Capital Regulation and Asset Allocation Amidst Agency Conflicts: Evidence From Mortgage Servicing *

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Abstract

We study the real impacts of capital regulation caused by the reallocation of mortgage servicing rights (MSRs). Using U.S. credit registry data, we show that Basel III's stricter MSR regulation induced banks to transfer riskier MSRs, leading to a market-wide shift toward non-bank servicers. We develop a model showing that the privately optimal allocation of MSRs may not minimize agency conflict in a non-integrated mortgage market. Comparing foreclosure rates, a sufficient statistic for welfare in the model, we show that the reallocation of MSRs decreased agency conflicts and enhanced investor welfare at the expense of borrowers.

Keywords: Capital Requirement, Mortgage Servicing Rights, Non-Bank Financial Institutions, Household Finance
JEL Classification: G20, G21, G23

*Jiang, Lewis, and Padi thank the Alfred P. Sloan Foundation for the generous support through the NBER Household Finance Small Research Grant. We thank Darren Aiello, Todd Gormley, Brett Green, Gregor Matvos, Katie Moon, Christopher Palmer, Karen Pence, Michaela Pagel, Tarun Ramadorai, Rodney Ramcharan, Anthony Lee Zhang, Jonathan Wallen, Amit Seru, Janis Skrastins, the seminar participants at the Federal Reserve Board, Washington University in St. Louis, University of Colorado Boulder, University of Texas at Austin, University of Michigan, Texas A&M, and the conference participants at the Chicago Booth Empirical Finance Conference, SAET Paris Conference, Fischer Shain Research Conference, SITE Financial Regulation, Red Rock Conference, UW-Madison Junior Finance Conference, CEPR European Household Finance Conference, and the European Financial Management Association (EFMA) for helpful comments. We are grateful to Equifax Inc. for supporting this research and allowing access to the data. This paper represents the views of the authors only and not those of Equifax Inc., and the data use was in accordance with any and all applicable laws, limitations and protections. Pal has received compensation from Equifax Inc. This compensation has not affected any of the conclusions of the study. *First version: March, 2023*

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After the Global Financial Crisis, regulatory reforms have focused on tightening bank capital regulations. By shifting banks' incentives to hold risky assets, tighter regulation may lead to a market-wide reallocation of assets to non-banks. In the modern originate-to-distribute credit market, both banks and non-banks act as agents who are given discretion to impact investor returns and borrower welfare. Since these agents have different degrees of misaligned incentives, changes in the allocation of assets can have real consequences. In this paper, we shed light on this previously understudied channel by which capital regulation impacts investors and borrowers — the re-allocation of risky assets across delegated agents with conflicted incentives.

We focus on the market for mortgage servicing rights (MSR) using detailed credit registry data that tracks MSR holdings over time. MSR holders, or servicers, have discretion in providing liquidity to defaulting borrowers (*risk sharing*) (Cherry et al., 2022; Padi et al., 2023; Kim et al., 2022) and in influencing returns to investors (Aiello, 2022). In the US, MSRs have steadily become separated from loan ownership as most loans are securitized. In recognition of the growing importance of MSRs, regulators adopted Basel III's stricter MSR rule between 2012Q2-2013Q2. This capital regulation transformed MSRs into one of the most costly asset classes for a bank to hold on its balance sheet.

In this paper, we introduce an original framework to incorporate the welfare effects of asset allocation into evaluation of capital regulation. MSRs are allocated in a non-integrated mortgage market, in which investors need not originate or service the loan, and can be traded across servicers. We consider welfare impacts on two stakeholders: investors and borrowers. Investor welfare depends on the magnitude of the agency conflict in foreclosure policies between the servicer and the investor due to their different net returns from resolving borrower distress. Equilibrium allocations of MSRs to servicers may not minimize such agency conflicts, resulting in foreclosure rates farther from the investors' optimum than an alternative allocation. While borrowers are not in a direct agency relationship with either servicer or investor, borrowers bear the cost of foreclosure and thus are indirectly influenced by agency frictions through changes in the foreclosure rate. These economic consequences could be amplified for a vulnerable sub-group of borrowers. Empirically, the welfare implications of bank capital rules for borrowers and investors can be assessed by studying the impact on the allocation of MSRs and foreclosure rates.

To begin, we document new stylized facts about the market for MSRs centered around the regulatory reform. Prior to the reform, MSRs were largely assigned to bank servicers. The reform coincided with a market-wide shift toward non-bank servicers — outstanding mortgages serviced by non-banks increased from 10% in 2010 to nearly a third by 2015. Transfers of MSRs during the life of the loan, rather than at origination, became increasingly common, creating a robust secondary market in MSRs. The growth in non-bank servicing was concentrated in subprime mortgages. In addition, the dominance of non-bank servicing was accompanied by an increase in foreclosure rates, which are a key determinant of investor returns and borrower losses.

Motivated by these facts, we develop a model to study factors that determine the allocation of MSRs and how the MSR allocation affects borrowers and investors. We model non-integrated financial intermediation, in which mortgage investors do not service loans. This structure represents the case of the mortgage being securitized after origination, a common practice in the US. The model features a two-stage game. In stage 1, banks and non-banks decide how many MSRs to hold of each loan type, characterized by default probability. The price of MSRs for each loan type is determined in equilibrium to clear the market. In stage 2, given the allocation of MSRs, servicers choose their foreclosure rules for defaulted loans. The main trade-off servicers face is that delaying foreclosure preserves the possibility of receiving future servicing fees but is costly because they need to make payment advances on behalf of delinquent borrowers. Banks and non-banks have different discount rates, affecting their foreclosure rules and thus ex-ante expected profits from servicing each loan type. The second stage decisions affect the first stage equilibrium allocation: in anticipation of their second stage foreclosure rules, servicers optimize their first stage MSR holdings conditional on the market prices.

In this model, a misalignment arises between investors' and servicers' optimal foreclosure policies because servicers do not consider the interest payments to investors or the asset value in foreclosure when choosing whether to bear the cost of helping distressed borrowers recover from delinquencies. This misalignment in incentives drives a wedge between servicer and investor optimal foreclosure rates, causing welfare loss for the investor. Thus, the absolute value of the foreclosure rate differential serves as a sufficient statistic for the investor welfare loss caused by misaligned servicers. Importantly, servicers' foreclosure policies could be too

strict, or too lenient, compared to investors' optimal policies depending on how the benefit of delaying foreclosure, perceived by the servicer, deviates from the benefit perceived by the investor. However, more lenient servicers — e.g., servicers with lower funding costs — are always assigned more MSRs in equilibrium. Therefore, the equilibrium allocation of MSRs may result in foreclosure rates closer to or farther from the investor's optimum.

We next model a tightening to banks' capital requirement. Since the capital regulation was intended to reduce excessive bank risk taking, not to minimize agency conflict between servicers and investors, the resulting re-allocation of MSRs may result in allocations that are more or less aligned with investors, yielding ambiguous welfare effects. Moreover, the model predicts a pecking order of MSR transfers from banks to non-banks based on loan default risk when there is a shock to the regulatory cost of holding MSRs for banks. Therefore, the welfare consequences of capital regulation are amplified for investors holding high-default-risk loans and for subprime borrowers.

We empirically examine whether the Basel III MSR regulation moved the allocation in the direction of the investor optimum and how it affected welfare. Using a near-universe of credit bureau data, we conduct a difference-in-differences (DiD) design centered around the rule change. We begin by comparing banks (the treatment group) to non-banks (the control group). We include loan fixed effects in our primary specification, which allows us to isolate whether the same exact loan is more likely to be transferred if it was serviced by a bank in the previous quarter. The loan fixed effects help rule out any potential effect of the loan's origination cohort. We find that the final adoption of Basel III in 2013Q2 increased banks' likelihood of transferring MSRs by 4% relative to that of non-banks. Banks' higher likelihood of MSR transfers persists for several quarters and remains more than 2% higher than that of non-banks' by the end of 2015. Moreover, prior to the initial proposal of the Basel III rule, bank MSR transfers exhibited pre-period parallel trends and were not statistically more likely than non-bank transfers. This alleviates the concern that unobservable characteristics might drive the different bank versus non-bank transfer likelihoods in the post-period. We also compare across banks with different treatment intensity, proxied by bank MSR to tier 1 equity ratio in 2011, and find that a 10% increase in treatment intensity corresponds to a .4% higher likelihood of MSR transfers post-regulation. In addition to the spike in transfers, we also document that Basel III led banks to increase assignment of loans to third-party

servicers at origination and to decrease originations.

If the banking sector as a whole had enough regulatory capacity to retain MSRs, the regulation could potentially lead to a reshuffling of mortgage servicing within the banking sector rather than a migration of servicing to outside the banking sector. Thus, to document that banks sell MSRs to non-banks as our model suggests, we examine non-banks' cumulative holding of mortgage servicing rights. We find that the total share of outstanding loans serviced by non-banks increased by 8.3% after the final adoption of Basel III. By adding loan fixed effects, we document that the increased likelihood of non-bank servicing is consistent with non-banks receiving MSRs from bank assignment or transfer rather than from non-banks increasing originations or changing servicer composition over time.

Consistent with a pecking order in MSR transfers, banks selectively transfer more MSRs for subprime and 60+ day delinquent loans, and non-banks increase their cumulative likelihood of servicing these loans, absorbing a majority of loans transferred away from banks. Thus, the re-allocation of MSRs after Basel III disproportionately increased exposure to non-banks for high risk loans held by disadvantaged borrowers with lower credit scores.

Finally, we evaluate subsequent impacts on borrower and investor welfare. The reallocation of MSRs can influence investor and borrower welfare through changes in foreclosure rates. We start with examining the borrower welfare implications of regulation-induced MSR reallocation. Since foreclosure is costly and there is no corresponding benefit that directly accrues to borrowers, borrowers in default prefer a lower foreclosure rate. Therefore, if the reallocation of MSRs increased foreclosure rates, it would unambiguously lower borrower welfare, and vice versa. To this end, we examine whether Basel III increased or decreased the foreclosure rate by implementing an intent-to-treat (ITT) estimator. The empirical design defines loans as treated if they were serviced by a bank in 2011Q1 and as control if they were serviced by a non-bank in 2011Q1. "Serviced by bank in 2011Q1" indicates that a loan is intended to be treated by transfer to a non-bank and we capture the average effect of Basel III on the entire portfolio of mortgages that bank servicers held prior to the shock. We find that prior to the policy change, the performance of loans serviced by banks and by non-banks were on a parallel trend. After the policy change, the foreclosure likelihood of the 2011 bank-serviced loans increased significantly, relative to the 2011 non-bank-serviced loans. The effect on foreclosure rates is heterogeneous for subprime and prime borrowers,

such that the regulation increased foreclosures disproportionately for subprime borrowers.

We then examine the investor welfare implications of regulation-induced MSR reallocation. Whether these regulation-driven MSR transfers enhance or diminish investor welfare hinges on whether non-bank servicers have more misaligned incentives than bank servicers. Our model indicates that the servicer whose foreclosure rate most closely aligns with the investor's optimal rate is the least conflicted and therefore minimizes agency costs. To estimate investors' optimal foreclosure rate, we use the foreclosure rate of portfolio loans — i.e., loans that banks hold on their balance sheets — as a proxy. These portfolio loans typically have the lowest agency conflicts because their servicer and investor are the same entity. We then compare the foreclosure rates of these "unconflicted" portfolio loans, originated in 2011, with those of "conflicted" loans serviced by third-party banks and non-banks during the same period. To avoid biasing our results with the high transfer rates that followed the MSR regulation, we focus on loan performance before the regulation. We find that the foreclosure rates for bank-serviced third-party loans were further below the investor's optimal rate compared to loans serviced by non-banks. The finding suggests that by reallocating MSRs to non-banks, the MSR regulation shifted loans to servicers with higher foreclosure rates, closer to the investor's optimal rate, thus enhancing investor welfare.

Taken together, our findings suggest that post Basel III MSR regulation, although investors benefited from a shift toward non-bank servicers, borrowers suffered from stricter foreclosure policies. The welfare loss is more pronounced for subprime borrowers, whom our empirical results establish were disproportionately exposed to reallocation to non-banks.

These results have several policy implications. Macroeconomic reforms have important microeconomic impacts, especially in markets with agency conflicts. Therefore, when planning capital regulations, a social planner ultimately concerned with maximizing borrower and investor welfare should consider the welfare gain to investors and welfare loss to borrowers that we document. The social planner, weighting both investor and borrower welfare, should ensure that foreclosure rates stay weakly below the investors' optimum, as regulation that pushes foreclosures above that level is Pareto-dominated. Our results suggest that regulators face trade-offs between the efficacy of bank capital regulation and spillover effects of regulation onto stakeholders. If there are distributional differences in demographic groups that are serviced by non-banks and if non-banks differ in their degree of underlying frictions,

regulation can lead to unequal distributional effects on investors and borrowers. One insight from our work is that recent attempts to provide liquidity to servicers could worsen agency conflicts between servicers and investors, even as they benefit borrowers. Future capital regulation reforms should account for private market frictions and re-allocation to the non-bank sector.

Literature Review Our paper relates to the literature studying the impacts of macroprudential regulations (Acharya et al., 2012, 2022; Allen and Gale, 2018). There is a long debate weighing the amount of bank capital regulation necessary to increase financial stability against the possible reduction in growth due to over-regulating banks.[1] Following this debate, literature has carefully considered the impact of such regulation on individual institutions' behavior. Examples include lending (Degryse et al., 2021; Behn et al., 2016; Gropp et al., 2019; Jiang et al., 2020) as well as portfolio allocation and risk taking (Becker et al., 2022; Koehn and Santomero, 1980; Plosser and Santos, 2023).[2] The Basel III End Game debate brings these considerations back into the spotlight. In this paper, we highlight a new potential effect of bank regulation: as non-bank share of the credit markets increase, stakeholders such as borrowers and investors may experience different returns, resulting in welfare consequences. We document this "asset allocation channel" of capital regulation in the context of the mortgage servicing market and offer a framework for quantifying the welfare effects on investors and borrowers.

In addition to studies focusing on bank balance sheets, a growing body of literature recognizes the importance of considering the migration to non-banks to evaluate the impacts of macroprudential regulations (Buchak et al., 2018a, 2024; Lewis, 2023). Post financial crisis, tighter bank regulations led to increased lending activity outside the traditional banking system (Buchak et al., 2018b; Jiang, 2023; Irani et al., 2021; Cherry et al., 2022; Gopal and Schnabl, 2022; Chernenko et al., 2022; Davydiuk et al., 2020). The development of securitization contributed to the expansion of the originate-to-distribute intermediation model, making lending less reliant on balance sheet financing (DeMarzo, 2005) and contributing to the rise of non-bank financial institutions. Financial services have become unbundled by securitization, leading to a large literature on the costs and benefits of the originate-to-distribute

[1] See Santos (2001) for a survey review of the literature.
[2] See VanHoose (2007) for a survey review of theoretical studies on bank behavior under capital regulation.

model. See, for example, Keys et al. (2010). Our paper contributes to this literature by formalizing the agency conflict between investors and servicers in a non-integrated mortgage market and studying its welfare implications. Moreover, we show how bank and non-bank servicers differ and how they are affected by bank regulation.

We also contribute to a growing literature on mortgage servicing. Servicers play an important role in facilitating the pass-through of government forbearance and debt relief programs (Piskorski and Seru, 2021a; Cherry et al., 2022), extending liquidity to resolve borrower distress (Padi et al., 2023; Mayock and Shi, 2022), which in turn affects investor returns (Aiello, 2022), and nudging borrower refinance (Buchak et al., 2023; Berger et al., 2024). Kytömaa (2023) documents that servicer behavior and debt relief design in the presence of borrower private information contribute to foreclosures in the US. Kuong and Zeng (2021) finds that servicers play an important role in optimal information sensitivity design of securities. In addition, literature has also shown the importance of mortgage servicing for financial stability (Kim et al., 2018) and monetary policy transmission (Agarwal et al., 2023). Our empirical analysis establishes the Basel III MSR rule change as a shock to the allocation of servicing rights.[3] Drawing on insights from the literature on marginal home buyers (Adelino et al., 2016; Mian and Sufi, 2009; Lewis, 2021; Fuster et al., 2022), we separately assess the impact of capital regulation on high and low risk borrowers. We demonstrate that regulatory reform can worsen existing disparities across borrowers. Accompanying our results on differential transfer by borrower type with an analysis on foreclosure rate by servicer type, we provide evidence of the welfare effects of MSR allocations on both investors and borrowers.

[3]Previous literature disagreed on whether this rule would have significant impacts. The Report to the Congress on the Effect of Capital Rules on Mortgage Servicing Assets, available at https://www.federalreserve.gov/publications/capital-rules-mortgage-servicing-assets.htm, suggests the MSR rule has relatively little impact on banks, but Hendricks et al. (2016) uses bank level data to show that Basel III was associated with a significant shift in the MSR market.

1 Institutional Background and Data

1.1 Mortgage Servicing Right (MSR)

Though servicing is inherent in all mortgages, an independent asset called a mortgage servicing right (MSR) is created when the act of servicing is contractually separated from the underlying loan. An institution reports an MSR on its balance sheet as an asset if it sells its originated mortgage to a third party but retains the servicing. Conversely, an institution does not report an MSR if it performs servicing for mortgages held on its balance sheets.[4] Thus, it is for securitized loans that MSRs are most commonly discussed as a separate asset.

MSR holders are referred to as loan servicers and are responsible for collecting mortgage payments and resolving borrowers' financial distress.[5] Servicers receive revenues from servicing fees. The value of an MSR is the present value of future revenues from servicing the loan for its expected duration.Servicers make the key decision of when to foreclose on a mortgage. When borrowers miss payments, servicers are required to make payment advances to investors on behalf of the delinquent borrowers until the distress resolution process is complete or foreclosure is initiated. During this process, securitization structures offer varying liquidity incentives for servicers.[6] Once the foreclosure process begins, servicers are often made whole for the advances they incur.

1.2 Regulatory Debate about Holding MSRs

Following the Global Financial Crisis (GFC), the Basel Committee proposed several regulatory changes in Basel III that aimed at strengthening the banking sector. These included changes to banks' required capital for holding intangible assets, including mortgage servicing rights (MSRs), on their balance sheets.

[4] See: Fed Report to the Congress on the Effect of Capital Rules on Mortgage Servicing Assets.

[5] It is worth noting that many financial institutions conduct both loan origination and loan servicing businesses, and mortgage servicers are different from debt collectors. The key distinction between a "loan servicer" and a "debt collector" depends on whether the loan was in default at the time it was obtained. Moreover, the term debt collector typically refers to a secondary buyer of unsecured debt, while a servicer specializes in repossession of collateral.

[6] For example, while private-label servicers are typically required to make advances as long as the amount advanced is deemed recoverable, Fannie Mae and Freddie Mac are able to aid servicers by paying supplemental servicing fees, reimbursing servicers for property tax and insurance advances, and forwarding payments to investors in lieu of their servicers. Ginnie Mae is only able to forward advance payments if the servicer is insolvent, thus Ginnie's insurers (FHA, VA, and RD) all have different servicer liquidity guidelines. See Economic Commentary by the Cleveland Fed: Why Wasn't there a Nonbank Mortgage Servicer Liquidity Crisis? by Lara Loewenstein.

The following expression formulates banks' capital requirement, with a particular emphasis on the role of MSRs:

$$\frac{\overbrace{\text{Common Equity} + \text{Allowable MSR}}^{\text{CET1}} + \text{Other Tier 1 Capital}}{\text{Risk Weight} \times \text{Allowable MSR} + \text{Other Risk-Weighted Assets}} \geq \text{Capital Requirement.}$$

In words, bank's tier 1 equity capital, a key indicator of its financial strength for regulators, is composed of common equity (CET1), disclosed reserves, and additional tier 1 capital.[7] Intangible assets are typically deducted from tier 1, however an allowable portion of MSRs are able to be included in tier 1 equity. We exploit a change in the definition of *Allowable MSR* as well as its assigned risk weight that affects how costly it is for banks to hold MSRs. In particular, Basel III increases banks' regulatory cost of holding MSRs by changing both of these two factors.

Prior to Basel III, the amount of MSRs that banks were able to include in tier 1 equity was the lesser of 90 percent of the MSR's fair value or 100 percent of its carrying amount.[8] Basel III propose restricting MSRs to comprise 10% of banks' common equity component of tier 1 equity capital, at maximum. This restriction alone is very costly. According to estimates in the literature, for a bank that must maintain an 8% capital requirement, it equates to a risk weighting on the order of 1,250%. In addition to reducing banks' equity capital, the risk weighting on the portion of MSRs included in equity increased from 100% to 250%. The two changes together significantly increased the regulatory burden of holding MSR assets for traditional banks.

As mentioned above, the Basel Committee proposed several regulatory changes in Basel III, however, the Federal Reserve did not adopt the proposed changes all at once. From 2012Q2 to 2013Q2, the regulatory change pertaining to MSRs progressed from being proposed by Basel to adopted by the Federal Reserve, and thus applicable to US commercial banks. Prior to 2012Q2, Basel's progress report classified the US as stage "1-Draft regulation not published." In June 2012, the Federal Reserve Board issued a proposal to adopt Basel III's treatment of MSRs and invited comments by September 2012. This moved Basel's classification of the US to stage "2-Draft regulation published." However, the final terms

[7] Basel Accord Annex 1D - Definition of Capital Elements (p 14.)
[8] Fed Report to the Congress on the Effect of Capital Rules on Mortgage Servicing Assets

of the proposal were not agreed upon since the Federal Reserve Board was actively seeking comments. On July 2, 2013, the Federal Reserve Board adopted Basel III's treatment of MSRs and the new regulatory framework took effect. This early July 2013 adoption date indicates that the final version of the regulation was finalized at the end of the second quarter of 2013. In October 2013, Basel re-categorized the US as phase "3 - Final rule published." We include a full timeline of the policy change in Appendix A.

1.3 Data and Servicer Classification

Our primary dataset is a detailed anonymized tradeline-level credit bureau panel with near-universal coverage of the United States. The data include information about each mortgage on an individual's credit report, including the loan's origination date and characteristics such as loan type, loan amount, loan term, and borrower characteristics such as credit score, and monthly payment status. We keep monthly data between 2011 and 2015 and drop all individuals who do not have an active mortgage at some time in this window. While our stylized facts are generated using the full sample, we select a representative 1% sample of the entire nation for our primary regression analysis. We do so by selecting a 1% sample of unique loan IDs active between 2011-2015 and then following them through time. We provide the summary statistics of the full sample and the 1% sample in Table 1. The two samples share similar loan characteristics.

Identifying Servicing Transfer. In this data, we identify servicing transfers as the closing of one trade line, followed immediately by the opening of another trade line with the same origination characteristics, but different servicer characteristics. We code the servicer transfer indicator as one in the calendar month when this transition happens, and zero otherwise. Based on this classification, 5.1% of loans experience at least one servicing transfer throughout the life of the loan during our sample period 2011-2015.

Servicer Classification. We use publicly available data on deposit-taking institutions such as Bank Call Reports and Y9C data to classify servicers as banks or non-banks. This classification is validated by comparing the estimated number of banks in our dataset with the number estimated in the publically available datasets. In the analysis, our definition of banks includes both commercial banks, credit unions, and savings & loan associations.

Originator Classification. For each loan in the tradeline data, we identify all mortgage related income-verification inquiries pulled by lenders for the corresponding borrower within 30 days from origination. The entity with the inquiry date closest to origination is identified as the originator of the loan. The inquiry data is available starting in 2011, thus the originator information can only be obtained for loans originated from 2011 onwards. This method allows us to recover originator information for 32% of all loans outstanding between 2011-2015.

Merging with Bank Call Reports. We construct MSR-to-CET1 (MSR/CET1) ratios for each bank in the publicly available Y9C data in 2011. We then merge this with the 1% sample of our credit registration data.

We report summary statistics for this merged sample in Table 1, which are similar to that of the full sample.

2 Stylized Facts

2.1 The Rise in Non-Bank Servicing

The share of outstanding mortgage loans serviced by non-banks has been rising over time. As Figure 1 shows, by the end of 2015, non-banks serviced about 30% of total mortgage loans outstanding, which increased from slightly above 10% in 2011.

The rise in non-bank servicing could be driven in part by non-banks originating more mortgages while maintaining the same amount of servicing rights on loans they originated themselves (Buchak et al., 2018b). It could also be driven by non-banks obtaining a larger share of servicing rights on loans originated by themselves or by banks. We refer to the former as the "origination margin" and refer to the latter as the "servicing margin." We next document facts about the servicing margin.

2.2 The Allocation of Servicing Rights at Origination

Before 2013, most mortgage servicing rights were assigned to traditional banks at origination. As Figure 2 shows, before 2013, the servicing rights of bank originated loans were almost completely kept by the originating banks or assigned to other banks (Panel a), while the

MSRs of non-bank originated loans were largely assigned to banks (Panel b).

Starting in 2013, the number of MSRs assigned to traditional banks at origination declined significantly. Among loans originated by banks, fewer loans had MSRs kept by their originators or obtained by other banks post-2013 relative to pre-2013 (Panel a). Additionally, banks acquired significantly fewer MSRs of loans originated by non-banks post-2013, whereas non-banks both kept more MSRs originated by themselves and obtained more MSRs of loans originated by other non-banks post-2013 (Panel b).

2.3 Servicing Right Transfers

Before 2012Q2, mortgage servicing rights were barely transferred after origination. As shown in Figure 3, the MSR transfer volume started to rise in 2012Q2, spiked in 2013Q2, and remained at an elevated level thereafter. Traditional banks became the dominant sellers, while non-banks became the dominant buyers of MSRs in the secondary market. Quantitatively, there were more than 3 million loans whose MSRs were transferred in 2013Q2 alone, which was seven times the number of transfers in 2013Q1. This number declined in the following quarter, but there were still 2 million MSR transfers in 2013Q3. After the major wave of MSR transfers in 2013, the quarterly number of MSR transfers stayed at about 1 million, which was five times the pre-2012Q2 level.

The timing of the MSR transfer wave, beginning in 2012Q2 and followed by a spike in 2013Q2, coincides with the Federal Reserve's gradual adoption of the Basel III regulations. Consistent with the spike being driven by bank regulation, about 82% of the transfers were from banks to non-banks. This large market shift likely had spillover effects on other MSR sales, which is supported by the slight increase in transfers from non-banks to non-banks, non-banks to banks, and from banks to other banks at this time.

2.4 Composition and Performance of Loans Serviced by Different Institutions

Table 1 describes the characteristics of loans serviced by banks and non-banks in the 2011-2015 period. Compared to loans serviced by banks, loans serviced by non-banks have lower credit scores and lower incomes. Since 2011, non-banks have serviced an increasing share of

outstanding subprime mortgage loans (Figure 4). By the end of 2015, they serviced nearly 50% of all subprime loans.

Moreover, relative to loans serviced by banks, loans serviced by non-banks have significantly higher foreclosure rates, both unconditionally and conditional on default. As Figure 5 shows, the majority of foreclosure sales over this sample period were from loans serviced by non-banks. In 2012Q2 the number of non-bank foreclosure sales began increasing relative to banks, peaking in 2014, while the number of bank foreclosure sales remained flat and close to zero over this time period.

3 Model: Private Allocation of MSRs

We construct a model of non-integrated financial intermediation in the mortgage industry, in which the investor in the mortgage does neither origination nor servicing. This setup represents mortgages that are securitized after origination, which is commonplace in the US mortgage industry. Our model focuses on the equilibrium allocation of MSRs across heterogeneous servicers, taking as given the structure of servicing contracts.[9] The model aims to demonstrate that when there is a misalignment in incentives between the MSR holder (the servicer) and either the loan holder (the investor) or the borrower, the allocation of MSRs has welfare impacts.

The model will illustrate the agency conflicts in a non-integrated intermediation structure and how the allocation of MSRs affects welfare. We will use the model to study the effects of increased bank regulation on the allocation of MSRs and the resulting implications for risk sharing between borrowers and lenders, with a particular focus on the distributional consequences of capital regulation.

3.1 Setup

We model a two-stage game, in which MSRs are allocated between two types of servicers, banks and non-banks, who can decide whether to foreclose if loans they service default.

[9] Note that our model will not consider other issues created by a non-integrated financial intermediation structure, such as inefficient refinancing, which is studied in Buchak et al. (2023).

Banks and non-banks differ on two dimensions: capital regulation and funding cost. In stage 1, MSRs are allocated among servicers. In stage 2, given the allocation of MSRs, servicers choose their foreclosure rules.

The two stages are connected. The second stage decisions affect the first stage equilibrium allocation: in anticipation of their cost associated with handling potential loan defaults, servicers set their servicing price to optimize their total expected profits from MSR holdings. Servicers face different constraints in demanding MSRs, and some asset allocations may result in foreclosure behaviors that are better or worse aligned with investors or borrowers. We next describe each stage in detail.

3.1.1 Stage 1: MSR Allocation

There is a fixed pool of MSRs on loans of different types that need to be allocated among servicers indexed by s. There are two types of servicers, banks ($s = b$) and non-banks ($s = n$), that supply mortgage servicing by acquiring MSRs.

Loan types are indexed by l. There are L types of loans, and each type has a different default probability. Knowing the default probability, servicers post their prices for acquiring MSRs on loans of type l, given their expectations of future profit from servicing in stage 2. MSRs on loans within each type are indexed by i. Observing the posted prices, the owner of the loan chooses a servicer for each MSR independently.

Supply. Servicers set prices, $\eta_{s,l}$, to maximize total profit on each loan type, given their expectation about stage 2 revenue:

$$\max_{\{\eta_{s,l}\}} E(\hat{\Pi}_{s,l}) = \left(\underbrace{\Big((1-d_l)E(\pi^c_{s,l}) + d_l E(\pi^d_{s,l})\Big)}_{E(\Pi_{s,l})} - \eta_{s,l} \right) q_{s,l}(\eta_{s,l}|\{\eta_{s',l}\}). \tag{1}$$

$E(\pi^c_{s,l})$ is the expected revenue of servicing each current loan of type l if the loan does not default, while $E(\pi^d_{s,l})$ is the expected revenue if the loan defaults. We will characterize these revenue functions in stage 2. d_l is the probability of default for loan of type l, which is common knowledge. Thus, the first term represents the expected revenue of servicing each

loan of type l, $E(\Pi_{s,l})$ for servicer s. $\eta_{s,l}$ is the price of MSR on loan type l, charged by servicer s. $q_{s,l}(\eta_{s,l})$ is the equilibrium quantity, which is a function of $\eta_{s,l}$.

Demand. Observing the posted prices, the owner of the loans chooses a servicer for the MSR on each loan to maximize its payoff. The payoff derived by the owner of MSR i on loan of type l from choosing servicer s is:

$$u_{i,l,s} = \eta_{s,l} + \epsilon_{i,l,s}. \tag{2}$$

$\eta_{s,1}$ is the acquiring price posted by servicer s on MSRs of loan type l. $\epsilon_{i,l,s}$ is an i.i.d. type 1 extreme value idiosyncratic shock to the owner's payoff from working with servicer s. This term could reflect the value of convenience or perceived brand value that allows the owner of the loan to extract more rent from the borrower.[10]

3.1.2 Stage 2

Given the allocation of MSRs, servicers service loans on behalf of the investors and receive fees. If a loan does not default, the servicer's profit is the net present value (NPV) of servicing fees net of servicing costs, denoted by λ_l, for both bank servicers and non-bank servicers. That is, $E(\pi^c_{s,l}) = \lambda_l$ for both $s = b$ and $s = n$. In this case, the investor's profit is the NPV of future interest payments, denoted by I.

If a loan defaults, the *servicer* decides either to foreclose or to delay foreclosure and bridge the payment gap by making advance payments to the investor on behalf of a delinquent borrower in the hope the loan recovers. In this case, the profits of both the servicer and the investor depend on the servicer's foreclosure policy. If deciding to foreclose, the servicer loses future servicing fees, and the investor receives the recovered value of the asset, A, in foreclosure immediately. The return to the servicer from a foreclosed, defaulted loan is normalized to 0.

If deciding not to foreclose, the servicer must bridge the payment gap by making payment advances. In this case, the loan may recover from default, with probability p. When

[10] The technical reason to include idiosyncratic shocks is that it helps generate more realistic equilibrium allocation, without which the dominant servicer will take all MSRs on a given loan type, which is not consistent with the data.

MSRs were allocated in stage 1, default had not yet realized, and servicers only knew the default probability d_l and the distribution of default recovery likelihood p.[11] Servicers obtain additional information once they start servicing: they know the default recovery likelihood of each defaulted loan in their servicing portfolios, instead of just knowing the distribution.

If the loan recovers from default, the servicer keeps future servicing fees and receives $(\delta_s\lambda_l - (1-\delta_s)C)$. δ_s is the servicer's discount factor. Higher δ_s means that the servicer is more patient, for instance, if its funding cost is cheaper. $(1-\delta_s)C$ is the one period value of unrecoverable payment advances.[12] The servicers' payment advances mean that the investor receives regular interest payments I. If the loan does not recover, the servicer incurs a cost of unrecoverable payment advances C without repayment.

Therefore, when a loan of type l defaults, observing its recovery likelihood p, the servicer chooses foreclosure rule $f_{s,l}$ to maximize profit:

$$\max_{f_{s,l}|p} \; E(\Pi^d_{s,l}|p) = (1-f_{s,l})\Big(p\big(\delta_s\lambda_l - (1-\delta_s)C\big) - (1-p)C\Big). \tag{3}$$

The servicer faces the following trade-off when deciding whether to foreclose: if deciding to foreclose (i.e., $f_{s,l}=1$), the servicer loses future servicing fees; and if deciding not to foreclose (i.e., $f_{s,l}=0$), the servicer must bridge the payment gap by making payment advances at the cost of C, which allows the servicer to keep future servicing fees if the loan ends up recovering from default. The benefit of not foreclosing is $\delta_s\lambda_l$ if the loan recovers from default and is 0 otherwise. λ_l is discounted by δ_s because the servicing fees are delayed. The cost of not foreclosing is $C(1-\delta_s)$ if the loan recovers from default and is C otherwise.

Given the servicer's foreclosure rule, $f_{s,l}$, the investor's payoff from a defaulted loan is:

$$E(\Pi^d_{i,l}|p, f_{s,l}) = f_{s,l}A + (1-f_{s,l})\Big(pI + (1-p)\delta_i A\Big). \tag{4}$$

[11] We use d_l to capture the risk heterogeneity and assume no ex-ante difference in the expected recovery likelihood across loans.

[12] C can be viewed as the present value of the unrecoverable portion of payment advances and other operating costs ("advances" in short) if the loan never cured. Thus, the one period value of advances X can be solved for using $C = \frac{X}{(1-\delta_s)}$ so that $X = (1-\delta_s)C$. This formulation of advances represents the NPV of servicer liquidity, since servicers will need to pay these in the relatively short term. We abstract from servicers being made whole on advance payments after the foreclosure sale because this can take quite a while. Additionally our setting is more general since private-label loans do not have advances reimbursed (Goodman, 2016a) while GSE, FHA, VA, and RD loans have varying policies on reimbursing advances. In other words, the decision of when and how to repay servicers for their advances is made at the discretion of these entities.

As introduced above, A is the recovered value of the asset in foreclosure, I is the NPV of future interest payments, and δ_i is the investor's discount rate. In words, if the loan is foreclosed, the investor receives A immediately; whereas if the loan is not foreclosed, it may recover from distress, with probability p, in which case the investor receives regular payments. However, the loan may not recover, with probability $(1-p)$, in which case the investor receives the discounted recovered asset value. Compared to the servicer's payoff, the investor's payoff does not involve a payment delay or any associated costs because if the loan defaults and foreclosure is delayed, the investor receives advance payments from the servicer until the loan recovers or is foreclosed on.

3.2 Equilibrium

We solve for the servicers' equilibrium foreclosure rule, profit, MSR allocation, and price by backwards induction.

Stage 2: Optimal Foreclosure. Based on Eqn. (3), foreclosure is optimal for the servicer if the expected cost of payment advances exceeds the expected benefit of keeping future servicing fees, i.e.,

$$\underbrace{p\delta_s\lambda_l}_{\text{benefit}} < \underbrace{p(1-\delta_s)C - (1-p)C}_{\text{cost}}. \tag{5}$$

This yields the following foreclosure rule for the servicer:

$$f^*_{s,l}|p = \begin{cases} 1 & \text{if } p < \frac{C}{\delta_s(\lambda_l + C)} \\ 0 & \text{if } p \geq \frac{C}{\delta_s(\lambda_l + C)} \end{cases}. \tag{6}$$

Intuitively, conditional on default, a borrower is more likely to experience foreclosure if, all else equal, the recovery probability p is low; the loan is serviced by a servicer with higher cost of bridging the payment gap (i.e., lower δ); or the servicer receives less compensation from servicing (λ_l) or has to make costly payment advances (C).

Stage 1: MSR Allocation. Given the optimal foreclosure rule in Eqn. 6, the foreclosure rate of loan of type l is $f_{s,l} = \frac{C}{\delta_s(\lambda_l + C)}$. The ex-ante expected profit of servicing loan of type

l for servicer s is as follows:

$$
\begin{aligned}
E(\Pi_{s,l}) &= (1-d_l)\lambda_l + d_l \int_{\frac{C}{\delta_s(\lambda_l+C)}}^{1} \Big(p\big(\delta_s\lambda_l - C(1-\delta_s)\big) - (1-p)C\Big) dp_l \\
&= (1-d_l) \underbrace{\lambda_l}_{E(\pi^c_{s,l})} + d_l \underbrace{\frac{C(f_{s,l}-1)^2}{2f_{s,l}}}_{E(\pi^d_{s,l})}.
\end{aligned} \tag{7}
$$

Since $f_{s,l} \in [0,1]$, the servicer's MSR valuation, $E(\Pi_{s,l})$, monotonically changes with foreclosure rates: servicers with lower foreclosure rates always have a higher valuation of the MSRs.

Given the expected profits, bank and non-bank servicers post prices to acquire MSRs. We assume that before the new MSR capital requirement under Basel III, MSRs were not the marginal asset category that made banks' capital constraints bind. Therefore, both non-banks and banks solve the unconstrained optimization problem in Equation 1 to determine their prices, $\eta_{s,l}$, knowing that the prices will affect the allocation of the MSRs. In particular, the owner of the loan assigns the MSR to servicer s if $u_{i,l,s} > u_{i,l,s'}$, where $u(\cdot)$ is defined in Equation 2. Based on the error distribution, this yields the following standard logit demand:

$$
q_{s,l} = \frac{\exp(\eta_{s,l})}{\sum_{n\in N}\exp(\eta_{n,l}) + \sum_{b\in B}\exp(\eta_{b,l})}. \tag{8}
$$

Given the demand in Eq. 8 and the expected profit in Eq. 7, the optimal pricing strategy for servicer s is defined as follows:

$$
\eta_{s,l} = \underbrace{(1-d_l)\lambda_l + d_l\frac{C(f_{s,l}-1)^2}{2f_{s,l}}}_{E(\Pi_{s,t})} - \frac{1}{1-q_{s,l}}. \tag{9}
$$

PROPOSITION 1. *When banks' acquisition of servicing assets is not constrained by capital requirements, servicers with more lenient foreclosure policies, and thus higher valuation, of loan type l are allocated with more MSRs of that loan type. That is,* $\frac{\partial q_{s,l}}{\partial E(\Pi_{s,l})} > 0$.

3.3 Agency Problem

Once the right to service a loan is stripped from ownership of the loan during the securitization process, a classic agency problem arises between the servicer, who is the agent dealing with borrower distress, and the investor, who is the principal receiving payments. Servicers may have too strict, or too lenient, foreclosure policies compared to what investors would prefer, making investors' payoffs deviate from their optimum. Importantly, the previously discussed servicers' private optimal allocation of MSRs may not account for such agency conflicts.

To clearly illustrate this, we establish the investor's optimal foreclosure policy, $f_{i,l}$, and compare the investor's payoffs under its own optimal foreclosure policy and under the servicer's foreclosure rule. As section 3.1.2 describes, the investor's payoff from a defaulted loan under $f_{i,l}$ is as follows:

$$E(\Pi^d_{i,l}|p) = f_{i,l}A + (1 - f_{i,l})\Big(pI + (1-p)\delta_i A\Big), \tag{10}$$

which yields the following investor's optimal foreclosure rule:

$$f^*_{i,l}|p = \begin{cases} 1 & \text{if } p < \frac{A(1-\delta_i)}{I-\delta_i A} \\ 0 & \text{if } p \geq \frac{A(1-\delta_i)}{I-\delta_i A} \end{cases}. \tag{11}$$

Hence, the foreclosure rate, of loan type l, that maximizes investors' expected profit is $\frac{A(1-\delta_i)}{I-\delta_i A}$, while the foreclosure rate under servicers' optimization is $\frac{C}{\delta_s(\lambda_l+C)}$ according to Equation 6. The difference between the two foreclosure rates reflects the misaligned incentives between servicers and investors:

$$\Delta f_{s,l} = \frac{C}{\delta_s(\lambda_l + C)} - \frac{A(1-\delta_i)}{I - \delta_i A}. \tag{12}$$

Intuitively, the misaligned incentives arise because servicers do not consider the interest payments to investors or the asset value in foreclosure when choosing whether to bear the cost of helping distressed borrowers recover from delinquencies. Importantly, servicers' foreclosure policies could be too strict, or too lenient, compared to investors' optimal policies — i.e., $\Delta f_{s,l}$ could be positive or negative — depending on how the benefit of delaying foreclosure, perceived by the servicer, deviates from the benefit perceived by the investor.

Holding fixed investor patience (δ_i) for a given loan, differences in $\Delta f_{s,l}$, reflect differences in underlying servicer patience (δ_s). Thus, differences in $\Delta f_{s,l}$ between servicers indicate relative servicer patience or impatience, relative to the investor. Servicer patience may be impacted by things like deposit taking, deposit insurance, and whether a servicer's business model indirectly considers borrower welfare due to the potential for repeat business with the borrower or public relations concerns.

3.4 Welfare Implications of Allocation

The misaligned incentives in handling defaulted loans always lead to a reduction in the investor's expected profit, regardless of how the servicer's foreclosure policies deviate from the investor's optimal. Specifically, the investor's expected payoff under a given foreclosure rule, f is as follows:

$$E(\Pi_{i,l}|f) = (1-d_l)I + d_l\left[\int_0^f A\ dp_l + \int_f^1 \Big(pI + (1-p)\delta_i A\Big)dp_l\right], \tag{13}$$

which yields the following difference between the investor's expected profit under both the servicer's foreclosure rule and the investor's optimal foreclosure rule:

$$E(\Pi_{i,l}|f_{s,l}) - E(\Pi_{i,l}|f_{i,l}) = -\frac{I-\delta_i A}{2}(f_{i,l}-f_{s,l})^2 < 0. \tag{14}$$

As shown in Appendix B.1, the above equation is always negative.[13]

While Proposition 1 states that more lenient servicers are assigned more MSRs, this may not be optimal for the investors. This is because the private market allocation in the non-integrated intermediation system does not minimize agency conflicts; it only considers servicers' preferences and is not a social planners' allocation, which also accounts for investor preferences. As illustrated by Equation 12, the deviation between the investor's and servicer's foreclosure rates, the investor and servicer will have no misalignment if the foreclosure rate of the servicer is equal to the foreclosure rate of the investor.

Equation 14 reveals two things about the deviation between the investor's profits under

[13]Note that it has to be true that $\delta_i A < I$ to satisfy investor's incentive compatibility for lending.

the servicer's foreclosure rule relative to the investor's profits under their own optimal foreclosure rule. First, an investor's profit deviation is always negative, holding fixed the interest rate and recovery value of the asset, implying that an investor's profit loss is minimized when the servicer's foreclosure rate equals their own optimum. Second, the perfect square term indicates that the loss that the investor incurs grows symmetrically as the servicer's foreclosure rate deviates either above or below the investor's optimum. As a result, we can use the absolute value of the deviation between the investor and servicer's optimum as a sufficient statistic for welfare loss, conditional on loan characteristics A and I, and the investor's δ_i.

Since the degree to which a servicer's optimal foreclosure rule deviates from the investor's impacts the welfare loss, the private market allocation of MSRs could create a misalignment by allocating MSRs to more misaligned servicers. In other words, which servicer receives the allocation of MSRs impacts the investor's welfare.

Borrower welfare is also impacted by MSR allocation because foreclosures impose significant unrecoverable costs on borrowers. No direct benefits accrue to borrowers, meaning that borrowers are always better off with a lower foreclosure rate. The allocation that minimizes the deviation between borrower optimum foreclosure rates and observed foreclosure rates would be the allocation to servicers with the lowest propensity to foreclose. In other words, borrower welfare increases monotonically as foreclosure rate decreases.

3.5 Regulation and MSR Transfers

Basel III increases the capital required for holding MSRs for banks. If banks face a binding capital constraint under Basel III, i.e., $\sum_l q_{b,l} > \xi \bar{m}$, banks need to re-optimize their portfolio by transferring at least $(\sum_l q_{b,l} - \xi \bar{m})$ to non-banks.[14] MSR transfers incur a cost, κ. We focus on the case in which the cost of transfer is sufficiently high such that there is no gain from trade after accounting for κ during normal times, and thus servicers do not engage in MSR transfers unless they are hit by shocks. In this case, bank b solves the following constrained optimization problem by deciding the amount of MSRs of each loan type l to keep in its portfolio, $\{q'_{b,l}\}$:

[14]The capital requirement is modeled as constraint ξ. The constraint can be rewritten as $\frac{\sum_l q_{b,l}}{\xi} \leq \bar{m}$, which is consistent with bank assets divided by equity. A lower value of ξ indicates a more stringent limit on MSR holdings for banks.

$$\begin{aligned}
&\max_{\{q'_{b,l}\}} \sum_l q'_{b,l} E(\Pi_{b,l}) + (q_{b,l} - q'_{b,l})\eta_{n,l}^{transfer} \\
&s.t. \;\; \eta_{n,l}^{transfer} = \alpha\Big(E(\Pi_{n,l}) - E(\Pi_{b,l}) - \kappa\Big), \;\; \alpha \in [0,1] \\
&\qquad \sum_l q'_{b,l} \leq \xi\bar{m}, \;\; q'_{b,l} \leq q_{b,l} \forall l
\end{aligned} \tag{15}$$

$\eta_{n,l}^{transfer}$ is the gain bank b receives from transferring MSRs on loan of type l to non-banks. The gain is α share of the net surplus of MSR transfer.

From Equation 15, we derive the following proposition regarding banks' optimal transfer strategies:

PROPOSITION 2. *When an unexpected increase in the regulatory cost of holding MSRs makes a bank's capital constraint bind, the bank prioritizes transferring MSRs of the type (l) that yields the highest returns, i.e., for all* $l' \in L$

$$\alpha\Big(E(\Pi_{n,l}) - E(\Pi_{b,l})\Big) - E(\Pi_{b,l}) \geq \alpha\Big(E(\Pi_{n,l'}) - E(\Pi_{b,l'})\Big) - E(\Pi_{b,l'}).$$

Proposition 2 suggests there is a pecking order of MSR transfers based on loan default risk, such that whether to prioritize transferring riskier or less risky loans depends on whether the bank can price in a part of non-banks' valuation (i.e., the value of α). If α is low, banks put more weight on their own valuation and prioritize transferring MSRs with the lowest own valuation, which is the riskiest type.

As α increases, the bank puts more weight on non-banks' valuation in deciding which MSRs to transfer. If α is sufficiently high, banks prioritize transferring MSRs with the lowest own valuation *relative* to non-banks' valuation. In this case, there are two scenarios. If banks have more lenient foreclosure policies than non-banks, e.g., due to lower funding costs according to Eqn. 6, then banks' MSR valuation is higher than non-banks' valuation, and banks' valuation relative to non-banks' is lower among less risky loans (Eqn. 7). In this scenario, the bank prioritizes transferring less risky MSRs. In contrast, if non-banks have more lenient foreclosure policies than banks, banks' valuation relative to non-banks is lower among riskier loans. In this scenario, the bank prioritizes transferring riskier MSRs.

Given that the previous section establishes that there is welfare loss when servicers' op-

timal foreclosure rule differs from investors', transfer of mortgage servicing rights in the private market could exacerbate this misalignment. This is because not only does the investor in the disintegrated intermediation system not participate in the initial allocation, but neither do they participate in the transfers of MSRs. Transfers move the MSRs among misaligned servicers, in response to the servicers' individual constraints, without regard to the principals', or investors', preferences – none of the principals are involved.

4 Causal Effect of Regulation on MSR Allocation

4.1 MSR Regulation and Incentive to Transfer

Our stylized facts show that pre-Basel III, banks were the primary holders of MSRs and the incidence of transfer was low, and our model shows that banks transfer MSRs in response to the capital regulation change. Thus we study empirically whether Basel III changed the allocation of MSRs by increasing MSR transfers, and if so, whether banks or non-banks transferred more MSRs. We utilize panel data on each individual loan and include loan fixed effects in our regression specification. The inclusion of loan fixed effects allows us to examine how the likelihood of a given loan being transferred evolves over time and how it depends on servicer type. Thus our specification captures the servicer transfer likelihood rather than a change in bank originations, relative to non-bank originations, that may be driving our results. We estimate the following specification:

$$Transfer_{i,j,t} = \beta_1 Middle_t \times Bank_{i,j,t-1} + \beta_2 Post_t \times Bank_{i,j,t-1} + \mu_i + \theta_t + \epsilon_{i,j,t}. \quad (16)$$

$Transfer_{i,j,t}$ is an indicator for whether the servicing right on loan i is sold by institution j in quarter t. $Bank_{i,j,t-1}$ is an indicator for whether the servicer of loan i in the previous quarter is a bank. $Middle_t$ is an indicator for whether quarter t is between 2012Q2 and 2013Q2. $Post_t$ is an indicator for whether quarter t is in or after 2013Q2. μ_i and θ_t are loan fixed effects and quarter fixed effects, respectively. Including loan fixed effects absorbs variations in loan characteristics, enabling us to examine whether a loan is more likely to be transferred after the policy change. Additionally, including quarter fixed effects allows us to exploit variation within the same quarter across different servicer types. We cluster

standard errors at the zip code level to account for neighborhood spatial correlation.

Table 2 presents the results. Column 4 corresponds to Equation 16, which has loan and quarter fixed effects. Following the proposal to adopt Basel III in 2012Q2, MSR sales by banks increased by 1.0% more than those by non-banks. Following the final adoption of Basel III in 2013Q2, banks were 3.1% more likely to sell MSRs than non-banks, relative to the periods before 2012Q2. We obtain similar effects using less saturated specifications with servicer, zip code, and quarter fixed effects in columns 1-3.

We show the dynamic evolution of bank versus non-bank differences in MSR transfers relative to 2012Q2 in Figure 6a. The figure plots the estimated coefficients in a dynamic version of Specification 16. The final adoption of Basel III in 2013Q2 increases banks' likelihood of selling MSRs by 4% relative to that of non-banks. Banks' higher likelihood of MSR transfers persisted for several quarters and remains more than 2% higher than non-banks' by the end of 2015. More importantly, prior to the initial proposal of the Basel III MSR rule, bank MSR transfers were not statistically more likely than non-bank MSR transfers. The lack of pre-trend alleviates the concern that unobservable loan characteristics drive different bank versus non-bank transfer likelihoods.

4.2 Robustness: Is It About MSR Regulation?

As Section 1.2 discussed, Basel III MSR regulation changes the treatment of MSRs in the calculation of banks' tier 1 capital ratio. This moves many banks closer to violating their capital requirement, thus banks with higher pre-shock MSR-to-CET1 ratio are more exposed to the policy change. We test whether facing a higher cost from the constraint tightening makes banks more likely to sell MSRs.

We estimate a treatment intensity research design that compares MSR sales for high MSR-to-CET1 banks relative to those for low MSR-to-CET1 banks:[15]

$$Transfer_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k \left(\mathbb{1}_k \times \left(\frac{MSR}{CET1} \right)_{i,j,2011} \right) + \mu_i + \theta_t + \epsilon_{i,j,t}, \tag{17}$$

[15] To estimate this, we use a sample that removes outlier banks with very high MSR-to-Asset ratio (top 1% of distribution). Outlier banks appear to specialize heavily in servicing and servicing is not the marginal asset category that those banks will adjust in response to a change in regulation.

where i denotes loan, j denotes the servicer of loan i, and t indicates the current quarter. The servicer of a loan is defined in the quarter before transfer. $Transfer_{i,j,t}$ is an indicator for whether loan i experiences a transfer in quarter t. $(\frac{MSR}{CET1})_{i,j,2011}$ is the MSR to common equity tier 1 ratio of servicer j in 2011. μ_i and θ_t are loan fixed effects and quarter fixed effects, respectively. Banks with higher MSR-to-CET1 ratios prior to the regulation experience more intense treatment. Thus, β_k is the coefficient of interest, which captures the effect of the treatment intensity on MSR transfers.

Figure 6b plots the estimated β_k in Equation 17. The results indicate that banks with higher MSR-to-CET1 ratios increase their transfers of mortgage servicing rights by more than banks with lower MSR-to-CET1 ratios. There is a slight dip down in the second half of 2014 which is consistent with more exposed banks selling their MSRs first, followed by less exposed banks selling MSRs later to catch up. Column 5 of Table 2 estimates the magnitude of the average dynamic effect. A 10% higher MSR-to-CET1 ratio prior to the regulation leads to a .8% higher likelihood of selling MSRs between 2012Q2-2013Q2 and to a .4% higher likelihood of selling MSRs on average following 2013Q2.

4.3 Migration of Servicing to Outside the Banking Sector

While our model shows that banks sell MSRs to non-banks following the regulation change, banks selling MSRs could potentially lead either to a reshuffling of mortgage servicing within the banking sector or to a rise of non-bank servicing.[16] We thus examine whether the MSRs sold by banks were transferred to non-banks by estimating the following specification, using the same panel data for individual loans as used for estimating Specification 16:

$$NonBank_{i,j,t} = \beta_1 Middle_t + \beta_2 Post_t + \mu_i + \epsilon_{i,j,t}. \tag{18}$$

$NonBank_{i,j,t}$ is an indicator for whether a non-bank is the current servicer in quarter t of loan i. $Middle_t$ and $Post_t$ are defined the same as in Specification 16. μ_i is the loan fixed effect. By including loan fixed effects we exploit within-loan variation, in other words, we study whether the same loan is more likely to change to a non-bank servicer following the

[16] For example, a report to Congress finds that more banks entered the servicing market after the MSR regulation: Report to the Congress on the Effect of Capital Rules on Mortgage Servicing Assets.

policy change. Thus, the two coefficients of interest, β_1 and β_2, identify whether non-banks were more likely to be the buyers of the transferred servicing rights after the policy change. In addition to this fully saturated specification, we run less saturated specifications with initial servicer fixed effects (ν_j) and zip code fixed effects (z_i) in place of loan fixed effects.

Table 3 presents the results. Column 3 corresponds to Specification 18, while columns 1-2 estimate less saturated specifications. Columns 1 and 2 show that the share of total outstanding loans serviced by non-banks increased by about 10.1% after the final adoption of Basel III (the sum of Middle and Post coefficients). Column 3 confirms that the increased likelihood of non-bank servicing was not merely driven by non-banks originating more loans following the policy change or by changes in the composition of loans or servicers over time.[17] The inclusion of loan fixed effects in column 3 absorbs the effect of MSR regulation on loan origination by exploiting within loan variation. Quantitatively, after the rule was finally adopted in 2013Q2, the likelihood of servicing rights being transferred to non-banks increased to 11.9% on average.

Figure 7 shows the evolution of MSR transfers to non-banks over time. It plots the estimated coefficients in a dynamic version of Equation 18. Prior to the initial proposal of Basel III, there was no pre-trend in non-bank servicing, alleviating the concern that the static DiD results are driven by a time series trend in banking activity migrating to the non-banking sector after the financial crisis. Non-banks' likelihood of receiving of the transferred MSRs began increasing in 2012Q2, grew rapidly in 2013Q2, when the regulation was finally adopted, and remained elevated thereafter.

4.4 Other Possible Margins: Initial Assignment and Origination

Finally, we discuss the potential relevance of two non-transfer margins, which may contribute to the rise of non-banks following the increased MSR capital regulation. First, there could be a change in initial *assignments*. Initial assignment is when originators assign the servicing rights of newly originated loans to a third party. Unlike MSR transfers, which occur in the secondary market during the life of the loan, initial assignments can be viewed as an activity at the mortgage origination stage. As banks' regulatory cost of holding MSRs

[17] As Buchak et al. (2018b) argues, the higher regulatory risk weight on MSR assets lowered banks' incentives to originate mortgages, which led to an increase in non-bank loan origination.

increases, banks may assign the MSRs of their originated mortgages to non-banks. Second, banks may choose to originate fewer mortgages if the combined value that they derive from both mortgage origination and servicing rights declines enough to impact their decision to originate mortgages.[18] We discuss both margins below.

Initial Assignment We estimate a loan-level DiD specification and present the dynamic evolution of bank versus non-bank differences in initial assignments of MSRs relative to 2012Q2 in Figure 8. The final adoption of Basel III in 2013Q2 increases banks' likelihood of assigning MSRs to a third party by 0.5% relative to that of non-banks. Banks' higher likelihood of MSR assignments persisted until the end of 2015. Importantly, prior to the initial proposal of the Basel III adoption, bank MSR assignments were not statistically more likely than those for non-banks. The lack of pre-trend alleviates the concern that unobservable loan characteristics might drive different bank versus non-bank assignment likelihoods.

Origination We estimate a bank-level DiD specification and present the dynamic evolution of bank origination relative to non-bank origination in Figure E5. Consistent with the finding in the literature, bank origination drops relative to that of non-banks following the policy change. Relative to non-banks, banks are on average 5% less likely to originate mortgages post Basel III.

Thus, banks are both originating fewer mortgages after Basel III and simultaneously increasing the probability of assigning the mortgages that they originate to a third party. Thus we provide evidence that both the initial assignment margin and the origination margin contribute to the rise of non-banks in mortgage servicing following Basel III.

5 Which Segment Became More Exposed to Non-Banks?

Our model predicts that an unexpected regulatory shock will result in a pecking order of MSR transfers by riskiness of loan type. This pecking order regime could result in a certain market segment becoming more exposed to non-banks. Which segment becomes more exposed to

[18] This origination margin has been examined in Buchak et al. (2018b).

non-banks depends on whether banks prioritize transferring risky or less risky MSRs, a choice which is theoretically ambiguous.

We test this empirically in the data by examining heterogeneity in MSR transfers. If results show that high risk MSRs are more likely to be transferred, there are two implications. First, banks are insensitive to non-bank valuation, which could occur if transfers occur under fire sale conditions. Second, borrowers of risky loans are more likely to experience the welfare effects of transfer to non-bank servicers. Transfers that cause welfare losses may hurt risky borrowers more than they would safe borrowers.

5.1 Selective Transfer of Risky MSRs

If banks cannot price in much of non-banks' MSR valuation, banks prioritize transferring riskier MSRs, which banks value least. Intuitively, by transferring the loans that they value the least, banks minimize the losses that they receive on each transfer when they are not able to command a good price. However, as banks capture a larger portion of non-banks' MSR valuation, banks prioritize transferring MSRs with the lowest own valuation *relative* to non-banks' valuation. In this case, banks may prioritize transferring less risky MSRs to minimize value lost in transfer.

To empirically examine which types of MSRs banks prioritize transferring, we estimate the dynamic version of Eqn. 16 separately on subgroups by credit score and realized delinquency status:[19]

$$Transfer_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k \left(\mathbb{1}_k \times Bank_{i,j,t-1} \right) + \sum_{k \neq 2012Q1} \mathbb{1}_k + \gamma Bank_{i,j,t-1} + \mu_i + \epsilon_{i,j,t}, \quad (19)$$

where $Transfer_{i,j,t}$ is an indicator for whether the servicing right on loan i was sold by institution j in quarter t. $Bank_{i,j,t-1}$ is an indicator for whether the servicer of loan i in the quarter before transfer is a bank. $\mathbb{1}_k$ is an indicator for the quarter. μ_i are loan fixed effects.

Figure 9 plots the estimated coefficients, β_k, on the interaction term that denotes whether

[19] The method is similar to that used in Curtis, Garrett, Ohrn, Roberts, and Serrato (2021).

a bank serviced the loan in each quarter pre and post transfer. The differences between subgroups in each category shown in the figure are equivalent to the triple difference coefficient. Columns 1 and 2 of Table 4 report the average triple differences between each subgroup for a given category in the Middle (between 2012Q2-2013Q2) and Post (on or after 2013Q2) period, each relative to the pre-period. We explain these results in detail below.

Panel (a) of Figure 9 shows banks' likelihood of transferring MSRs relative to non-banks' for prime and subprime borrowers, defined based on borrower's credit score at loan origination. We define subprime borrowers as those with a below 620 credit score and prime borrowers as those with a 620 or above credit score. Banks transferred statistically significantly more MSRs for subprime borrowers, and the difference persists. Quantitatively, the final adoption of Basel III in 2013Q2 increases banks' likelihood of selling MSRs on subprime loans by 2% more than prime loans during 2013-2015 (Table 4 column 1).

Panel (b) of Figure 9 shows banks' likelihood of MSR transfers relative to non-banks' for loans by delinquency status in the current quarter. The figure shows the effects for loans that were current, 60-90-120 days, and 120+ days delinquent at the time of transfer. Banks transferred more MSRs for loans that were already 60-90-120 and 120+ days delinquent at the time of the transfer relative to loans that were current. Since loans that are 120+ days delinquent may be foreclosed on, these results are consistent with non-banks exhibiting cost efficiencies in foreclosure, relative to banks. The results are consistent with transferred loans being the "highest touch" in terms of need for communicating with borrowers and offering debt relief. Quantitatively, banks' likelihood of selling MSRs of 60-90-120 days delinquent loans increased by 2.5% more than that of non-delinquent loans after the rule change (Table 4 column 2).

5.2 Non-Bank MSR Holding by Loan Type

Finally, we examine whether non-banks are buying the MSRs, that banks are selectively selling, by analyzing non-banks' cumulative likelihood of holding the riskier MSRs. Specifically, we examine non-bank dynamic MSR holdings by credit score and realized delinquency status:

$$NonBank_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k \ \mathbb{1}_k + \mu_i + \epsilon_{i,j,t}, \tag{20}$$

where $NonBank_{i,j,t}$ is an indicator variable for whether a non-bank is the current servicer j (in quarter t) of loan i. μ_i are loan fixed effects.

Figure 10 plots the estimated coefficients for each regression specification in each subgroup. Table 4 reports the average differences between each subgroup for a given category in the Middle (between 2012Q2-2013Q2) and Post (on or after 2013Q2) period, each relative to the pre-period. These differences are equivalent to the difference-in-differences coefficient. We explain these results in detail below.

Panel (a) of Figure 10 depicts the results by borrower credit score. It shows that following the policy change, non-banks increase their cumulative likelihood of servicing loans for subprime borrowers relative to prime borrowers. The final adoption of Basel III in 2013Q2 increases non-banks' holdings of subprime MSRs by 2% more than their MSRs holdings of prime loans during 2013-2015 (Table 4 column 3).

Panel (b) of Figure 10 depicts the results by realized delinquency status. It shows that non-banks see a larger increase in their cumulative likelihood of servicing 60-90-120 day delinquent loans relative to current loans. The final adoption of Basel III in 2013Q2 increases non-banks' holdings of delinquent MSRs by 2.3% more than their holdings of non-delinquent MSRs during 2013-2015 (Table 4 column 4).

The relative increase in non-banks' likelihood of servicing subprime loans and defaulted loans co-moves with banks selling the MSRs associated with these characteristics to non-banks. Combining the results of the DiD in Figure 9 with the results of the event study in Figure 10 provides compelling evidence that non-banks were purchasing the riskier MSRs that banks sold following Basel III.

6 Real Consequences and Welfare Implications

We have shown that Basel III's MSR regulation led to a migration of servicing activity from banks to non-banks. Consistent with Proposition 2 of the model, our results suggest a pecking order in the transfer of servicing rights following the shock, leading the riskier loan segment to become more exposed to non-banks. As our model illustrates, such reallocation of MSRs may impact investor welfare, depending on how the reallocation impacts foreclosure

rates relative to the investor's optimal level. While borrowers are not in a direct agency relationship with either servicer or investor, borrowers bear the cost of foreclosure and thus are affected by agency frictions through changes in the foreclosure rate. This section studies the welfare implications for both borrowers and investors by analyzing foreclosure rates.

6.1 Borrower Welfare

We begin by examining the borrower welfare implications of regulation-induced MSR reallocation. Since foreclosure is costly and there is no corresponding benefit that directly accrues to borrowers, borrowers in default prefer a lower foreclosure rate. Therefore, if the reallocation of MSRs increased foreclosure rates, it would unambiguously lower borrower welfare, and vice versa. To this end, we examine whether Basel III increased or decreased the foreclosure rate.

We start with visualizing the evolution of foreclosure rates of loans serviced by banks versus non-banks in Figure 11. In this figure, the servicer of a transferred loan is defined as the servicer in the quarter before transfer. Panel (a) plots the foreclosure rates for the entire portfolio of loans a servicer holds. As this panel shows, the foreclosure rate of loans previously serviced by banks started rising in 2012Q2 and continued climbing until it peaked in 2015Q1. This timing coincides with the increased transfers in 2012Q2-2013Q2.[20] In contrast, the foreclosure rate of loans previously serviced by non-banks stayed low and experienced close to no fluctuation during the treatment period or after.

Panels (b) and (c) of Figure 11 plot the foreclosure rates of loans whose servicing rights were transferred (*transferred loans*) and never transferred (*non-transferred loans*), respectively. Comparing the two panels suggests that transferred loans drove the disproportionate rise in foreclosures of previously-bank-serviced loans. Specifically, panel (b) shows that, after Basel III, the foreclosure rate soared for transferred loans that were serviced by banks in the quarter before transfer, while the foreclosure rate of transferred loans that were serviced by non-banks in the quarter before transfer remained flat over time. In contrast, panel (c)

[20] Note we plot foreclosure sales. Foreclosure sales are likely more representative of servicer incentives than the foreclosure filings. The sale of the home in foreclosure is the point at which the servicer can be made whole for payments that it advanced while the borrower was in delinquency. Furthermore, the speed to foreclosure sale is likely to reflect servicer efficiency in the foreclosure process. Therefore an increase in the number of foreclosure sales observed is consistent with more mortgage servicing rights moving to servicers who are more efficient at completing foreclosure sales.

shows that foreclosure rates remained relatively stable both pre and post policy change for non-transferred loans serviced by both types of servicers.

To examine the causal effect of the regulatory change on foreclosure rates, we conduct an intent-to-treat (ITT) estimation, which tracks the performance of the cohort of loans originated pre-2011. The ITT design compares the performance of loans serviced by banks versus by non-banks in 2011Q1, regardless of whether or not a loan was transferred later. According to our analysis in Section 4, bank-serviced loans are more likely to experience servicing right transfers following the regulatory shock. Therefore, bank-serviced loans form the treated sample of the ITT estimation, while non-bank-serviced loans form the control sample. Essentially, the design uses the status of being serviced by a bank in 2011Q1 as an instrument for servicing right transfer following the regulatory shock. Thus the design estimates the change in foreclosure rates for all loans serviced by banks relative to the foreclosure rate for all loans serviced by non-banks following the shock, relative to the analogous difference pre-shock. We estimate the following specification:

$$Y_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k (\mathbb{1}_k \times Bank_{i,j,2011}) + \mu_i + \theta_t + \gamma Loan\ Age_{i,t} + \epsilon_{i,j,t}. \tag{21}$$

$Y_{i,j,t}$ is an indicator for whether loan i, serviced by servicer j in 2011, experiences a foreclosure in quarter t. $\mathbb{1}_k$ is an indicator for the quarter. $Bank_{i,j,2011}$ is an indicator variable for whether loan i was serviced by a bank in 2011. μ_i and θ_t are loan fixed effects and time fixed effects, respectively. $Loan\ Age_{i,t}$ is the number of years since origination.

We estimate the specification using both foreclosure conditional on entering default one year before or less, and unconditional foreclosure. Foreclosure rate conditional on default is the version of foreclosure rate that emerges from our model, since it describes the servicer's discretionary policy. Conditioning on default removes information about the borrower's choice from the regression to help isolate the impact of re-allocating to non-banks. The unconditional foreclosure rate measures the net effect of borrower and servicer behavior. Similar patterns across these metrics would suggest that differences in propensity to foreclose across bank and non-bank servicers are driving our results.

Figure 12 plots the estimated β_k. Prior to the MSR regulation, there was no statistically significant difference in the foreclosure likelihoods for the portfolio of loans serviced

by banks in 2011 relative to the portfolio serviced by non-banks in 2011.[21] Following the policy change, the foreclosure rate of the 2011 bank-serviced portfolio of loans increased significantly relative to the 2011 non-bank-serviced portfolio of loans. Quantitatively, the conditional foreclosure likelihood increased by 0.04% during the two years following the policy change (Table 5 column 1), corresponding to 25% of its sample average. The unconditional foreclosure likelihood increased by 0.01% on average during the two years following the policy change (Table 5 column 3), corresponding to 40% of its sample average. Given that the hazard rate of foreclosure varies with loan age, we estimate a more saturated model including loan age fixed effects in columns (2) and (4) of Table 5 and obtain similar results.[22]

Finally, we estimate Equation 21 separately for prime and subprime borrowers. Figure 13 plots the estimated β_k. Panel (a) plots the estimated effect of being serviced by a bank in 2011 on foreclosure conditional on default. Panel (b) plots the estimated effect on unconditional foreclosure. In both panels, the increase in foreclosure after the regulatory shock is driven mainly by subprime loans. The difference in performance between bank-serviced and non-bank-serviced loans for prime borrowers is not statistically different from zero throughout the period. The results are consistent with banks transferring more subprime loans in response to Basel III, and those loans experiencing differentially more foreclosures.

In sum, while borrowers are not in a direct agency relationship with either servicer or investor, the magnitude of agency frictions between servicers and investors affects borrower welfare. Given that foreclosure is costly and there is no corresponding benefit that directly accrues to borrowers, borrowers in default prefer a foreclosure rate of 0. Therefore, the documented increased foreclosure rate unambiguously lowers borrower welfare. Moreover, the total loss is higher in magnitude than it may have been because it was concentrated among subprime borrowers, who face the highest foreclosure costs (Piskorski and Seru, 2021b).

[21] There is a small but noisy difference in 2011Q1 that makes it seem, if anything, that there may have been a small downward trend in the first half of 2011

[22] Note that these results capture the net effects of the Basel III MSR rule change on foreclosure, including the effects of banks selecting risky loans to transfer, non-banks foreclosing more rapidly, and the potentially detrimental effect of transfer itself.

6.2 Investor Welfare

Whether the MSR transfers caused by Basel III MSR regulation increase or decrease investor welfare depends on whether non-bank servicers are more conflicted agents than bank servicers. As our model shows, the size of an investor's welfare loss scales with the absolute size of the deviation in foreclosure rate from their optimum. In other words, the servicer with the lowest absolute deviation in foreclosure rate from the investor's optimum is the least conflicted agent, minimizing agency costs. Therefore, if we obtain a proxy for the investor's optimal foreclosure rate and compare it to the observed foreclosure rates of different servicer types, we can determine the least conflicted agent, which will allow us to shed light on the welfare implications of MSR transfers for investors.

We use the foreclosure rate of portfolio loans — i.e., loans held on banks' balance sheets — as a proxy for investor's optimal foreclosure rate.[23] Conceptually, portfolio loans have the lowest agency conflicts since they are typically originated, financed, and serviced in-house by the same entity, meaning that their servicer and investor are the same. We compare foreclosure rates of these "unconflicted" portfolio loans originated in 2011 to foreclosure rates of the "conflicted" loans serviced by third party banks and third party non-banks originated during the same period. To avoid biasing our results with the high levels of transfer that characterized the post-Basel market, we focus on these loans' performance before the regulatory shock.

We utilize a subset of loans originated in 2011 that report both servicers and originators and classify them into three groups. Group 1 consists of the "unconflicted" portfolio loans. We identify loans as portfolio loans if their originators and servicers are the same entities and they are neither FHA loans nor securitized by GSEs.[24] Groups 2 and 3 consist of securitized loans, or "conflicted" non-portfolio loans, that were serviced by third-party banks and third-party non-banks, respectively. We then estimate the following specification:

$$Y_i = Group2_i + Group3_i + \mathbf{X_i} + \gamma_z + \epsilon_i. \tag{22}$$

[23] Fuster et al. (2023) find that banks are the largest holders of agency and GSE-backed securities, holding 32%.

[24] In 2010, private label securitization was nearly zero (Goodman, 2016b). Therefore, if a loan originated in 2010 was not securitized by GSEs or Ginnie Mae and was originated and serviced by the same entity, the loan was very likely to be held on a bank's balance sheet.

Y_i is an indicator for whether loan i, originated in 2011, was foreclosed prior to the regulatory shock. $Group2$ and $Group3$ are the indicators of interest and $Group1$ is the excluded category. We include a variety of controls $\mathbf{X_i}$, consisting of credit score categories, loan amount, loan term, property value, and income, as well as zip code fixed effects (γ_z).

The results of this analysis are shown in Table 6. In particular, the rate of foreclosure conditional on default, shown in columns (1) and (2), closely approximates the parameters in the model. The foreclosure rates for Group 1 are significantly higher than those for both Group 2 and Group 3. This suggests that the investor's optimal foreclosure rate is significantly higher than both the bank and non-bank third-party-servicers' optimums. However, the differential foreclosure rate is almost twice as large for Group 2 than for Group 3 (column 2). This informs us that the non-bank third-party-serviced foreclosure rate is meaningfully higher than the bank third-party-serviced foreclosure rate. Since our empirical results document a shift toward non-bank servicing, Group 3 approximates the benchmark foreclosure rate that Basel III shifts the servicing market towards. The results suggest that Basel III moved the economy toward a foreclosure rate that was nearly twice as high as the bank serviced foreclosure rate. Though this change was more closely aligned with the investor optimum, it came at the expense of borrower welfare.

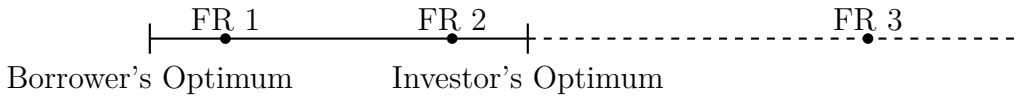
As we document in Section 3.3, the absolute value of the difference between servicer and investor optimal foreclosure rate is a sufficient statistic for investor welfare loss. If all servicing was done by banks, the absolute difference between bank optimal and investor optimal foreclosure rates would be 8.6 percentage points. On the other hand, if all servicing was done by non-banks, the absolute difference would be 4.76 percentage points. As we document in Equation 14, the investors' welfare loss is scaled by the square of the difference between the servicer and investor foreclosure rates. Since reallocating all loans to non-bank servicers shrinks the wedge from 8.6 to 4.76 percentage points, the investor's welfare would increase by a factor of 3.3.[25] Although the shift we document due to Basel III does not encompass all loans, non-bank servicer market share nearly triples throughout our time period from 10 percent to 30 percent of mortgage servicing. Assuming a linear relationship between investor welfare and servicer share, this implies that the shift to non-banks increased investor welfare by about 66%, a substantial decrease in agency costs.

[25] Calculated from Equation 14 as $\frac{\left(E(\Pi_{i,l}|b)-E(\Pi_{i,l}|i)\right)}{\left(E(\Pi_{i,l}|n)-E(\Pi_{i,l}|i)\right)} = \left(\frac{8.6}{4.76}\right)^2 = 3.3$.

7 Policy Discussion and Conclusion

Two key policy issues arise in light of the welfare impacts of Basel III. First, our analysis sheds light on how a policymaker who values both investor and borrower welfare should intervene in the private market's allocation of servicing rights. Second, we demonstrate the tension inherent in financial stability regulation: rules that increase the safety of the banking sector may also have welfare implications for borrowers and investors, since regulators currently do not consider misaligned incentives between servicers and investors and externalized effects on borrowers. We discuss both issues below.

First, our results illustrate that the allocation of MSR assets impacts both borrower and investor welfare.[26] It follows that there is a socially optimal allocation of MSR assets, depending on the weight placed on each stakeholder's utility. Social welfare, the sum of utilities of borrower and investor, is maximized when the servicer's optimum is aligned with the weighted average of the investor and borrower's optimum. Given that foreclosure rates are sufficient statistics for assessing both borrower and investor welfare, it follows that there is a social-welfare-maximizing foreclosure rate. We can see this graphically depicted below as the range of foreclosure rates with the borrower's optimum and the investor's optimum marked.



Foreclosure Rates (FR) 1 and 2 are between the borrower and investor optima. FR 1 is optimal if the social welfare function weights borrowers more heavily than investors. FR 2 is optimal if the social welfare function weights investors more heavily than borrowers. The regulator's choice of social weights may depend on externalities created by low versus high foreclosure rates. On the borrower side, externalities include financial contagion and both pecuniary and non-pecuniary losses that borrowers' communities face when foreclosure rates are high. On the investor side, externalities include high lending costs created by low foreclosure rates, which can decrease credit access for future borrowers and lower overall

[26] We abstract away from any weight being placed on servicers' welfare.

credit supply in the market.[27] Without additional evidence about externalities, both FR 1 and 2 lie on the frontier with regard to holding MSR assets.

FR 3, however, is the most highly misaligned, with a foreclosure rate higher than both the borrower's and investor's optimum. Any social planner that places weight on borrower welfare would regard a servicer with optimal foreclosure rate at FR 3 as Pareto-dominated by a servicer at or strictly below the investor's optimum.[28]

Our empirical analysis on pre-period foreclosure rates in Section 6.2 reveals that bank servicers' optimum resembles FR 1, as if the pre-period equilibrium internalized borrower welfare. In our model, differential foreclosure behavior is driven by banks' higher patience level relative to non-bank servicers. The difference between bank and non-bank business models could account for this, including the incentives created by bank deposit taking, deposit insurance, having multiple trade lines that benefit from repeated borrower interaction, and public relations concerns.

Our results show that Basel III capital regulations on MSRs induced banks to sell MSRs to non-banks, moving servicing away from servicers who behaved as if they internalized borrower welfare, toward servicers who foreclosed more quickly. However, whether this regulatory change increases or decreases welfare of investors is theoretically ambiguous and needs to be empirically tested. Although the regulation moved the MSR allocation toward non-banks, if non-banks' foreclosure rate was as far, or farther, above the investor's optimal as banks' was below, there would be no welfare improvement for investors. Thus it is an empirical question whether the differential between non-bank servicer and investor foreclosure rates is more closely approximated by FR 2 or FR 3.

This reflects a more general question – whether capital regulation improves or worsens stakeholder welfare, by shifting equilibrium towards or away from investor optimum. We find that capital regulation improves investor welfare by shifting foreclosure rates towards FR 2, suggesting that regulation reduces misalignment between investors and servicers at the expense of borrower welfare.[29] However, this result may differ for other asset classes.

[27] Higher foreclosure rates maintain credit access for future borrowers and limit investor losses. Lower foreclosure rates raise the risk of investor losses but benefit current borrowers.

[28] Note that to justify allocating MSRs to servicers with optimal foreclosure rate FR 3, a policymaker must place positive weight on the welfare of servicers for whom the equilibrium foreclosure rate is higher than the investor optimum.

[29] The zero lower bound on foreclosure means that the effect of regulations that lower foreclosure rates do not have

Our findings suggest that capital regulation is a blunt tool because it does not target the allocation that minimizes investor-servicer agency conflict and does not account for borrower welfare. Furthermore, non-banks are lightly regulated, so their foreclosure rate can fluctuate relative to investors' and borrowers' optimum with limited regulatory oversight.

Second, our setting raises new questions about the optimal design of financial regulation. As long as a lightly regulated non-bank sector exists, there is a fundamental tension between increasing the stability of banks and pushing risky financial services outside of the regulated banking sector. Bank capital regulation cannot be levied considering only bank balance sheets. This is because non-banks' exclusion from bank capital requirements gives them a regulatory arbitrage opportunity and penalizing risky assets for banks simply pushes these assets to the less regulated sector. Our work provides evidence that pushing MSRs to the less regulated sector impacts borrowers heterogeneously. The most vulnerable economic groups often present higher risks, are pushed to the less regulated sector, and thus are subject to servicing quality that is privately optimal for the non-banks. For example, in our setting, MSR regulation exacerbated existing disparities between high and low risk borrowers in two ways. First, high risk borrowers were more likely to have their loans transferred to non-banks. Second, these transferred loans experienced disproportionately higher foreclosure rates.

These effects may be mitigated if non-banks also complied with the regulation levied on banks, increasing financial stability and borrower welfare in our setting.[30] However, if a strict separation exists between regulation for banks and for non-banks, policymakers should carefully weigh economic externalities of bank regulation against the intended benefits and consider tailoring risk weighting policy across loan types to combat unintended distributional consequences. Regulators may also consider ways to subsidize non-bank liquidity, since our results suggest that source of funding is a driving factor in non-bank servicing policies.[31]

Taken together, our analysis suggests a new channel by which capital regulation impacts investors and households - asset allocation. In markets with dispersed ownership over dif-

a symmetric effect on borrowers and investors - they always improve borrower welfare, but foreclosure rates may get too low for investors.

[30] We document that stricter MSR regulations drove foreclosure rates higher than the borrower optimum. In addition to high direct costs of foreclosure (Diamond et al., 2020), it has negative externalities both on borrowers' health (Downing, 2016), neighborhoods (Gupta, 2019; Lin et al., 2009), and labor market outcome (Pal, 2024).

[31] For example, in August 2020, Fannie Mae began offering stop advances where servicers are able to discontinue payment advances on behalf of delinquent borrowers after four consecutive missed payments, see: Servicer Principal and Interest (P&I) Advances Solution.

ferent pieces of a single asset, such as securitized debt, principals who hold ownership rights have misaligned incentives with agents who hold other rights. Heterogeneous agents can then freely trade contract rights amongst themselves, with no guarantee that the resulting private market equilibrium will maximize investor welfare. Moreover, third parties such as borrowers can face welfare consequences when agents can externalize losses onto them. Capital regulators who want to maximize investor and household welfare should consider the asset allocation channel alongside other well-documented impacts of bank capital regulation, such as its effects on bank risk-taking and on credit supply.

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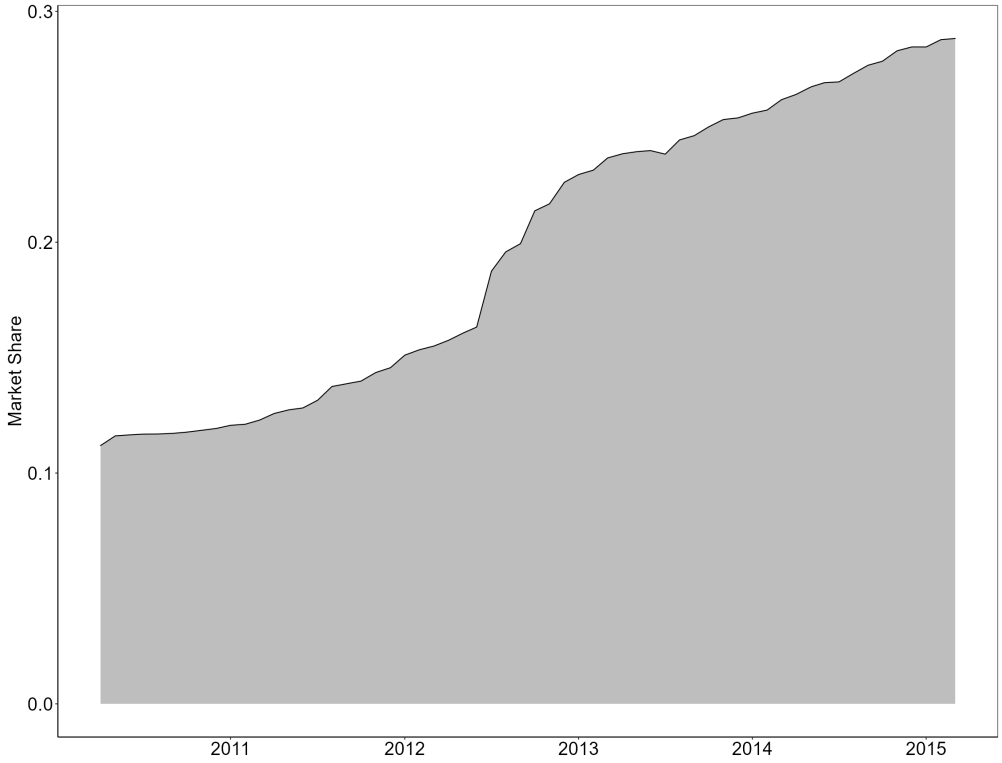
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Figure 1. Rise of Non-Bank Servicers



Notes: This figure presents the time trends in market share of outstanding loans that are serviced by non-banks. The sample comprises of all loans outstanding during the period 2011-2015. The shaded area indicates the share of loans serviced by non-banks as a fraction of all the outstanding mortgages between 2011 and 2015.

Figure 2. Third-Party Assignment by Institution Type



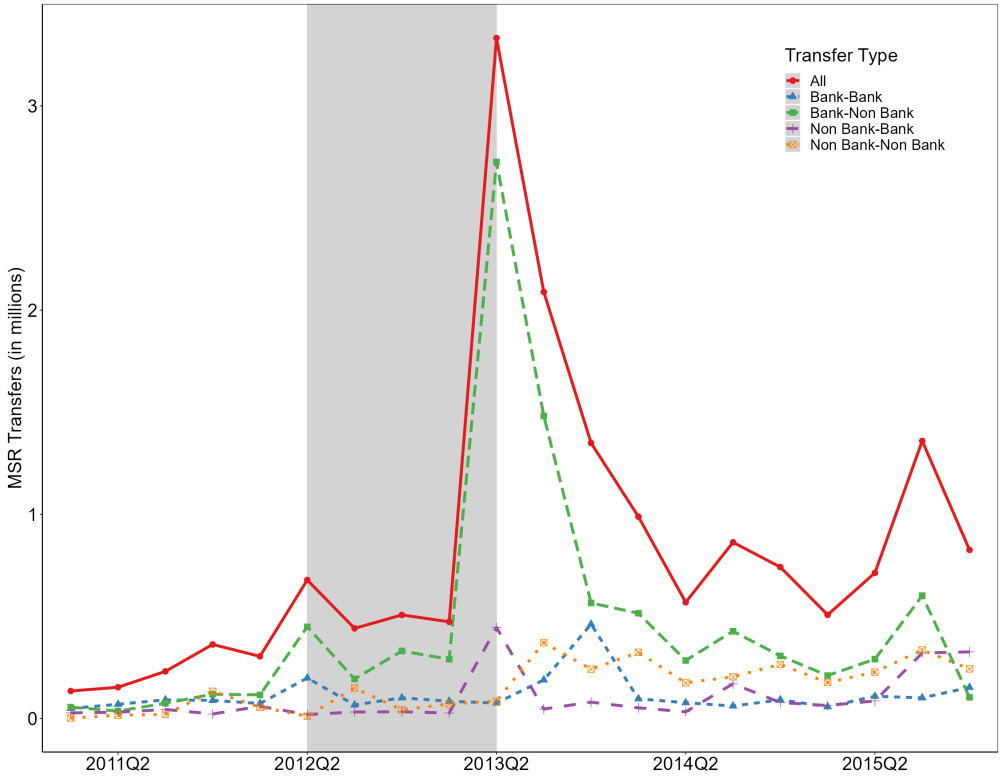
(a) Loans Originated by Banks



(b) Loans Originated by Non-Banks

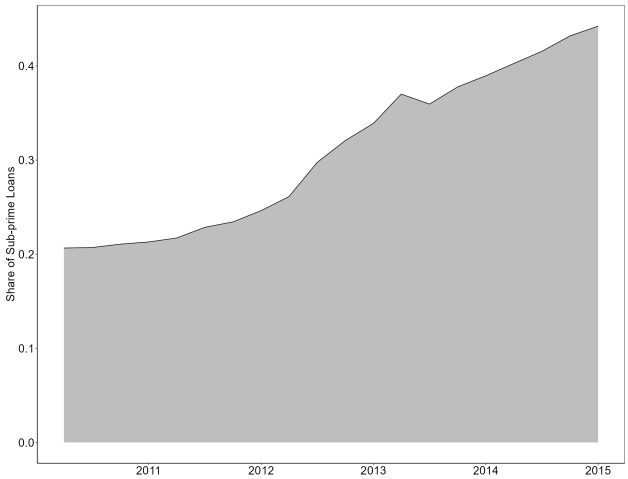
Notes: This figure presents quarterly time series for the total count of outstanding mortgages that underwent a third-party assignment of servicing rights between 2011-2015 at origination. The sample comprises of loans outstanding during the period 2011-2015 with information on originating entity. Third party initial assignment is defined as an instance where the originating entity is different from the servicing entity at origination. Panel A presents the statistics about third-party assignments for loans originated by banks. *Bank-Bank* (*Bank-Non Bank*) corresponds to loans that were originated by a bank and whose servicing rights were transferred at origination to another bank (non-bank). *Non-Transferred (Bank)* loans are those whose servicing was retained by the originating bank at the time of origination. Similarly, Panel B presents the statistics about third-party assignments for loans originated by non-banks and whose servicing was either transferred to another bank (*Non Bank-Bank*) or another non-bank (*Non Bank-Non Bank*) or retained (*Non-Transferred (Non Bank)*).

Figure 3. Aggregate MSR Transfers Around Basel III MSR Rule Change



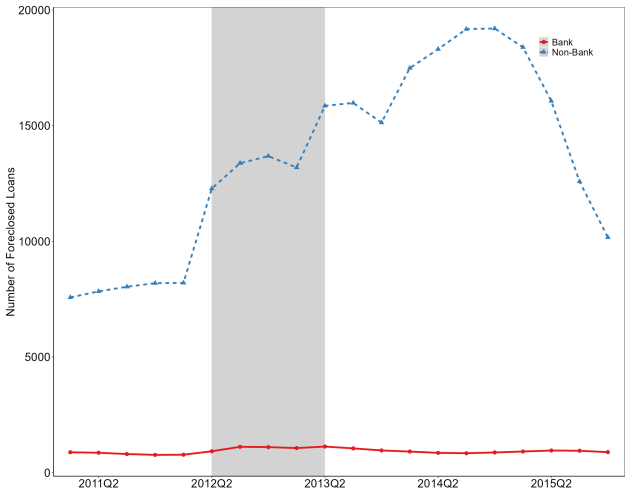
Notes: This figure presents quarterly time series for the total count of outstanding mortgages that underwent a transfer of mortgage servicing rights between 2011-2015. The sample comprises of all loans outstanding during the period 2011-2015. The bold red line denoted by *All* plots the count of outstanding loans whose servicing rights were sold in a given quarter. *Bank-Bank* (*Bank-Non Bank*) corresponds to the number of outstanding mortgages whose servicing rights were held by a bank in the prior quarter and sold to a bank (non-bank) in the current quarter. *Non Bank-Bank* (*Non Bank-Non Bank*) counts the number of outstanding mortgages transferred to a bank (non bank) in a given quarter which were held by a non-bank in the prior quarter.

Figure 4. Share of Subprime Mortgages Serviced by Non-Banks



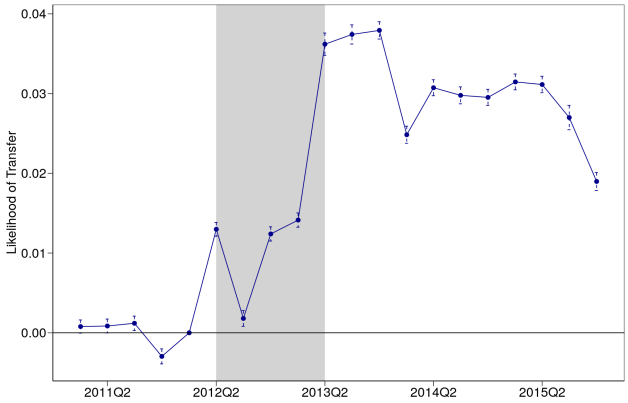
Notes: This figure presents quarterly time series of the share of total outstanding subprime loans that are serviced by non-banks. The sample comprises of all outstanding subprime loans during the period 2011-2015. A loan is classified as *subprime* when the associated vantage score is below 620. The shaded area indicates the share of subprime loans serviced by non-banks as a fraction of all outstanding subprime mortgages between 2011 and 2015.

Figure 5. Bank versus Non-Bank Foreclosures

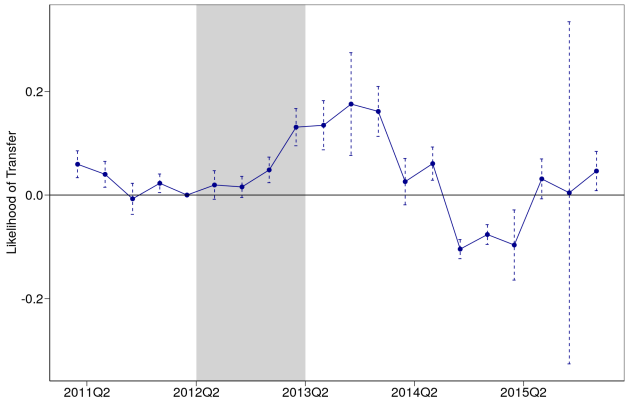


Notes: This figure presents the number of foreclosures on loans serviced by banks versus non-banks in the contemporary period. The sample comprises of all loans outstanding during the period 2011-2015. Foreclosure is defined as an indicator variable coded as 1 if a loan contains a repossession flag.

Figure 6. MSR Regulation and Incentive to Transfer



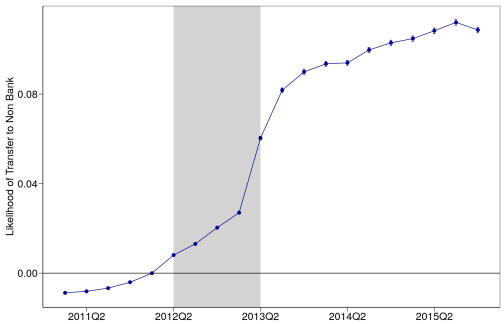
(a) MSR Regulation and Bank Incentive to Transfer



(b) Transfer Heterogeneity Across Banks

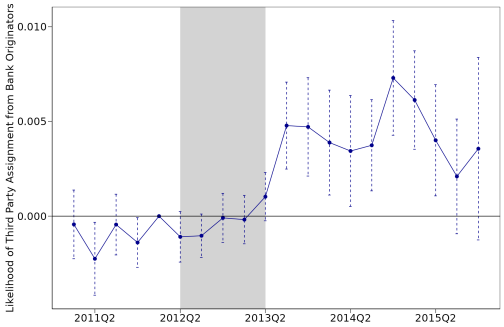
Notes: The figure shows the likelihood of servicing rights transfer in the period around the implementation of Basel III. Panel (a) plots estimated coefficients β_k in Equation 16 capturing the differential likelihood of servicing rights transfer of a loan serviced by a bank relative to non-bank (measured as the entity servicing the loan in the quarter prior to transfer). If a loan was not transferred during our sample period, we take the servicer type of the only servicer of the loan. The sample comprises of a 1 percent random sample of all outstanding mortgages during 2011-2015. Panel (b) plots the estimated β_k from Equation 17 capturing the differential likelihood of servicing right transfer across loans serviced by banks with varying MSR to common equity tier 1 ratio (measured as of 2011 for the entity servicing the loan in the quarter prior to transfer). The sample comprises of the one percent random sample of all mortgages outstanding during 2011-2015 merged with the Y9C data from 2011. Both panels control for loan and quarter fixed effects. 95% confidence intervals are included for each quarterly point estimate. Standard errors are clustered at the zip code level.

Figure 7. Cumulative Servicing by Non-Banks



Notes: This figure shows point estimates from Equation 20 capturing the likelihood of the servicing rights on a loan being held by a non-bank entity (measured as the entity servicing the loan in the quarter prior to transfer) during 2011-2015. The estimation controls for loan fixed effects. The sample comprises of loans from our one percent random sample. 95% confidence intervals are included for each quarterly point estimate and standard errors are clustered at the zip code level.

Figure 8. MSR Regulation and Assignment

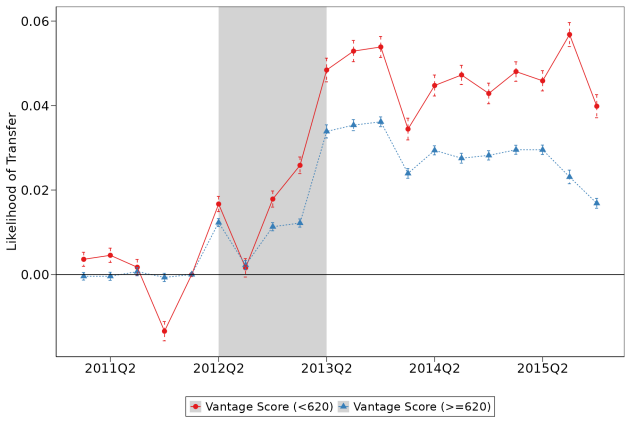


Notes: This figure plots the estimated coefficients β_k in

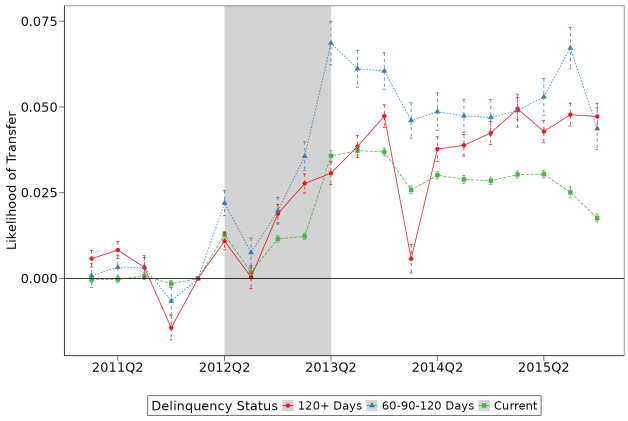
$$Assignment_i = \sum_{k \neq 2012Q1} \beta_k \; \mathbb{1}_k \; Bank_o + \sum_{k \neq 2012Q1} \mathbb{1}_k + \gamma Bank_o + \mathbf{X_i} + \eta_o + \nu_j + z_i + \epsilon_i, \qquad (23)$$

where *Assignment* denotes whether the first servicer for a loan differs from its originator. *Bank* denotes whether the originator of the loan in the period before assignment is a bank. $\mathbb{1}_k$ is an indicator for the quarter. $\mathbf{X_i}$ includes controls for loan amount, credit score, loan term and type (FHA, GSE). η_o, ν_j and z_i refer to fixed effects for originator, servicer to whom the loan is assigned and zip code respectively. The sample comprises of loans from our random sample with information on the originating entity. 95% confidence intervals are included for each quarterly point estimate and standard errors are clustered at the zip code level.

Figure 9. Transfer Heterogeneity Across Loan Types



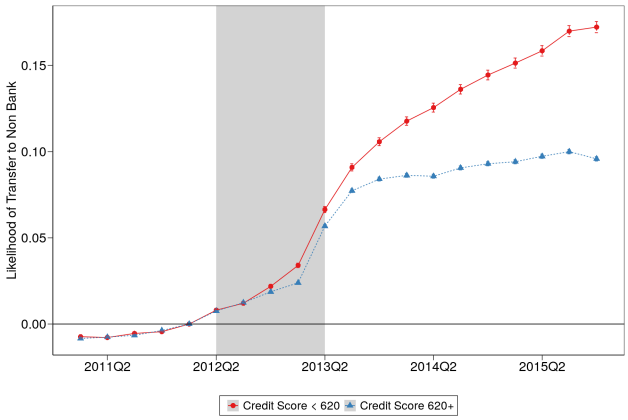
(a) Credit Score — Transfer



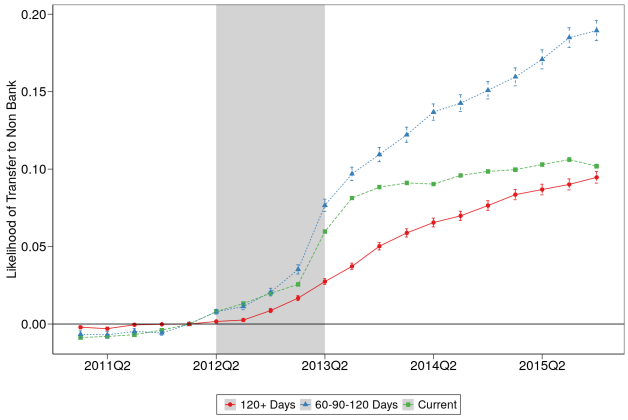
(b) Loan Performance

Notes: Panels (a) and (b) plot the dynamic response of β_k from Equation 16 capturing the differential likelihood of servicing rights transfer of a loan serviced by a bank relative to non-bank (measured as the entity servicing the loan in the quarter prior to transfer). The sub-samples are based on credit score in panel (a) and on loan performance in panel (b). The sample comprises of a 1 percent random sample of all loans outstanding during the period 2011-2015. 95% confidence intervals are included for each quarterly point estimate. Standard errors are clustered at the zip code level.

Figure 10. Non-Bank MSR Holdings by Credit score & Loan performance



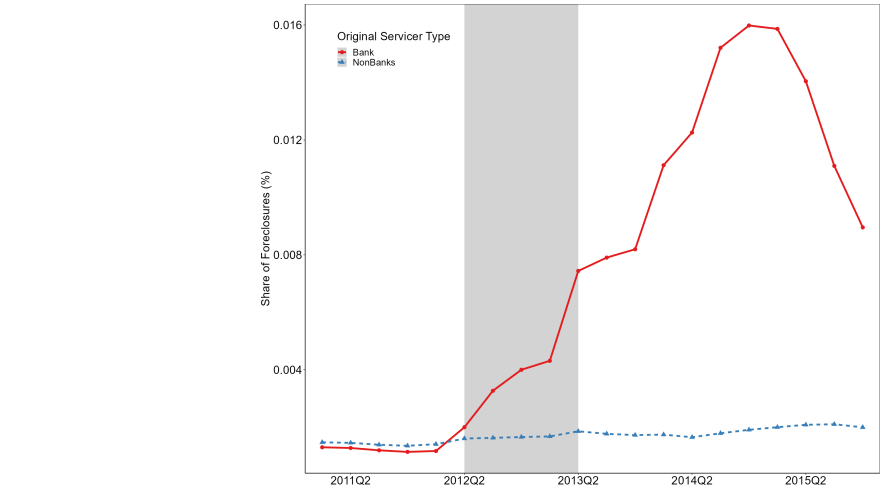
(a) Credit Score



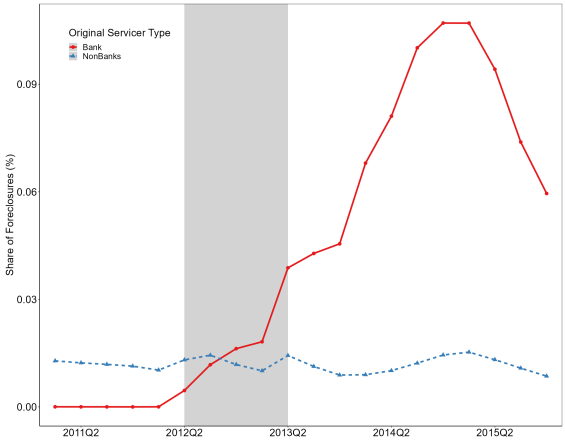
(b) Loan Performance

Notes: This figure plots the estimated coefficients β_k in Equation 20 capturing the likelihood of the servicing rights on a loan being held by a non-bank entity (measured as the entity servicing the loan in the quarter prior to transfer) for each sub-population listed: The sub-samples are based on credit score in panel (a) and loan performance in panel (b) respectively. The sample comprises of a 1 percent random sample of all loans outstanding during the period 2011-2015. 95% confidence intervals are included for each quarterly point estimate. Standard errors are clustered at the zip code level.

Figure 11. Foreclosure by Servicer Type



(a) All Loans



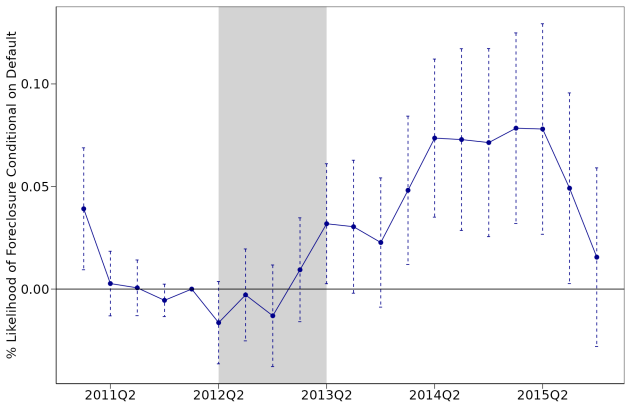
(b) Transferred Loans



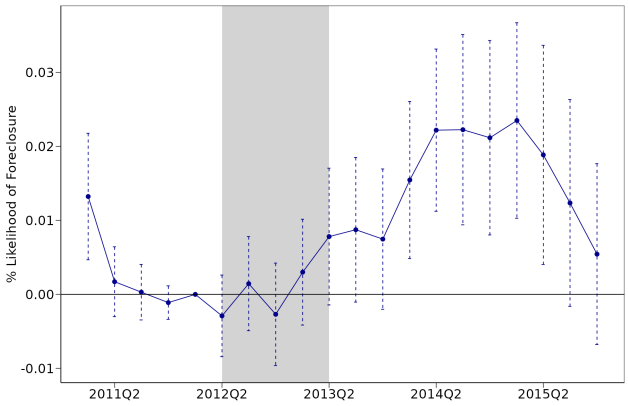
(c) Non-Transferred Loans

Notes: This figure plots the monthly time-series for the share of foreclosure based on the type of entity servicing the loan. The sample consists of all loans outstanding in the period 2011-2015. *Original Servicer Type* is identified based on the type of entity servicing the loan in the quarter prior to transfer for transferred loans and the servicer in any given quarter for the never transferred loans. Panel (a) shows the average likelihood of foreclosure for the entire sample of loans. Panel (b) restricts the sample to only loans that were transferred between 2011-2015 and Panel (c) to loans never transferred during the sample period.

Figure 12. Intent-to-Treat (ITT) Estimates



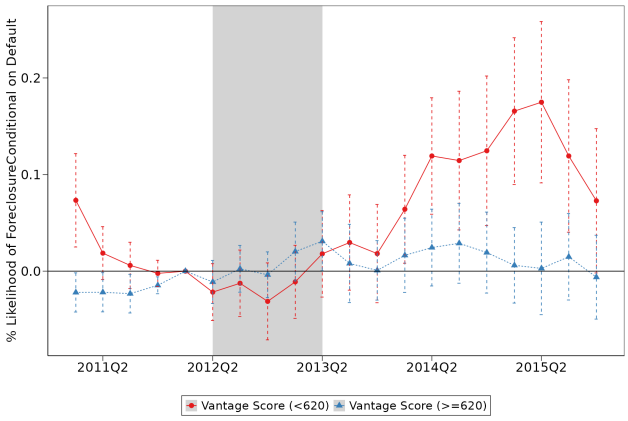
(a) Foreclosure|Default



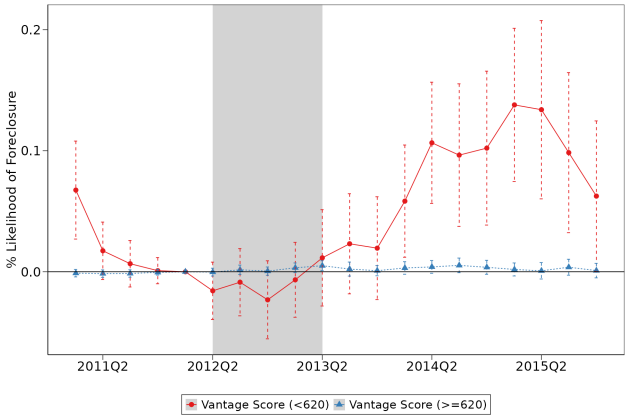
(b) Foreclosure

Notes: This figure plots the estimated β_k in the intent-to-treat (ITT) specification Equation 21, the estimated effect of being serviced by a bank in 2011 on foreclosure. The outcome variable is foreclosure, an indicator variable coded as 100 when a loan is subject to foreclosure in a quarter. In panel (a) the sample is restricted to the sample of defaulted loans and all loans outstanding in the sample in panel (b). The estimation includes loan fixed effects and quarter fixed effects and controls for loan age measured in years as the time since origination. The sample consists of loans originated before 2011. The 95% confidence intervals are included for each quarterly point estimate with standard errors clustered at zip code level.

Figure 13. Heterogeneity in Intent-to-Treat (ITT) Estimates



(a) Foreclosure|Default



(b) Foreclosure

Notes: This figure plots the estimated β_k in the intent-to-treat (ITT) specification Equation 21, the estimated effect of being serviced by a bank in 2011 on foreclosure, separately for subprime (< 620) and prime borrowers. The outcome variable is foreclosure, an indicator variable coded as 100 when a loan is subject to foreclosure in a quarter. In panel (a) the sample is restricted to the sample of defaulted loans and all loans outstanding in the sample in panel (b). The estimation includes loan fixed effects and quarter fixed effects and controls for loan age measured in years as the time since origination.

Table 1: Summary Statistics

This table reports summary statistics for the two main datasets for outstanding mortgages between 2011-2015: the loan-level credit registration data and the loan-level MSR transfer data. Panel A presents the statistics for the loan-level credit registration data. Panel B (Panel C) presents the statistics of the loan-level MSR transfer data (Y9C matched sample), which constitutes a one percent sample of outstanding mortgages. Standard deviations are reported in parentheses.

	All	Banks	Non Banks
	(1)	(2)	(3)
A. Full Sample			
Number of Servicers	8,944	5,030	1533
Number of Loan per Year (in Millions)	70	53	19
% Transferred	1.03	0.35	3.04
Loan Amount	192,615	193,860	188,970
	(131,732)	(133,490)	(126,371)
Loan Term	314	314	314
	(78)	(78)	(78)
Credit Score	715	718	707
	(108)	(107)	(109)
Income	54,921	55,310	53,669
.	(26,509)	(26,552)	(26,332)
% Foreclosure	0.03	0.002	0.07
	(1.34)	(0.39)	(2.58)
% Foreclosure (conditional on default)	0.162	0.014	0.549
	(4.03)	(1.20)	(7.39)
B. 1% Sample			
Number of Servicers	6,115	3,427	798
Number of Loan per Year (in Millions)	0.93	0.71	0.23
% Transferred	1.12	0.43	3.13
Loan Amount	192,473	193,732	188,779
	(131,662)	(133,393)	(126,371)
Loan Term	314	314	314
	(78)	(78)	(78)
Credit Score	715	718	707
	(107)	(107)	(109)
Income	57,149	57,767	55,284
	(34,029)	(34,820)	(31,451)
% Foreclosure	0.02	0.001	0.07
	(1.32)	(0.42)	(2.52)
% Foreclosure (conditional on default)	0.160	0.017	0.5430
	(3.99)	(1.31)	(7.26)
C. Y9C Matched Sample			
Number of Servicers	905	799	131
Number of Loan per Year (in Millions)	0.55	0.54	0.05
% Transferred	0.28	0.06	56
Loan Amount	190,055	190,119	184,775
	(132,004)	(132,036)	(129,279)
Loan Term	314	314	325
	(78)	(78)	(71)
Credit Score	715	715	691
	(111)	(111)	(115)
Income	57,529	57,573	53,878
	(34,662)	(34,617)	(34,459)
% Foreclosure	0.003	0.002	0.07
	(0.50)	(0.41)	(2.71)
% Foreclosure (conditional on default)	0.074	0.011	0.912
	(2.73)	(1.03)	(9.51)

Table 2

Are Banks More Likely to Sell MSRs After MSR Regulation

This table presents loan level difference-in-difference regression results from Equation 16. The sample includes all loan-quarter observations in our random sample (loans serviced by banks in the quarter prior to transfer in column 5). $Transfer$ denotes whether a loan's servicing right is transferred in a given quarter. $Bank$ is 1 for loans serviced by a bank in the quarter prior to transfer and 0 for non-banks. $Middle$ ($Post$) indicates whether the time is between 2012Q2 and 2013Q2 (after 2013Q2). MSR/CET is the MSR to common equity tier 1 ratio measured as of 2011 for entity servicing the loan in the quarter prior to transfer. Servicer FE corresponds to initial servicer fixed effects. Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Transfer				
	(1)	(2)	(3)	(4)	(5)
Middle x Bank	0.006***	0.006***	0.006***	0.010***	
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	
Post x Bank	0.012***	0.012***	0.011***	0.031***	
	(0.0002)	(0.0002)	(0.0002)	(0.0004)	
Middle $\times MSR/CET1$					0.080***
					(0.012)
Post $\times MSR/CET1$					0.039**
					(0.019)
Servicer FE	Yes	Yes	Yes		
Zip FE		Yes	Yes		
Quarter FE			Yes	Yes	Yes
Loan FE				Yes	Yes
N	14,384,063	14,384,063	14,384,063	14,384,063	5,438,217
R^2	0.036	0.038	0.043	0.139	0.181

Table 3

Are Non Banks More Likely to hold MSRs After MSR Regulation

This table presents regression estimates from Equation 18 showing the likelihood of the non banks' holding of mortgage servicing rights. The underlying sample includes all loan-quarter observations in our random sample. $Non\ Bank$ denotes whether a loan is serviced by a non-bank in a given quarter. Servicer FE is initial servicer fixed effects. Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Non Bank		
	(1)	(2)	(3)
Middle	0.018***	0.018***	0.022***
	(0.0002)	(0.0002)	(0.0002)
Post	0.083***	0.083***	0.097***
	(0.0004)	(0.0004)	(0.0006)
Servicer FE	Yes	Yes	
Zip FE		Yes	
Loan FE			Yes
N	14,384,063	14,384,063	14,384,063
R^2	0.761	0.764	0.873

Table 4
Selection in MSR Transfers

Columns 1 and 2 present the heterogeneity in loan level difference-in-difference regression estimates from Equation 16 measuring the effect of MSR regulation under Basel III on the likelihood of transfer. Columns 3 and 4 present heterogeneity in the likelihood of the non banks' holding of mortgage servicing rights from Equation 18. In columns 1 and 2, the outcome variable is $Transfer$, which is an indicator for whether a loan's servicing right is transferred in a given quarter. The treatment indicator $Bank$ is coded as 1 for loans which were serviced by a bank in the quarter prior to transfer and 0 for non-banks. In columns 3 and 4, the outcome variable is $Non\ Bank$, which is an indicator for whether a loan is serviced by a non-bank in a given quarter. In all columns, $Middle$ indicates whether the time is between 2012Q2 and 2013Q2, and $Post$ indicates whether the time is in or after 2013Q2. $Category$ is an indicator variable which takes a value of 1 if the loan has a credit score lower than 620 (columns 1, 3) or is in default (columns 2, 4). For all columns, the underlying sample includes all loan-quarter observations in our random sample. Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Transfer		Non Bank Servicer	
	Subprime	Default	Subprime	Default
	(1)	(2)	(3)	(4)
Middle × Bank × Category	0.012***	0.017***		
	(0.0005)	(0.0009)		
Post × Bank × Category	0.021***	0.025***		
	(0.0005)	(0.0009)		
Middle × Category	-0.008***	-0.008***	-0.008***	-0.018***
	(0.0004)	(0.0007)	(0.0005)	(0.0009)
Post × Category	-0.010***	-0.006***	0.021***	0.023***
	(0.0004)	(0.0006)	(0.0007)	(0.001)
Middle × Bank	0.008***	0.009***		
	(0.0002)	(0.0002)		
Post × Bank	0.028***	0.030***		
	(0.0003)	(0.0003)		
Category × Bank	-0.001***	-0.006***		
	(0.0002)	(0.0004)		
Bank	0.016***	0.014***		
	(0.0002)	(0.0002)		
Loan FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	No	No
N	14,383,904	13,359,276	14,383,904	13,359,276
R^2	0.139	0.142	0.873	0.872

Table 5
Intent-to-Treat

This table presents the regression estimates from the static version of our intent-to-treat (ITT) specification in Equation 21 showing the effects of MSR regulation under Basel III on foreclosure. Foreclosure is defined as an indicator variable coded as 100 during a calendar month if a loan contains a repossession flag. Foreclosure|Default is defined as an indicator variable coded as 100 if a loan was foreclosed conditional on the sample of defaulted loans. The sample is restricted to loans originated before 2011. *Middle* indicates whether the time is between 2012Q2 and 2013Q2, and *Post* indicates whether the time is in or after 2013Q2. *Bank* is an indicator variable equal to 1 if the loan was serviced by a bank in 2011Q1. Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Foreclosure|Default (p.p)		Foreclosure (p.p)	
	(1)	(2)	(3)	(4)
Middle × Bank	-0.015	-0.014	-0.003	-0.003
	(0.010)	(0.011)	(0.003)	(0.003)
Post × Bank	0.041***	0.042***	0.010**	0.012**
	(0.015)	(0.016)	(0.005)	(0.005)
N	2,113,228	2,113,228	8,724,868	8,724,868
R^2	0.331	0.331	0.628	0.628
Loan FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
Loan Age FE	No	Yes	No	Yes

Table 6

Foreclosure by Investor versus Servicer

Table reports the results of Equation 22 which estimates the response of foreclosure and foreclosure conditional on default to whether the loan is both serviced and owned by the same entity (Group1 - portfolio loans), securitized and serviced by a bank (Group2), or securitized and serviced by a non-bank (Group3). The omitted category is Group 1. Foreclosure is defined as an indicator variable coded as 100 if a loan contains a repossession flag within two years of origination. Foreclosure|Default is defined as an indicator variable coded as 100 if a loan was foreclosed within two years of origination conditional on the sample of defaulted loans. The additional covariates are included as controls. The sample consists of loans originated in 2011 with information on originating entity from our random sample. Standard errors are clustered at the zip code level in the regressions where zip code level fixed effects are included. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Foreclosure|Default (p.p)		Foreclosure (p.p)	
	(1)	(2)	(3)	(4)
Constant	13.6***		2.21***	
	(1.68)		(0.148)	
Group 2 - Bank Serviced	-7.85***	-8.60***	-0.152***	-0.187***
	(1.04)	(1.67)	(0.033)	(0.044)
Group 3 - Non Bank Serviced	-5.23***	-4.76*	0.039	0.014
	(1.92)	(2.49)	(0.079)	(0.106)
Score 580-669	0.849	-0.599	-1.11***	-1.18***
	(1.64)	(1.98)	(0.152)	(0.415)
Score 670-739	1.37	-0.317	-1.81***	-1.82***
	(1.75)	(1.88)	(0.149)	(0.404)
Score 740-799	1.16	0.158	-2.04***	-2.02***
	(2.09)	(2.67)	(0.149)	(0.405)
Score 800-850	3.52	1.39	-2.10***	-2.06***
	(3.63)	(4.76)	(0.151)	(0.405)
Log(Origination Amount)		0.908		0.023
		(1.38)		(0.037)
Log(Loan Term)		1.94		0.223***
		(3.80)		(0.034)
Log(Income)		-2.01		-0.127***
		(1.64)		(0.046)
Zip FE	No	Yes	No	Yes
N	3,932	3,830	118,984	117,037
R^2	0.015	0.197	0.005	0.015

Internet Appendix

A Basel III Timeline

A full timeline of Basel III's regulatory changes follows, adapted from Hendricks, Neilson, Shakespeare, and Williams (2016).

- Dec 2009 – Basel Committee proposes that intangible assets (e.g., MSRs) be deducted from the equity component of Tier 1 capital. Comments invited by April 16, 2010.
- Jul 2010 – Basel Committee modifies the initial proposal so that MSRs are allowed to comprise 10% of Tier 1 Equity, rather than being fully deducted.
- Dec 2010 - Basel Committee increases the risk weighting on MSRs included in Tier 1 capital from 100% to 250% and releases timeline for banks to comply by 2015.
- Apr 2012 – Basel Committee issues a member progress report and classifies the US as "1-Draft regulation not published. This status corresponds to cases where no draft law, regulation, or other official document has been made public to detail the planned content of the domestic regulatory rules."
- Jun 2012 – Fed Board issues a proposal to adopt the Basel III's treatment of MSRs. The Fed Board proposes that this treatment of MSRs be in addition to the current rules that only allow 90% of MSRs to be counted in the common equity component of Tier 1. The Fed Board invites comments by Sep 2012.
- Oct 2012 – Basel Committee issues a member progress report and classifies the US as "2-Draft regulation published."
- Apr 2013 – Basel Committee issues a member progress report and still classifies the US as "2. draft regulation published."
- July 2013 – The Fed Board approves the Basel III rule with only minimal changes to the proposed treatment of MSRs. Specifically, the previous requirement that only 90% of MSRs could be included in the common equity component of Tier 1 capital was removed in favor of the Basel Committee's more stringent requirements. Implementation to begin on Jan 1, 2014 (Jan 1, 2015) for Advanced Approaches (non-Advanced Approaches) institutions.

- Oct 2013 - Basel Committee issues a member progress report and classifies the US as "3 - Final rule published."
- Apr 2014 - Basel Committee classifies US as "4 - Final rule in force."

B Supplementary Materials to Model

B.1 Proof of Proposition 2

To illustrate how the servicer's private optimal allocation may not minimize agency conflicts, we solve for both the investor's expected profit using the servicer's foreclosure rule as well as using the investor's own foreclosure rule. Using the servicer's optimal foreclosure rule, the investor's expected profit is the following:

$$E(\Pi_{i,l}|s) = (1-d_l)I_l + d_l\left[\int_0^{\frac{C}{\delta_s(\lambda_l+C)}} A\ dp_l + \int_{\frac{C}{\delta_s(\lambda_l+C)}}^1 \Big(pI + (1-p)\delta_i A\Big)dp_l\right] \tag{A1}$$

Using the investor's optimal foreclosure rule, the investor's expected profit is the following:

$$E(\Pi_{i,l}|i) = (1-d_l)I_l + d_l\left[\int_0^{\frac{A(1-\delta_i)}{I-\delta_i A}} A\ dp_l + \int_{\frac{A(1-\delta_i)}{I-\delta_i A}}^1 \Big(pI + (1-p)\delta_i A\Big)dp_l\right] \tag{A2}$$

Solving for the expected profits and taking the difference between them yields:

$$\begin{aligned} E(\Pi_{i,l}|s) - E(\Pi_{i,l}|i) &= A(1-\delta_i)\left(\frac{C}{\delta_s(\lambda_l+C)} - \frac{A(1-\delta_i)}{I-\delta_i A}\right) \\ &\quad + \frac{I-\delta_i A}{2}\left(\left(\frac{A(1-\delta_i)}{I-\delta_i A}\right)^2 - \left(\frac{C}{\delta_s(\lambda_l+C)}\right)^2\right) \\ &= \frac{I-\delta_i A}{2}\Big(2f_{i,l}(f_{s,l}-f_{i,l}) + (f_{i,l}^2 - f_{s,l}^2)\Big) \\ &= -\frac{I-\delta_i A}{2}(f_{i,l}-f_{s,l})^2 \end{aligned} \tag{A3}$$

The expression for the difference in profit between investor and servicer's optimal foreclosure rates have two key features. First, the welfare loss to investors is minimized when servicers' optimal foreclosure rate coincides with that of investors. Second, the welfare loss increases symmetrically as the foreclosure rate of servicers deviates from that of investors. As a result, we can use the absolute value of the deviation between the investor and servicer's optimum as a sufficient statistic for welfare loss, conditional on loan characteristics A and I, and investor preference δ_i.

C Other Margin of Adjustment: Initial Assignment

To understand whether banks are more likely than non-banks to assign mortgage servicing rights to a third party at origination, which we refer to as initial *assignment*, we estimate the following difference-in-differences (DiD) specification:

$$Assignment_i = \sum_{k \neq 2012Q1} \beta_k \, \mathbb{1}_k \, Bank_o + \sum_{k \neq 2012Q1} \mathbb{1}_k + \gamma Bank_o + \mathbf{X_i} + \eta_o + \nu_j + z_i + \epsilon_i, \quad \text{(A4)}$$

where $Assignment_i$ is an indicator for whether the first servicer observed in the performance data for loan i differs from its originator. $Bank_o$ is an indicator for whether the originator of loan i in the period before assignment is a bank. $\mathbb{1}_k$ is an indicator for the quarter. $\mathbf{X_i}$ includes controls for loan amount, credit score, loan term and type (FHA, GSE). We also include fixed effects for the originator of the loan (η_o) and zip code (z_i). We cluster standard errors at the zip code level, to allow for neighborhood spatial correlation.

We show the dynamic evolution of bank versus non-bank differences in initial assignments of MSRs relative to 2012Q2 in Figure 8. The figure plots the estimated coefficients of the β_k in Equation A4. The final adoption of Basel III in 2013Q2 increases banks' likelihood of assigning MSRs to a third party different from themselves by 0.5% relative to that of non-banks. Banks' higher likelihood of MSR assignments persisted until the end of 2015. Importantly, prior to the initial proposal of the Basel III adoption, bank MSR assignments were not statistically more likely than those for non-banks. The lack of pre-trend alleviates the concern that different unobservable loan characteristics might drive different bank versus non-bank assignment likelihoods.

The result that the likelihood of bank initial placements is higher than that of non-banks following the policy change, is striking. This is because Figure 2 shows that the level of bank initial assignments fell dramatically following the policy change, while the level of non-bank initial assignments increased following the policy change, as discussed in subsection 2.2. Bank originations, plotted in appendix Figure E4, help us reconcile the results shown in Figure 2 and Figure 8. Bank originations drop following the policy change. Relative to non-banks, Figure E5 indicates that banks are on average 5% less likely to originate mortgages post Basel III. Thus banks are both originating fewer mortgages after Basel III and simultaneously increasing the probability of transferring the mortgages that they do originate to a third party. This results in the level of bank assignments falling while the probability of assignment increases, and increases at a faster rate than that of non-bank initial assignments despite their growth over this time period.

D Other Margin of Adjustment: Origination

For a subsample of loans, we are able to see the originator. To classify originators as banks versus non-banks, we utilize the same algorithm that we use to classify servicers. Figure E4 plots the originations by banks versus non-banks from 2011 to 2015. The figure shows that bank and non-bank originations moved in parallel from 2011Q1 to 2012Q1. In 2012Q2, non-bank originations begin increasing and almost double during the treatment period. Bank originations also increase slightly during the treatment period and then fall sharply from nearly 1.25 million originations in 2013Q1 to close to 0.25 million in 2013Q2 and remain steady at this level throughout the duration of our sample. Conversely, non-bank originations rise, ending 2015 with almost double the originations that they made in 2011.

To interpret the results that we show in Figure E4, we estimate the following regression specification to study the share of bank originations, relative to all originations overtime:

$$BankOriginator_i = \sum_{k \neq 2012Q1} \beta_k \mathbb{1}_k + \mathbf{X_i} + \eta_o + z_i + \epsilon_i \tag{A5}$$

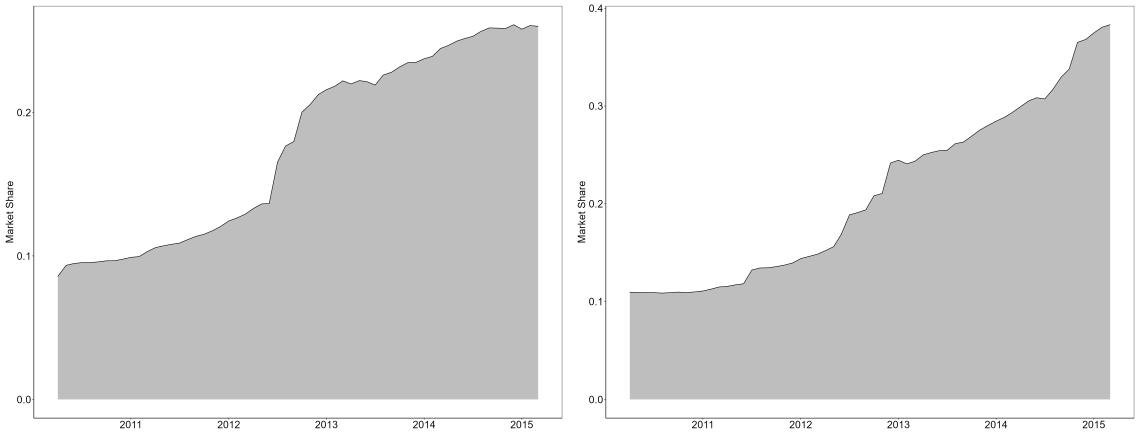
where $BankOriginator_i$ is an indicator variable that is equal to one if the originator of a loan was a bank. $\mathbb{1}_k$ is an indicator for the quarter. β_k is the coefficient of interest, which identifies

the change in the share of bank originations relative to 2012Q1. $\mathbf{X_i}$ includes controls for loan amount, credit score, loan term and type (FHA, GSE). We also include fixed effects for the originator of the loan (η_o) and zip code (z_i). We cluster standard errors at the zip code level (z_i), to allow for neighborhood spatial correlation.

We show the dynamic evolution of the share of bank originations relative to 2012Q2 in Figure E5. The figure plots the estimated coefficients of the β_k in Equation A5. From 2011Q1 to 2013Q2, prior to the policy change, banks' share of originations maintained a relatively flat pre-period trend. This indicates that the share of originations originated by banks remained relatively stable prior to 2013Q2. Following 2013Q2, the final adoption of Basel III decreases banks' likelihood of originating mortgages by 5% by 2014Q2. Banks' likelihood of originating mortgages continues to decline until banks are nearly 10% less likely to originate mortgages relative to the pre-period.

E Additional Tables and Figures

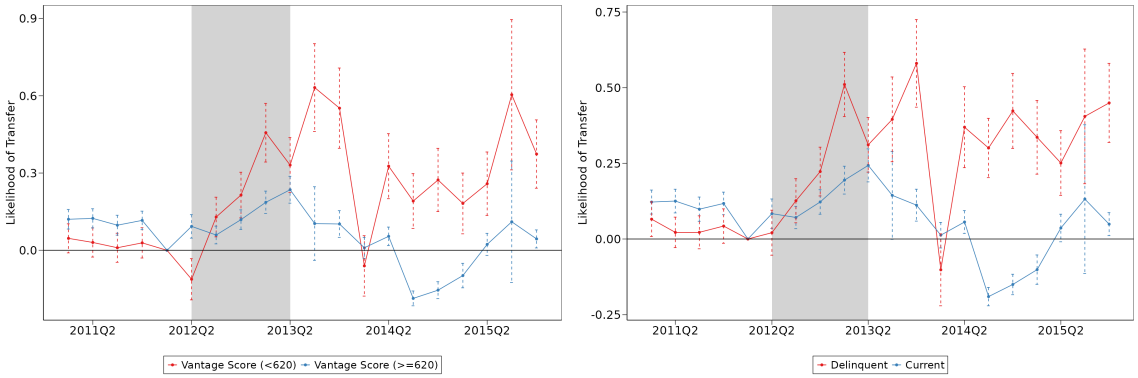
Figure E1. Rise of Non-Bank Servicers



(a) GSE **(b)** FHA

Notes: This figure presents the time trends in market share of outstanding loans that are serviced by non-banks among GSE and FHA loans respectively. The sample consists of all loans outstanding during 2011-2015. Panel (a) shows share of loans serviced by non-banks as a fraction of all outstanding conforming mortgages. Panel (c) shows the non-bank serviced share among FHA mortgages.

Figure E2. Transfer Heterogeneity Across Banks–Selective Transfer DiD



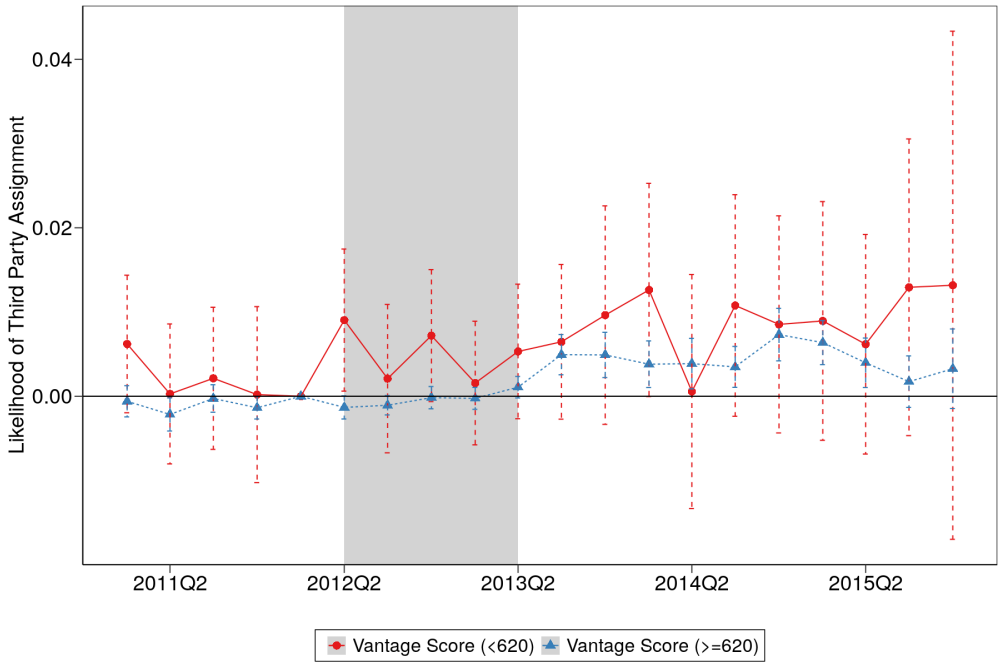
(a) Credit Score **(b)** Loan Performance

Notes: This figure plots the dynamic response of β_k from the specification below

$$Transfer_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k \, \mathbb{1}_k \left(\frac{MSR}{CET1} \right)_{i,j,2011} + \mu_i + \theta_t + \epsilon_{i,j,t}$$

for subgroups based on credit score and loan performance. $Transfer_{i,j,t}$ is an indicator for whether the servicing right on loan i was sold in quarter t. $(\frac{MSR}{CET1})_{i,j,2011}$ is the MSR to common equity tier 1 ratio measured as of 2011 for the entity servicing the loan in the quarter prior to transfer. μ_i and θ_t correspond to loan and quarter fixed effects respectively. Panel (a) shows effects separately for above and below 620 credit score, Panel (b) for current and delinquent loans. The sample comprises of the 1 percent random sample of all mortgages outstanding during 2011-2015 merged with the Y9C data from 2011. 95% confidence intervals are included for each quarterly point estimate. Standard errors are clustered at the zip code level.

Figure E3. Initial Assignment Heterogeneity Across Loan Types

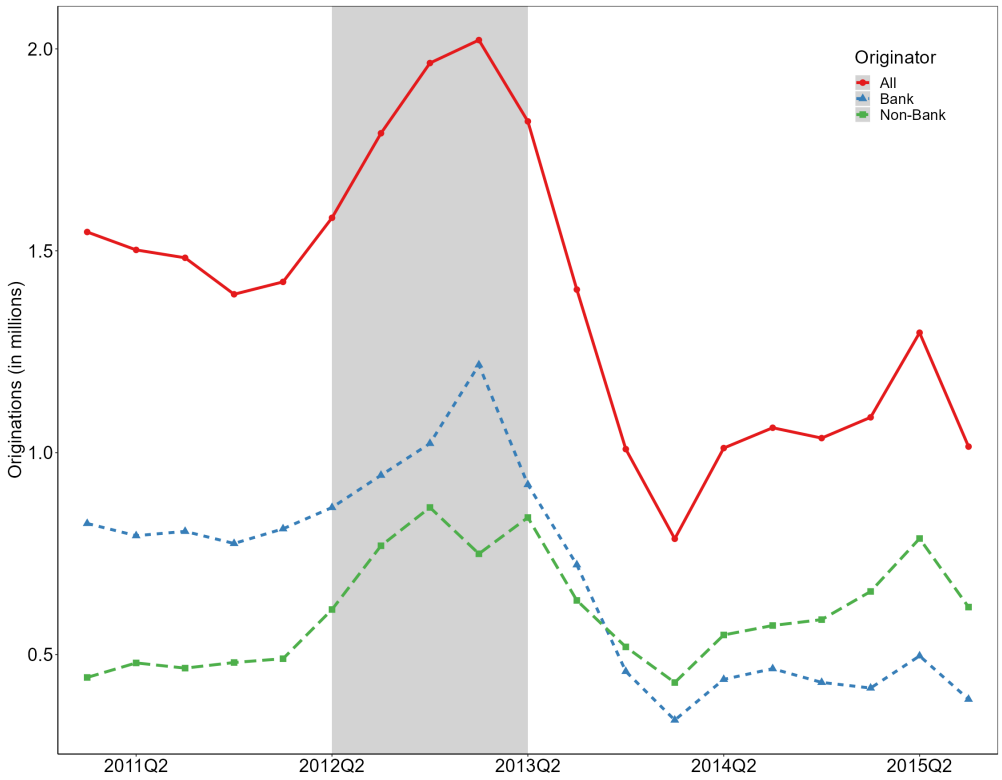


Notes: This figure plots the dynamic response of β_k from the specification below for subgroups based on borrower credit score:

$$Assignment_i = \sum_{k \neq 2012Q1} \beta_k \; \mathbb{1}_k \; Bank_o + \sum_{k \neq 2012Q1} \mathbb{1}_k + \mathbf{X_i} + \gamma Bank_o + \mu_i + \epsilon_i,$$

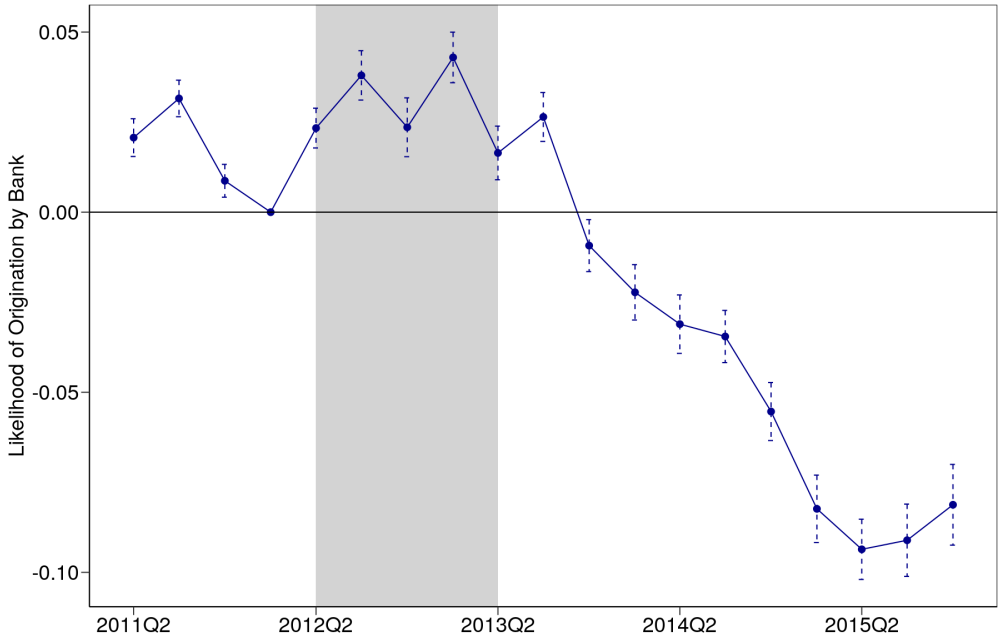
$Assignment_i$ is an indicator for whether the servicing right on loan i originated by originator o was assigned to a third party at origination. $Bank_o$ is an indicator for whether the originator of loan i is a bank. The sample consists of a 1 percent random sample of all outstanding loans during 2011-2015 with information on originating entity. 95% confidence intervals are included for each quarterly point estimate. Standard errors are clustered at the zip code level.

Figure E4. Originations



Notes: This figure presents the quarterly time series the total count of mortgages originated between 2011-2015. The sample consists of all loans outstanding between 2011-2015 with information on originating entity.

Figure E5. MSR Regulation and Origination

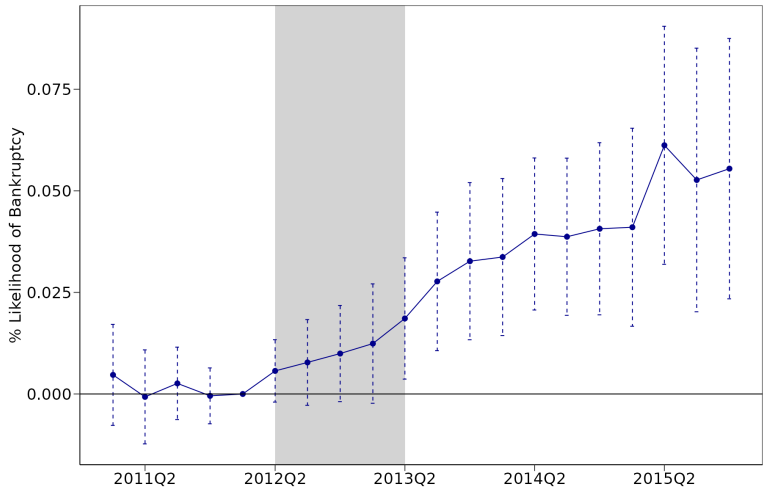


Notes: This figure plots the estimated coefficients β_k in the specification below:

$$Bank\ Originator_i = \sum_{k \neq 2012Q1} \beta_k \mathbb{1}_k + \mathbf{X_i} + \eta_o + z_i + \epsilon_i \tag{A6}$$

where $Bank\ Originator_i$ is an indicator variable that is equal to one if the originator of a loan was a bank. $\mathbb{1}_k$ is an indicator for the quarter. β_k is the coefficient of interest, which identifies the change in the share of bank originations relative to 2012Q1. $\mathbf{X_i}$ includes controls for loan amount, credit score, loan term and type (FHA, GSE). We also include fixed effects for the originator of the loan (η_o) and zip code (z_i). The sample consists of a 1 percent random sample of loans outstanding during 2011-2015 with information on originating entity. We cluster standard errors at the zip code level (z_i), to allow for neighborhood spatial correlation.

Figure E6. Intent-to-Treat (ITT) Estimates for Bankruptcy

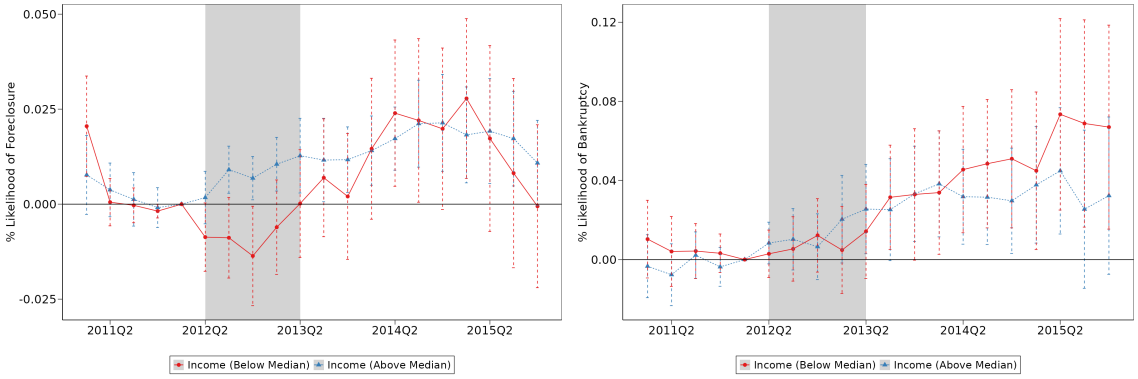


Notes: This figure plots the estimated β_k in the intent-to-treat (ITT) specification:

$$Y_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k \; Bank_{i,j,2011} + \mu_i + \theta_t + \gamma Loan \; Age_{i,t} + \epsilon_{i,j,t}$$

where $Y_{i,j,t}$ is an indicator for whether loan i is subject to bankruptcy in quarter t. $Bank_{i,j,2011}$ is an indicator for whether loan i is serviced by a bank in 2011Q1. μ_i and θ_t are loan fixed effects and quarter fixed effects, respectively. $Loan \; Age_{i,t}$ corresponds to the time since origination, measured in years. The sample consists of loans originated before 2011. The 95% confidence intervals are included for each quarterly point estimate with standard errors clustered at zip code level.

Figure E7. Intent-to-Treat (ITT): Heterogeneity



(a) Foreclosure: Income **(b)** Bankruptcy: Income

Notes: This figure plots the estimated β_k in the intent-to-treat (ITT) specification, separately by sub-category:

$$Y_{i,j,t} = \sum_{k \neq 2012Q1} \beta_k \, Bank_{i,j,2011} + \mu_i + \theta_t + \gamma Loan\ Age_{i,t} + \epsilon_{i,j,t}$$

where $Y_{i,j,t}$ is an indicator for whether loan i is subject to foreclosure in Panel (a) or faces personal bankruptcy in Panel (b) in quarter t. $Bank_{i,j,2011}$ is an indicator for whether loan i is serviced by a bank in 2011Q1. μ_i and θ_t are loan fixed effects and quarter fixed effects, respectively. $Loan\ Age_{i,t}$ corresponds to the time since origination, measured in years. The sample consists of loans originated before 2011. The 95% confidence intervals are included for each quarterly point estimate with standard errors clustered at zip code level.

Table E1
Selection in MSR Transfers

This table presents the heterogeneity in loan level difference-in-difference regression estimates from Equation 16. The underlying sample includes all loan-quarter observations in our random sample. The outcome variable $Transfer$ is an indicator for whether a loan's servicing right is transferred in a given quarter. The treatment indicator $Bank$ is coded as 1 for loans which were serviced by a bank in the quarter prior to transfer and 0 for non-banks. $Middle$ indicates whether the time is between 2012Q2 and 2013Q2, and $Post$ indicates whether the time is in or after 2013Q2. $Category$ is an indicator variable which takes a value of 1 if the loan is below-median income (column 1, 4), jumbo (column 2, 5), and has a 30-year loan term (column 3, 6). Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Transfer			Non Bank		
	$\text{Income}_{<Median}$	Jumbo	30 Year	$\text{Income}_{<Median}$	Jumbo	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)
Middle × Bank × Category	0.002***	-0.002**	0.007***			
	(0.0004)	(0.0009)	(0.0004)			
Post × Bank × Category	0.004***	-0.002**	0.012***			
	(0.0005)	(0.001)	(0.0005)			
Middle × Bank	0.010***	0.011***	0.006***			
	(0.0003)	(0.0002)	(0.0003)			
Post × Bank	0.030***	0.031***	0.022***			
	(0.0004)	(0.0003)	(0.0005)			
Middle × Category	-0.001***	0.0007	-0.001***	0.0003	0.001	0.015***
	(0.0004)	(0.0008)	(0.0003)	(0.0004)	(0.0008)	(0.0004)
Post × Category	-0.002***	2.07×10^{-5}	-0.003***	0.004***	0.044***	0.033***
	(0.0004)	(0.0009)	(0.0004)	(0.001)	(0.002)	(0.001)
Category × Bank	0.007***	-0.010***	0.005***			
	(0.0005)	(0.0009)	(0.0004)			
Bank	0.011***	0.016***	0.011***			
	(0.0003)	(0.0002)	(0.0004)			
Loan FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes			
N	13,995,539	14,384,063	13,504,541	13,995,539	14,384,063	13,504,541
R^2	0.139	0.139	0.139	0.870	0.873	0.869

Table E2
ITT: Heterogeneity

This table presents heterogeneity in the regression estimates from the dynamic version of our intent-to-treat (ITT) specification in Equation 21 showing the effects of MSR regulation under Basel III on foreclosure Columns (1-2) and personal bankruptcies Columns (3-4). *Foreclosure* is an indicator coded as 100 if a loan has a repossession flag. Similarly, *Bankruptcy* is an indicator variable coded as 100 if a loan has a bankruptcy flag. The sample is restricted to loans originated before 2011. *Bank* is an indicator variable equal to 1 if the loan was serviced by a bank in 2011Q1. *Middle* indicates whether the time is between 2012Q2 and 2013Q2, and *Post* indicates whether the time is in or after 2013Q2. *Category* is an indicator variable which takes a value of 1 if the loan belongs to below median zipcode (column 1 & 3) and has credit score below 620 (column 2 & 4). *Loan Age* corresponds to the time since origination, measured in years. Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Foreclosure (p.p)		Bankruptcy (p.p)	
	$\text{Income}_{<Median}$	Subprime	$\text{Income}_{<Median}$	Subprime
	(1)	(2)	(3)	(4)
Middle × Bank × Category	-0.015**	-0.007	-0.011	-0.009
	(0.006)	(0.012)	(0.011)	(0.018)
Post × Bank × Category	-0.002	0.067***	0.006	0.028
	(0.009)	(0.015)	(0.018)	(0.024)
Middle × Category	0.014**	0.025**	0.012	0.020
	(0.006)	(0.011)	(0.011)	(0.017)
Post × Category	0.013	0.017	0.003	0.014
	(0.008)	(0.012)	(0.018)	(0.023)
Middle × Bank	0.004	-0.001	0.013*	0.010**
	(0.003)	(0.002)	(0.007)	(0.005)
Post × Bank	0.013***	-0.0004	0.034***	0.031***
	(0.004)	(0.003)	(0.013)	(0.008)
Loan FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
Loan Age	Yes	Yes	Yes	Yes
N	8,477,621	8,724,784	8,477,621	8,724,784
R^2	0.618	0.628	0.769	0.765

Table E3

Servicer Level Summary Statistics

This table reports summary statistics for servicer level portfolio between 2011-2015. Panel A presents the statistics for all years, Panel B and C summarize years 2011 and 2015 respectively. The servicer-year panel is constructed from a one percent sample of outstanding mortgages. Standard deviations are reported in brackets.

	All	Banks	Non Banks
	(1)	(2)	(3)
A. All Years			
Vantage Score	717	717	716
	(68)	(67)	(69)
Income	51,125	51,568	50,593
.	(19,949)	(22,454)	(16,425)
% FHA	2.70	1.71	3.89
	(12.01)	(8.98)	(14.74)
% Foreclosure (if 60+Dpd)	15.96	17.29	14.62
	(28.97)	(29.54)	(29.77)
% Foreclosure (if 90+Dpd)	20.96	21.20	20.69
	(29.81)	(30.50)	(30.67)
% Foreclosure (if 120+Dpd)	26.12	22.57	30.02
	(34.13)	(30.49)	(39.03)
B. 2011			
Vantage Score	716	718	714
	(72)	(69)	(76)
Income	50,511	50,740	50,225
.	(20,467)	(23,103)	(16,604)
% FHA	1.91	1.25	2.72
	(10.10)	(7.31)	(12.68)
% Foreclosure (if 60+Dpd)	19.70	13.06	23.68
	(34.14)	(17.56)	(42.80)
% Foreclosure (if 90+Dpd)	27.25	19.78	31.73
	(33.81)	(26.20)	(39.88)
% Foreclosure (if 120+Dpd)	28.15	20.63	32.65
	(33.25)	(25.54)	(39.25)
C. 2015			
Vantage Score	722	723	722
	(66)	(65)	(67)
Income	50,898	51,197	50,542
.	(18,967)	(20,722)	(16,640)
% FHA	2.84	1.66	4.23
	(12.38)	(8.98)	(15.35)
% Foreclosure (if 60+Dpd)	20.18	30.00	0.55
	(19.72)	(14.14)	(-)
% Foreclosure (if 90+Dpd)	22.36	33.08	0.92
	(22.71)	(18.49)	(-)
% Foreclosure (if 120+Dpd)	22.43	33.08	1.15
	(22.60)	(18.49)	(-)

Table E4

Summary Statistics for Third Party Assignment Sample

This table reports summary statistics for sample of outstanding mortgages between 2011-2015 with information on originators. This is a static sample with only information as of origination. Standard deviations are reported in brackets.

	All	Banks	Non Banks
	(1)	(2)	(3)
Number of Originators	2,753	807	1,946
Number of Loans (in Millions)	2.49	2.00	0.49
% of Loans Initially Assigned	0.85	0.91	0.55
% of Portfolio Loans	0.04	0.03	0.11
% of Bank Serviced Loans	0.87	0.96	0.53
% of Non-Bank Serviced Loans	0.09	0.01	0.36
Loan Amount	227,732	228,037	226,571
	(145,657)	(150,688)	(125,221)
Loan Term	311	307	325
	(79)	(81)	(71)
Vantage Score	741	743	734
	(62)	(62)	(62)
Income	60,626	61,056	58,844
.	(35,958)	(36,734)	(32,683)

Table E5

Are Banks More Likely to Assign MSRs After MSR Regulation

This table presents loan level difference-in-difference regression results from Equation A4. The underlying sample includes a random sample of all loan observations with information on origination lender. The outcome variable *Assignment* is an indicator for whether the first servicer observed for loan i differs from its originator. *Bank* is an indicator for whether the originator of loan i in the period before assignment is a bank. *Middle* indicates whether the time is between 2012Q2 and 2013Q2, and *Post* indicates whether the time is in or after 2013Q2. Servicer FE corresponds to servicer to whom the loan was assigned at origination and originator FE is the originator of the loan. Standard errors are clustered at zip code level. ***, **, * represent 1%, 5%, and 10% significance, respectively.

	Assignment			
	(1)	(2)	(3)	(4)
Middle x Bank	0.004***	0.001	-0.0002	0.0002
	(0.0002)	(0.001)	(0.0003)	(0.0004)
Post x Bank	0.002***	0.012***	0.004***	0.005***
	(0.0002)	(0.001)	(0.0004)	(0.0005)
Bank	-0.003***	-0.006***	0.680	0.563
	(0.001)	(0.0009)	(210.5)	(50.1)
Fixed-effects				
Servicer FE	Yes	Yes	Yes	Yes
Quarter FE		Yes	Yes	Yes
Originator FE			Yes	Yes
Loan Amount Decile				Yes
Loan Term Decile				Yes
Vantage Score Decile				Yes
Loan Type				Yes
Observations	2,243,896	2,243,896	2,243,896	1,867,836
R^2	0.774	0.775	0.931	0.933