Transparency in the Mortgage Market

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Abstract

This paper studies the impact of transparency in the mortgage market on the underlying real estate markets. We show that geographic transparency in the secondary mortgage market, which implies geographic risk based pricing in the primary market, can limit risk-sharing and make house prices more volatile. Ex-ante, regions prefer opaque markets to enable insurance opportunities. We discuss the implications for risk based pricing and house price volatility more generally.

In addition, we investigate the specific conditions under which competitive lenders would optimally choose to provide opaque lending, thus reducing volatility in the real estate markets. We show that in general the opaque competitive equilibrium is not stable, and lenders have incentives to switch to transparent lending if one of the geographic regions has experienced a negative income shock. We propose market and regulatory mechanisms that make the opaque competitive equilibrium stable and insurance opportunities possible.

1 Introduction

One of the most often-cited causes for the severity of the 2008 financial crisis is that most housing-related financial instruments were highly opaque (see for example Gorton, 2008). Since investors were unable to ascertain the exposure of separate financial institutions to these instruments and because the exposures were crosscutting, the entire financial system was put at risk. As a result, numerous regulatory, policy, and institutional recommendations have called for greater transparency in mortgage portfolios and their derivatives(Squam Lake Report, French et al 2010).

Nonetheless, the design of transparency features matters. Transparency in some forms may in fact have neg- ative side effects. In this paper we build upon the literature on debt and insurance markets to investigate the impact of increased transparency in the mortgage market. There is an existing literature on the negative impact of transparency on liquidity in financial markets. In this paper, we introduce a model which shows that certain forms of transparency can lead to increased volatility in housing and mortgage markets. Specifically, we develop a model of the mortgage lending system that can be transparent or opaque and show the impact of a transparent system, as it relates to diversifiable region specific risk. While we focus on region specific risk, the model has general implications.

We develop a model showing that a transparent market may be undesirable because it increases real estate price volatility and magnifies the impact of income shocks. Under a transparent system, lenders (and investors), know the geographic location of each mortgage. When a local negative in- come shock occurs, lenders (investors) rationally withdraw from that region in anticipation of future (auto-correlated) shocks. This withdrawal magnifies the price impact of the original income shock.

In our setting, both borrowers and lenders may be worse off in a transparent system. While both borrowers and MBS investors prefer a geographically opaque system if it can be sustained, the impact on borrowers is more severe. as they are unable to diversify local income shocks. Originators and MBS investors can fully diversify local risks. Therefore, the impact of switching to a transparent system is temporary and limited to the adjustment period only. Borrowers, on the other hand, cannot diversify local risks. The impact on them is substantial and persistent.

We further design mechanisms that preserve a stable opaque equilibrium that allow for insurance. One mechanism keeps a multitude of competitive lenders in the opaque equilibrium as long as they consider the long-term returns from that system. We show that in the case of multiple lenders, the presence of a short-term player in the market forces everyone to switch to a transparent system. The transparent equilibrium we derive is stable. Lenders require an external intervention or coordination to switch back to the preferred opaque equilibrium.

We proceed as follows. Section 2 reviews the relevant literature. Section 3.1 presents a theoretical model with a single lender. Section 3.2 extends the work to two lenders and discusses the game-theoretic outcomes. Section 4 provides a numerical calibration. Section 5 discusses policy implications. Section 6 concludes.

2 Literature Review

There are two major strands of literature related to transparency in financial markets. The first strand focuses on liquidity for debt markets. [1] A major question in security design is whether securities should be made transparent (and therefore tranched) or made opaque (bundled). Papers in this literature include Dang, Gorton and Holmstrom (DGH, 2013), Pagano and Volpin (PV, 2012) and Farhi and Tirole (FT, 2013).

In a theoretical model, PV 2012 show that issuers of asset-backed securities, facing a tradeoff between transparency and liquidity, deliberately choose to release coarse information to enhance the liquidity of the primary market. FT 2013 look at the implication of tranching vs bundling on liquidity. They show that tranching has adverse welfare effects on information acquisition as tranching provides an incentive against commonality of information that contribute to the liquidity of an asset. They also show that liquidity is self-fulfilling: a perception of future illiquidity creates current illiquidity.

[1] For a discussion of the liquidity of the MBS market and its benefits as measured in the TBA market see Vickery and Wright (2013).

DGH 2013 argue that opacity is essential for liquidity. Investors in their models are not equally capable of processing the transparent information. When the composition of a security is opaque then all investors are symmetrically ignorant. If it is made transparent, investors will pay a cost to process the additional information. Since not all investors are capable of processing this information, transparency will create asymmetric information, which has an adverse effect on liquidity. [2] To illustrate their logic, Holmstrom (2012) explains that DeBeers sells wholesale diamonds in opaque bags. If the bags were transparent, buyers would examine each bag individually leading to increased transaction costs due to time allocated to inspections and adverse selection among buyers. This would make the diamond market much less liquid.

Nonetheless Downing, Jaffe and Wallace (DJW, 2005), in the context of MBS. DJW 2005 shows that making available to investors information that inform on risk and reduces uncertainty enables tranching to be efficient by dividing informed investors willing to invest in riskier tranches from non-informed investors who are sheltered from the risk in higher tranches. This is what has been done in agency MBS and does not interfere with liquidity. But tranching for risk that is not transparent creates adverse selection and is not stable similarly to the situation demonstrated by Ackerlof (1970). This is what happened in the private MBS and CDO markets over the crisis as shown in French et al (2010) and Beltran, Cordell and Thomas (BCT 2013).

This first set of studies focuses on the trade-off between the liquidity benefits of opaqueness and the adverse selection implications. The lack of transparency can ensure symmetric information among actors, unless the issuers and institutions lead to differentially disclosed information.

Our model extends a second strand of literature that studies the relationship

[2] DGH argue that while symmetry of information about payoffs is essential for liquidity, transparency is not and opacity actually contributes to liquidity as symmetric information can be achieved through shared ignorance. Highly nontransparent markets can be very liquid (19th century clearinghouses, currency). When you make it possible to obtain information about an asset, people invest in finding information differentially, resulting in lower overall liquidity.

between transparency and risk pooling. Hirshleifer (1971), [3] the seminal paper in this literature, shows how transparency can be harmful through its destruction of insurance opportunities. If as the insurance contract is being entered into, knowledge of the risk is made known to the actors, they will price it separately, even if the risk is diversifiable. If market participants have updated information about each other's risk they will not want to insure each other. This mechanism has been applied to financial markets. For example Bouvard, Chaigneau and Motta (BCM 2013) study the role of transparency among financial intermediaries. They find that transparency enhances the stability of the financial system during crises but has destabilizing effects in normal times.

While consistent with the literature on transparency and liquidity, our work predominantly draws on the second strand discussed above to show that transparency limits risk pooling and reduces insurance opportunities. As such, transparency can be detrimental to borrowers, originators, and security investors alike. We advance the literature by developing a stylized model that has implications for optimal disclosure policy in housing finance. Building on the first strand of the literature, which focuses on liquidity and transparency outcomes for debt markets, our model shows the interaction of transparency and mortgage markets, a form of debt, and the underlying housing markets. While DGH and other papers cited above focus on liquidity and access to information by agent type, we build on this using an extension of the Hirshleifer mechanism to show the impact of transparency on markets that are geographically segmented. This allows us to study the policy implications of transparency for both mortgage and housing markets.

3 Model

We develop a simple model that captures key features of residential real estate markets. The first assumption is that homes are purchased with mortgages from the financial system only, and homeowners cannot raise equity or issue debt directly to the market. We further assume that lenders are competitive, so they generate zero profits. This assumption is consistent with our

[3] This is in contrast to Akerlof (1970) who shows that transparency is good in markets that suffer a "lemons" problem. Informing all parties who the lemons are will make the market function more smoothly.

discussion that local shocks are fully diversifiable to originators and MBS investors. The only choice lenders have is whether to be transparent or opaque in their lending decisions. Most importantly, lenders are not able to derive monopolistic/duopolistic profits in any scenario by altering their pricing and quantity mix.

A limitation of the model is the assumption that homeowners base their purchase decisions on their current income and current loan availability, with no foresight of potentially changing availability of credit, and no ability to increase their investment if they perceive good opportunities.

We begin by describing the housing and credit markets under transparency and opacity. Our baseline model for both of these regimes utilizes a single loan originator (or lender) funded by the secondary market and two cities. We then expand this to two (or more) originators, both funded by a secondary market, to analyze the coordination problem faced by individual originators under these circumstances.

3.1 One Lender

We assume that the loan originators in our model are competitive (or face the threat of competition in the case of the single originator). Thus, the lending rate offered is determined entirely by the secondary market. We assume that the lenders charge a spread between their funding cost and lending to cover their costs. Also, originators can fully diversify their exposure to local income shocks. In other words, the interest rate, $R = (1 + r)$, lenders charge their borrowers is exogenous. Lenders are funded by selling an unlimited volume of mortgage-backed securities (MBS) in the secondary market as long as those securities provide zero profit to their investors.

Consider two cities denoted by j, $j \in \{A, B\}$. Each city j has a representative household who receives income in period t, denoted y_t^j. Income in the two cities follows a correlated stochastic process $(y_t^A, y_t^B) \sim F$ (defined below). In addition to income, homes are also financed by loans L_t^j.

The demand for housing is given by:

$$Q_t^j = \alpha + y_t^j + L_t^j - \gamma p_t^j \tag{3.1}$$

The supply of housing is fixed: $H_t^j = H$. The equilibrium condition is that supply of housing equals demand, $Q_t^j = H_t^j$. This provides the following price for real estate at each point in time in each city:

$$p_t^j = \frac{1}{\gamma}\left(\alpha + y_t^j + L_t^j - H\right) \tag{3.2}$$

The loan to the representative household in city j, L_t^j, is given by a risk-neutral loan originator who operates in a competitive market. L_t^j satisfies a zero expected profit condition.

We consider two regimes. A loan in a transparent regime where each loan is city specific, L_t^j, and a loan in an opaque regime where mortgage-backed securities investors cannot geographically discriminate, L_t.

We model transparent markets as those in which originators give loans to regions conditional on region specific risks (i.e. geographic risk based pricing). If the secondary mortgage market sells securities that are geographically transparent then investors are able to tranche these securities according to their geographic risk. Demand for MBS based on geographic risk will make lenders in the primary mortgage market price and lend according to their geographic risk.

Consider two cities, A and B. If the secondary mortgage market is geographically opaque, then lenders will neglect city-specific risk. In this regime, loans would incorporate the average risk of both city A and city B. However, if the secondary market is geographically transparent, investors will tranche the MBS into MBS A and MBS B. Demand for MBS will now reflect region specific risk. Thus lenders will price their loans to each region based on that region's local risk. This is how transparency would remove the ability to pool risk between city A and city B as the following shows.

Transparent Mortgage Markets Regime

The MBS expected profit for loan's to city j is given by the expected collection (loan amount plus interest if no default, or house value if default) less the initial loan amount:

$$\mathbb{E}[\pi_t^j] = -L_t^j + \eta \mathbb{E}_t \min\left[L_t^j R, p_{t+1}^j H\right] \tag{3.3}$$

Where η is the lender's discount factor. Credit markets are competitive so L_t^j is given by a zero expected profit condition:

$$\begin{aligned}&\mathbb{E}[\pi_t^j] = 0\\&\quad\Leftrightarrow\\&\quad L_t^j = \eta L_t^j R \cdot P\{L_t^j R \leq p_{t+1}^j H\} + \eta H \mathbb{E}_t[p_{t+1}^j | L_t^j R > p_{t+1}^j H]\end{aligned}$$

Opaque Mortgage Markets Regime

When markets are geographically opaque, the lender is not able to discriminate geographically and gives the same loan to both cities. The expected profits are:

$$\begin{aligned}\mathbb{E}[\pi_t] =& -(L_t + L_t) + \eta \mathbb{E}_t \min\left[L_t R, p_{t+1}^A H\right] + \eta \mathbb{E}_t \min\left[L_t R, p_{t+1}^B H\right] \quad (3.4)\\=& -2L_t\\&+ \eta L_t R \cdot P\{L_t R \leq p_{t+1}^A H\} + \eta H \mathbb{E}_t[p_{t+1}^A | L_t R > p_{t+1}^A H]\\&+ \eta L_t R \cdot P\{L_t R \leq p_{t+1}^B H\} + \eta H \mathbb{E}_t[p_{t+1}^B | L_t R > p_{t+1}^B H]\end{aligned}$$

The corresponding zero expected profit condition is:

$$\begin{aligned}\mathbb{E}[\pi_t] =& 0\\&\Leftrightarrow\\L_t =& \frac{1}{2}\eta L_t R \cdot P\{L_t R \leq p_{t+1}^A H\} + \frac{1}{2}\eta H \mathbb{E}_t[p_{t+1}^A | L_t R > p_{t+1}^A H]\\&+ \frac{1}{2}\eta L_t R \cdot P\{L_t R \leq p_{t+1}^B H\} + \frac{1}{2}\eta H \mathbb{E}_t[p_{t+1}^B | L_t R > p_{t+1}^B H]\\&\Leftrightarrow\\L_t =& \frac{1}{2}\eta L_t R \cdot \left(P\{L_t R \leq p_{t+1}^A H\} + P\{L_t R \leq p_{t+1}^B H\}\right)\\&+ \frac{1}{2}\eta H \left(\mathbb{E}_t[p_{t+1}^A | L_t R > p_{t+1}^A H] + \mathbb{E}_t[p_{t+1}^B | L_t R > p_{t+1}^B H]\right)\end{aligned}$$

Under opacity the loan is made to average risk across cities.

Income Shock

We now consider a situation with two time periods $t \in \{0, 1\}$, and two income levels, $y_t^j \in \{y_L, y_H\}$. Assume city A starts with the low income shock and city B starts with the high income shock: $y_0^A = y_L$, $y_0^B = y_H$. The probability city A will have a low shock next period is given by:

$P\{y_1^A = y_L | y_0^A = y_L\} = \frac{1+\rho}{2}$

Where $\rho \in [-1, 1]$ is the auto-correlation for income [4]. We assume income follows a two-state Markov chain:

$y_t^j \sim \begin{pmatrix} \frac{1+\rho}{2} & \frac{1-\rho}{2} \\ \frac{1-\rho}{2} & \frac{1+\rho}{2} \end{pmatrix}.$

For simplicity we assume that the spatial correlation in income shocks is perfectly negative $\rho_{A,B} \equiv -1$, so whenever city A has a negative shock $y_t^A = y_L$, city B will have a positive shock $y_t^B = y_H$ and vice-versa.

In a transparent market, zero profit level of lending to each city is:

$$L_0^A = \frac{\eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^A - H\right)\right)H}{\left(1 - \eta\left(\frac{1-\rho}{2}\right)R\right),}$$

$$L_0^B = \frac{\eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^B - H\right)\right)H}{\left(1 - \eta\left(\frac{1+\rho}{2}\right)R\right)}$$

In an opaque market, the lender's zero profit level of lending (same in both cities) is:

$$L_0 = \frac{\frac{1}{2}\eta\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1 - H\right)\right)H}{\left(1 - \frac{1}{2}\eta R\right)}$$

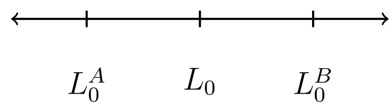
(See derivations in the appendix.)

Proposition 1

If income shocks are positively correlated $\rho > 0$ and if the lender's discount rate is less than the mortgage rate ($\eta R > 1$), the transparent level of lending to the city with the bad shock is less than the opaque level, which is

[4] The exogenous auto-correlation in income we assume in the model generates an auto-correlation in house prices. For evidence on auto-correlation in house prices see Duca et al 2010, Case, Shiller 1989, and Poterba 1989.

less than the transparent level of lending in the city with the good shock: $\boxed{L_0^A < L_0 < L_0^B}$.



This proposition is intuitive. Since income shocks are auto-correlated, the badly shocked city is more likely to have more bad shocks. Hence lenders are more reluctant to lend.

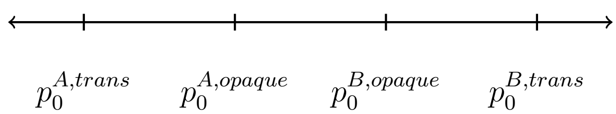
Plugging this into the equilibrium price function: $p_0^j = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^j - H\right)$ provides the important result that prices in the city which received a bad income shock are lower under the transparent regime relative to the opaque regime.

Proposition 2

$p_0^{A,trans} = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^A - H\right) < \frac{1}{\gamma}\left(\alpha + y_0^j + L_0 - H\right) = p_0^{A,opaque}$

Likewise:

$p_0^{B,trans} = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^B - H\right) > \frac{1}{\gamma}\left(\alpha + y_0^j + L_0 - H\right) = p_0^{B,opaque}$



We have assumed that city A starts with a bad income shock at time 0 and city B starts with a good income shock. Ex Ante with probability $\frac{1}{2}$ we have $y_0^A = y_L$ and $y_0^B = y_H$, and with probability $\frac{1}{2}$ we have $y_0^A = y_H$ and $y_0^B = y_L$. However, ex ante neither city knows which state of the world they will start in. Hence, ex ante they will prefer opacity to have less volatile house prices.

Proposition 3 The ex-ante house price volatility is greater under transparency than under opacity:

$\boxed{\sigma_{p,opaque}^2 < \sigma_{p,trans}^2}$

3.2 Two Lenders

Now consider two originators, each choosing independently whether to operate in a transparent or opaque way. As discussed above, the originators can place their mortgage-backed securities in the secondary market as long as those securities provide zero expected profit to the investors. The price in each city is given by:

$$p_0^j = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^{j,1} + L_0^{j,2} - H\right)$$

where $L_t^{j,k}$ denotes the lending of lender k in city j at time t. If both lenders operate the same way (transparent or opaque), the equilibrium level of total lending is exactly the same as with the single lender case above, and satisfy the following inequality:

$$L_0^{A,1} + L_0^{A,2} < L_0 < L_0^{B,1} + L_0^{B,2}$$

However, if one lender deviates, then the above order extends to the following:

$$L_0^{A,1} + L_0^{A,2} < L_0^{A,1} + \delta L_0 < L_0 < L_0^{B,1} + \delta L_0 < L_0^{B,1} + L_0^{B,2}$$

where δ denotes the market share of lender 2 if both lenders are opaque, e.g., $\delta = 1/2$. Prices follow the same relationship, which is easily verified because a mixed scenario always results in switch to transparent lending in period 1 (i.e., p_1^j is given by the transparent lending expression given above (3.2)). While the profits of the two lenders in each of the above scenarios sum up to zero, the lender who choses the transparent method has positive profits in the mixed scenario, at the expense of the lender who continues to lend in an opaque way. The second lender has no choice but to also switch to transparent lending.

The above conclusion indicates that if both originators stay with opaque lending, the MBS of both satisfy the zero-profit condition indefinitely. However, this equilibrium is unstable because each of the originators (and their investors) has an incentive to switch to transparent lending in case one of the cities experiences a negative income shock. The originator who switches can offer securities that generate positive profit for one period, after which the second originator also switches to transparent lending, and the transparent equilibrium continues indefinitely.

Note that the only choice originators (and their investors) have is between transparent and opaque lending. We are excluding any additional lending quantity choice because the market for MBS is assumed fully competitive. In other words, investors can choose between opaque or transparent portfolios, but have no ability to restrict lending to monopolistic levels.

Short-term and Long-term Lenders

The model above implies the following payoff matrix for the MBS of the two originators at time zero, denoting the one-period profit of the lender who switches from opaque to transparent as π:

Table 1

MBS 1, $t = 0$ Payoff Function

MBS 1\ MBS 2	Transparent	Opaque
Transparent	0	π
Opaque	$-\pi$	0

Payoffs beyond time 0 are all zero as both originators switch to transparent lending forever. With these payoffs, both originators have incentives to switch to transparent lending the moment one of the cities experiences a negative income shock. To preclude this trivial solution, we assume that an originator (or its MBS investors) receive a (small) benefit, ε, $(0 < \varepsilon < \pi)$, above it's zero profit if that lender lends in an opaque way. The one-period payoff matrix then becomes:

Table 2

MBS 1, $t = 0$ Payoff Function

MBS 1\ MBS 2	Transparent	Opaque
Transparent	0	π
Opaque	$-\pi$	ε

An originator who optimizes over a long (infinite) horizon has an incentive to remain in the opaque equilibrium, as receiving ε over a long time horizon dominates the one-time profit, π. However, if one of the originators switches to a short horizon view of the world, that originator would switch to transparent lending in case of a negative income shock to collect the one period positive profit, π.

There are two potential mechanisms that can make the opaque lending more stable. First, if each of the lenders can switch to transparent lending in the same period their competitor switches, then both lenders move to the fully transparent equilibrium and satisfy the zero profit conditions in this equilibrium. In this case, there is no incentive for a lender to switch away from the opaque equilibrium, so it can continue indefinitely.

The second mechanism is to increase the incentive, ε, for the lenders to stay in the opaque equilibrium. While a very short-term lender would still switch to transparent lending, this scenario is less likely. Also, if the short-term lender gets out of business or changes back to a long-term optimization, then the probability that the remaining lender(s) return to opaque landing is higher.

4 Numerical Calibration

In this section, we will provide a numerical exploration of the results in our model. Consider a world where the parameters are:

parameter	description	value
ρ	autocorrelation	0.5
η	discount factor	.99
R	gross interest rate	1.04
H	exogenous housing supply	10
α	demand intercept	15
y_L	low income level	5
y_H	high income level	8
L_1	exogenous loan	10
γ	demand slope on price	1

We assume city A has a bad income shock at time 0 and income shocks are negatively correlated across space: $y_0^A = 5, y_0^B = 8$.
The corresponding loans are:
$L_0^A = 199.97 < L_0^{opaque} = 204.04 < L_0^B = 217.296$

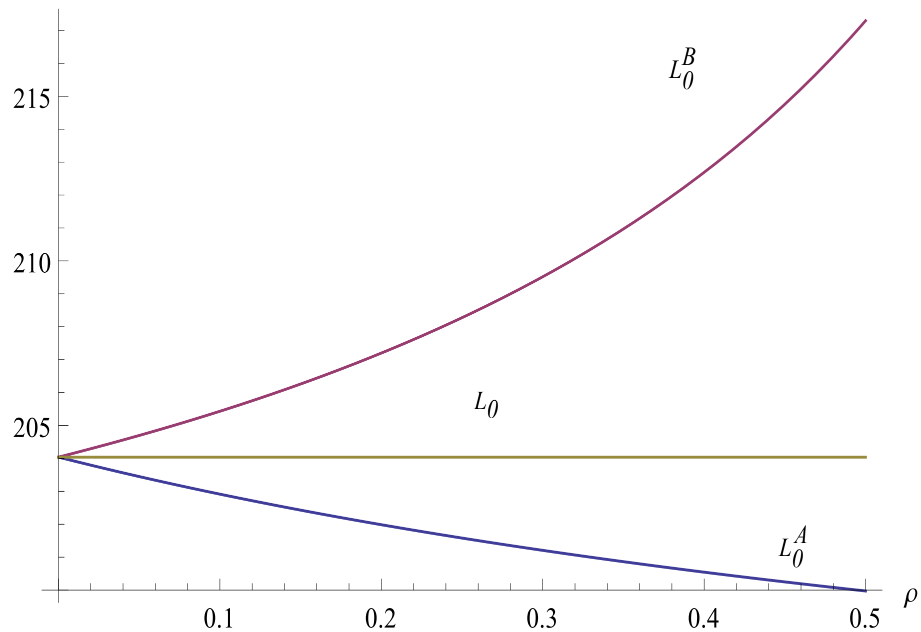
$$L_0^A = 199.97 \qquad L_0 = 204.04 \qquad L_0^B = 217.296$$

Since city A is more likely to default than city B it will receive a smaller loan in a transparent world (with risk based pricing). However in an opaque world the lender averages risks across cities and both cities receive the same intermediate loan.

The corresponding house prices are:
$p_0^{A,trans} = 209.97 < p_0^{A,Opaque} = 214.04$,
$p_0^{B,trans} = 230.296 > p_0^{B,Opaque} = 217.04$

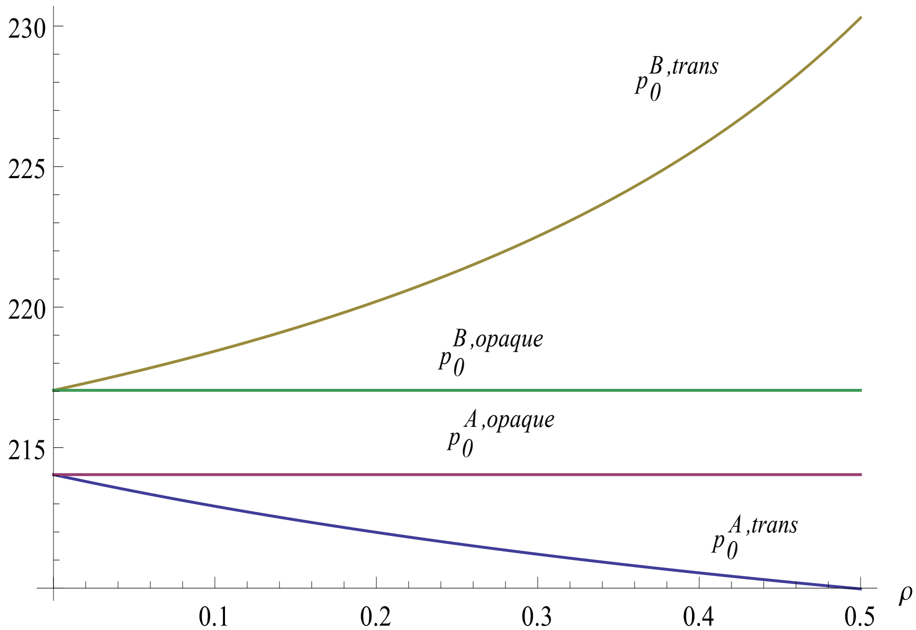
$$p_0^{A,trans} = 209.97 \qquad p_0^{A,opaque} = 214.04 \qquad p_0^{B,opaque} = 217.04 \qquad p_0^{B,trans} = 230.296$$

Since city A is more risky, it receives a smaller loan in a transparent world and therefore has lower house prices. Note that under opacity city A has lower house prices than city B even though they receive the same loan because city A has a lower income shock than city B.
The following figure plots the loans L_0^A, L_0^B, L_0 as a function of the persistence of income $\rho \in [0, .5)$:



This figure illustrates that the spread in loans $L_0^B - L_0^A$ is an increasing function of persistence ρ. The intuition is that the more auto-correlated the shock is, the more likely the bad shocked region (city A) is to experience another bad shock. Hence it will receive a smaller loan with higher ρ.

The following figure plots the prices $p_0^{A,trans}, p_0^{A,opaque}, p_0^{B,trans}, p_0^{B,opaque}$ as a function of the persistence of income $\rho \in [0, .5)$:



We have the same lesson. When $\rho > 0$, higher auto-correlation ρ corresponds to a bigger spread in house prices.

The lesson is that in a world with greater persistence (ρ) the benefits from risk-pooling through opacity are even greater.

5 Policy Implications

The main point of this paper is to augment the view that greater transparency in mortgage-backed securities is necessarily better. While transparency has its own advantages and is intuitively appealing, we show that it may actually leave both borrowers and lenders worse off. Specifically, we show that transparent lending results in larger changes in loan availability to areas which recently experienced an income shock. This leads to increased home price volatility. This is clearly undesirable for the homeowners, but can also hurt the MBS investors as well and overall system stability.

At the very least, this work suggests that calls for regulatory requirements for increased transparency in the MBS market may not necessarily achieve their original intent. In fact, such calls very much hurt the very borrowers they are trying to help and protect because regulatory requirement for transparency prevents lending markets from providing an indirect insurance against idiosyncratic shocks and shocks over the cycle.

Preventing regulatory requirements for geographic transparency in mortgage origination is of course not sufficient. Policymakers also need to ensure that mortgage originators are protected in their decision to issue geographically opaque instruments. Regulatory steps are needed to specifically prevent changing the level of transparency for a particular MBS issue through time. In other words, if an MBS is issued and labeled as opaque, originators should keep it that way. They may not be able to do so alone, and would likely require legislative protection. At the minimum, such issues should be clearly labeled as opaque from the start.

While our work suggests that geographic transparency is not welfare improving, other types of transparency can still be very much desirable. For instance, transparency with respect to origination standards and other mortgage characteristics can improve pricing in the secondary markets and help investors detect changes in these standards.

We further develop mechanisms to keep opaque MBS viable even if one region experiences a negative income shock. The natural inclination of originators (and their MBS customers) in such case is to switch to transparent lending. First and foremost, as already discussed, it is imperative that the opaque instruments remain that way. Second, it is important for opaque instruments to continue to exist, and preferably dominate the market. Since MBS investors have a short-term view of the underlying market to begin with (they are only exposed to the specific issue they hold), the only player who can ensure geographic opaqueness in the system is the originator.

Our work suggests two mechanisms to maintain opaqueness. First, all originators need to be long-term players in the market, so that they weight the potential immediate benefit of switching to transparent issuance against the long-term benefit of keeping the system geographically opaque. Second, the originators do need to realize some (small) benefit, above their zero-profit condition, in case they issue opaque instruments. Such benefits can come from many sources, including simple customer loyalty built through being in the market for a long time or lighter regulatory burden in exchange for issuing opaque MBS. When both of these conditions are present, originators can remain in the opaque equilibrium, thus benefiting their customers and themselves in the long run. MBS investors are not worse off, as all lending we consider satisfies an ex-ante zero-profit condition.

Finally, let us note that geographically opaque MBS is nothing new or exotic. In fact, it is the predominant form of securitization to date. Both agency MBS and private-label MBS have historically been opaque, and have been well received by investors. We have only recently seen attempts to offer geographic transparency in the private market. While one might argue that our historical experience is not supportive of opaqueness, as we show here, geographic transparency is unlikely to be an improvement. Transparency in other dimensions would likely be highly beneficial.

6 Conclusion

In this paper we develop a model to analyze the implications of a geographically transparent or opaque lending system on the underlying real estate markets. We show that geographically opaque lending system benefits homeowners as it allows them to insure against local income shocks. Under opaqueness, the real estate market volatility is lower. Loan originators and MBS investors are no worse-off under the opaque system, and in fact they can be better off in certain circumstances.

We further analyze the interaction of two (or more) originators and develop the conditions under which they can sustain an opaque system. These conditions involve a long-term benefit that offsets the potential immediate gain from switching to a transparent system. A sustained opaque system requires all originators to be long-term players.

Based on our model, we develop a number of policy implications focused on developing and sustaining a geographically opaque lending system. Such system can be achieved with no additional regulation, in fact we argue against introducing new regulation that potentially requires originators to be geographically transparent in structuring their MBS.

The results of the model we develop here point to the increased house price volatility that results from the withdrawal of credit in response to a diversifiable shock. While the transparency literature clearly points to the need to monitor origination of loans for securitization to prevent lemons and adverse selection, the pricing of diversifiable risks has its own negative consequences in terms of increased house price volatility. What is needed is transparency, monitoring and accountability for risk introduced in origination, without the pricing of risk that would make the pooling of risk infeasible.

While this goes beyond the model introduced here that focuses on geographic transparency or opaqueness, this paper points to the need to construct such a transparency design. There are numerous other dimensions in which MBS can be far more transparent than they have been in the past. In future research we plan to investigate additional types of transparency and determine if it is beneficial for the homeowners and MBS investors.

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8 APPENDIX: 2 periods, 2 states

Transparent Mortgage Markets

The lender lends L_0^j to city j, gets $\left\{ \begin{array}{c} L_0^j R, \text{ if } y_1^j = y_H \text{ repay} \\ p_1^j H, \text{ if } y_1^j = y_L \text{ foreclose} \end{array} \right\}$

At time $t = 1$ the loan is exogenous L_1^j. The market clearing condition for housing gives the equilibrium price:

$p_1^j = \frac{1}{\gamma}\left(\alpha + y_1^j + L_1^j - H\right)$

Assume city A starts with the low income shock and city B starts with the high income shock: $y_0^A = y_L$, $y_0^B = y_H$.

The probability city A will have a low shock next period is given by:

$P\{y_1^A = y_L | y_0^A = y_L\} = \frac{1+\rho}{2}$

Where $\rho \in [-1, 1]$ is the auto-correlation for income. We assume income follows a two-state Markov Chain:

$y_t^j \sim \left(\begin{array}{cc} \frac{1+\rho}{2} & \frac{1-\rho}{2} \\ \frac{1-\rho}{2} & \frac{1+\rho}{2} \end{array} \right)$.

For simplicity we assume that the spatial correlation in income shocks is perfectly negative $\rho_{A,B} = -1$, so whenever city A has a bad shock, city B will have a good shock vice-versa.

In a transparent market, the lender's expected profit to city j is:

$$\begin{aligned} \mathbb{E}[\pi_t^j] &= -L_t^j + \eta \mathbb{E}_t \min\left[L_t^j R, p_{t+1}^j H\right] \\ &= -L_t^j + \eta L_t^j R \cdot P\{L_t^j R \le p_{t+1}^j H\} + \eta H \mathbb{E}_t[p_{t+1}^j | L_t^j R > p_{t+1}^j H] \end{aligned}$$

The zero expected profit condition implies:

$L_0^A = \eta\left(\frac{1-\rho}{2}\right) L_0^A R + \eta\left(\frac{1+\rho}{2}\right) p_1^j H$

$\Leftrightarrow$

$L_0^A = \eta\left(\frac{1-\rho}{2}\right) L_0^A R + \eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^A - H\right)\right) H$

$\Leftrightarrow$

$L_0^A\left(1 - \eta\left(\frac{1-\rho}{2}\right) R\right) = \eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^A - H\right)\right) H$

$\Leftrightarrow$

$L_0^A = \frac{\eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^A - H\right)\right) H}{\left(1 - \eta\left(\frac{1-\rho}{2}\right) R\right)}$

$L_0^B = \eta\left(\frac{1+\rho}{2}\right) L_0^B R + \eta\left(\frac{1-\rho}{2}\right) p_1^j H$

$\Leftrightarrow$

$L_0^B = \eta\left(\frac{1+\rho}{2}\right) L_0^B R + \eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^B - H\right)\right) H$

$\Leftrightarrow$

$L_0^B \left(1 - \eta\left(\frac{1+\rho}{2}\right) R\right) = \eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^B - H\right)\right) H$
$\Leftrightarrow$
$L_0^B = \frac{\eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha+y_L+L_1^B-H\right)\right)H}{\left(1-\eta\left(\frac{1+\rho}{2}\right)R\right)}$

In an opaque market, the lender's zero profit condition is:
$L_0 = \frac{1}{2}\eta L_0 R \cdot \left(\frac{1-\rho}{2}\right) + \frac{1}{2}\eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^A - H\right)\right) H$
$+ \frac{1}{2}\eta\left(\frac{1+\rho}{2}\right) L_0 R + \frac{1}{2}\eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^B - H\right)\right) H$
$\Leftrightarrow$
$L_0 = \frac{1}{2}\eta L_0 R \cdot \left(\frac{1-\rho}{2}\right) + \frac{1}{2}\eta\left(\frac{1+\rho}{2}\right) L_0 R$
$+ \frac{1}{2}\eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^A - H\right)\right) H + \frac{1}{2}\eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}\left(\alpha + y_L + L_1^B - H\right)\right) H$
If we assume $L_1^A = L_1^B = L_1$
$\Leftrightarrow$
$L_0 = \frac{1}{2}\eta L_0 R$
$+ \frac{1}{2}\eta\left(\frac{1+\rho}{2}\right)\left(\frac{1}{\gamma}(\alpha + y_L + L_1 - H)\right) H + \frac{1}{2}\eta\left(\frac{1-\rho}{2}\right)\left(\frac{1}{\gamma}(\alpha + y_L + L_1 - H)\right) H$
$\Leftrightarrow$
$L_0 = \frac{1}{2}\eta L_0 R + \frac{1}{2}\eta\left(\frac{1}{\gamma}(\alpha + y_L + L_1 - H)\right) H$
$\Leftrightarrow$
$L_0 \left(1 - \frac{1}{2}\eta R\right) = \frac{1}{2}\eta\left(\frac{1}{\gamma}(\alpha + y_L + L_1 - H)\right) H$
$\Leftrightarrow$
$L_0 = \frac{\frac{1}{2}\eta\left(\frac{1}{\gamma}(\alpha+y_L+L_1-H)\right)H}{\left(1-\frac{1}{2}\eta R\right)}$
Each city receives the same loan L_0.

Proposition 1
If $\rho > 0$, then
if $\eta R > 1$: $\boxed{L_0^A < L_0 < L_0^B}$
if $\eta R < 1$: $L_0^A > L_0 > L_0^B$
If income is negatively correlated $\rho < 0$, then signs are reversed. But this is not the case we are interested in.
The case we study has $\rho > 0$ and $\eta R > 1$. Plugging this into the equilibrium price function:
$p_0^j = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^j - H\right)$
Since the loan to city A under transparency is smaller than the loan to city A under opacity $L_0^A < L_0$, the transparent price is lower than the opaque price:
$p_0^{A,trans} = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^A - H\right) < \frac{1}{\gamma}\left(\alpha + y_0^j + L_0 - H\right) = p_0^{A,opaque}$

Likewise:
$p_0^{B,trans} = \frac{1}{\gamma}\left(\alpha + y_0^j + L_0^B - H\right) > \frac{1}{\gamma}\left(\alpha + y_0^j + L_0 - H\right) = p_0^{B,opaque}$
NOTE: we have assumed that city A starts with a bad income shock at time 0 and city B starts with a good income shock. Ex Ante with probability $\frac{1}{2}$ we have $y_0^A = y_L$ and $y_0^B = y_H$, and with probability $\frac{1}{2}$ we have $y_0^A = y_H$ and $y_0^B = y_L$. However, ex ante neither city knows which state of the world they will start in they will prefer opacity to have smoother house prices.

The lesson from this model is that a geographically transparent mortgage market has more volatile house prices which are more strongly correlated to local risks.

9 APPENDIX: Finite horizon, continuum of states

Suppose there are two periods $t \in \{0, 1\}$.
At time $t = 1$ the loan is exogenous L_1^j.
$p_1^j = \frac{1}{\gamma}\left(\alpha + y_1^j + L_1^j - H\right)$
The only randomness regarding house prices at $t = 1$ comes from the income shock.
Now we can compute:

$$\begin{aligned}
P\{L_0^j R \leq p_1^j H\} &= P\left\{\frac{\gamma L_0^j R}{H} + H - \alpha \leq y_1^j + L_1^j\right\} \\
&= P\left\{\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j \leq y_1^j\right\} \\
&= 1 - P\left\{\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j > y_1^j\right\} \\
&= 1 - F_{y_1^j}\left\{\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j\right\}
\end{aligned}$$

Also

$$\begin{aligned}
\mathbb{E}_0[p_1^j | L_0^j R > p_1^j H] &= \mathbb{E}_0\left[\frac{1}{\gamma}\left(\alpha + y_1^j + L_1^j - H\right) | \frac{\gamma L_0^j R}{H} + H - \alpha > y_1^j + L_1^j\right] \\
&= \frac{1}{\gamma}\left(\alpha + L_1^j - H\right) F_{y_1^j}\left\{\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j\right\} \\
&+ \frac{1}{\gamma}\mathbb{E}_0\left[y_1^j | \frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j > y_1^j\right]
\end{aligned}$$

If we assume the income shock obeys a continuous uniform distribution $U[y_L, y_H]$:

$P\{L_0^j R \leq p_1^j H\} = 1 - \frac{\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j - y_L}{y_H - y_L}$

$$\mathbb{E}_0[p_1^j | L_0^j R > p_1^j H] = \frac{1}{\gamma}\left(\alpha + L_1^j - H\right)\left(\frac{\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j - y_L}{y_H - y_L}\right)$$
$$+ \frac{1}{2\gamma}\left(\frac{\gamma L_0^j R}{H} + H - \alpha - L_1^j + y_L\right)$$

The zero expected profit condition:
$L_0^j = \eta L_0^j R \cdot P\{L_0^j R \leq p_1^j H\} + \eta H \mathbb{E}_0[p_1^j | L_0^j R > p_1^j H]$
$\Leftrightarrow$
$L_0^j = \eta L_0^j R \cdot P\{L_0^j R \leq p_1^j H\} + \eta H \mathbb{E}_0[p_1^j | L_0^j R > p_1^j H]$
We solve this equation for L_0^j.