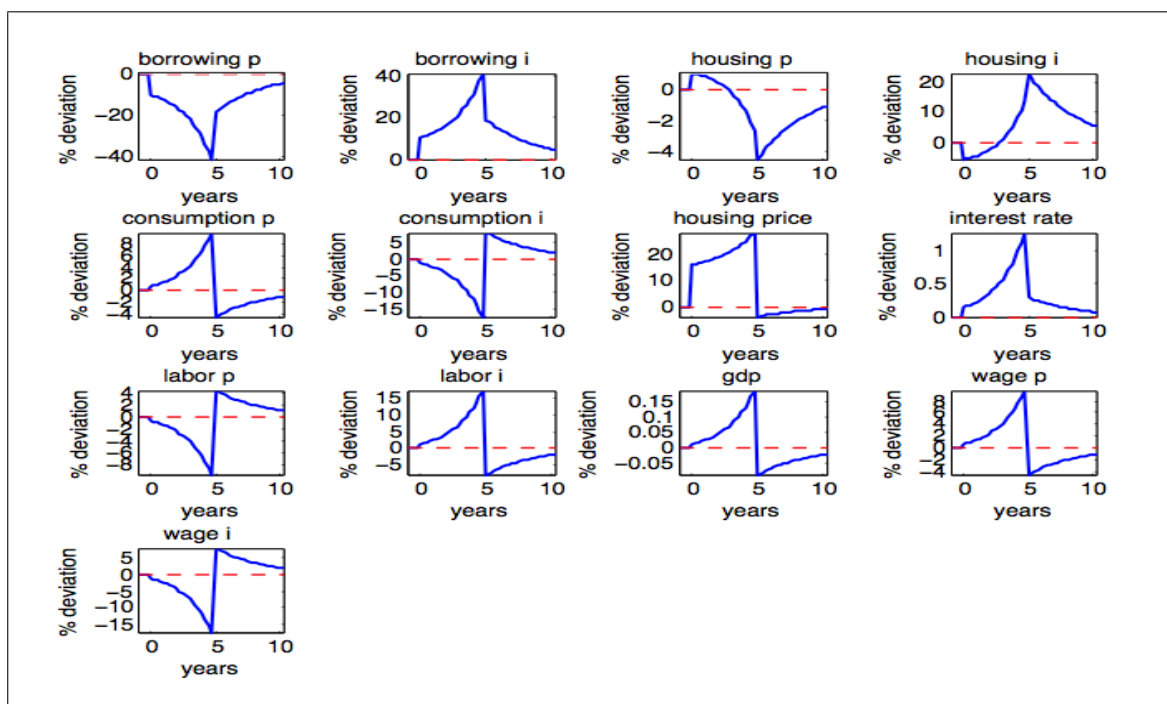

Figure 7: Response to future financial innovation and news is incorrect

Figure 7 shows the housing price jumps as the news arrives, and continues increasing until the news turns out to be false at period 5. When the belief collapses, the price immediately goes below the steady state. In the following period, the housing price converges to the steady state level as the time

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[7]Let us refer to Nutahara(2007) very much in making the code.

goes by. The reason why the news shock generates boom and bust results from the forward-looking collateral constraint. When the financial innovation actually loosens the borrowing limit, the housing price increases due to the reduction of the cost of borrowing as is seen in the previous simulation. Given this expectation, the lenders in the previous period allow the impatient households to borrow more because they anticipate the capital gain from the housing as collateral. Since borrowers use some fraction of their borrowing to purchase houses, the housing price actually rises at the time. Repeating this anticipation, surges of borrowing, and actual increment of demand, the housing market experiences the boom as soon as the news arrives in the market. The interesting thing is that even though the fundamentals does not change before the news, the economy is in the prosperous times.

Regarding other variables, at first due to the high price the amount of holding of the housing by the impatient households decreases, but they accumulate it as the years pass by. They finance the money to purchase houses by working more, and reducing their consumption.

The bust happens because impatient households realizes that housing is not worth holding as they thought. They do want to sell houses in the market and this sudden increase in the "conceptual" supply of the housing in the market loosen the market so that makes the need of the huge price adjustment.

The sudden fall of the housing price immediately tighten the loan market and therefore the borrowing by the impatient households drops as the news proves wrong. After this fall the borrowing gradually reduces to the steady state level along the decrease of the holding of the houses.

The consumption by the patient households jumps above the steady state level owing to the substitution effect. They understand that the housing price is now so high that they want to allocate their money into the consumption. This increment of the consumption reduces the hours of work by them since the increase dampens the incentive to work through the intra-temporal relationship between consumption and working.

The action taken by the patient households is as straightforward as is discussed in the previous

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section. Since the housing price increases they have more incentive to allocate their income toward consumption. As for housing, even though at first amount of housing increase due to the high price, as the impatient become eligible to purchase lots of housing, the holdings by the patient households decreases. The transition of the consumption explains the movement in the hours of working by the patient.

2.6   Extension

One clear problem observed in the transition is the movement of the consumption by the impatient household. Figure 8 and Figure 9 show the comovement of the housing and the other total average annual expenditure by the highest 20 quantile and lowest 20 quantile income households in US.[8] The income is defined by the income before taxes. The horizontal axis is the year and the vertical axis is the annual growth rate. These graphs show that two kind of expenditures have positive relationship. In fact, the number 0.70 and 0.34 is found as the correlation between the two expenditure for wealthy and poor people, respectively. Especially, during 2005 and 2006, the time the housing market is at their best, both expenditure significantly increases. This observation motivates to modify my model to provide the positive movement in the consumption by the impatient households. The key strategy is to provide the impatient households with more money to purchase. It is hypothesized that if the constrained households earn enough money, they start allocating some fraction of it toward consumption, which will lead to the positive movement of the consumption of the impatient households. The room for entrepreneurs to react to the shock to make more goods is considered so as to make this dynamics,. In order to represent the situation where entrepreneurs are willing to make more goods when they expect the shock and price increase of the housing, the constraint on the entrepreneurs is assumed as Iacoviello(2005) has adapted.

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[8]Housing expenditure includes housing related expenditure such as purchase of housing, public services, housekeeping supplies and so on. The other expenditure includes expenditure on things like food, health care, entertainment, reading, education and so on.
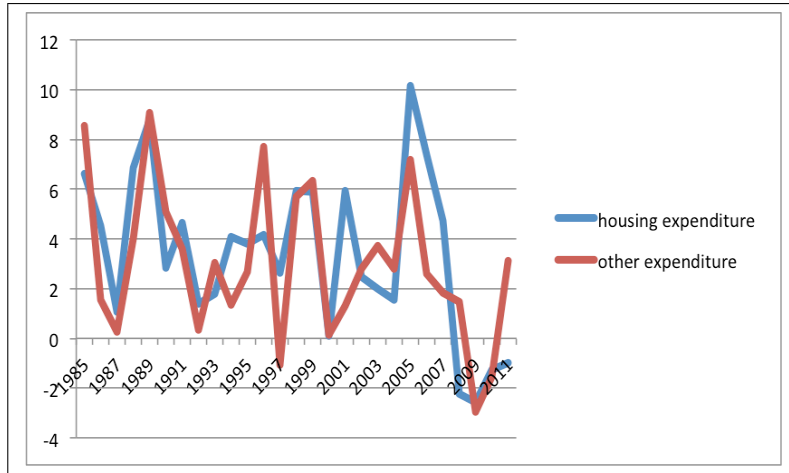
Figure 8: Housing and other expenditure by the highest 20 quantile income households, Data source: Consumer Expenditure Survey, Bureau of Labor Statistics
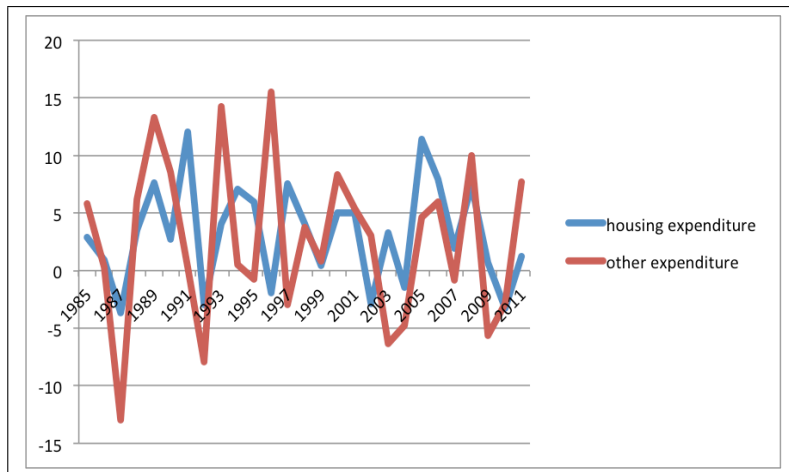

Figure 9: Housing and other expenditure by the lowest 20 quantile income households, Date source: Consumer Expenditure Survey, Bureau of Labor Statistics

2.7 Constrained Entrepreneurs

The problem of the entrepreneurs is modified. They maximize their lifetime utility rather than profit itself.

$$maxE_0\Sigma(\gamma^t ln C_t^f) \tag{35}$$

$$s.t. C_t^f + q_t(h_t^f - h_{t-1}^f) + (1 + r_{t-1})b_{t-1}^f + w_t^p l_t^p + w_t^i l_t^i = b_t^f + Y_t \tag{36}$$

$$b_t^f \le m_t^f E_t(\frac{q_{t+1}h_t^f}{1 + r_t}) \tag{37}$$

$$Y_t = A_t(h_t^f)^v(l_t^p)^{\alpha(1-v)}(l_t^i)^{(1-\alpha)(1-v)} \tag{38}$$

They have production technology to create the final goods. They use two types of labor and real estate as the input and pay wages and housing price. Let us assume today's real estate can be used as the input. Assumption behind the modification is that entrepreneurs easily utilize their real estate. The timing is modified because the late utilization only slightly disturbs the transition and it does not show any meaningful difference. In fact, that the change does not matter on the implication of the model is assured by examining the both transitions. The expenditure share of the housing is denoted as v as in Iacoviello (2005). They are eligible to borrow money from households. However, they are at the same time constrained by the collateral constraint. The patience is smaller than that of the patient households, that is, $\gamma < \beta^p$, which simplifies the analysis. The first order conditions are all straightforward:

$$\frac{1}{C_t^f}(\frac{vy_t}{h_t^f} - q_t) + \frac{\mu_t m_t^f E_t q_{t+1}}{1 + r_t} + E_t \frac{\gamma q_{t+1}}{C_{t+1}} = 0 \tag{39}$$

$$w_t^p l_t^p = (1 - \alpha)(1 - v)Y_t \tag{40}$$

$$w_t^i l_t^i = \alpha(1 - v)Y_t \tag{41}$$

$$\frac{1}{C_t^f} - \mu_t - E_t \frac{\gamma(1 + r_t)}{C_{t+1}^f} = 0 \tag{42}$$

$$\mu_t \geq 0, \mu_t(m_t^f E_t(\frac{q_{t+1}h_t^f}{1 + r_t}) - b_t^f) = 0 \tag{43}$$

The first equation is the Euler equation between consumption and housing. μ_t describes the Lagrange multiplier of the collateral constraint. The second, and the third are the labor supply functions. The fourth equation shows the intertemporal relationship using the loan. The last line is the KKT conditions. Let us allow to focus around the steady state where the constraint is binding because of $\gamma < \beta^p$ as in the problem of the impatient households. Thus, the following loan demand for entrepreneurs is obtained:

$$b_t^f = m_t^f E_t(\frac{q_{t+1}h_t^f}{1 + r_t}) \tag{44}$$

The problem of the households are unchanged. Only the market clearing conditions need slight modification:

$$C_t^i + C_t^p + C_t^f = Y_t \tag{45}$$

$$h_t^i + h_t^p + h_t^f = H \tag{46}$$

$$b_t^i + b_t^p + b_t^f = 0 \tag{47}$$

The new equations are first log-linearized as follows:

$$\hat{y}_t = \hat{A}_t + v\hat{h}_t^f + \alpha(1-v))\hat{l}_t^p + (1-\alpha)(1-v)\hat{l}_t^i \tag{48}$$

$$\hat{w}_t^p + \hat{l}_t^p = \hat{y}_t \tag{49}$$

$$\hat{w}_t^i + \hat{l}_t^i = \hat{y}_t \tag{50}$$

$$\frac{1}{1-\frac{m^f}{1+r}}q_t + \left(-\frac{\frac{m^f}{1+r}}{1-\frac{m^f}{1+r}} + \frac{qm^f}{\frac{vy}{h^f}+(1-m^f)q}\right)\hat{m}_t^f - \left(\frac{\frac{m^f}{1+r}}{1-\frac{m^f}{1+r}} + \frac{(1-m^f)q}{\frac{vy}{h^f}+(1-m^f)q}\right)E_t\hat{q}_{t+1} + \tag{51}$$

$$+\frac{\frac{m^f}{1+r}}{1-\frac{m^f}{1+r}}\hat{r}_t - \hat{C}_t^f + E_t\hat{C}_{t+1}^f + \frac{\frac{vy}{h^f}}{\frac{vy}{h^f}+(1-m^f)q}(-E_t\hat{y}_{t+1} + \hat{h}_t^f) = 0 \tag{52}$$

$$\hat{y}_t = \frac{C^p}{y}\hat{C}_t^p - \frac{C^i}{y}\hat{C}_t^i + \frac{C^f}{y}\hat{C}_t^f \tag{53}$$

$$b^p\hat{b}_t^p + b^i\hat{b}_t^i + b^f\hat{b}_t^f = 0 \tag{54}$$

$$h^p\hat{h}_t^p + h^i\hat{h}_t^i + h^f\hat{h}_t^f = 0 \tag{55}$$

$$\hat{b}_t^f = E_t\hat{q}_{t+1} + \hat{h}_t^f - \hat{r}_t + \hat{m}_t^f \tag{56}$$

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$$C^f \hat{C}_t^f + qh^f(\hat{h}_t^f - \hat{h}_{t-1}^f) + b^f(1+r)\hat{r}_{t-1} + b^f(1+r)\hat{b}_{t-1}^f = b^f\hat{b}_t^f - w^p l^p(\hat{w}_t^p + \hat{l}_t^p) - w^i l^i(\hat{w}_t^i + \hat{l}_t^i) + y\hat{y}_t \quad (57)$$

The first equation is the production function. The second and the third are labor demand functions. The fourth equation describes the Eular equation between the consumption and housing for the entrepreneurs. The fifth to seventh show the market clearing conditions and the last two indicate loan demand by the entrepreneurs and the flow of fund for them, respectively.

Now let us investigate how the transition of the economy has changed compared with the baseline model.[9] Since there are two paths that the financial innovation could possibly influence on the market, both, that is, shocks on the impatient households and on the constrained entrepreneurs are considered.

Table 2-Added Parameters in the extended model		
Description	Parameter	Value
Patience of entrepreneurs	γ	0.98
Degree of financial development for entrepreneurs	m^f	0.89
Housing expenditure share	v	0.03
Autocorrelation of financial innovation shock on the entrepreneurs	ρ^{mf}	0.99

The parameter values added in the model are summed up in Table 2. These values are also in Iacoviello(2005). The important thing is that the patience of the entrepreneurs is strictly smaller than that of the patient households, which allows us to concentrate on the binding case in terms of the collateral constraint.

Figure 10 and 11 present the transition to the shock on the households and entrepreneurs, respectively. The boom and bust is still in the graphs. Regarding the purpose, it is found that the result is on the way: At period zero when the news arrives, the consumption of the impatient households actually rises. This jump is derived from the increment of the total production named as GDP in the figure. In fact, compared with the baseline case, it is ten times more at the peak of the tran-

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[9]I put the system of steady state of the extended model in the Appendix.

sition. This movement results from the collateral constraint on the entrepreneurs. First, the future price hike, which is derived from the action of the impatient households, loosens the constraint of the entrepreneur because it is forward-looking. The reduction of the cost of borrowing allows them to purchase more houses and so increase the total production. However, the impatient households reduce their consumption to be below the steady state level. This is because the price rises so high that entrepreneurs become unwilling to purchase houses more, letting the total production converge to the original steady state level.
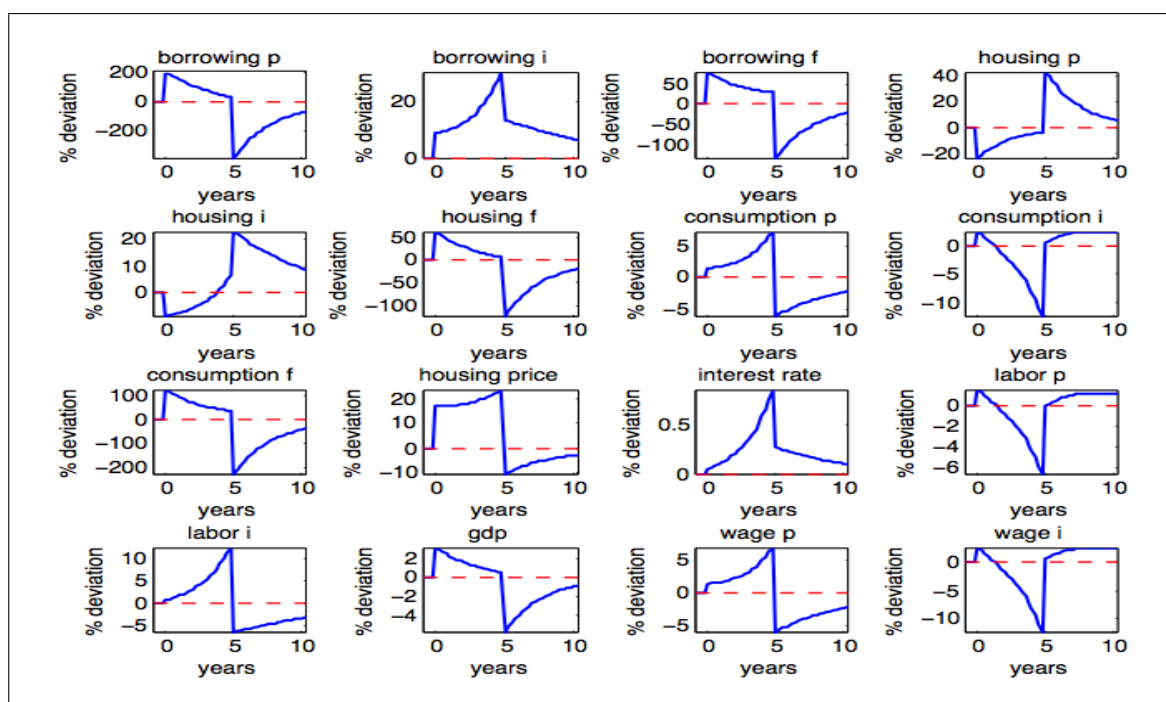

Figure 10: Response to future financial innovation for households and news is incorrect; entrepreneurs are constrained

The interesting thing is that the two different shock present almost the same transition. One reason is that in any case housing price due to the decrease of the cost of borrowing allow both households and entrepreneurs to borrow more before the shock. The important thing for them is the fact that the credit limit is mitigated, and therefore given the future price hike they borrow more now and so current price moves to increase. This makes the transitions of the two shock look surprisingly similar.

There are two ways to construct the model that feature the desirable characteristics. One is to allow the impatient households' income to grow continuously so that they will become willing to share satisfactory fraction into consumption. This is what the extended model is aiming at. The other way is to change the degree of elasticity of substitution. In this direction, the difficulty is to keep their income at least increasing.

In conclusion, the introduction of the constraint on the entrepreneurs partly mitigates the contradicting transition of the impatient consumption in the baseline model. However, the new transition is not satisfactory because it is still pulled back to the baseline even though at first the consumption actually increases due to the increment on the total production, which is mainly from the collateral constraint on the entrepreneurs.
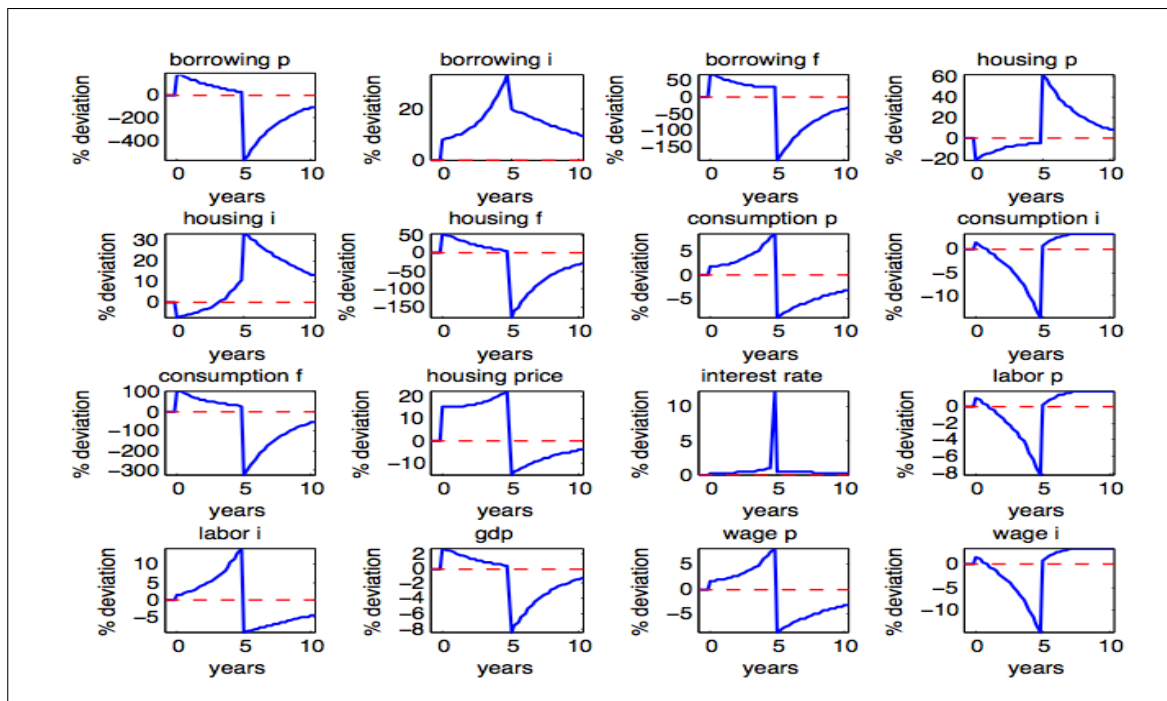

Figure 11: Response to future financial innovation for entrepreneurs and news is incorrect; entrepreneurs are constrained

3 Conclusion

Throughout the discussion in this paper, the effect of the news about the financial innovation on the housing price is examined. In both baseline and extended model, the boom-bust transition of the housing price is clearly observed. The housing price increases when the financial innovation occurs whether it happens now or it will in the future. When the shock is about the future, the price hike before the realization is not from the change of the fundamentals. But it is due to the forward-looking collateral constraint. Anticipation of the future price hike allows the impatient households to borrow more because lenders think even increased amount loan will be repaid taking the capital gain of the housing into account. Since the loan is used to purchase housing, the surge of the borrowing actually increases the demand of housing, resulting in the price increment in the housing market. This mechanism continues till the period when the news shock arrives in the market, and therefore generates the boom even though the market does not virtually experience the change of the fundamentals. The discovery of this path is my main contribution.

While the strength of the model can be stipulated, it is worth considering the ways for the further research in order to enrich the analysis. Three promising topics are pointed out here: modification of the consumption by the impatient agents, deepen the analysis regarding the information structure, and the degree of the amplification.

The first is to modify the consumption action by the impatient households to fit the data. This modification gets us to understand the mechanism of the boom and bust by the news shock more. The strategy for this way is discussed in the previous part.

The second way is to introduce other information structure. One important assumption of the news shock is that people can misunderstand the signal. Even though this seems true and inevitable in the real world, it is interesting to allow agents to behave more cautiously. One direction is the Baysian learning as Mendoza(2012) introduces.

The third is about the strength of the amplification. It would be intriguing to think about the case

where the market liquidity in the boom and bust is different. If agents believe the financial innovation surely comes as it is assumed in the model, this optimistic mood reduces the transaction or search cost because everyone believes housing market is booming and sellers can easily find the buyers. This mood fuels the economy. However, if the bust occurs, it is natural to assume people become more pessimistic and dubious, which will incredibly aggravate the shock by increasing supply and reducing demand. This is related to the fire sales literature and it may be worth investigating the connection with this field.

Appendix

A Steady state system of the baseline model

$$\alpha\frac{y}{l^p} = w^p \tag{58}$$

$$\alpha\frac{y}{l^i} = w^i \tag{59}$$

$$\frac{q}{C^p} = \frac{j}{h^p} + \beta^p\left(\frac{q}{C^p}\right) \tag{60}$$

$$\frac{1}{C^p} = (1+r)\beta^p\frac{1}{C^p} \tag{61}$$

$$\frac{w^p}{C^p} = (l^p)^{(\eta-1)} \tag{62}$$

$$-\frac{q}{C^i} + \frac{j}{h^i} + m\lambda\frac{q}{1+r} + \beta^i\frac{q}{C^i} = 0 \tag{63}$$

$$\frac{1}{C^i} - \lambda - \beta^i(1+r)\frac{1}{C^i} = 0 \tag{64}$$

$$\frac{w^i}{C^i} = (l^i)^{(\eta-1)} \tag{65}$$

$$b^i = m\left(\frac{qh^i}{1+r}\right) \tag{66}$$

$$y = A(l^p)^\alpha (l^i)^{1-\alpha} \tag{67}$$

$$C^i + C^p = Y \tag{68}$$

$$h^i + h^p = H \tag{69}$$

$$b^i + b^p = 0 \tag{70}$$

$$C^p + rb^p = w^p l^p \tag{71}$$

B Steady state system of the extended model

$$\alpha(1-v)\frac{y}{l^p} = w^p \tag{72}$$

$$(1-\alpha)(1-v)\frac{y}{l^i} = w^i \tag{73}$$

$$\left(1 - \frac{m^f}{1+r}\right)q = \gamma\left(\frac{vY}{h^f} + (1-m^f)q\right) \tag{74}$$

$$b^f = m\left(\frac{qh^f}{1+r}\right) \tag{75}$$

$$\frac{q}{C^p} = \frac{j}{h^p} + \beta^p(\frac{q}{C^p}) \tag{76}$$

$$\frac{1}{C^p} = (1+r)\beta^p \frac{1}{C^p} \tag{77}$$

$$\frac{w^p}{C^p} = (l^p)^{(\eta-1)} \tag{78}$$

$$-\frac{q}{C^i} + \frac{j}{h^i} + m\lambda\frac{q}{1+r} + \beta^i\frac{q}{C^i} = 0 \tag{79}$$

$$\frac{1}{C^i} - \lambda - \beta^i(1+r)\frac{1}{C^i} = 0 \tag{80}$$

$$\frac{w^i}{C^i} = (l^i)^{(\eta-1)} \tag{81}$$

$$b^i = m(\frac{qh^i}{1+r}) \tag{82}$$

$$Y = A(h^f)^v(l^p)^{\alpha(1-v)}(l^i)^{(1-\alpha)(1-v)} \tag{83}$$

$$C^i + C^p + C^f = Y \tag{84}$$

$$h^i + h^p + h^f = H \tag{85}$$

$$b^i + b^p + b^f = 0 \tag{86}$$

$$C^p + rb^p = w^p l^p \tag{87}$$

$$Y = C^f + rb^f + w^p l^p + w^i l^i \tag{88}$$

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