The Industrial Organization of the U.S. Residential Mortgage Market*

Richard Stanton† Johan Walden‡ Nancy Wallace§

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Abstract

We show that the U.S. residential single-family mortgage-origination market is highly concentrated once account is taken of the contractual coordination that arises from the correspondent- and warehouse-funding channels. We represent these channels as a network, using the flow of loans through three strata of the loan origination market: origination, aggregation, and securitization. We develop a network representation of the origination market and demonstrate that it is a "small world," in that most nodes are close in the network. We then rank-order the interlinked aggregators and securitizers using ex post mortgage foreclosure rates as a proxy for performance. Our findings suggest that these significant interlinkages in the mortgage origination network represent a previously under-appreciated source of systemic risk. Many apparently atomistic mortgage underwriters are, in fact, coordinated to act in parallel because of their funding relationships with the large, "too-big-to-fail" bank holding companies.

1 Introduction

The U.S. single-family residential-mortgage market is large in terms of the number of employees and the dollar volume of annual mortgage origination. In the lead up to the crisis between 2004 and 2006, the average origination volume per year was $2.97 trillion.[1] In 2006,

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†Haas School of Business, U.C. Berkeley, stanton@haas.berkeley.edu.

‡Haas School of Business, U.C. Berkeley, walden@haas.berkeley.edu.

§Haas School of Business, U.C. Berkeley, wallace@haas.berkeley.edu.

[1]See *Inside Mortgage Finance*, May 25, 2007.

there were 975 thousand employees working for entities that were directly involved in mortgage lending[2] and another 1.3 million employees working for commercial banks and REITs where the direct involvement in mortgage lending is not known.[3] Surprisingly, despite the size of the industry and its role in the current financial crisis, there are no studies to our knowledge that consider the overall competitive structure of the industry, controlling for the ownership and contractual funding arrangements that exist between firms.

We analyze the competitive structure of residential mortgage origination in the U.S., focusing on five aspects of the market: 1) overall mortgage origination activity; 2) the competitive structure of the local geography of mortgage origination; 3) the sources of capital flows used to fund the mortgage-origination pipeline; 4) the performance (measured via foreclosure rates) of the loans over the funding channels; and 5) the inter-relationships among the mortgage originators, their funding sources, and the entities that securitize their loans. To capture the last of these, we build upon the methodology of Eisenberg and Noe (2001) and Stanton, Walden, and Wallace (2013), and develop a network representation of the mortgage-origination market.

The residential-mortgage market involves a wide variety of firms, including commercial banks, savings banks, savings and loan institutions (thrifts), mortgage companies, real estate investment trusts (REITs), mortgage brokers and credit unions. The Home Mortgage Disclosure Act (HMDA) Surveys provides information on the loan-level origination activity of entities that originate loans; the geographic location of these entities can be identified using the HMDA Lender File, which has information on corporate affiliations.[4] We link these data with regulatory data, industry surveys conducted by *Inside Mortgage Finance*, and loan-level mortgage origination, securitization, and performance data. Linking these data allows us to accurately account for the capital flows that support the underwriting and funding decisions of the originators that report to HMDA.

Although there are many firm-types in the industry, residential mortgages are underwritten and processed through two origination channels: retail and wholesale.[5] Retail origination

[2]See Bureau of Labor Statistics, `http://www.bls.gov/data/#employment` . We define the direct mortgage industry as NAICS 522120 (Federal Savings Institutions/Savings Institutions, except federal); NAICS 522190 (Federal Credit Unions/State Credit Unions); NAICS 522292 (Mortgage Bankers/Mortgage Brokers, using own money); and NAICS 522310 (Mortgage Brokers arranging for Loans using money of others).

[3]See Bureau of Labor Statistics, `http://www.bls.gov/data/#employment` for NAICS 522110 (Commercial Banking/State Commercial Bank/Commercial Banking/Commercial Banks) and NAICS 525900 (Real Estate Investment Trusts).

[4]The HMDA surveys account for approximately 90% of mortgage origination in the U.S. (see Engel and McCoy, 2011). HMDA reporting is not required for institutions with assets (when combined with the assets of any parent corporation) that are below $10 million on the preceding December 31, or institutions that originate 100 or more home purchase loans (including refinancings of home purchase loans) in the preceding calendar year (see `http://www.ffiec.gov/hmda/pdf/2010guide.pdf`).

[5]See Consumer Finance Protection Bureau, *The Mortgage Origination Examination Pro-*

is defined as mortgage origination in which the underwriting and funding processes are carried out by the labor and capital of a single originator, or the consolidated subsidiary of a single originator.

Wholesale originations are defined as either originations or loan purchases for which the origination and underwriting processes are handled in whole, or in part, by the labor and capital of another party. There are also two types of wholesale lending, broker and correspondent, defined by the degree of autonomy that the originating party exercises over the underwriting and funding processes. Wholesale broker lending usually involves a more limited level of autonomy, because brokers generally do not make the final credit decision nor do they fund they loan. In addition, the underwriting process involves a pre-commitment to a wholesale lending agreement with the wholesale lender before the broker may take applications from consumers. A hybrid form of this wholesale lending type is called "Table Funding." With table funding, the broker originates the loan as the lender of record and then, immediately after the loan closes, the broker assigns the loan to a purchaser, who is the wholesale lender. Thus the wholesale lender provides the funding for the loan under table funding. The loan documents, however, show the broker as the creditor.

The second type of wholesale lending is called correspondent lending. Correspondents can be mortgage companies, REITs, or depositories. They originate and deliver loans determined by the underwriting standards (usually an advance commitment on the loan structure and price) set by the wholesale lender. Correspondents exercise full control over the underwriting and funding processes of loan origination and they are legally the creditor of record. Wholesale lenders usually require that their correspondents enter into a written correspondent lending agreement before the correspondent may originate loans for sale to the wholesale lender. Usually correspondents must meet a minimum net worth requirement, and they must have the ability to fund their own loans either through their depository or by using warehouse lines of credit.

A final important variant of wholesale correspondent lending is the warehouse line of credit provided by warehouse lenders. The warehouse line of credit is a short-term, revolving line of credit provided to the correspondent for funding its mortgage origination pipeline from the date of the loan closing, when the borrower is funded, to the sale of the mortgage into the secondary mortgage market. The revolving line includes a repurchase commitment on each funded loan, which requires the line to be paid off upon the sale of the loan by the correspondent, upon securitization. The repurchase commitments usually require that the collateral be repaid within thirty to forty-five days. Correspondents that originate using

cedures, June, 2012, `http://www.consumerfinance.gov/wp-content/uploads/2012/01/Mortgage-Origination-Examination-Procedures.pdf`.

warehouse lines also exercise full control over the underwriting and funding processes of the loan origination and are legally the creditor of record. Prior to the crisis, correspondent funding for origination was based on short-term borrowing using asset-backed commercial paper, warehouse lines of credit, and, in the case of depositories, borrowings from the Federal Reserve Banks and advances from the Federal Home Loan Banks. Correspondents are crucially dependent upon the cost and availability of short-term funding as well as the pricing and liquidity of the secondary mortgage market.

By 2006, about 63% of all residential single family mortgages were originated through the wholesale channel and about 53% of wholesale origination was through correspondent relationships.[6] Because the large bank, thrift, and non-depository holding companies "aggregate" almost all home mortgages through retail originations, warehousing or correspondent channels, the U.S. residential mortgage market is more highly concentrated than it appears through a simple accounting of the market shares of mortgage originators. The important economic question is what are the effects of this market concentration and whether the efficiency gains from scale dominate the competitive losses.

To address this question, we represent the residential mortgage market as a network using the flow of loans and funding through three strata of the loan origination market: origination, correspondent/aggregation, and securitization. We hypothesize that these contractual linkages will lead the (ex ante and ex post) quality and risk profiles of intermediaries to be strongly related to network positions, in stark contrast to a simple count of institutions, and we find that these networks show high levels of market concentration. We demonstrate the economic consequences of these interlinkages through the *ex post* mortgage performance of firms within the networks, and we identify channels by which risk appears to propagate through the networks.

We focus on 2006 mortgage origination channels because we seek to identify the similarities and differences in the funding flows between the conventional, conforming mortgage market, which was securitized by Fannie Mae and Freddie Mac, and the Alt-A, high balance and subprime mortgage market, which was securitized through private-label securitization. The private-label securitization market collapsed in 2007 and has not recovered.

The paper is organized into six sections. Section 2 discusses the operational characteristics and regulatory supervision of the many types of institution engaged in residential single-family mortgage lending in the U.S. Section 3 maps two measures of the geographic concentration of mortgage origination — origination per capita and a Herfindahl index — for the three primary lender types: banks, thrifts, and (affiliated and unaffiliated) mortgage companies. Section 4 discusses the corporate ownership structures of the industry, presents the

[6]See *Inside Mortgage Finance*, May 25, 2007, p. 3.

contractual structures that link smaller originators to correspondent and warehouse lenders, and provides a brief case study for New Century Financial Corporation. Section 5 presents a network representation of the origination, aggregation, and securitization channels of the mortgage market. Section 6 concludes.

2 Mortgage Originators

Figure 1 presents the HMDA breakdown of U.S. residential single-family mortgage origination (in thousands of dollars) by type of institution. It shows the self-reported charter of the institution that made the funding decision for loans originated from 2000–2010. The blue segments represent the loan origination of banks,[7] which represented 45.45% of all mortgage originations in 2006. The red segments are the originations of thrift institutions,[8] which made up 18.37% of loan origination in 2006. The origination by credit unions and their subsidiaries is shown in green. This accounted for only 2% of origination in 2006, and for that reason will not be a focus of the paper. The purple segments are independent mortgage companies and (after 2004) the turquoise segments represent the origination of mortgage companies affiliated with a depository institution.[9] Overall, the mortgage origination by affiliated and unaffiliated mortgage companies comprised 30.02% of all single-family residential lending in 2006; by 2008, most mortgage companies affiliated with bank and thrift holding companies had closed.

The mortgage-origination industry operates within the dual (state and federal) supervisory system of the banking industry established by the National Bank Act (1863). Under this system, there is a federal system based on national bank charters and a state system based on state charters. There are three different types of bank charter, corresponding to the three different primary federal regulators: the Office of the Comptroller of the Currency (OCC), the Federal Deposit Insurance Corporation (FDIC), and the Federal Reserve System (FRS). Federally chartered banks and their branches are known as National Banks (N.A.), and are primarily chartered and supervised by the OCC (see Engel and McCoy, 2011). The FDIC regulates state-chartered banks that are not members of the Federal Reserve System.

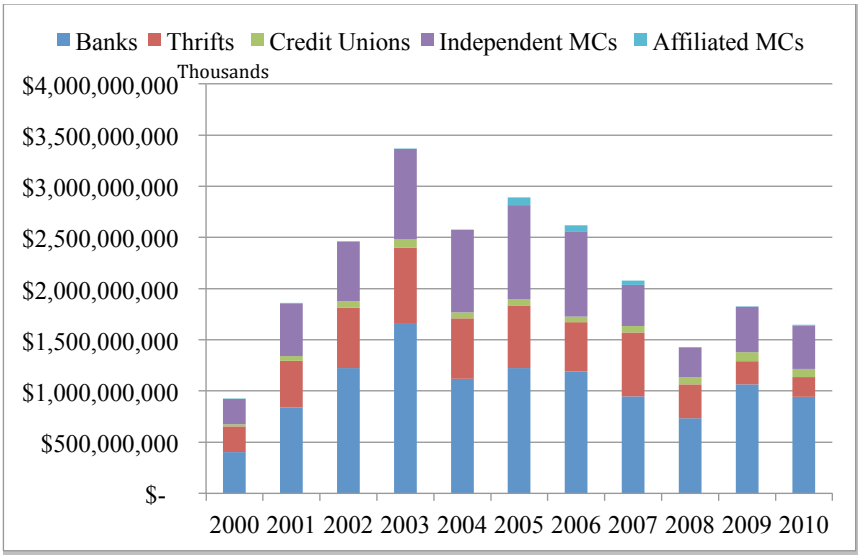
Prior to October 19, 2010, and after the passage of the Financial Institutions, Reform, Recovery and Enforcement Act (1989), thrift institutions were regulated by the Office of

[7] This includes originations by commercial banks, commercial bank subsidiaries, subsidiaries of commercial bank holding companies, liquidated commercial banks, and the subsidiaries of liquidated commercial banks.

[8] This includes originations by thrift institutions, thrift institution subsidiaries, the subsidiaries of thrift holding companies, and liquidated thrift institutions.

[9] HMDA identifies affiliated mortgage companies as subsidiaries where the holding company parent has a greater than 0% and 50%, or less, ownership position.

Figure 1: Mortgage Originator Activity by the Banks, Thrifts, Mortgage Companies, and Credit Unions as reported in the 2006 Panel of the Home Mortgage Disclosure Act (HMDA) Data



Thrift Supervision (OTS). After the financial crisis, under the mandate of Section 312 of the Dodd-Frank Wall Street Reform and Consumer Protection Act (2010), the OCC has taken over the functions of the OTS. The OTS no longer exists.

Mortgage companies are the most diverse group of mortgage originators. They include mortgage bankers, large mortgage brokers that use their own money for origination, and Real Estate Investment Trusts. Since 2004, mortgage companies, even those affiliated with large bank or thrift holding companies, tend to be regulated by either the OCC or by the Department of Housing and Urban Development (HUD) (see Engel and McCoy, 2011). In addition to the mortgage companies, which report to HMDA, there are also mortgage brokers, which do not report to HMDA. These are firms or individuals who do not make the funding decisions for loans, but instead intermediate between borrowers and lenders. Because they are not reported in HMDA, the origination activities of these entities cannot be directly tracked at the loan level. Mortgage brokers are regulated by the states (see Pahl, 2007).

In the early 1990s, all banks and thrifts had to obey state mortgage and consumer protection laws, and non-bank mortgage companies had to comply with the same laws. In 1996 the OTS issued two preemption rules, under which federal thrifts and their subsidiaries were exempted from many state mortgage laws. In 2004, the OCC issued a preemption rule giving national banks the ability to exercise "incidental powers" for activities such as lending and deposit taking, thus preempting all state laws that "obstruct, impair or condition" the

business of banking. Again, many of these laws involved consumer protection.[10] The mixing of federal preemption and charter competition among the various regulatory agencies appears to have led to inconsistencies in the implementation of examination rules for mortgage lending, probably because of differences in regulatory design and incentives (see Agarwal, Lucca, Seru, and Trebbi, 2012). It also allowed mortgage originators to actively shop for regulators (Rosen, 2003, 2005) and to engage in a "race to the bottom" for subprime lenders (see Kane, 1989; Calomiris, 2006).

3 The Economic Geography of Mortgage Origination

In addition to the regulatory trends discussed above, the passage of the Riegle-Neal Act (1994) and the Gramm-Leach-Bliley Act (1999) further relaxed intrastate and interstate branching regulation.[11] These changes coincided with the introduction by large banks of new technologies in mortgage lending, such as call centers and automated underwriting, and the weeding out of weak banks (see Jayaratne and Strahan, 1998; Kroszner and Strahan, 1999). Because of the special nature of insured depositories, competition policies have been a focus of much research and policy debate. In the non-financial sector, competition policy has mainly focused on economic efficiency (competitive pricing). For financial institutions there is another important dimension: systemic risk. Theoretical predictions and empirical results on the link between competition among financial institutions, risk taking, and stability are ambiguous. But overall they suggest that an intermediate degree of bank competition is optimal. Too much competition erodes the charter values of financial institutions and creates incentives for risk-taking; too little competition reduces efficiency and may lead to the too-big-to-fail problem (see Allen and Gale, 2004; Beck, Coyle, Seabright, and Freixas, 2010; Claessens, 2009).

Surprisingly, given the important role played by mortgage lenders in the financial crisis, there are few studies of competition and financial stability among mortgage lenders. Rosen (2011) uses HMDA and servicer data to study how competition among mortgage lenders affected the quality of mortgage-loan origination characteristics. He finds that, on average, the commercial banks originated safer loans (measured via the contractual terms of the loans) than did the independent mortgage companies. Tenenbaum and Waters (2011) use the HMDA data to analyze the spatial patterns of subprime lending (high-coupon lending), and find that nonlocal banks and independent mortgage companies appeared to have made

[10] See Ding, Quercia, Reid, and White (2010) and *Mortgage Banking: Comptrollers Handbook*, Comptroller of the Currency, Administration of National Banks, March, 1998.

[11] These outcomes are also consistent with rent-seeking theories of regulation (see Stigler, 1971; Shleifer and Vishny, 1999).

the same underwriting decisions as local banks. Scharfstein and Sunderam (2013) find that more highly concentrated local lending markets exhibited a lower sensitivity of mortgage rates to GSE mortgage backed security yields. All of these papers rely on the HMDA definition of mortgage originators as entities that independently make the underwriting and funding decisions for newly originated mortgages. Importantly, they do not consider how these firms obtain the capital that they need to "independently" underwrite and fund these loans, nor do the loan-level HMDA surveys account for correspondent lending.

Figure 3 shows the mortgages issued per head in each county in the lower 48 states in 2006. The allocation to county is based on the address of the lending institution (rather than the address of the underlying property). The map was created using Python's Matplotlib Basemap mapping toolkit using loan-count data for 9.4 million mortgages: 1.3 million issued by thrifts, 3.8 million by banks, and 4.2 million by mortgage companies.[12] The figure shows that origination rates are highest in large urban areas. However, there are particularly high origination levels in Southern California, Arizona, Nevada, and Florida. Even within these states some counties, such as Riverside, San Bernardino, and Washoe County, Nevada (Reno), have especially high levels of mortgage origination compared with the rest of the country. Clearly some counties had extremely high levels of origination per capita, a feature of the pre-crisis mortgage origination market that has been explained by Mian, Sufi, and Trebbi (2011) and Mian and Sufi (2009) as a "credit-push" cause of the crisis.

This per-capita evaluation of mortgage origination, however, does not provide a clear picture of the competitive structure of the local origination markets. We therefore compute the Herfindahl-Hirschman Index (HHI) for the originators by county,[13] defined as the sum of squared market shares of the loan counts of single-family mortgage origination within a county in 2006 for each of the mortgage companies, banks, and thrifts that originated mortgages in that county. For a county with a single originating institution the HHI would equal one, while in a perfectly competitive, atomistic market the HHI would approach zero. Figure 3 shows that, with the exception of parts of Texas, lower-population areas tend to

[12]Since our interest is in the local markets for loan originators, we follow the methodology of Loutskina and Strahan (2009) and update the HMDA data in various ways to obtain an accurate address for each local originator. To obtain the true addresses and ownership structure, we merge the Reports of the Conditions and Income (FFIEC004) with the Survey of Deposits to determine the agency code and the respondent identification number that corresponds to each HMDA lender ID. We then merge these data with the HMDA Lender File. This last merge gives us the corporate membership linkages for all of the local mortgage originations that are banks. For the thrifts and their branches, we follow a similar merging strategy, but without the merge to the Survey of Deposits. For the mortgage companies, we use the address reported in HMDA for the unaffiliated mortgage companies and we use a merge with the NETS database for the missing addresses of the remaining affiliated mortgage companies.

[13]The deposit Herfindahl-Hirschman Index (HHI) has long been a standard tool used in the antitrust oversight of bank mergers (see Cetorelli and Strahan, 2006; Berger, Demsetz, and Strahan, 1999).

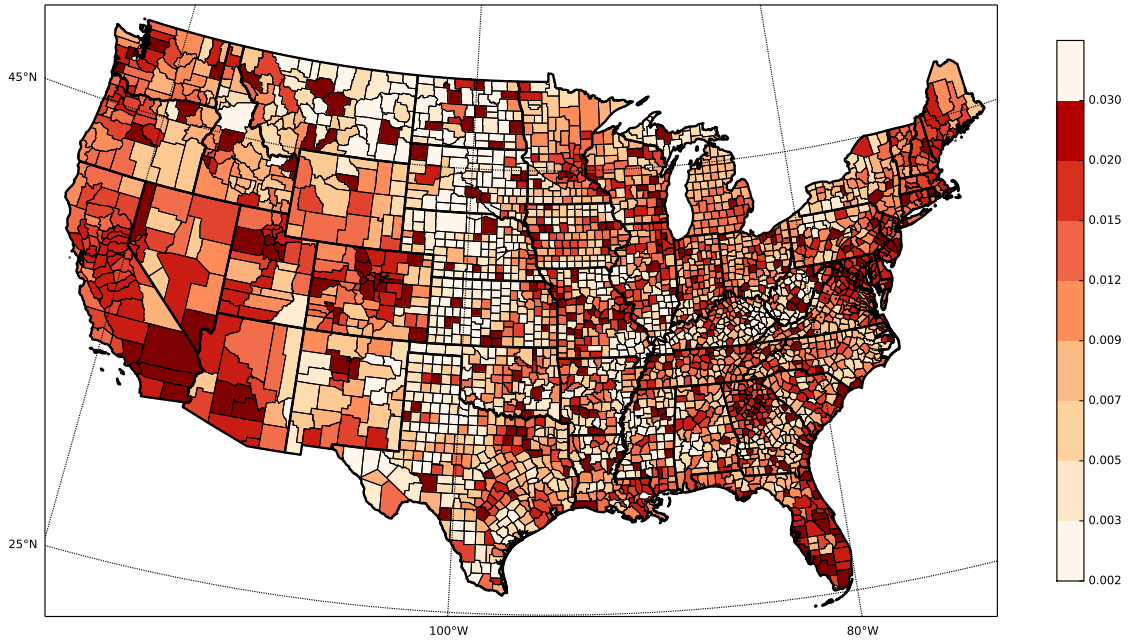


Figure 2: Loan counts per head (banks, thrifts, and mortgage companies), 2006

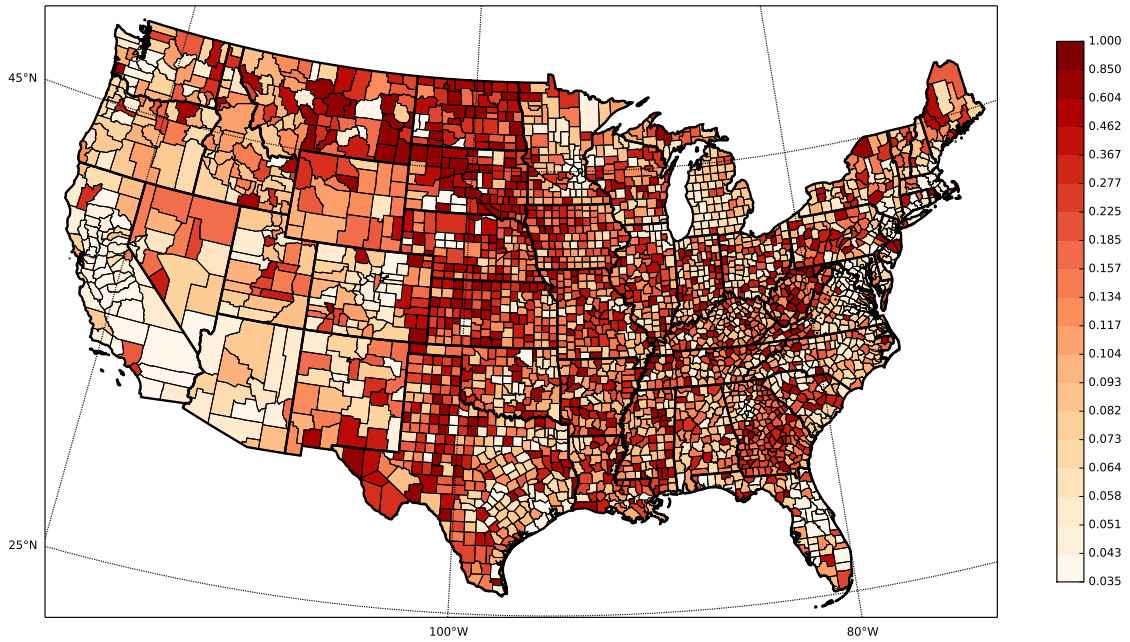


Figure 3: Herfindahl (banks, thrifts, and mortgage companies), 2006

have higher levels of market concentration. The markets with the highest concentrations of mortgage originations per capita also have many different entities and ownership structures competing.

Our measurement of the market concentration levels within local geographies across the U.S. follows the prior literature in using HMDA loan-level survey data. HMDA's narrow definition of originators, as independent entities that underwrite and fund the loan in their own name, will always over-estimate the level of competition in the industry. This over-estimate will arise because the HMDA definition ignores the importance of the wholesale funding channels that determine the supply of capital available for the origination activities of the small depository and non-depository mortgage companies. Because mortgage origination and securitization takes time, capital is required both to fund the loans themselves and to warehouse the loans before they can be sold to a correspondent or to a secondary mortgage market securitizer. The available wholesale lending channels provide a menu of exposure and reward for entities that bear the origination pipeline risk, the time between when the contractual features of the loan are locked in with the borrower and the loan is funded, and the risks associated with securitizing the loans or funding the loans. Accounting for the capital funding channels and these risk sharing mechanisms requires other data sources to reveal how the activities of many apparently independent originators are highly coordinated and regulated by the contractual relationships between the wholesale and warehouse lenders and the originators.

4 Corporate Linkages Among U.S. Mortgage Originators

Figure 4 presents the corporate organizational structure for the residential mortgage origination market in 2006. As shown, the mortgage origination flows are organized within five strata of influence: 1) the independents, either depositories or non-depository mortgage companies; 2) the depositories and subsidiaries; 3) the bank and thrift holding companies; 4) the regulators; and 5) the securitization channels.[14] Direct ownership (or partial ownership) channels between these strata are shown by red dotted lines. Black dotted lines connect the regulators to their respective regulated entitles. Blue dotted lines are the primary securitization channels, and green dotted lines represent the contractual mortgage-origination funding channels from the correspondent lenders and the warehouse lenders to the independent mortgage companies (MCs) and depositories who make the underwriting and funding

[14]Mortgage brokers are not shown because, following the logic of HMDA, these entities do not make the underwriting and funding decision in mortgage origination.

decision, as reported by HMDA.

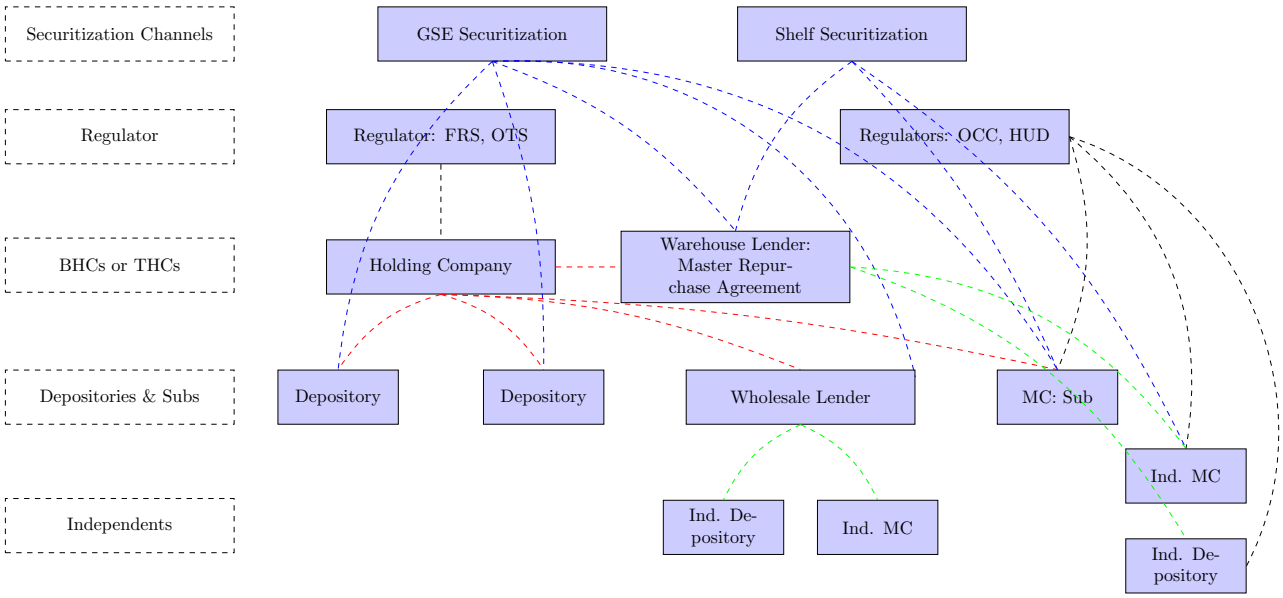
As shown in Figure 4, the bank and thrift holding companies usually have ownership, or partial ownership, control over their depositories and their branches, their affiliated mortgage company (MC) subsidiaries, and their warehouse and correspondent lending subsidiaries. The independent depositories and the MCs making the underwriting and funding decisions for loans, as reported in HMDA, have important contractual linkages with the bank and thrift holding companies through the correspondent and mortgage warehouse subsidiaries. Within the table-funded correspondent channel, the "independent" depositories and the MCs originate and fund mortgages in their own name and then immediately sell their loans under pre-contracted purchasing agreements with the correspondent lenders.[15] Within the warehouse-lending channel, the independent depositories and the MCs also originate and fund the mortgages in their name. However, the MCs actually fund the loans using credit facilities provided by the warehouse lenders, which are subsidiaries of bank, thrift, or investment bank (not shown) holding companies. These contractual funding channels introduce important elements of systemic risk associated with short-term liquidity risk and with counterparty exposures among the mortgage originators and their funders.

As presented in Figure 4, in 2006 there were two important securitization channels: the Government Sponsored Enterprises' (Fannie Mae and Freddie) securitization of conventional conforming loans and the private shelf securitization channel. In contrast to GSE securitization, private-label MBS are subject to the registration requirements of federal securities laws. To offer and sell these securities, there must be a sponsor who files a registration statement with the SEC. This statement must meet the disclosure, content, and procedural requirements of the Securities Act. When private-label issuers file a registration statement to register an issuance of a REMIC security, they typically use what is called a "shelf registration." These registrations are specific to sponsors that are usually subsidiaries of bank, thrift, or investment bank holding companies.[16] Mortgages acquired by the correspondent lenders within the large bank holding companies went both to private-label and to GSE securitization. The warehouse lending channel was also securitized through both the GSE and the private-label (shelf securitization) channels.

[15]Commitments to purchase "when-issued" mortgage loans held for sale by the correspondent are reported as derivative positions on the FR Y-9C of the bank holding company. The notional value of the commitment is reported as an over-the-counter written option on Schedule HC-L. The fair value of the derivative contracts is reported as either other assets or liabilities on the balance sheet. Commitments to purchase when-issued mortgage loans held for investment are instead reported as "other commitments" on the off-balance sheet schedule (HC-L, item 9), as reported by the Statistics Division of the New York Federal Reserve Bank.

[16]See the Secondary Mortgage Market Enhancement Act (SMMEA), the SEC amended Rule 415 of the Securities Act, known as the shelf rule.

Figure 4: Organizational Structure of Mortgage Origination Flows in 2006: The Underwriting Agents, the Regulators, and the Funding and Securitization Channels



4.1 Contractual Linkages

As shown in Figure 4, warehouse lenders provide mortgage origination capital through warehouse lines of credit called Master Repurchase Agreements (MRAs). MRAs are revolving lines of credit where a warehouse lender arranges a loan facility to an independent mortgage company or depository.[17] The mortgage originator uses the revolving lines to fund the mortgages that it originates in its own name. The warehouse lender then simultaneously purchases an interest in the mortgage, which is subject to a commitment to repurchase the loan from the originator within thirty days. The warehouse lender "perfects" its interest in the collateral (the note), usually through assignment or through UCC-1.[18] The originator pays a haircut for each dollar of loan balance originated,[19] as well as an interest payment, typically priced at LIBOR plus a spread. The lines are structured such that the newly originated loan collateral held in the facility must be sold within the next 30 to 45 days. Unsold loans held for more than 45 days are subject to further margin calls and mark-to-market charges. These fees can rapidly increase the cost of the MRA to the mortgage originator

[17] In 2006, most of the warehouse lending activity for subprime and Alt-A mortgages was securitized through the private-label market. Currently the MRA funding structure is widely used for conventional conforming mortgage origination that is intended for GSE securitization.

[18] A perfected security interest in the mortgage note automatically perfects a security interest in the underlying mortgage (see UCC §§9-203(g), 9-308(e)).

[19] The haircut is charged as a percentage of balance, such that less than 100% of the loan would be funded, or owned, by the warehouse lender. In 2006, these haircuts ranged between 95% and 100%.

by five to six hundred basis points. Once the mortgage originator sells the loan into the securitized market, either through private-label or GSE securitization, the proceeds from the sale are repaid to the warehouse lender, releasing the capacity of the facility for future lending.

Under the Basel II Advanced Approach used by the largest banks in 2006, the warehouse lenders were allowed to "look through" the facility to the underlying collateral. However, in a recent supervisory memorandum,[20] the OCC reiterated its position that MRAs should be accounted for by the warehouse lender as a loan to a mortgage originator rather than as a true-sale purchase of individual mortgage loans.[21] Surprisingly, even today large warehouse lenders continue to consider assets generated by their mortgage warehouse division as "loans held for sale," with risk weights applicable under current regulations for mortgage loans (50% for qualifying mortgages or 20% for loans guaranteed by the FHA or VA).[22] The MRA accounting for the mortgage originators is always treated as debt.

Another reason for the prevalence of MRAs in structuring mortgage warehouse facilities (both currently and in 2006) involves the treatment of these facilities under the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA).[23] Under BAPCPA, MRAs qualify as "repurchase agreements," so the collateral can be safe harbored upon bankruptcy of the counterparty. Since the warehouse lender usually has a perfected interest in the unsold mortgage collateral within the facility, the exemption from automatic stay enables them to take over the collateral upon the default of the mortgage originator. The warehouse lender can then immediately sell its interests in the mortgage loans to repay the related advances, repurchases, and other obligations of the mortgage originator.[24]

The MRAs continue to be treated as collateralized lending by many lenders, despite the recent insistence by the OCC that they do not qualify as true sales under GAAP. Their treatment as repurchase agreements under BAPCPA and their eligibility for exemption from automatic stay guarantees the warehouse lender significant speed and freedom to liquidate collateral and close down the facilities. The MRA covenants also allow the warehouse lender the right to close down the facility and take over the collateral due to triggers tied to the

[20]See Supervisory Memorandum, the Comptroller of the Currency, December 18, 2012.

[21]The OCC Memorandum criticized warehouse lenders that incorrectly accounted for their MRAs as purchased loans with a 50% risk-weight allowed for qualifying mortgages, and argued, instead, that the MRA should be recognized as a financing transaction (i.e., a warehouse line of credit) with a 100% risk weight. Warehouse lines have the additional restriction that there are legally binding limits for these programs by counterparty exposure.

[22]See the December 2012 10-K for a large current warehouse lender, Texas Capital Bancshares, Inc.

[23]See Pub.L. 1098, 119 Stat. 23, enacted April 20, 2005, `http://www.gpo.gov/fdsys/granule/STATUTE-119/STATUTE-119-Pg23/content-detail.html` and `http://www.gpo.gov/fdsys/pkg/PLAW-109publ8/html/PLAW-109publ8.html`

[24]See Schweitzer, Grosshandler, and Gao (2008).

economic performance of the originator or due to the inability of the originator to make margin calls associated with holding loans seasoned for more than 45 days. Given the contractual features of the MRAs, the warehouse lender typically has an incentive to focus on counterparty risk and the liquidity of the mortgage collateral, rather than on the underwriting quality of any given loan.[25] As a result, these facilities are vulnerable to systemic slowdowns in the liquidity of whole loan sales into the secondary mortgage market, the aggressive margining requirements on seasoned loans that are intended to guarantee that these funding sources are short term (usually less than 30 days), and even short-term performance weakness of the counterparties. Without reliable demand for whole loans in the secondary mortgage market, whether from the GSEs or (in 2006) from private-label securitization, the MRA funding structure for mortgage origination is quite vulnerable to runs.

4.2 New Century Financial Corporation

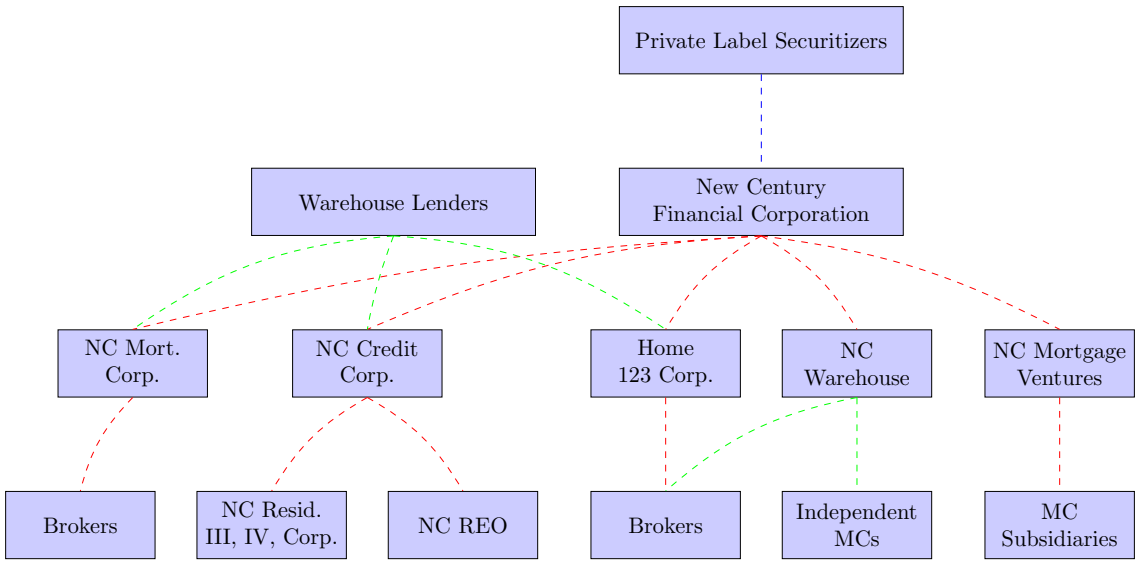
New Century Financial Corporation was the largest independent mortgage company in 2006. A schematic for the company is shown in Figure 5. As shown, New Century operated a warehouse lending entity, New Century Warehouse Corporation, which provided funding to smaller independent mortgage companies and brokers. It also operated a mortgage correspondent entity, New Century Mortgage Corporation, with divisions that originated mortgages through a network of 14,000 brokers and purchased loans from mortgage companies. New Century Mortgage Corporation and New Century Warehouse Corporation were regulated by HUD. From 2004 until its bankruptcy in 2007, New Century Financial Corporation operated as a Real Estate Investment Trust (REIT). New Century's REIT status provided it with substantial shelter from federal income taxes at the corporate level. However, to maintain its federal income tax exemptions as a REIT, New Century was required to distribute at least 90% of its annual taxable income to its shareholders. As a result, New Century had limited capacity to accumulate the capital needed for its mortgage origination and purchasing operations.

By 2005 New Century was reliant on the warehouse lenders shown in Figure 5.[26] More than 75% of New Century's $16.35 billion of warehouse lending capacity was structured as MRAs and 47% of this capacity was committed to unsold mortgages as of December 31,

[25] A further reason for this focus is that the put-back options for all loans that are sold out of the facility remain with the originator since the originator underwrote and funded the loan in its own name.

[26] According to the New Century 10-K, December 31, 2005, the warehouse lenders were: Von Karman Funding Trust ($2B); Bank of America, N.A. ($3B); Barclays Bank, PLC ($1B); Bear Stearns Mortgage Capital ($800M); Citigroup Global Markets Reality Corporation ($1.2B); Credit Suisse First Boston Capital, LLC ($1.5B); Deutsche Bank ($1B); IXIS Real Estate Capital, Inc. ($850M); Mortgage Stanley Mortgage Capital, Inc. ($3B); UBS Real Estate securities Inc.($2B) (See `http://www.secinfo.com/dR7Km.v8d.p.htm`).

Figure 5: Organizational Structure of New Century Financial Corporation



2005.[27] Although the exact contractual features of the MRAs are not available, the notes to New Century's consolidated financial statements and its bankruptcy fillings reveal that the MRAs were priced at one-month LIBOR plus a spread, the contracts included "haircuts" and margin calls on the committed mortgage collateral, there were margin escalations for mortgage collateral held in the facilities for more than 45 days, and there were covenants allowing the warehouse lender to take over the collateral if New Century did not have certified financial statements in compliance with GAAP every quarter and did not have positive net income for any rolling two-quarter period.[28] The facilities had two-year maturities.

New Century sold the loans it originated and/or purchased with funds sourced from its warehouse facilities into REMIC securities and used the sales proceeds to repay its warehouse lenders, releasing warehouse-lending capacity for future loan origination. The REMIC securitization process involved the purchase of the loans by sponsors, often entities within the same large banks that were their warehouse lenders. These sponsors then securitized through their REMIC shelf registration as discussed above. In 2006 the largest shelf sponsors for mortgages originated and/or purchased by New Century were Carrington Mortgage (a subsidiary of New Century), Credit Suisse First Boston, Deutsche Bank, Goldman Sachs,

[27] See `http://www.secinfo.com/dR7Km.v8d.p.htm`.

[28] See United States Bankruptcy Court for the District of Delaware in re: New Century TRS Holdings, Inc., Chapter 11 Case No. 07-10416 (KJC), Final Report of Michael J. Missal, Bankruptcy Court Examiner, February 29, 2008 `http://graphics8.nytimes.com/packages/pdf/business/Final_Report_New_Century.pdf` and Form 8K, Mar. 12, 2007 `http://www.sec.gov/Archives/edgar/data/1287286/000129993307001553/htm_18857.htm`.

HSBC, IXIS Real Estate, and Morgan Stanley. On March 8, 2007, New Century reported in its Form 8-K that it had received an aggregate of about $150 million of margin calls from its warehouse lenders and that it was unable to satisfy $70 million of that obligation.[29]

By March 12, 2007, the short-term nature of New Century's warehouse funding, its inadequate reserves for put-back exposures from prior poor-quality REMIC securitization, and the slowing of loan sales had triggered insurmountable liquidity challenges for the firm. By this time, New Century had received default and acceleration notices from all of its warehouse lenders due to its failure to meet margin calls for the unsold loans in its warehouse facilities, its inability to make interest payments on the facilities, and its inability to maintain the required levels of profitability under the master repurchase agreements with its lenders. Because the unsold loans in the MRA facilities were perfected to the warehouse lenders and because MRAs are exempt from automatic stay, New Century's warehouse lenders were able to sell the mortgage loans held within their facilities and to offset the proceeds from these sales against New Century's obligations.[30] At the same time all of New Century's warehouse lenders closed down their financing facilities, which extinguished New Century's ability to continue to fund new mortgage originations and purchases.[31] New Century filed for bankruptcy protection on April 2, 2007.[32] As will be discussed below, despite the automatic stay exemptions, New Century's largest creditors were their warehouse lenders.

4.3 Correspondent Lending and Market Concentration

Table 1 compares the important differences that appear in the market concentration of the U.S. residential mortgage market when proper accounting is made for the retail and wholesale origination channels. We compare two different sources of data representing mortgage origination. The first source is *Inside Mortgage Finance* (IMF), which bases its census of origination on industry surveys and is the industry standard. The IMF definition of mortgage origination is the total dollar amount of new 1–4 family residential mortgages funded by individual lenders through both their retail and wholesale channels. The second source is the HMDA Lender File (2011), which aggregates the lending activities of individual HMDA originators into their origination and purchasing (correspondent) activity levels. HMDA reports two levels of aggregate origination activity at the level of the holding company: origination activity (an aggregate of the loan-level HMDA survey) and purchase activity that cannot

[29]See `http://online.wsj.com/public/resources/documents/filing-NEW-20070308.pdf`.

[30]Again, it is worth pointing out here that the put-back options on these loans remained with New Century Financial Corporation despite its lack of capital.

[31]See `http://www.sec.gov/Archives/edgar/data/1287286/000129993307001553/htm_18857.htm`.

[32]See Form 8-K, April, 2, 2007 `http://www.sec.gov/Archives/edgar/data/1387580/000091412107000947/gs8145031-8k.txt`.

be aggregated by firm using loan-level survey due to HMDA reporting policies. One caveat with the HMDA Lender File is that reporting of the firm's HELOC lending is optional and firms that do not originate any loans but only purchase may not be required to file with HMDA.[33]

As shown in Table 1, according to IMF's definition of loan origination, the top forty lenders accounted for more that 96% of all residential mortgage origination in 2006 and 65% of U.S. mortgage origination (this measure of origination includes correspondent and wholesale funded originations, but not warehouse-funded lending) was carried out by a mere ten lenders.[34] The top ten lenders in 2006 were Countrywide Financial, Wells Fargo Home Mortgage, Washington Mutual, CitiMortgage Inc., Chase Home Finance, Bank of America Mortgage & Affiliates, Wachovia Corporation, Residential Capital Group, IndyMac, and GMAC Residential Holding Corporation. With the exception of GMAC, these lenders were all bank and thrift holding companies. The next thirty largest mortgage originators accounted for more than 32% of all U.S. origination in 2006. These originators were primarily independent mortgage companies funded by warehouse lenders.[35] Clearly, as shown in Table 1, the HMDA origination activity of the top forty lenders represents less than 33% of actual market total for these lenders, because most of their origination activity was through loan purchases, their correspondent lending. The HMDA aggregates, even accounting for the correspondent lending, only account for about 86% of the actual top 40 totals, and the eleventh largest mortgage originator in 2006, EMC Mortgage Co. (a subsidiary of JP Morgan Chase) does not appear in the HMDA aggregates at all. This under-reporting is why the HMDA loan-level data, focusing only on origination, and the HMDA Lender aggregates (which may or may not report correspondents) is biased toward showing too much competition in residential mortgage origination markets.

Table 1 shows that ten of the top forty lenders in 2006 were REITs structured like New Century Financial Corporation, with significant reliance on warehouse lines of credit and master repurchase agreements (MRAs). Like New Century Financial Corporation, seven of these REITs also declared bankruptcy. All of these bankruptcies were triggered by their inability to make required margin calls or meet other performance requirements stipulated in the covenants of their MRAs. As a result of these performance failures, the warehouse lenders terminated their lines. Despite the benefit of MRAs to exemptions from automatic

[33]Firms must only report to HMDA if, in the preceding calendar year, the institution's home purchase loan originations (including refinancings of home purchase loans) equaled or exceeded 10 percent of its total loan originations, measured in dollars, or equaled $25 million or more. If an originator hasn't originated any loans, under the HMDA definitions they are exempted.

[34]See *Inside Mortgage Finance*, February 2, 2007, p. 5.

[35]See *Inside Mortgage Finance*, February 2, 2007, p. 5. The exceptions were HSBC Finance; Flagstar Bank, and SunTrust Mortgage Inc.

Table 1: Comparison of *Inside Mortgage Finance* (IMF) and HMDA Lender File Statistics for U.S Loan Origination, with Performance Outcomes, for the Top Forty Residential Mortgage Lenders in 2006 ($ Billions)

The data reported in this table were assembled from a variety of sources including: *Inside Mortgage Finance*, February 2, 2007, the HMDA Lender File, and various financial statements and bankruptcy filings for the individual firms.

Rank	Name	IMF Total Orig+Pur	HMDA Lender File Total Originated	Purchased	Orig.+Pur	Status	Firm Type	Losses	TARP[a]	FDIC or FDIC Insured Creditors
1	Countrywide Financial Corp.	462.50	297.58	220.27	517.86	Sold 2008	Thrift			
2	Wells Fargo Co.	397.64	80.08	176.80	256.88		CB		25.00	
3	Washington Mutal Bank	195.70	77.94	106.49	184.42	FDIC Supervised Sale (2008)	Thrift			
4	Citigroup	183.48	89.42	57.00	146.42		CB		45.00	
5	JPMortgage Chase Corp.	172.90	33.36	78.11	111.47		CB		25.00	
6	Bank of American Corporation	167.90	64.49	89.17	153.66		CB		45.00	
7	Wachovia Corp.	104.74	14.95	77.85	92.80	FDIC Supervised Sale (2007)	Thrift			
8	GMAC Residential Capital Group	96.75	0.00	3.28	3.28	CH 11 2012	MC AF	11.50 Ally Financial	16.30	WL, MRA[b]
9	Indymac Bank	89.95	37.56	39.30	76.85	FDIC Supervised Sale (2009)	Thrift	4.00		FDIC
10	GMAC Residential Holding Corp.	74.60	151.64	56.15	207.80	CH 11 2012	MC AF	See GMAC Res		See GMAC Res
11	EMC Mortgage	72.43	0.00	0.00	0.00		MC Ind.			
12	New Century Financial Corp.	59.80	8.49	42.06	50.56	CH 11 2007	REIT	33.43 Claim		WL,MRA[c]
13	American Home Mortgage Corp.	58.90	2.96	54.83	57.79	CH 11 2007	REIT	1.10		WL,MRA[d]
14	SunTrust Bank	56.45	17.89	46.27	64.16		CB		4.85	
15	HSBC Holding PLC	50.00	41.92	41.36	83.28		CB			
16	National City Corp.	43.12	1.20	66.61	67.80	Sold 2009	CB			
17	PHH Home Loans, LLC	41.26	0.00	7.24	7.24		REIT			
18	ABN AMRO Home Mortgage, NV	38.31	6.99	31.04	38.03	Sold 2007	MC AF			
19	GreenPoint Mortgage Funding Inc.	36.40	0.86	30.82	31.69	Closed 2007	MC AF	7.99 Capital One	3.56	
20	Aurora Loan Services	34.30	0.00	0.43	0.43	FDIC Supervised Sale 2009	FSB	N.A.	0.00	
21	WMC Mortgage Corp.	33.20	3.97	29.14	33.11	Closed (2007)	MC AF	1.00 GE Fin. Corp.		
22	Fremont General Corp.	32.30	0.00	32.49	32.49	CH 11 2007	MC AF	3.14 Fremont Inv. & Loan		
23	First Horizon National Corp.	31.21	1.98	28.45	30.43		CB		0.87	
24	First Magnus Financial Corp.	30.07	0.65	24.93	25.59	CH 11 2007	REIT	.10		WL,MRA[e]
25	MortgageIT Inc.	29.00	1.86	24.54	26.40	Sold 2006	REIT			
26	Ameriquest Mortgage Company	27.80	0.00	5.30	5.30	Closed 2008	REIT	N.A.		
27	First Franklin Financial Corp.	27.67	0.00	0.78	0.78	Closed 2008	MC AF	.10 Merrill Lynch		
28	Option One Mortgage Corp.	27.35	3.21	25.44	28.64	CH 11 2007	REIT	N.A.		
29	Taylor, Bean & Whitaker	24.80	2.25	21.64	23.89	CH 11 2011	MC AF	2.98		FDIC
30	US Bancorp	22.29	14.93	12.72	27.65		CB		6.60	
31	Ohio Savings Bank	22.24	2.53	18.96	21.49	FDIC Supervised Sale 2009	FSB	2.00		FDIC
32	Flagstar Bank	19.00	2.84	15.67	18.51		CB		0.27	
33	Aegis Mortgage Co.	17.00	0.14	17.89	18.03	CH 11 2007	REIT	.20		WL,MRA[f]
34	Quicken Loans, Inc.	16.71	0.00	15.74	15.74		MC Ind			
35	Accredited Home Lenders, Inc.	15.70	0.01	15.34	15.34	CH 11 2008	REIT	0.2		WL,MRAs[g]
36	USAA Federal Savings Bank	15.70	0.00	9.86	9.86		FSB			
37	BB&T Corp.	14.73	4.30	11.85	16.15		CB		3.13	
38	BNC Mortgage	14.00	1.19	12.52	13.71	CH 11 2009	MC Ind	.05 Lehman		
39	American Mortgage Network, Inc.	13.73	0.00	13.45	13.45	CH 11 2007	REIT	.98		WL,MRA[h]
40	CTX Mortgage Co.	13.47	0.00	10.42	10.42	Closed 2008	MC AF	N.A.		
	Market Total	2,980.00								
	Top 40 Total	2,885.10	967.22	1,572.21	2,539.44			68.78	175.58	
	Top 40 % of Market Total	96.82%	32.46%	52.76%	85.22%					

[a] See http://projects.propublica.org/bailout/entities/

[b] Wachovia, Ally Financial, U.S. Treasury

[c] BofA,Countrywide, Citi, GMAC, Indy Mac, WAMU, JP Morgan Chase

[d] JP Morgan Chase, BofA

[e] WAMU, Countrywide

[f] Wachovia, Citigroup

[g] Citigroup, Wells Fargo

[h] JP Morgan Chase

stay and thus allowing the MRA lenders to take possession of the outstanding loan collateral, in all cases the MRA lenders are always the largest class of creditors in the bankruptcy proceedings. These losses are usually associated with substantial mark-to-market write downs on the mortgage collateral compared to the funding disbursements. The average number of warehouse lenders for these institutions is about ten with commitments of usually about $11 billion. We only report those creditors that are FDIC insured entities along with the substantial either gross loss claims or net realized losses of the REITs MRA creditors. As is clear, the large commercial bank and thrift lenders were involved as MRA lenders in all the bankruptcies for which we have information. The missing information is for Ameriquest that was shut down by Citigroup and Option One that was part of the New Century bankruptcy.

The affilitated mortgage companies (MC AFs) were subsidiaries of depositories. These companies were also reliant on MRAs for their mortgage origination funding. The two GMAC subsidiaries received large short term funding facilities from Ally Financial in addition to warehouse lines from Barclays, Citigroup, and Deutsche Bank among others just prior to their failure. Taylor, Bean, & Whitaker, securitized their loan origination and purchases through the GSEs and Ginnie Mae, and most of its warehouse lines were provided by its parent Colonial Bank. Abuse of these warehouse lines led to a $2.98 billion fraud on the part of Taylor, Bean, & Whitaker, which was finally exposed by the FDIC. All of the thrifts reported in Table 1 were themselves large warehouse and correspondent lenders, who provided capital both to the independent mortgage companies and to many smaller depositories. These correspondent and warehouse relationships further exposed these institutions to the quality of mortgage underwriting carried out by their counterparties. Estimates from the bankruptcy filings and FDIC resolutions suggest that next to the REITs the losses were largest for the thrifts and the MC AFs, all of whom were reliant on MRAs and warehouse lines for mortgage origination, either as originators or as lenders. The Losses column in Table 1 shows, using data from various bankruptcy filings, that the claims, write downs, and net losses for these closures and bankruptcies were about $68 billion.

The commercial banks appeared to have fared the best of this group. Wells Fargo, Citigroup, JP Morgan Chase, and Bank of America were all heavily involved in correspondent and warehouse lending as lenders. All of the banks reported in Table 1, with the exception of National City, were recipients of TARP, including Ally Financial, which was the warehouse lender for GMAC Rescap and GMAC Residential Holding Corporation. Both Ally Financial and Flagstar Bank have yet to fully repay the U.S. Treasury. As shown in the TARP column in Table 1, these firms received short-term support under TARP amounting to more that $175 billion. These firms also benefited from the automatic stay exemptions associated with the MRAs, even though in most instances they remained some of the largest creditors in

the MC AF and REIT failures. Accounting for the total warehouse lending activity of these entities is difficult due to the way the positions are reported in the call reports.

Overall, Table 1 establishes how highly concentrated the U.S. residential mortgage market was in 2006. The large lenders dominated both in their direct retail and wholesale origination, and also importantly in their activity as funders of the warehouse lines of credit provided to smaller lenders or lenders such as the REITs that had significantly constrained access to the short term funding sources required to sustain high volumes of mortgage origination. Of course, the warehouse lending market depended on the liquidity of the secondary mortgage market for both private label and GSE securitization. The large commercial bank and thrift warehouse lenders structured the MRAs such that most of the risk of not selling the mortgages, the securitization risk, was borne by their counterparties. Since the MRAs were collateralized, the warehouse lenders earned their returns through coupon interest on the lines and from the recovery rates on the principal balances. Their counterparties, on the other hand, had significant exposure to the liquidity of the secondary mortgage market and to the stability of their short term funding facilities. They also bore all the put-back liabilities on the mortgage loans that they originated because they were the initial legal creditor (originator) of record. Thus to fully understand the industrial organization of this market, the originators and funders must be linked to the entities that purchased mortgages on the secondary mortgage markets, the sponsors and the GSEs, and the *ex post* loan performance along these channels.

5 Financial norms in a network of intermediaries

As we have seen in the prior discussion, complex dependency structures between intermediaries exist in the mortgage origination market. As modeled in Eisenberg and Noe (2001), the financial relationship between two intermediaries can be viewed as a link in a network, i.e., two such intermediaries are neighbors in a financial intermediary network.

A fundamental implication of Eisenberg and Noe (2001), and more generally of the literature on financial contagion, is that the financial health of an intermediary is closely related to the health of its neighbors. A very tangible mechanism for why such network effects arise is that the default on an obligation by one intermediary may trigger the default of its counterparties. This is an ex post effect, given a realization of cash flows. However, it could be argued that ex ante effects should be at least as important. Specifically, the incentives of an intermediary to carry out high-quality investments will be affected by the actions of its counterparties. The (ex ante and ex post) quality and risk-profiles of intermediaries should therefore be closely related to their network positions.

The problem of understanding the evolution of incentives and risk-profiles of intermediaries in a financial network is related to the problem in the social network literature of understanding the evolution of social norms (see, for example, Friedkin and Johnsen, 1999; Jackson and Lopez-Pintado, 2013). We build upon this relation in a companion paper, Stanton, Walden, and Wallace (2013), where we introduce a strategic model in which heterogeneous "financial norms," defined as intermediaries' attitudes toward risk and quality of investments, evolve endogenously in a network. The key implications of the model is that network structure influences financial norms, that heterogeneous financial norms may coexist in the network, and that close intermediaries in the network tend to develop similar financial norms.

We build upon this intuition in our study of the U.S. mortgage market. Specifically, we hypothesize that a lenders' quality of loans will be related to the quality of the intermediaries the lender interacts with, in addition to its individual characteristics and the characteristics of the market in which it operates.

We define a *mortgage origination network*, using the flow of loans through three strata of the mortgage origination market: 1) the geographic location of the originator of the loan, measured via the county of the loan collateral; 2) the corporate entity that is the aggregator of the loan, either because it was the correspondent or because it was the corporate headquarters for the local originator; 3) the securitization entity for the loan: Fannie Mae or Freddie Mac, or the shelf sponsor of the loan (if it was securitized through the private-label channel).

The loan-level data that we use were obtained from ABSNet and from the Federal Housing Finance Administration data release for all fixed-rate mortgages securitized by the GSEs.[36] Our loan-level flow representations track the month-by-month loan-level performance of each loan from its 2006 origination date to the end of 2011. For each loan, we know the geographic location of the property, the mortgage originator or the correspondent lender, and the securitization channel. As a proxy for the unobservable "quality" of a set of loans, we use the fraction of individual loans that subsequently went into foreclosure along a given origination, aggregation, and securitization channel. Our hypothesis, along the lines of evolving financial norms, is that patterns of heterogeneous quality can be identified and that these will be closely related to a lender's network position along these channels.

Table 2 summarizes the loan characteristics of the more than three million single-family residential mortgages originated in 2006 with complete data identifying the origination,

[36]The loan-level data that we have from the GSEs does not include any adjustable-rate mortgages securitized by Fannie Mae or Freddie Mac. This exclusion means that we do not see the loans of important lenders, such as Countrywide, that securitized large amounts of adjustable rate mortgages through Fannie Mae, nor do we see Indy Mac and Washington Mutual loans securitized through the GSE channel. The ABSNet data, however, do include the private-label securitization for these three thrifts.

aggregation, and securitization channels of the loan along with its monthly performance through 2011. The original loan balances for the private-label securitized loans are higher than those securitized through the GSE channel, their cumulative loan-to-value ratios are higher, and their FICO scores are considerably lower. The performance data similarly reflect the lower quality of the private-label mortgages. The foreclosure rate on these loans is 20%, compared with 8% for the GSE loans (measured as actual forecloseures plus loans that are more than 150 days delinquent or that left the sample due to foreclosure-related modifications). The prepayment speed of the private-label mortgages was half that of the GSE-securitized loans over the same period.

These important differences in the characteristics of the mortgages securitized through the GSE and private-label securitization channels probably reflect the different monitoring strategies of these two channels. The GSE channel was primarily based on loan-specific scoring and the GSEs had the right to exercise significant secondary-market exclusions for originators whose loans consistently scored poorly, or whose ex post loan performance was poor.[37] In contrast, the originators who securitized through the private-label channel were primarily mortgage companies reliant on MRAs for origination capital. Because the warehouse lenders considered the revolving credit lines to be collateralized lending based on perfected collateral, the monitoring focus was directed to the counterparty performance of the originator and market liquidity of the loans rather than individual loan-level performance. Of course, one caveat to these conclusions is that the GSE data limitations exclude three of the more problematic lenders (Countrywide, Washington Mutual, and Indy Mac), which primarily originated adjustable-rate mortgages. Because the FHFA excluded the release of all adjustable-rate mortgage securitization, we cannot comment on the overall relative quality of GSE securitized loans compared with loans securitized through the private-label channel.

5.1 Network Representations of Interconnectedness

Following the methodology of Stanton et al. (2013), who build upon Eisenberg and Noe (2001), we graph the network representations for the private-label and GSE securitization networks. Figure 6 represents the origination, aggregation and securitization channels for the 1.37 million mortgages securitized through only the private-label channels, while Figure 7 includes the full sample of more than 3.02 million mortgages securitized through both the private-label and GSE channels.

There are three levels of the network, most easily identified in the right-hand-side of Figure 6. The inner circle, the "pupil" of diamond-shaped nodes, represents securitizers.

[37] These processes are known to have been relaxed under blanket contracts with thrifts such as Countrywide.

Table 2: Contractual Structure of Single-Family Residential Mortgages Included in the Network Analysis

Loan Characteristics	Mean	Standard Deviation
Fannie Mae and Freddie Mac Mortgage Securitization		
Loan count = 1,650,867; Percentage Fixed = 100%		
Original Loan Balance	$192,893	$94,322
Original Cumulative Loan-to-Value Ratio	74%	17%
FICO Score	718	58
Foreclosure Rate	8%	
Prepayment Rate	38%	
Private-Label Mortgage Securitization		
Loan Count = 1,371,327; Percentage Fixed = 20%		
Original Loan Balance	$239,040	$174,167
Original Cumulative Loan-to-Value Ratio	83%	15%
FICO Score	661	68
Foreclosure Rate	20%	
Prepayment Rate	19%	

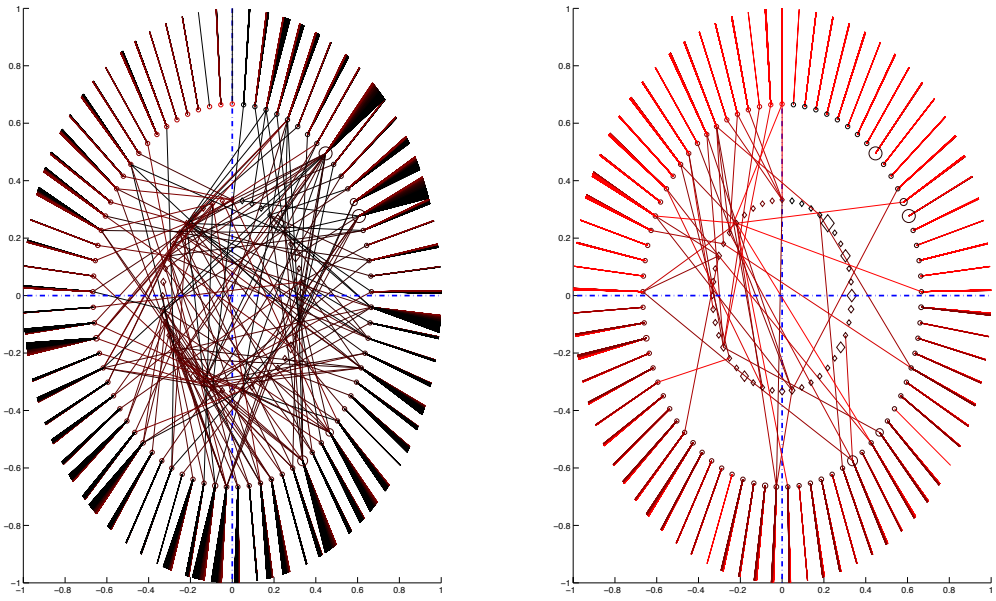
The outer circle, the "iris" of circle-shaped nodes, represents aggregators. A link between a securitizer and an aggregator represents a flow of loans between the two. The higher the fraction of foreclosures in the flow of loans between two nodes, the "redder" the link. The fraction of foreclosures also serves as a cutoff point, such that links with a relatively high fraction of foreclosures (more than 35% of loans) are drawn in the right panel of the figure, whereas links with a relatively low fraction (less than 35%) are drawn in the left panel.

The total fraction of all foreclosed loans associated with a node determines the node's color—the higher the fraction, the "redder" the node. It also determines the position of the node. Specifically, nodes are ordered clockwise in increasing order of their fraction of foreclosures, starting at "midnight." Thus, a node at 12:01 a.m. (in the upper right quadrant) has a very low fraction of foreclosures, whereas a node at 11:59 p.m. (in the upper left quadrant) has a very high fraction. The size of nodes varies, so that nodes with a larger loan volume are bigger. Here, for expositional reasons, we truncate extreme sizes, so that the size range is between 3 and 15 points.

The "cilia" from the aggregators to the periphery of the network represent links between aggregators and originators (defined by county). There are a large number of such originators (39,367 in the full sample), so the cilia look as if they are solid, since they represent a large number of links. The larger the angle of a cilium, the more originators are linked to the specific aggregator.

The figure thus conveniently summarizes and ranks the performance of different entities in the network, with respect to fraction of foreclosed loans. It also points to systematic

Figure 6: Networks for Banks, Thrifts, Mortgage Companies for Private-Label Securitized Single-Family Residential Mortgage Origination in 2006

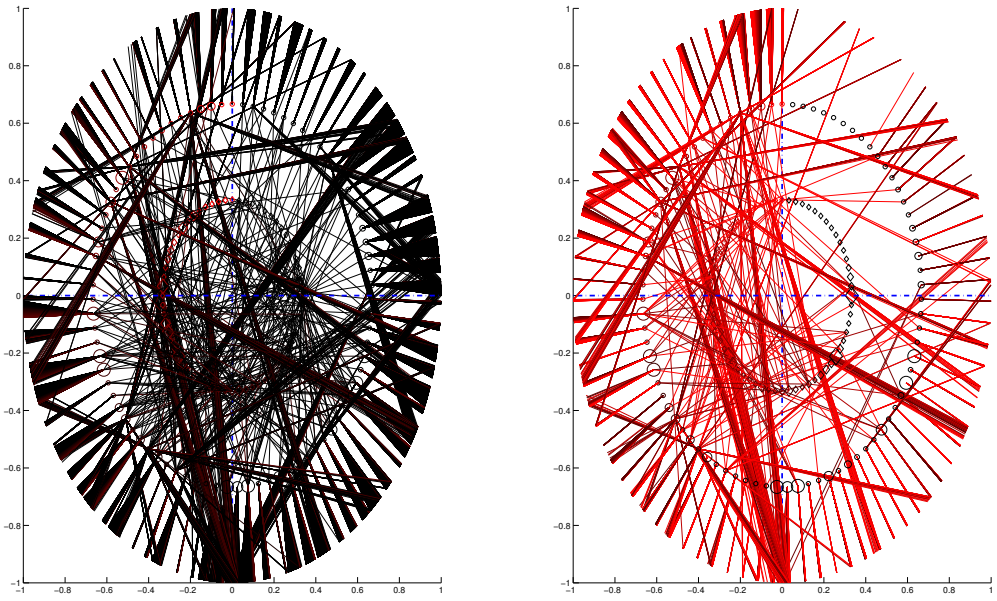


structures in the mortgage origination network, in line with our previous discussion about existence of different financial norms in different parts of a network of intermediaries. Specifically, as is easiest seen in Figure 6, the nodes and links with high rates of foreclosure form a well-separated sub-community of the full network. Not only are aggregators and securitizers with high foreclosure rates often linked, which is natural given how we define links, but when an aggregator with a high foreclosure rate is connected to a securitizer, other aggregators connected to that securitizer tend also to have high foreclosure rates (and vice versa for securitizers connected with an aggregator). It is also interesting that black cilia tend to have wide angles whereas red cilia tend to be narrow-angled. This suggests that the nodes with highest foreclosure rates are those that specialized in a smaller number of local markets, whereas nodes with a broader presence fared relatively better.

5.2 An Alternative Representation of Interconnectedness

A network can also be represented by an adjacency matrix, a representation which can provide additional insights about the network's structure. Specifically, a link from node i to node j in a network can be represented by a nonzero element on row i, column j in the network's adjacency matrix. Focusing on the subnetwork of aggregators and securitizers

Figure 7: Networks for Banks, Thrifts, Mortgage Companies for GSE and Private-Label Securitized Single-Family Residential Mortgage Origination in 2006



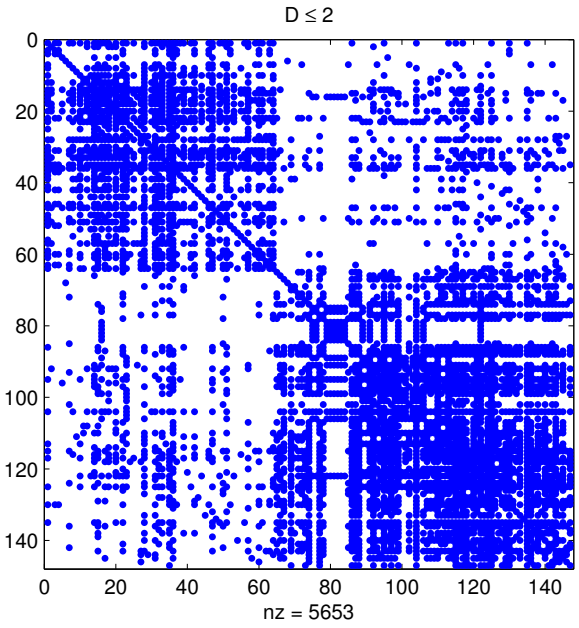
in the mortgage origination network, we study a generalized adjacency matrix that also takes into account if two nodes are at distance of 2 away from each other. Thus, two aggregators that are indirectly connected via a securitizer, and two securitizers that are indirectly connected via an aggregator will also be represented in the generalized adjacency matrix. There are in total 147 nodes in the network. We order these so that elements 1–64 represent the securitizers, whereas elements 65–147 represent the aggregators.

Figure 8 shows the generalized adjacency matrix. In the figure, a blue dot on the ith row and jth column of the matrix denotes that the distance between node i and j in the network is at most two. Direct links only exist between securitizers and aggregators, so two aggregators can only be indirectly connected, via a securitizer. Similarly, two securitizers can only be indirectly connected via an aggregator.

The lower left and upper right parts of the matrix show direct links between securitizers and aggregators ($i \leq 64$ and $j > 64$, or $i > 64$ and $j \leq 64$). The upper left corner shows indirect connections between two securitizers ($i \leq 64$ and $j \leq 64$), and the lower right corner shows indirect connections between two aggregators ($i > 64$ and $j > 64$). Altogether there are 5,653 direct and indirect connections in the network, out of a total of 21,609 (147^2) possible links. Thus, on average, any node is within a distance of two of about 26% of the

other nodes in the network. When distances up to 3, 4 and 5, are included in the matrix, the fraction of linked nodes increases to 61%, 86% and 95%, respectively. This implies that in the full mortgage origination network, which also includes originators, 95% of all nodes are within a distance of 7 from each other. The mortgage origination market, although made up of almost 40,000 separate entities, is thus a "small world," in the terminology of Milgram (1967) (see also Jackson, 2008, and references therein).

Figure 8: Degree of Network Interconnectedness at two counties distant from a given originator for Banks, Thrifts, Mortgage Companies for GSE and Private-Label Securitized Single-Family Residential Mortgage Origination in 2006



We use the matrix to analyze how foreclosure rates relate to indirect connections. The correlation between the foreclosure rate of an aggregator's loans and the average foreclosure rates of the loans of all other aggregators that were indirectly connected via a securitizer (shown in the lower right part of Figure 8) was 0.23. Similarly, the correlation between the foreclosure rate of a securitizer and the average foreclosure rates of the other indirectly connected securitizers (the upper left part of Figure 8) was 0.21. There was thus a significant positive relationship between foreclosure rates and network position, in line with our previous discussion.

5.3 The Risk Ranking of Financial Institutions

Following the logic of portfolio models, Acharya, Brownlees, Engle, Farazmand, and Richardson (2010), Acharya, Engle, and Richardson (2012), and Engle (2012) have written a series of influential papers, where the systemic risk of a firm is measured by the firm's exposure to aggregate risk factors and, especially, to a market risk factor. Specifically, the papers assume that the broad equity index, which is publicly available, is a suitable proxy for most risks. Their firm-specific measure of systemic risk (SRISK) represents the capital that an institution would need to raise in the event of a crisis, and the magnitude of SRISK depends on the size of the institution, its leverage, and its stock return during the crisis scenario.[38] These models have proven quite successful in ranking the relative risks of financial institutions.[39]

A significant advantage of these models is their parsimony and their track record in successfully matching the ex ante risk rankings of financial institutions to the ex post rankings for the same institutions based on realized returns. Another strength is that they are based on a broad equity index that is in the public domain and readily available over long time series. The transparency of this modeling framework is in stark contrast to the highly proprietary nature of the data inputs required for the Dodd-Frank Act Stress Tests (DFAST).[40]

A possible limitation of these models, however, is their inability to identify the actual channels of risk propagation.[41] As emphasized in the financial contagion literature, interconnectedness among financial intermediaries is pivotal for our understanding of the propagation and creation of systemic risk. An intermediary's (stock) market risk exposure may in this context provide a very narrow view of its exposure to—and, more importantly, role in generating—systemic risk.

Residential mortgage loans have historically been an important asset class on the balance sheets of bank and thrift institutions.[42] Our network representation of the mortgage industry

[38]The crisis is induced by a 40% decline in aggregate market equity over six months (see Brownlees and Engle, 2012) In an extension, Acharya, Engle, and Pierret (2011) use a Dynamic Conditional Beta, which is the correlation times the ratio of the firm volatility to the market volatility.

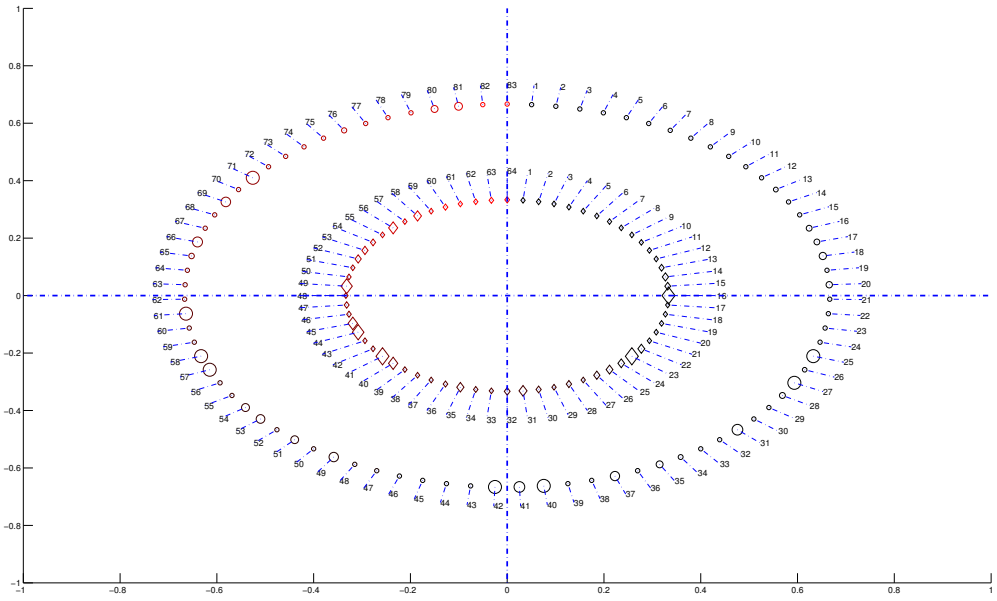
[39]The results of the risk rankings are available on the New York University Stern School of Business, Volatility Laboratory (Vlab) website, and are updated weekly (see `http://Vlab.stern.nyu.edu/`).

[40]The DFAST framework is based on highly disaggregate proprietary data from individual portfolios that is used to estimate net income from estimates of revenue, expenses, and various types of losses and provisions that flow into pre-tax net income, including loan losses and changes in the allowances for loan and lease losses (ALLLs); losses on investment securities; losses generated by operational risk; other expenses; and, for the bank holding companies with large trading operations, losses on trading and counterparty positions. The projected net income is then combined with the capital action assumptions that are prescribed in the DFAST rules to project changes in equity capital.

[41]See Billio, Getmansky, Lo, and Pelisson (2010), who focus on the correlations, cross-correlations, principal components analysis, regime-switching models, and Granger causality tests to measure the interrelatedness of the equity returns in the financial sector.

[42]From the Call Reports and Thrift Financial Reports (2006), they represented on average about 20% of bank total assets and on average 50% of thrift balance sheets. For smaller institutions they could represent

Figure 9: Quality Ranking of Banks, Thrifts, Mortgage Companies for GSE and Private-Label Securitized Single-Family Residential Mortgage Origination in 2006



allows us to rank order originators and securitizers by loan quality, and may in extension allow identification of an important source of systemic risk in the economy. Our approach therefore complements that of market-risk factor-based models.

Figure 9 focuses on the nodes in the mortgage origination network. As mentioned, the figure provides a relative ranking of the performance of mortgage originators along the outside circumference of the figure, and of the mortgage securitizers along the inner circumference. The figure is designed to be read from right to left, with the firms that delivered the best performance shown in black, ordered from 1 through 20 in the upper right quadrant. The size of the circle in the outer circumference represents the relative size of the originator or correspondent. The lower performance mortgage originators and correspondents are reported in the lower right quadrant, where the coloring evolves from black to red for the firms that are ranked from 42 through 62. The worst performing mortgage originators (63–83) are those located in the upper left quadrant.

A similar ranking of securitizers is presented in the inner circumference, where firms with larger levels of mortgage securitization are identified with larger diamonds. Again, the firms are ordered from good-performance securitizers (ranked in the upper right quadrant along

as much as 70% of the balance sheet.

Table 3: Names of Best and Worst Aggregators and Sponsors in Figure 9

Ranking	Aggregators with Lowest Foreclose Shares	Ranking	Shelf Sponsors with Lowest Foreclosure Shares
1	Novastar Mortgage Inc.	1	Credit Suisse First Boston
2	RESMAE Mortgage Corp.***	2	GreenPoint Mortgage Finance*
3	Ohio Savings Bank**	3	Ellington Loan Acquisition
4	Delta Funding Corporation***	4	Newcastle Investment Corp.
5	UBS Real Estate Securities, Inc.	5	PHH Mortgage Finance
6	First National Bank of Nevada**	6	Renaissance***
7	Home Loan Expanded Mortgage	7	Natixis Real Estate Holdings
8	CIT Mortgage*	8	Royal Bank of Scotland
9	GMAC Residential Funding Corp.***	9	Alliance Securities
10	Wilmington Finance Co.	10	HIS Asset Securitization Corp.
Ranking	Aggregators with Highest Foreclosure Shares	Ranking	Shelf Sponsors with Highest Foreclosure Shares
74	Silver State Financial Services**	55	MortgageIT*
75	Realty Mortgage Corp.***	56	Indymac Mortgage Corp.**
76	IMPAC Mortgage Corp.	57	Structure Asset Mortgage Investments*
77	GMAC RESCAP***	58	First Franklin Funding Corp.*
78	Lime Financial Services*	59	New Century Funding Corp.***
79	Aegis Mortgage Corp.***	60	Asset Backed Funding Corp.
80	BNC Mortgage***	61	Banccap Asset Securities
81	First Franklin Financial Corp.*	62	Aegis Mortgage Corp.***
82	NationStar	63	Securitized Asset Backed Receivables*
83	Ownit Mortgage Solutions, Inc.*	64	Structured Asset Invest Loans*

* Parent Closed
** FDIC Supervised Sale of Parent
*** Chapter 11 of Parent

the circumference) to bad-performance securitizers (ranked in the upper left quadrant along the circumference).

As a sanity check on the rankings reported in Figure 9, the top panel of Table 3 reports names and rankings for the ten aggregators and ten shelf sponsors with the lowest fraction of foreclosures (the outer and inner rings, respectively, of the upper-right quadrant along the circumference in Figure 9). The lower panel of Table 3 reports names and rankings for the ten aggregators and ten shelf sponsors with the highest realized foreclosure levels (the outer and inner rings, respectively, of the upper-left quadrant along the circumference in Figure 9). As shown in the table, twelve of the top forty originators discussed in Table 1 also appear in Table 3. Among the better-performing firms in the upper half of the table, there are four mortgage REITs — Novastar Mortgage Inc., Wilmington Finance Co., PHH Mortgage Finance, and Ellington Loan Acquisition — which survived the crisis and remain in operation. The better aggregators also include two failed savings banks that were transferred under FDIC supervised sales to other institutions after their parent holding companies, who provided their liquidity, filed for chapter 11 bankruptcy protection.

The three additional chapter 11 closures for originators with lower levels of foreclosures include a subsidiary of GMAC, GMAC Residential Funding Corporation, whose parent, Ally Financial, refused to provide further liquidity to all of the GMAC subsidiaries. GMAC Residential Funding was the GMAC subsidiary that focused primarily on the origination and purchase of conventional conforming loans following the guidelines of FNMA, FHLMC, and Ginnie Mae. As previously discussed, these loans tended to be of higher quality. RESMAE was a REIT that filed chapter 11 in February, 2007, due to its inability to meet the margin calls of its primary warehouse lenders. In March, 2007, its assets were of sufficient quality to be purchased by Citadel Investment Group, and this purchase enabled RESMAE to emerge from bankruptcy in November 2007. Delta Funding Corporation was another mortgage REIT that defaulted due to the margin calls of its warehouse lenders. Interestingly, Delta focused on higher-quality fixed-rate mortgages for most of 2006 in an effort to dilute its prior exclusive focus on subprime adjustable-rate mortgages.[43] Thus, all three of these originators originated higher quality loans in 2006 and appear to have failed due to the closure of their funding facilities and their lack of reserves for the exercised put-back options from earlier securitizations. Among the sponsors with the lower mortgage foreclosure shares, Renaissance was a subsidiary of Delta Funding Corporation, and GreenPoint Mortgage Finance was closed by its parent, Merrill Lynch.

As shown in Table 3, the survival rates for the firms in the lower half of the table are quite different. Only two of the aggregators survived the crisis and both of them, IMPAC

[43]See Delta Financial Corporation, 10K, Q4, 2006.

Mortgage Corp. and NationStar, are mortgage REITs. Among the parents of the sponsors, there were two survivors, Bank of America (holding company sponsor Asset Backed Funding Corp.) and Banccap. All the rest of the sponsors for these shelf registrations have been closed under a supervised sale by the FDIC, have entered Chapter 11, or have been closed by the parent holding company. The trusts within these shelf registrations are structured so that they cannot be closed nor can they enter bankruptcy. Overall, the channels with the highest shares of foreclosed mortgages are associated with the firms with lowest survival rates. There is, however, no clear pattern in the relationship between the firm types and survival, although the commercial banks again appeared to have faired better. There does not appear to be a clear weighting against the mortgage REITs since six of them appear in the lower half of the table and five in the upper half. Of course, interpreting this finding does not really control for the paths the good and bad loans followed to get to the aggregators and, in turn, to the securitizers. Analyzing these path dependencies requires a full representation of the network structure, as shown above.

Stanton, Walden, and Wallace (2013) show how these network representations can be used to represent the interlinkages expressed in other mortgage-risk measures. With these (ex ante) measures, such as expected mortgage default or expected effective duration, the networks could be used in a forecasting framework informed by the contractual characteristics of all the loans represented in the network. Within this framework the network representations could then be used to forecast network performance under a pre-defined crisis scenario, similar to DFAST and SRISK, and in extension allow for the identification of sources of systemic risk in the mortgage industry.

6 Conclusion

In contrast to merely counting the number of nominally independent entities in the market, a more nuanced representation of the residential single-family mortgage origination market shows it to be highly concentrated, dominated by the direct origination and funding activities of a small number of firms. We have shown that it is not accurate to regard the thousands of originators who appear active in the HMDA data as atomistic underwriters and funders. Instead, the origination market is more accurately defined by the important levels of contractual coordination that arise from the dominance of the correspondent and warehouse funding channels.

We represent these channels as a mortgage-origination network, using the flow of loans through three strata of the market: origination, aggregation, and securitization. Assuming that these contractual linkages will lead the (ex ante and ex post) quality and risk-profiles

of intermediaries to be strongly related to their network positions, we graph the network representations for the market. Our analysis of the market in 2006 shows that the network is a "small world" — most nodes are close to each other. We rank-order the interlinked aggregators and securitizers with respect to loan performance, and show that there is a well-defined sub-community of poorly performing nodes in the network. We argue that this may constitute an important, potentially measurable, source of systemic risk.

From our network perspective, the overall extent of truly atomistic competition in the residential mortgage origination market is greatly lessened. Another component of the high level of coordination among smaller less well capitalized firms is the contractual structure of the funding channels, which appear to be characterized by very short term contracting on the funding flows (both for GSE and private-label securitization), in turn inducing a high level of dependency on the short-term liquidity of the secondary mortgage market. Other factors which induce short-term vulnerabilities include the automatic stay exemptions currently enjoyed by MRAs under BAPCPA, and the sensitivity of the warehouse contracts to the performance of poorly capitalized counterparties. A final concern with the originator to aggregator coordination that characterizes this market is that there remain important ambiguities in the accounting treatments of (and capital requirements for) forward purchase commitments for mortgages and MRAs on the correspondent and warehouse lending balance sheets.

As we have shown, an important additional level of coordination is introduced once account is taken of the corporate ownership patterns found within the mortgage securitization channels, where even fewer large firms were dominant in 2006, and currently with the dominance of Fannie Mae and Freddie Mac. An important feature of this channel is that the put-back options for poor quality securitized loans remain with the supposedly independent originators (the underwriter/funders), who are almost always poorly capitalized. Our finding of significant network interlinkages thus represents a previously under-appreciated source of systemic risk, because these many small firms are coordinated to act in parallel by their funding relationships with the large, "too-big-to-fail" bank holding companies.

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