# Credit Without Proximity: Informational Frictions and Unequal Gains from Technology *

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**Abstract**

Lenders screen applicants to limit default losses, but they do not fully internalize the surplus borrowers lose when imprecise screening rejects creditworthy applicants. We study this wedge in mortgage lending, where lenders choose between local and remote screening. Using U.S. administrative data linking mortgage applications, loan officers, and loan performance, we show that the same officers approve a larger share of observably similar applications when handling them locally, without evidence of higher default rates. Further evidence supports an informational advantage for local officers instead of borrower sorting, but lenders rely more heavily on remote officers in higher-wage markets. We estimate an equilibrium model of mortgage and loan-officer labor markets with endogenous screening of latent borrower risk. The estimates imply too little local screening relative to a constrained optimum. Credit rationing reaches up to 15 percent of applicants in the subprime refinance market; local officers roughly halve rationing while also reducing false approvals. A counterfactual increase in remote processing productivity, holding each officer type's precision fixed, shifts applications toward less precise remote screening. Credit rationing, false approvals, and expected default rates rise, while mortgage rates fall modestly.

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Financial intermediaries produce information about borrower risk through costly screening (Diamond, 1984; Leland and Pyle, 1977; Ramakrishnan and Thakor, 1984). How they organize this activity determines both its cost and the information available for lending decisions. When screening methods differ in cost and precision, lenders choose among them according to their expected contribution to profits. These choices need not maximize total surplus, because lenders do not fully capture the benefits borrowers receive when more accurate screening allows them to obtain credit. We study the efficiency of these production choices in the U.S. mortgage market, where lenders allocate screening labor between local and remote loan officers.

We combine administrative data on mortgage applications, loan officers, and loan performance with a structural model of mortgage and labor markets. Empirically, we provide evidence supporting an informational advantage for local loan officers, even as lenders rely more heavily on remote officers in higher-wage markets.. In the model, lenders choose their screening labor and set mortgage rates before observing borrower-specific information, which they subsequently use to approve or reject applications. Imprecise screening can lead lenders to reject applicants they would approve under full information ("credit rationing") and approve applicants they would otherwise reject. We show that, because lenders do not fully capture the borrower surplus lost through credit rationing, their incentives to use more informative local screening fall short of its social value. The estimated model implies substantial credit rationing—up to 15 percent of applicants in the subprime refinance market—with local officers reducing rationing by roughly half while also reducing false approvals. These screening errors provide a basis for evaluating productivity improvements that change lenders' input choices. A counterfactual increase in remote processing productivity, holding informational precision fixed, induces substitution toward remote officers, increasing credit rationing and expected default rates while lowering mortgage rates only modestly.

We document two empirical patterns that motivate the model's tradeoff between information production and labor costs. First, we show that applications handled by loan officers working in the applicant's county ("local officers") have higher approval rates in both home-purchase and refinance markets. This advantage persists when comparing applications handled by the same officer and controlling for borrower and loan characteristics, local market conditions, and lender-specific conditions. Among originated loans, we find lower default rates under local handling for home purchases and a small, statistically insignificant

default difference for refinancing. We also find economically small differences in mortgage rates. Local handling is associated with faster processing for refinance applications, while the home-purchase processing-time difference becomes small after accounting for lender and officer differences.

Second, we show that lenders rely more heavily on remote officers in higher-wage markets. Applications from markets with higher finance-sector wages are less likely to be handled locally, even when comparing observably similar applications at the same lender. We document the corresponding pattern in lenders' geographic staffing: higher-wage metropolitan areas exhibit larger gaps between their share of a lender's applications and their share of its loan officers. These findings connect lenders' allocation of screening labor to geographic differences in labor costs.

We then examine whether the local advantage reflects better information or a more favorable applicant pool. Our conceptual framework shows that, absent sorting of unobservably safer applicants toward local officers, the joint approval and default patterns imply an informational advantage. Distinguishing these explanations matters for the model: better information improves screening of a given applicant pool, whereas sorting changes the pool that local officers face. We use several empirical tests to assess the role of each mechanism.

We find that local rejection decisions are less closely tied to standardized borrower and loan characteristics. The same set of observed characteristics explains less of the variation in rejection decisions under local handling, including in specifications that account for lender, officer, and local market conditions. We also show that the local approval advantage is largest among applicants with low credit scores, high debt-to-income ratios, or high loan-to-value ratios, without evidence of higher default in these groups. These findings support the interpretation that local officers produce information beyond standardized application fields and that this information is particularly valuable for evaluating observably riskier applicants.

We further show that the local advantage appears in the relationship between approval decisions and subsequent default, with little corresponding difference in the relationship between mortgage rates and default. After accounting for observed characteristics and fixed effects, the rejection–default relationship is flatter under local handling, while the interest-rate–default relationship is similar across local and remote handling. Our conceptual framework distinguishes these patterns: when screening information can be incorporated into mortgage rates, more precise information predicts a tighter rate–default relationship; when

rates are set before screening and subsequent adjustments are limited, information operates primarily through approval decisions. The evidence supports the latter case and motivates the model's treatment of underwriting information.

Finally, our parametric test finds no evidence of advantageous sorting within lenders. The test uses the finding that local officers are scarcer relative to application demand in higher-wage markets. Under the sorting explanation captured by the test, this scarcity should allow local officers to select a more favorable applicant pool, producing a larger local rejection advantage. Within lenders, however, we find no statistically detectable increase in that advantage with local wages. Across lenders, the evidence instead points toward a somewhat less favorable applicant pool at lenders employing more local officers. Together with the preceding tests, these results support an informational interpretation of the local advantage.

Taken together, these findings point to a tradeoff between the informational benefits of local screening and the labor costs of providing it. They leave open how much credit rationing and how many false approvals result from imperfect information, whether lenders' screening choices are efficient, and how these outcomes change when remote processing becomes more productive.

We develop a model of mortgage and loan-officer labor markets to address these open questions. Lenders set mortgage rates before observing borrower-specific underwriting information, hire officers to process applications, and use the resulting signals of default risk to approve or reject loans. Officers differ in informational precision and processing productivity, and their hiring costs depend on local labor-market conditions. Taking each officer type's technology as given, lenders choose the mix of local and remote officers and assign applications subject to their processing capacity. Lenders therefore determine how much of their application flow benefits from more precise screening by weighing its contribution to expected profits against the cost of providing it.

We allow mortgage rates to affect both the volume and risk composition of applications. Borrowers choose lenders based on posted rates and lender characteristics, with a correlation between price sensitivity and latent risk generating selection into each lender's applicant pool. Loan officers choose employers and locations based on wages and location preferences, so lenders' wage offers determine their access to local and remote screening capacity. These interactions link loan terms to input choices: applicant risk affects the return to more precise

screening, while wages and processing productivity determine its cost. In turn, screening affects approval rates and expected default losses, changing the rates lenders find profitable to offer.

We show that lenders' private valuation of local screening can fall short of its social value. To characterize this gap, we consider a constrained planner who reallocates applications between local and remote officers, taking posted rates, applicant pools, and lenders' approval rules as given and facing the same labor cost schedule. The model assumes that borrowers do not adjust their lender choices for differences in approval probabilities generated by local versus remote screening. The wedge between the planner's and the lender's valuation of local screening is then the additional expected borrower surplus it generates. Rejecting an applicant whose loan would yield little lender profit can still destroy substantial borrower surplus, leaving lenders with insufficient incentives to prevent such rejections.

We derive a condition under which this wedge implies too little local screening in equilibrium. When the borrowers whose approval local screening adds receive at least as much expected surplus on average as those whose approval it removes, a higher local approval rate implies that the planner prefers more local screening. Expected surplus accounts for the probability that a loan performs, and the condition holds at the estimated parameters. A subsidy per application assigned to local officers, equal to the additional expected borrower surplus, implements the planner's allocation. Market power affects this wedge through the division of gains from lending between lenders and borrowers. The wedge vanishes if lenders capture all of these gains; otherwise, its magnitude depends on the borrower surplus that screening preserves.

We jointly estimate the distribution of latent borrower risk, the signal precisions of local and remote officers, and the correlation between risk and price sensitivity. Approval rates and default rates among originated loans jointly discipline borrower risk and screening precision, with the local approval and default advantages providing information about the difference between officer types. The relationship between mortgage rates and subsequent default is informative about selection on latent risk. Labor shares across officer types discipline wage-adjusted processing efficiency, while lender market shares discipline demand shifters, conditional on the calibrated demand and labor-supply parameters. We also recover aggregate shocks that reconcile expected and realized default rates across mortgage segments. These estimates allow us to quantify both rejection of creditworthy applicants

and approval of applicants whose expected losses exceed the lender's margin.

The estimated model implies that local screening primarily reduces credit rationing. We measure rationing as rejection of applicants whose expected default losses would warrant approval at the posted rate under full information, and false approvals as approval of applicants who fail that benchmark. Rationing reaches up to 15 percent of applicants in the subprime refinance market, and local officers reduce it by roughly half, with the largest reductions in lower-credit-quality and refinance markets. Local officers also reduce false approvals, which are less frequent than false rejections at the estimated parameters. These results distinguish the contribution of local screening to credit access from its contribution to the risk of originated loans. Both errors are measured relative to the lender's full-information approval rule; their welfare consequences also depend on borrower surplus.

We use the model to examine a counterfactual increase in remote officers' processing productivity, holding their informational precision fixed. Lenders respond by substituting toward remote officers, so a larger share of applications is screened using less precise signals. We find that this reallocation raises both credit rationing and false approvals, with particularly large increases in subprime and near-prime purchase markets. Rationing can rise even when the overall rejection rate falls, because additional false approvals offset some of the increase in false rejections. Expected default rates rise, while posted mortgage rates fall modestly: the implied payment reduction is at most about $25 per month for the illustrative mortgage considered in the counterfactuals. The productivity gains therefore lower borrowing costs while also changing which applicants receive credit and the risk of approved loans.

We also find that the technology shock's effect on realized default rates varies with aggregate conditions. The additional false approvals can amplify increases in default during downturns. In sufficiently severe downturns, however, default probabilities on these loans approach saturation, while the additional credit rationing excludes other loans whose default probabilities would rise sharply. This change in the composition of originated loans attenuates and can reverse the increase in realized default rates. Benchmarking aggregate shocks against default rates during the global financial crisis, we find that the positive default effect persists in subprime and near-prime purchase markets even under shocks larger than the crisis benchmark. In prime purchase markets, the effect dissipates around that benchmark.

**Literature Review.** Our paper contributes to the literature on how informational frictions shape credit allocation (Adams et al., 2009; Einav et al., 2012; Crawford et al., 2018; DeFusco et al., 2022). Studies of mortgage markets also quantify the roles of search, market power, and constraints on lending (Allen et al., 2014, 2019, 2025; Buchak et al., 2018; Benetton, 2021; Jiang, 2023).[1] We are particularly close to Agarwal et al. (2024), who show how rejection risk shapes borrower search and equilibrium mortgage rates. We build on their emphasis on approval decisions by modeling lenders' choice of the labor inputs used to screen applications. This production choice determines the information available for lending decisions and links mortgage-market competition to regional labor markets. Our analysis also builds on work on credit rationing under imperfect information (Stiglitz and Weiss, 1981; Jaffee and Modigliani, 1969). Related work examines lenders' incentives to invest in screening (Yannelis and Zhang, 2023) and the role of additional lender screening in government-sponsored mortgage lending (Bosshardt et al., 2025). We use this framework to quantify credit rationing generated by imperfect screening and to characterize the difference between private and social returns to local information production.

A related literature examines how data quality and statistical prediction affect credit allocation (Fuster et al., 2022; Berg et al., 2020; Blattner and Nelson, 2021). Related work studies the design and regulation of credit information and lending technologies (Blattner et al., 2021, 2022; Cherry, 2025). We study productivity improvements that change the relative cost of screening inputs while leaving each officer type's informational precision unchanged. We show that the resulting substitution toward remote officers can increase credit rationing and expected default rates even as origination costs fall. Our contribution is to show how productivity improvements affect equilibrium information production through lenders' input choices. This adjustment matters for welfare because lenders do not fully capture the borrower surplus preserved by more precise screening.

Our paper also relates to studies of the geographic organization of banking and capital markets (Ji et al., 2023; Maingi, 2026; D'Amico and Alekseev, 2024; Morelli et al., 2025). Aguirregabiria et al. (2025) link deposit and loan markets across locations and quantify how branch networks, scope economies, and local competition affect geographic credit flows. Their framework highlights how the geographic distribution of funding and lenders' operations shapes access to credit. We study the geographic allocation of loan-officer labor, an

[1] Related work examines deposit markets (Egan et al., 2017; Xiao, 2020), payment networks and digital currency (Wang, 2025; Whited et al., 2022), and credit cards (Nelson, 2025).

input whose location affects both origination costs and the information available for screening. This margin connects to work on geographic proximity, organizational structure, and the use of information in lending (Petersen and Rajan, 2002; Berger et al., 2005; Agarwal and Hauswald, 2010; Liberti and Mian, 2008). Complementary reduced-form evidence in Huang et al. (2025) documents the role of local loan officers in credit availability and households' refinancing outcomes. Our approach also relates to work on the geographic organization of production (Bernard et al., 2019; Oberfield et al., 2024; Giroud et al., 2024; Arkolakis et al., 2025; Boehm et al., 2019) and international production (Antràs et al., 2006; Costinot et al., 2012; Ramondo and Rodríguez-Clare, 2013). We characterize an inefficiency in lenders' choice of inputs that bundle processing capacity with informational precision. Lenders internalize processing costs and expected loan profits, but not the full borrower surplus generated by more precise screening. Consequently, privately optimal input choices can provide too little information. Our counterfactuals show how productivity improvements favoring less precise inputs increase credit rationing even as production costs fall. This mechanism may also arise in other screening activities, such as employers' choice between in-person, remote, and automated interviews.

# 1 Data

Our analysis combines three primary data sources: (i) the Nationwide Mortgage Licensing System and Registry (NMLS) loan officer database, (ii) confidential Home Mortgage Disclosure Act (HMDA) loan-level application records, and (iii) Black Knight McDash loan performance data. Together, these datasets allow us to observe where loan officers work, which loan officers process which applications, origination outcomes, and how originated loans subsequently perform.

**Loan officer data (NMLS).** We begin with administrative records from the Nationwide Mortgage Licensing System and Registry (NMLS), which—under the Secure and Fair Enforcement for Mortgage Licensing Act of 2008 (SAFE Act)—requires every residential mortgage loan officer to maintain a unique license or registration. We obtain the universe of registered and federally licensed mortgage loan officers from 2015 onward.

From these records, we construct a longitudinal dataset containing each loan officer's

unique identifier, employer, and work location. Reported locations take one of three forms: *Branch*, *Main*, or *Work*. "Branch" refers to a specific branch office for state-regulated institutions; "Main" refers to the corporate address; and "Work" reflects the individual's actual work address for federally regulated institutions rather than the corporate headquarters. When multiple locations are reported for state-regulated lenders, we prioritize branch locations over main-office addresses. These data allow us to geocode each officer's work location and measure geographic proximity to each applicant.

**Loan application and underwriting data (Confidential HMDA).** We merge loan officer locations to confidential HMDA, an administrative dataset maintained by the Federal Reserve System that contains near-universe coverage of U.S. mortgage applications. Confidential HMDA includes lender identity, borrower and loan characteristics, applicant location, application and action dates, application outcomes, Automated Underwriting System (AUS) recommendations, and—critically for our purposes—a unique identifier for the loan officer who processed each application beginning in 2018. These data allow us to match individual applications to the specific loan officers who handled them.

**Loan performance data (McDash).** To measure ex-post outcomes, we merge originated loans in confidential HMDA to monthly servicing records from the Black Knight McDash dataset. Following Rosen (2011), we match loans on origination details, loan terms, and borrower characteristics. The merged dataset covers approximately 36% of approved loans in confidential HMDA and 68% of loans in McDash. For each matched loan, we construct a two-year delinquency indicator equal to one if the loan becomes 60+ days delinquent within 24 months of origination. To ensure a full performance window, we restrict the main estimation sample to applications submitted during 2018–2019.

**Merged Sample and Measures** After merging NMLS, confidential HMDA, and McDash, we obtain a loan-level dataset in which we observe the loan officer who processed each application, the officer's geographic location, rich borrower- and loan-level observables at application, lender identity and local market characteristics, approval or denial outcomes, interest rates on originated loans, and subsequent loan performance for matched originations. We classify loan officers as either *local* or *remote*. In the baseline specification, a loan officer

is *local* if the officer's work location is in the same county as the applicant, and *remote* otherwise. We also consider a continuous measure of proximity given by the geographic distance between the borrower and the loan officer's office. Appendix B provides additional details on sample construction.

Table 1 presents the summary statistics. These linked data provide the key objects needed to study the production of borrower information at the loan-officer level, including approval decisions, processing times, pricing, ex-post loan performance, and the allocation of underwriting labor across space.

# 2 Institutional Setting

Mortgage origination in the United States separates *pricing* from *underwriting*. Lenders post rate sheets and loan officers quote interest rates before any verified information is collected. Once a borrower submits a formal application, the lender must issue a Loan Estimate within three business days, after which TRID rules sharply restrict upward repricing.[2] Because lenders generally cannot freely adjust pricing upward after reviewing documents, approval decisions—rather than ex-post rate adjustments—are the primary mechanism for responding to borrower risk.

Loan officers play a central role in information production. They assemble income, asset, employment, and collateral documentation; underwriters rely on these materials and generally do not collect additional information themselves. Incomplete or inconsistent files frequently lead to denials, making the quality of information produced by the loan officer a key determinant of approval outcomes.

This role of loan officers makes the distinction between *local* and *remote* officers central for our analysis. Local officers operate within the borrower's market and can coordinate directly with local employers, real estate agents, appraisers, and title companies. Remote officers—often located in centralized hubs—rely primarily on phone or digital communication and face greater frictions in resolving documentation issues. Because rates cannot be freely adjusted after underwriting begins, these differences in information-production efficiency are

[2]Specifically, changing terms generally requires restarting the origination and disclosure process, which can delay closing and is costly for lenders. For example, Chase Bank offers a $5,000 guarantee that it will meet an agreed upon closing date (J.P. Morgan Chase & Co., 2025). See Appendix A for additional institutional and regulatory details.

more likely to affect approval outcomes and processing time than ex-post loan pricing.

In Appendix C, we formally model these institutional features in a simple model of mortgage origination to derive testable empirical predictions. Rather than assuming a priori that TRID rules fully eliminate ex-post repricing, we first consider a general case where banks can still incorporate ex-post information into their pricing decisions. In this case, the model makes a sharp prediction: superior information leads prices to be more tightly linked to ex-post default among observably similar borrowers. Conversely, when ex-post repricing is curtailed, informational differences manifest primarily through the approval margin, jointly affecting realized default rates and approval rates. This distinction organizes our interpretation of the empirical results and illustrates why joint patterns in approval, default, and pricing are critical to understanding the quality of information production.

# 3 Reduced-Form Evidence

We begin by documenting two reduced-form facts about information production and the allocation of origination activity in mortgage lending, together with evidence on the underlying mechanism.

## 3.1 Fact 1: Local Origination Improves Loan Outcomes

We begin by showing that local loan officers are associated with superior lending outcomes along two dimensions: the *quality* of underwriting decisions—reflected in approvals, pricing, and ex-post default—and the *physical efficiency* of underwriting, reflected in the speed with which applications move through the pipeline. We formalize this comparison using the following specification:

$$Y_{i\ell ct} = \beta \, \text{Local}_{i\ell ct} + \gamma' X_{i\ell ct} + \delta_{c\tau} + \lambda_{\ell\tau} + \mu_o + \varepsilon_{i\ell ct}, \tag{1}$$

where $Y_{i\ell ct}$ is alternatively an indicator for rejection, an indicator for default within two years of origination, the interest rate on originated loans, or the number of days between application and action on originated loans; $\text{Local}_{i\ell ct}$ equals one when the reviewing officer is local to the borrower; $X_{i\ell ct}$ includes detailed borrower and loan observables, including AUS

recommendations; $\delta_{c\tau}$ and $\lambda_{\ell\tau}$ are county–month and lender–month fixed effects; and $\mu_o$ are loan-officer fixed effects. This specification isolates variation in whether an application is handled locally or remotely, conditional on rich borrower and loan controls, county–month fixed effects, lender–month fixed effects, and loan-officer fixed effects. County–month fixed effects absorb local market conditions, while lender–month fixed effects absorb lender-specific pricing and underwriting policies at a point in time. Most importantly, our ability to include loan-officer fixed effects as a robustness test ensures that the estimates are identified from within-officer variation in proximity rather than from permanent differences in officer quality.

Tables 2 and 3 present the results. Panels A–C of Table 2 report rejection, interest-rate, and ex-post default outcomes, respectively, while Table 3 reports processing-time outcomes.

**Approval decisions.** Panel A of Table 2 shows that local handling is associated with significantly lower rejection rates in both home-purchase and refinance markets. In columns (1) and (4), the local coefficient is $-1.881$ percentage points for home-purchase loans and $-7.898$ percentage points for refinance loans. Once lender–month fixed effects are added in columns (2) and (5), the magnitudes decline to $-0.643$ and $-2.855$ percentage points, indicating that part of the raw local/remote difference reflects which lenders rely more heavily on local versus remote handling. In columns (3) and (6), after adding loan-officer fixed effects, the coefficients remain statistically significant at $-0.202$ percentage points for home-purchase loans and $-0.655$ percentage points for refinance loans. Thus, even comparing the same officer handling observably similar applications, local proximity continues to expand approval. Appendix Table A1 shows the same qualitative pattern using continuous distance.

**Loan pricing.** Panel B of Table 2 shows that the pricing effects are much smaller than the approval effects, but not uniformly zero. In the less saturated specifications, local handling is associated with slightly higher interest rates: for example, in column (2), the local coefficient is 0.010 percentage points for home-purchase loans and 0.037 percentage points for refinance loans. A natural interpretation is that lenders with better local information production may be willing to post or sustain somewhat higher rates, knowing that they can better screen the riskier applicant pool those rates attract. However, once lender–month and especially loan-officer fixed effects are included, the remaining within-officer pricing effect is very small: $-0.002$ percentage points for home-purchase loans and 0.009 percentage points for refinance

loans.

**Ex-post performance.** Panel C of Table 2 shows that the additional approvals under local handling do not worsen realized loan performance. For home-purchase loans, local handling is consistently associated with lower ex-post default, implying that local information production not only expands approval but also improves the selection of approved borrowers. For refinance loans, the raw cross-sectional association is positive, but it falls sharply once lender–month and loan-officer fixed effects are included and becomes economically and statistically close to zero in the most saturated specification. This pattern suggests that the raw refinance default difference is largely driven by sorting across lenders and officers rather than by proximity itself. Appendix Table A1 shows the same qualitative pattern using continuous distance: greater distance predicts higher default for home-purchase loans, while the refinance relationship vanishes in the saturated specifications.

**Processing speed.** The first three margins concern the *quality* of underwriting decisions. Table 3 turns to a complementary *physical efficiency* margin: how quickly applications move through the underwriting pipeline. For home-purchase loans, local handling appears faster in the less saturated specifications, but the effect becomes small and statistically insignificant once lender–month and loan-officer fixed effects are included. For refinance loans, by contrast, the local advantage remains economically meaningful and robust: in the most saturated specification, local handling shortens processing time by more than one day. The distance-based specifications in Table A2 yield the same qualitative conclusion, with greater borrower–officer distance associated with slower processing. Taken together with Panels A–C of Table 2, these results show that local handling delivers faster processing alongside—not at the expense of—higher-quality underwriting decisions.

## 3.2 Fact 2: Lender Labor Allocation Choices

Fact 1 establishes the *benefits* of local handling. These benefits are not free: local underwriting capacity must be paid local wages, which vary substantially across markets. We next examine how lenders trade off these costs and benefits when allocating loan officers across space.

We begin by examining how individual applications are allocated across local and remote loan officers. Columns (1)–(2) of Table 4 show that applications from higher-wage markets are less likely to be handled by local loan officers. We measure local labor-market conditions using the MSA-level finance-sector hourly wage from the Bureau of Labor Statistics, assigning each borrower the wage of the MSA in which the borrower's county is located. This measure is less susceptible than loan-officer wages to reverse-causality concerns arising from lenders' own local hiring decisions. The relationship remains negative after controlling for borrower and loan characteristics and absorbing lender–year and state–year fixed effects.

These assignment patterns aggregate into systematic market-level mismatch. To measure this, we construct a lender-level spatial imbalance index:

$$\text{Misalignment}_{jkt} = \frac{m_{jkt}}{M_{jt}} - \frac{l_{jkt}}{L_{jt}}, \tag{2}$$

where $\frac{m_{jkt}}{M_{jt}}$ is the share of lender $j$'s applications from MSA $k$ in year $t$, and $\frac{l_{jkt}}{L_{jt}}$ is the share of its loan officers located there. Positive values indicate that a market contributes more to a lender's application flow than to its local officer capacity. We then estimate:

$$\text{Misalignment}_{jkt} = \beta \, \text{Wage}_{kt} + \gamma_t + \gamma_{jt} + \mathbf{X}_{kt}\delta + \varepsilon_{jkt}, \tag{3}$$

where $\text{Wage}_{kt}$ is measured using local finance-sector wages, $\gamma_t$ are year fixed effects, $\gamma_{jt}$ are lender–year fixed effects, and $\mathbf{X}_{kt}$ denotes MSA-level controls, including employment rates, income per capita, and earnings per job.

Columns (3)–(5) of Table 4 show that higher local wages are strongly associated with greater misalignment. Lenders therefore place relatively less local underwriting capacity in higher-wage markets and rely more heavily on remote handling in those areas.

Figure 1 shows that these patterns generate systematic geographic mismatch: many high-demand counties are served by relatively little local underwriting capacity, while some lower-demand counties host more officers than demand would predict. Figure 2 shows that these wedges are especially pronounced in the highest-demand areas.

Thus, even though local handling improves approval decisions and sometimes speeds processing, lenders do not allocate local underwriting capacity solely according to where it is most valuable. Instead, labor allocation responds strongly to local wage differentials,

creating spatial mismatches between where mortgage demand arises and where local officer capacity is located.

## 3.3 Mechanism: Evidence for an Informational Advantage

The evidence thus far outlines a clear optimization problem: lenders reap substantial private underwriting benefits from local loan officers (Fact 1), but must weigh these gains against spatial wage differentials that often raise the cost of local processing (Fact 2). To formalize potential mechanisms, Appendix C develops a screening model in which a lender sets an ex-ante rate, observes a noisy signal of borrower risk after the application is submitted, and decides whether to approve. A central result of this framework is that, in the absence of sorting of unobservably superior applicants to local officers (*advantageous sorting*), the outcomes documented in Fact 1 are a sufficient condition for an informational advantage: at least one of these two forces must be present to generate the pattern we document. From the lender's point of view, both represent a private benefit, but for industry equilibrium, the welfare consequences depend on their relative importance. We therefore present a series of qualitative tests, complemented by a parametric test for sorting that builds on Fact 2; our results below point to information production as the primary driver of the local advantage, with no detectable role for advantageous sorting within lenders.

**Use of codified hard information.** A long literature in finance has argued that "soft information," best collected in nearby, face-to-face interactions, can yield superior informational efficiency (Petersen and Rajan, 1994; Berger and Udell, 1995). While soft information is not directly observable, we can test whether local officers collect it by comparing how much of the rejection decision is explained by codified hard information for local versus remote handling. Table 5 shows that across increasingly saturated specifications, the $R^2$ is consistently lower for local handling, even though both sets of regressions condition on the same borrower and loan characteristics (including AUS recommendations) and the richer specifications absorb county–month, lender–month, and loan-officer fixed effects. Local approval decisions therefore rely less on codified information, consistent with local officers producing additional soft information not captured in standardized application fields.

**Information appears in approvals, not pricing.** The framework in Appendix C delivers a sharper prediction about *where* an informational advantage shows up. The key distinction is whether the lender can adjust the rate after observing the underwriting signal. If it can, the lender uses the signal both to screen out bad risks and to price the remaining ones more finely; better signals then tighten the relationship between realized rates and realized default. If it cannot—as under TRID, which constrains upward repricing after the loan estimate is issued—the ex-ante rate is pinned down by the break-even condition over the ex-ante risk distribution, so the underwriting signal can affect only the approval decision. A more precise signal therefore expands approval at the same realized default rate, while leaving the rate–default relationship unchanged. Figure 3 shows the pattern predicted by the constrained-pricing case: the (residualized) rejection–default relationship is markedly flatter for local officers than for remote officers, while the relationship between (residualized) interest rates and default is nearly identical across the two groups. This bifurcation is difficult to reconcile with explanations in which superior information is incorporated into pricing, or in which officers steer better borrowers to apply locally—both of which would predict a tighter rate–default relationship for local officers.

**Heterogeneity and risk.** If local information helps distinguish among applicants who look similar on codified hard information, its value should be greatest where residual uncertainty is most severe. Because unobserved heterogeneity in credit risk tends to be positively correlated with the average credit risk of a segment (e.g., Iyer et al., 2016), the local advantage should be largest in high-risk segments. Table 6 confirms this: interacting *Local* with indicators for Subprime, High DTI, and High LTV yields significantly larger reductions in rejection for these groups, with no deterioration—and if anything, an improvement—in realized performance. Heterogeneity in pricing is limited by comparison. Figure 4 provides complementary nonparametric evidence within narrow FICO, DTI, and LTV bins. Together, these results indicate that local information production is most valuable precisely where codified hard information is least sufficient for distinguishing safer from riskier applicants.

**Direct test for sorting.** The patterns above are consistent with superior information production but do not directly speak to whether local officers also face a more favorable borrower pool. Nonparametric tests for sorting are infeasible here, since selection operates through rejection and censors the default risk of screened-out applicants. We therefore

develop a parametric test that builds on Fact 2. The logic is a limit argument: if the local advantage were driven by advantageous sorting, its magnitude should diminish as local officers process a larger share of the market. Because Fact 2 shows that local finance wages strongly predict local-officer scarcity, a sorting explanation predicts that the local advantage should be larger in high-wage markets, where local officers are scarce and best positioned to cream-skim. The design also distinguishes sorting *across* lenders from sorting *within* lenders—a distinction relevant for the equilibrium analysis in Section 4.

Table 7 reports the results. Without lender–month fixed effects, the local rejection advantage is somewhat smaller in higher-wage markets, suggesting that lenders employing more local officers may face a less favorable borrower pool on average—a pattern more consistent with adverse than advantageous sorting across lenders. Once lender–month fixed effects are introduced, these interactions attenuate toward zero and are statistically insignificant. The within-lender estimates emphasized throughout this section therefore appear unlikely to be driven by advantageous sorting, while some across-lender selection remains possible and is revisited in the structural analysis.

**Interpretation.** Taken together, these results match the patterns implied by an informational advantage when ex-post risk cannot be priced. Because lenders set ex-ante rates and use underwriting-stage information only on the approval margin, better information shows up primarily as more approvals at similar or better realized performance, rather than as more refined pricing. This is precisely what we find: local handling materially expands approval, has modest effects on pricing, does not worsen default, relies less on codified hard information, is most valuable in observably risky segments, and is not appreciably weakened where sorting incentives would be strongest. The reduced-form evidence is therefore naturally interpreted as reflecting an informational advantage of local handling.

## 3.4 Discussion and Implications for Modeling

The reduced-form evidence documents both the benefits and the costs of local officers, and characterizes the mechanism behind them. Fact 1 establishes the benefits: applications handled locally are approved more often without worse ex-post performance, and refinance applications are processed faster, with both results identified from within-officer variation

in proximity. Fact 2 establishes the costs: local officers require paying local wages, and lenders respond strongly to wage differentials, allocating local capacity away from high-wage markets and creating spatial mismatches between where mortgage demand arises and where local underwriting capacity is located. Section 3.3 identifies the mechanism: a battery of qualitative tests, together with a parametric test for sorting, indicates that the local advantage reflects superior information production rather than a more favorable applicant pool.

These patterns have direct implications for the industry equilibrium characterized in our structural model. Local loan officers produce superior information, which simultaneously expands credit access and reduces realized risk—a private benefit to the lender that is also a social benefit. At the same time, the absence of advantageous sorting toward local officers within lenders suggests that borrowers do not internalize the informational benefits of proximity when choosing where to apply.[3] Combined with lenders' high sensitivity to local outside-option wages, this raises the possibility that lenders over-rely on remote processing in equilibrium, generating credit-rationing externalities that market competition does not fully discipline. The structural model developed in Section 4, disciplined by the moments documented above, allows us to quantify this wedge and to evaluate how shocks that improve remote processing productivity alter credit access, default risk, and welfare.

# 4 Structural Model

To quantify the impact of information frictions and technological changes on credit allocation, we develop a structural model that links product market competition over mortgages with the labor market for loan officers. The core of the model is an information-production problem over latent borrower risk. Information is generated by loan officers who differ across locations in both their informational efficiency and physical efficiency. Borrowers differ in an unobserved type that affects expected repayment and, consequently, lender profits. Consistent with TRID rules, lenders must set posted rates based strictly on ex-ante information;

[3]The across-lender evidence in Section 3.3 suggests some adverse sorting across lenders, but within-lender estimates provide a clean measure of informational advantages that is uncontaminated by these selection effects. We therefore abstract from across-lender sorting in the quantitative model. Extending the model to incorporate such sorting is straightforward; we make this choice out of conservatism, since incorporating across-lender sorting would further widen the wedge between the private and social benefits of local loan officers and strengthen our equilibrium-misallocation results.

therefore, any additional information generated during underwriting is only used to manage risk on the approval margin. We endogenize this information production through the lender's organizational choice between local and remote loan officers, trading off the higher informational efficiency of local underwriting against the lower cost and greater physical efficiency of remote processing. Finally, we embed this organizational choice within a broader market equilibrium. Borrowers sort across lenders based on posted rates and lender characteristics, lenders compete simultaneously in the mortgage and labor markets, and loan officers optimally supply their labor. As a result, posted rates, applicant composition, information-production choices, approval decisions, and realized borrower default rates are all jointly determined in equilibrium.

## 4.1 Primitives and Timing

A market is defined by a unique combination of credit quality, loan purpose, county, and year-quarter (e.g., subprime × home purchase × Los Angeles County × 2018Q1). Markets are therefore segmented by ex-ante observable hard information. The economy consists of a collection of independent markets indexed by $i \in \mathcal{N}$. Each market $i$ is associated with a geographic region $g(i) \in \mathcal{K}$, where $\mathcal{K}$ denotes the set of regions in which loan officers may live. In each market, there is a mass $\mathcal{M}_i$ of potential borrowers and a set of lenders $\mathcal{J}_i$. Each lender $j$ operates in the set of markets $\mathcal{I}_j \subseteq \mathcal{N}$.

A potential borrower $\eta$ in market $i$ is characterized by price sensitivity $\theta_\eta$ and latent default risk $x_\eta$, drawn from the joint distribution $F_i^{x,\theta}$, with idiosyncratic preferences over lenders drawn from $F_i^{\epsilon}$. A mass $\bar{L}$ of potential loan officers chooses a job and where to live by selecting a tuple $(i, j, k)$—a market $i$ in which to process applications, a lender $j$ to work for, and a region $k \in \mathcal{K}$ in which to live—or a region-specific outside option paying $w_{ook}$. An officer who chooses tuple $(i, j, k)$ has *informational efficiency* pinned down by her screening noise standard deviation $\sigma_{ik}$, *physical efficiency* pinned down by her processing capacity of $e_{ijk}$ applications, and idiosyncratic preferences drawn from $F_{ijk}^{A}$. Lenders know all primitive distributions but not individual realizations; in particular, $x_\eta$ depends on hard-to-verify characteristics that are recoverable only through costly screening.

The timing in market $i$ unfolds as follows:

1. **Pricing and wage posting:** Lenders simultaneously post rates and wages under

Bertrand–Nash competition in both markets.

2. **Borrower application:** Each borrower observes posted rates and chooses one lender.
3. **Officer choice:** Each officer observes the full wage vector and chooses her tuple.
4. **Screening:** Lenders assign incoming applications across hired officers, who then generate signals of borrower risk.
5. **Origination:** Lenders observe the signals and decide which applications to approve. Because TRID prevents repricing, approval is the only post-application adjustment margin.

With these primitives and the timing in place, we now turn to each building block of the equilibrium. The lender's problem (Section 4.2) develops the novel information-production problem in which lenders choose how to allocate screening labor across regions that differ in informational efficiency. Borrower demand (Section 4.3) and loan officer labor supply (Section 4.4) close the model using standard specifications, characterizing the application share $s_{ij}(r_{ij})$ and the supply function $l_{ijk}(\mathbf{w})$ that the lender takes as given.

## 4.2 Lender's Problem

We first state the lender's optimization problem; we then derive the screening technology that determines the origination probability $p_{ijk}$ and expected default rate $d_{ijk}$; finally, we characterize the optimal pricing and assignment decisions, with the latter capturing the local-versus-remote tradeoff at the heart of the paper.

Lenders maximize expected profits under rational expectations. Each lender $j$ chooses interest rates $r_{ij}$, wages $w_{ijk}$, and loan officer assignment shares $\mathcal{S}_{ijk}$ to maximize profits across all markets in which it operates, subject to loan officer capacity constraints.[4]

Define

$$p_{ijk} \coloneqq \mathbb{P}_{ij}\{orig; r_{ij}, k\}, \qquad d_{ijk} \coloneqq \mathbb{E}_{ij}[d_i(x_\eta) \mid orig; r_{ij}, k]$$

[4]We show in Appendix D.2 that treating the origination decision as a balance-sheet profit-maximization problem is equivalent to selling the loan in an informationally efficient securitization market. Appendix D.2 details the institutional mechanisms—such as put-back covenants—that support this benchmark and provides a framework for modeling cases in which this internalization is incomplete. When the market is not informationally efficient, the externalities from under-employment of geographically proximate screening labor become larger, leading to greater inefficiencies in equilibrium.

as the region-$k$ origination probability and expected default rate. The lender solves

$$\begin{aligned}\max_{\{r_{ij},w_{ijk},\mathcal{S}_{ijk}\}_{i\in\mathcal{I}_j,k\in\mathcal{K}}} \sum_{i\in\mathcal{I}_j}\sum_{k\in\mathcal{K}}\Big\{\mathcal{M}_i s_{ij}(r_{ij})\,\mathcal{S}_{ijk}\,p_{ijk}\,(r_{ij}-f_{ij}-d_{ijk}) - w_{ijk}l_{ijk}(w_{ijk})\Big\} \\ \text{s.t. } \mathcal{M}_i s_{ij}(r_{ij})\mathcal{S}_{ijk} \le l_{ijk}(w_{ijk})e_{ijk} \quad \forall i\in\mathcal{I}_j,\, k\in\mathcal{K}, \\ \textstyle\sum_{k\in\mathcal{K}}\mathcal{S}_{ijk}=1,\ \ \mathcal{S}_{ijk}\ge 0 \quad \forall i\in\mathcal{I}_j,\, k\in\mathcal{K}.\end{aligned} \tag{4}$$

The objective sums, across regions $k$, the volume of originated loans $\mathcal{M}_i s_{ij}\mathcal{S}_{ijk}p_{ijk}$ multiplied by the expected profit margin per loan $(r_{ij}-f_{ij}-d_{ijk})$, net of the wage bill $w_{ijk}l_{ijk}$. The constraints require that applications assigned to loan officers living in region $k$ not to exceed the screening capacity available there, and that all loans are assigned to screening.[5] Both $p_{ijk}$ and $d_{ijk}$ depend on the rate $r_{ij}$, through adverse selection in applicant composition (Section 4.3), and on the region $k$, through signal precision $\sigma_{ik}^2$; we derive them from the screening technology below.

**Information Production and Approval** An officer in region $k$ screening an application in market $i$ observes a noisy signal of the borrower's latent risk,

$$\hat{x}_\eta = x_\eta + \tilde{x}_{\eta k}, \qquad \mathbb{E}[\tilde{x}_{\eta k}]=0, \qquad \mathrm{Var}(\tilde{x}_{\eta k})=\sigma_{ik}^2,$$

where the noise variance $\sigma_{ik}^2$ exhibits spatial decay—motivated by Section 3.1 and minimized at $k=g(i)$. Default losses depend on latent risk through a monotone mapping $d_i(x_\eta)$ with $d_i'>0$. Given the posted rate $r_{ij}$ and per-loan funding cost $f_{ij}$, the lender approves if and only if

$$\mathbb{E}\big[d_i(x_\eta)\mid \hat{x}_\eta, k\big] \le r_{ij}-f_{ij},$$

which defines a cutoff set $\hat{\Delta}_{ij}(r_{ij},k)$ in signal space. The origination probability and expected default rate introduced above can therefore be written as

$$p_{ijk}=\mathbb{P}\Big(\hat{x}_\eta\in\hat{\Delta}_{ij}(r_{ij},k)\Big), \qquad d_{ijk}=\mathbb{E}\Big[d_i(x_\eta)\mid \hat{x}_\eta\in\hat{\Delta}_{ij}(r_{ij},k),k\Big].$$

Two channels jointly determine $p_{ijk}$ and $d_{ijk}$. The posted rate $r_{ij}$ shifts the risk composition of the applicant pool through adverse selection, governing *who* the lender screens. The signal

[5] For expositional simplicity, we develop the model with a recovery rate of zero on defaulted loans. In the calibration and quantitative exercises, we account for the relatively high recovery rate on first mortgages in the United States.

precision $\sigma_{ik}^2$ governs the lender's ability to discern risky from safe applicants, determining *which* of them are approved. Together they make screening central to how informational frictions translate into credit rationing.

## 4.3 Borrower Demand

Borrowers in market $i$ choose which lender to apply to based on posted rates and lender characteristics. Their decisions deliver the application share $s_{ij}(r_{ij})$ that enters the lender's problem (4), and—because price sensitivity and default risk are correlated—also shape the risk composition of each lender's applicant pool.

Borrower $\eta$ receives random indirect utility

$$u_{ij\eta} = -\theta_\eta r_{ij} + \xi_{ij} + \epsilon_{ij\eta} \tag{5}$$

from applying to lender $j$, where $\theta_\eta$ is the price sensitivity introduced in Section 4.1, $\xi_{ij}$ is a lender-market demand shifter capturing local presence, staffing, and other residual demand components, and $\epsilon_{ij\eta}$ is an idiosyncratic shock. Each borrower applies to the utility-maximizing lender. Conditional on $\theta$, the application share is

$$s_{ij}(\theta, r_{ij}) = \mathbb{P}_\eta \left( \bigcap_{j' \in \mathcal{J}_i} \left\{ -\theta_\eta (r_{ij} - r_{ij'}) + (\xi_{ij} - \xi_{ij'}) \geq \epsilon_{ij'\eta} - \epsilon_{ij\eta} \right\} \right), \tag{6}$$

and integrating over the marginal distribution $F_i^\theta$ yields the aggregate share

$$s_{ij}(r_{ij}) \coloneqq \int s_{ij}(\theta, r_{ij})\, F_i^\theta(d\theta). \tag{7}$$

The posted rate also shapes the composition of applicants. The distributions of price-sensitivity and default-risk types among lender $j$'s applicants are

$$\begin{aligned} F_{ij}^\theta(t; r_{ij}) &= s_{ij}(r_{ij})^{-1} \int_{-\infty}^{t} s_{ij}(\theta, r_{ij}) F_i^\theta(d\theta), \\ F_{ij}^x(t; r_{ij}) &= s_{ij}(r_{ij})^{-1} \int_{-\infty}^{t} \int_{-\infty}^{\infty} s_{ij}(\theta, r_{ij}) F_i^{x,\theta}(dx, d\theta). \end{aligned} \tag{8}$$

The wedge between $F_{ij}^{\theta}$ and the population distribution $F_i^{\theta}$ is the standard selection-on-price effect: less price-sensitive borrowers are disproportionately likely to apply to higher-rate lenders. When $x$ and $\theta$ are correlated, this selection propagates to default risk through $F_{ij}^{x}$. Independence ($x \perp \theta$) reduces (8) to the population distribution $F_i^x(t)$; negative correlation produces adverse selection, in which raising $r_{ij}$ worsens the applicant pool and thereby raises the expected default rate $d_{ijk}$.

## 4.4 Loan Officer Labor Supply

Officers' tuple choices $(i, j, k)$ over markets, lenders, and regions, introduced in Section 4.1, deliver the supply function $l_{ijk}(\mathbf{w})$ that enters the lender's problem (4).

Officer $\lambda$'s indirect utility from choice $(i, j, k)$ is

$$u_{ijk\lambda} = a_{ijk\lambda}\, w_{ijk}, \tag{9}$$

where $a_{ijk\lambda}$ is an idiosyncratic preference shifter and $w_{ijk}$ is the wage offered for the tuple. The outside option in region $k$ pays $w_{ook}$.[6] Following Giroud et al. (2024), $\{a_{ijk\lambda}\}$ follows a joint Fréchet distribution with standard Fréchet marginals and a triple-nested Gumbel copula with region-specific outside options. The mortgage sector is atomistic relative to the broader labor market, so banks face upward-sloping labor supply at the firm level but take outside wages as given.[7] Aggregating over $\lambda$ delivers the supply function $l_{ijk}(\mathbf{w})$.

**Labor Cost.** Appendix D shows that the cost of processing $\tilde{l}_{ijk}$ loans with officers serving market $i$ from region $k$ reduces to

$$A_{ijk}^{-1}\, \tilde{l}_{ijk}^{1+1/\varrho}, \qquad A_{ijk} \propto \frac{e_{ijk}}{\Psi_k},$$

[6] As in Giroud et al. (2024), this constant outside-option wage is also consistent with heterogeneous wages paid by outside options, where $w_{ook}$ is the weighted average amenity-adjusted wage. Thus, while we could easily allow for heterogeneous outside options depending also on (destination) market $i$ and firm $j$, accounting for this does not affect the industry equilibrium.

[7] According to Bureau of Labor Statistics (2023), there are roughly 320,000 loan officers in the United States, compared to 136 million private-sector employees. The framework can accommodate cross-regional migration by loan officers with elasticity $\epsilon$, but the atomistic assumption effectively shuts down this margin, consistent with evidence from Huang et al. (2025) that loan officers rarely move. Calibrating this elasticity to Giroud et al. (2024) leaves the implied bank-market labor supply elasticities nearly unchanged. See Appendix D for details.

where $\Psi_k$ is a region-specific wage index summarizing outside-option wages in region $k$. The composite parameter $A_{ijk}$ summarizes regional labor cost: high outside-option wages drive $\Psi_k$ up and $A_{ijk}$ down, making screening labor in that region expensive on a per-dollar basis.

## 4.5 Solution to the Lender's Problem

With the demand system $s_{ij}(r_{ij})$ and labor supply system $l_{ijk}(\mathbf{w})$ in hand, we now characterize the lender's optimal pricing and assignment decisions. We use one result from Section 4.4: the cost of processing $\tilde{l}_{ijk}$ loans with officers in region $k$ reduces to $A_{ijk}^{-1}\tilde{l}_{ijk}^{1+1/\varrho}$, where $A_{ijk} \propto e_{ijk}/\Psi_k$ embeds processing capacity and the regional wage index $\Psi_k$. The lender's problem is separable across markets, so we analyze each market $i$ independently.

**Optimal Pricing.** The first-order condition with respect to $r_{ij}$ is a fixed point:

$$\sum_{k\in\mathcal{K}} A_{ijk}^{\varrho} p_{ijk}^{\varrho+1}(r_{ij}-f_{ij}-d_{ijk})^{\varrho}\Bigg\{ r_{ij}(\varepsilon_{p_{ijk},r}+\varepsilon_{s_{ij},r}+1) - f_{ij}(\varepsilon_{p_{ijk},r}+\varepsilon_{s_{ij},r}) \\ - d_{ijk}(\varepsilon_{p_{ijk},r}+\varepsilon_{s_{ij},r}+\varepsilon_{d_{ijk},r}) - \left(1+\varrho^{-1}\right)\varepsilon_{s_{ij},r}\bar{c}_{ij}(r_{ij}-f_{ij}-d_{ijk})\Bigg\} = 0, \quad (10)$$

where $\varepsilon_{x,y} = \partial \ln x/\partial \ln y$ and the capacity cost shifter is

$$\bar{c}_{ij} \coloneqq \left(\frac{\mathcal{M}_i s_{ij}}{\sum_{k\in\mathcal{K}}\left(A_{ijk}p_{ijk}(r_{ij}-f_{ij}-d_{ijk})\right)^{\varrho}}\right)^{1/\varrho}.$$

The economic content is sharpest when screening precision is shut down. If $\sigma_{ik}^2$ is constant across $k$, then $p_{ijk} = \bar{p}_{ij}$ and $d_{ijk} = \bar{d}_{ij}$, and (10) collapses to a closed-form decomposition of the optimal rate:

$$r_{ij} = \underbrace{f_{ij}\frac{\varepsilon_{p_{ij},r}+\varepsilon_{s_{ij},r}}{\varepsilon_{p_{ij},r}+\varepsilon_{s_{ij},r}+1}}_{\text{Funding cost}} + \underbrace{d_{ij}\frac{\varepsilon_{p_{ij},r}+\varepsilon_{s_{ij},r}+\varepsilon_{d_{ij},r}}{\varepsilon_{p_{ij},r}+\varepsilon_{s_{ij},r}+1}}_{\text{Default risk}} + \underbrace{p_{ij}^{-1}\left(\frac{\mathcal{M}_i s_{ij}}{\sum_{k\in\mathcal{K}} A_{ijk}^{\varrho}}\right)^{1/\varrho}\frac{\varepsilon_{s_{ij},r}}{\varepsilon_{p_{ij},r}+\varepsilon_{s_{ij},r}+1}}_{\text{Capacity cost}}. \quad (11)$$

Funding costs pass through weighted by the combined elasticity of origination and market

share. Default losses are priced in with an extra adverse-selection wedge $\varepsilon_{d_{ij},r}$, reflecting that higher rates worsen the applicant pool. The capacity component prices the marginal cost of screening labor and is paid for both originated and rejected applications, since screening is sunk at the application stage.

The general case (10) differs from this benchmark in one substantive way: elasticities and net margins are aggregated across heterogeneous officer types, with weights that depend on signal quality. This aggregation is how lenders internalize the differential value of precise information across regions—the *private value of information*.

**Optimal Assignment.** The first-order condition with respect to $\mathcal{S}_{ijk}$ delivers the assignment rule:

$$\mathcal{S}_{ijk} = \frac{A_{ijk}^{\varrho}\, p_{ijk}^{\varrho}\, (r_{ij} - f_{ij} - d_{ijk})^{\varrho}}{\sum_{m \in \mathcal{K}} A_{ijm}^{\varrho}\, p_{ijm}^{\varrho}\, (r_{ij} - f_{ij} - d_{ijm})^{\varrho}}. \tag{12}$$

Equation (12) is the private value of information made explicit. Each application is routed in proportion to the expected gross profit per application, $p_{ijk}(r_{ij} - f_{ij} - d_{ijk})$, scaled by screening capacity per dollar, $A_{ijk}$. The first factor rewards precision: nearby officers with low $\sigma_{ik}^2$ generate more accurate signals, raising $p_{ijk}$ and lowering $d_{ijk}$, hence raising expected profit per application. The second factor penalizes cost: in regions where outside options pay high wages, $\Psi_k$ is high and $A_{ijk}$ is low, so each dollar buys less screening capacity. The lender substitutes away from precise but expensive local labor toward cheaper but noisier remote labor whenever the wage gap dominates the precision gap.

## 4.6 The Social Value of Information Production

Equation (12) is based on the lender's private valuation of local screening: it routes applications toward local officers as far as the extra expected profit per application covers the extra cost. Whether that valuation matches the social value of the information requires a standard for which mortgages are worth making. Borrower $\eta$'s reservation rate,

$$r_{ij\eta}^{\text{res}} \coloneqq r_{ij} + \frac{u_{ij\eta} - u_{i0\eta}}{\theta_{\eta}}, \tag{13}$$

is the highest rate at which she prefers lender $j$'s loan to her outside option, and we call a mortgage socially optimal when $r_{ij\eta}^{\text{res}} \geq f_{ij} + d_i(x_\eta)$: what she would pay covers the funding

cost and the expected default loss that full information about her type would reveal.

To measure welfare, we impose additional conventional assumptions beyond the positive model in Sections 4.1 through 4.5. First, we convert payoffs into rate units by dividing utility by $\theta_\eta$, so that borrower surplus and lender margins are measured the same way, while funding costs, labor costs, and default losses are resource costs. Second, we assume that applicants only receive choice-specific utility from their choice if they are approved and do not default; otherwise, they simply end up with their outside option.[8] For our results, it is important that borrowers' decisions do not respond to gaps in approval probabilities due to local loan officers' information advantages; this holds in the demand system described in Section 4.3, and it is the model counterpart of the within-lender evidence in Section 3.3 that safer borrowers do not sort toward local officers.

Given these welfare assumptions, we can now characterize the welfare consequences of screening errors made by lenders. First, a lender can reject an applicant whose true expected loss rate is below its posted net interest margin, i.e., rejection when $r_{ij} - f_{ij} \geq d_i(x_\eta)$ ("credit rationing"). Second, a lender can approve an applicant whose true expected loss rate exceeds its posted net interest margin, i.e., approval when $r_{ij} - f_{ij} < d_i(x_\eta)$ ("pooled origination"). While both of these represent informational errors from the lender's point of view, the lender's perceived cost of the error does not line up with social cost. On one hand, by revealed preference, every applicant prefers lender $j$ to her outside option, so $r^{\text{res}}_{ij\eta} \geq r_{ij}$ and every loan the lender would make if it observed $x_\eta$ is socially optimal: credit rationing always denies a mortgage worth making. Pooled origination is different. A pooled origination whose expected default loss exceeds the lender's margin by less than the borrower's surplus is still worth making, but given TRID constraints on mortgage repricing, the lender would reject it even with full information, because the posted rate cannot rise to cover its cost.

To make this precise, consider a constrained planner who chooses the assignment shares $\mathcal{S}_{ijk}$ alone, taking posted rates, application shares, the lender's approval rule, and the labor cost function as given, and paying the same cost of officers as the lender. Let $b_{ijk}$ denote the expected gain of lender $j$'s applicants per application screened in region $k$, and write $L$ for the local region $g(i)$ and $R$ for a remote one. The wedge between the social and private

[8]The assumption that borrowers do not receive utility if they default significantly simplifies the exposition, but is not critical. In Appendix D.3, we show that the resulting equilibrium inefficiency is similar, but depends on differences in rejection rates, which Figure 4 shows are consistently lower for local loan officers across borrower types, rather than mainly on differences in credit rationing.

value of local screening is the borrowers' extra gain when an application is screened locally rather than remotely,

$$\tau_{ij} \coloneqq b_{ijL} - b_{ijR}. \tag{14}$$

**PROPOSITION 1.** *Fix posted rates, and let the lender's assignment be optimal for the lender with* $0 < \mathcal{S}_{ijL} < 1$.

*(i) The planner's marginal social value of moving one application from remote to local officers equals* $\tau_{ij}$*, and a subsidy of* $\tau_{ij}$ *per application assigned to local officers implements the planner's assignment. The planner assigns strictly more applications to local officers than the lender does if and only if* $\tau_{ij} > 0$.

*(ii) Suppose that applicants' expected gain from approval, weighted by the probability that their loan performs, is on average at least as large for the applicants whose approval local screening adds as for those whose approval it forgoes. Then* $\tau_{ij} > 0$ *whenever local screening raises the approval rate.*

*(iii) Suppose also that the posted rate is optimal for the lender and that borrowers' price sensitivity is independent of their risk. Then*

$$\tau_{ij} = \Lambda_{ij}\, \mu_{ij}\, (n_{ijL} - n_{ijR}), \tag{15}$$

*where* $\mu_{ij}$ *is the lender's markup on an approved loan over the marginal cost of making it,* $\Lambda_{ij}$ *is the ratio of its applicants' average surplus to that markup, and* $n_{ijk}$ *is the number of loans that perform per application screened in region* $k$.

*Proof.* See Appendix D.3.

Part (i) says that the lender equates the extra cost of local screening with the extra profit it generates, and that $\tau_{ij}$ is what that calculation leaves out. The labor market enters only through how far the wedge moves the allocation, scaled by the elasticity $\varrho$. The existence of the wedge is a property of setting prices before screening and using information only on the approval margin, and does not depend on our estimates; however, the magnitude of the wedge does.

Part (ii) turns the sign of the wedge into a statement about observables. Intuitively, its condition requires that riskier applicants' price sensitivity is not "too much" lower than safe

applicants', so that their larger surplus does not more than offset their lower probability of repayment.[9] Fact 1 shows that, within lenders and conditional on hard information, applications handled by local officers are rejected less often in both home-purchase and refinance markets, and Figure 4 shows that this advantage is largest for the riskiest applicants. Local screening raises approvals across credit buckets, so the wedge is positive and the lender employs too little local labor.

In part (iii), we analyze the special case to provide intuition on what determines the magnitude of the social inefficiency. To do so, we decompose the wedge into three terms: i) the number of additional loans that perform when an application is screened locally, ii) the lender's markup on an approved loan, and iii) the ratio $\Lambda_{ij}$, which measures how much surplus the posted rate leaves with borrowers relative to what it extracts for the lender. In other words, the wedge is the surplus that the posted rate leaves with the borrowers whose loans perform because of local screening. This decomposition shows that market power affects the wedge through two opposing forces. On one hand, if a lender extracts the full value of its loans through its rate, borrowers receive no surplus and thus rationing creates no inefficiency. On the other hand, when the structure of the market prevents the lender from extracting surplus through its rate, that surplus stays with borrowers, and rationing destroys it. Which force dominates depends on why the lender has market power. When borrowers are less sensitive to price, the markup and their surplus rise together, so the wedge rises with the markup. When borrowers instead value the loan more, a monopolist raises its rate and extracts the added value, so $\Lambda_{ij}$ falls, while competing lenders cannot raise their markups, so $\Lambda_{ij}$ rises. Thus, to understand the wedge, we now turn to structurally estimating the model, which disciplines the relative importance of its components.

**Additional Potential Inefficiencies.** Our baseline welfare results study one class of inefficiency that a constrained planner would prefer to remedy. In Appendix D.3, we consider extensions that show this benchmark is conservative. Of particular interest in the context of mortgages is securitization. We show that, to the extent that lenders do not fully internalize default costs, as long as local loan officers approve more applicants at (weakly) lower default rates (consistent with Fact 1) and at a default rate below the market average, the resulting inefficiency in equilibrium is even larger. Thus, the concern that securitization weakens

[9] Given the parameterization in Section 5, the condition holds at the estimated parameter values.

lenders' incentives to screen strengthens, rather than undermines, our conclusion that lenders employ too little local labor.

# 5 Estimation

We now take the model to the data. There are two purposes: to discipline the model's novel components—the precision and processing efficiency of local versus remote loan officers—using the empirical moments documented in Section 3.1, and to recover the borrower-side primitives that govern adverse selection and default. Some parameters are calibrated externally to standard values from the literature; the rest are estimated internally by matching a set of empirical moments that we argue identify them. We begin with the parametric assumptions used to take the model to data, then describe each estimation step, and conclude by validating the estimated model against untargeted heterogeneity in the data.

## 5.1 Parameterization

To take the model to data, we make the following parametric assumptions. Borrower types $(\theta_\eta, x_\eta)$ are jointly normally distributed,

$$\begin{pmatrix} \theta_\eta \\ x_\eta \end{pmatrix} \sim \mathcal{N}\left( \begin{pmatrix} \mu_\theta \\ \mu_i^x \end{pmatrix}, \begin{pmatrix} \sigma_\theta^2 & \gamma\sigma_\theta\sigma_i^x \\ \gamma\sigma_\theta\sigma_i^x & (\sigma_i^x)^2 \end{pmatrix} \right).$$

The demand shocks $\epsilon_{ij\eta}$ are i.i.d. Type I extreme value, and screening noise is normally distributed, $\tilde{x}_{\eta k} \sim \mathcal{N}(0, \sigma_{ik}^2)$. We assume signal precision and processing efficiency depend on whether a loan officer is local or remote: $\sigma_{ik} = \sigma_{\text{local}}$ and $e_{ijk} = e_{ij,\text{local}}$ if $g(i) = k$, and $\sigma_{ik} = \sigma_{\text{remote}}$ and $e_{ijk} = e_{ij,\text{remote}}$ otherwise.[10] Finally, $d_i$ follows a probit process with correlated shocks: borrower $\eta$ defaults if $\epsilon_\eta + \epsilon_{it} \leq x_\eta$, where $\epsilon_\eta$ and $\epsilon_{it}$ are i.i.d. standard normal idiosyncratic and aggregate shocks, respectively.[11,12]

[10] It is straightforward to show that this implies bank $j$ will offer the same wage to all remote workers processing applications in market $i$, regardless of where they live. Further, due to max-stability, remote loan officer supply acts as-if it follows a single "remote" market. We abstract from further heterogeneity in remote informational and processing efficiencies to map directly to our empirical setting and avoid overparameterizing the model.

[11] The inclusion of aggregate shocks is motivated by correlated default rate spikes across credit grades and loan purposes, as shown in Appendix Figure A1.

[12] We provide the parametric versions of the equilibrium conditions in Appendix D.4.

## 5.2 Estimation Strategy

The estimation proceeds in three steps. We first calibrate parameters with widely accepted values from prior work; we then estimate the remaining parameters internally by matching a set of empirical moments; finally, we describe the identification of the novel loan officer parameters that are central to the paper.

**Externally Calibrated Parameters.** We calibrate the logit price coefficients to match Buchak et al. (2018), giving $\mu_\theta = 165$ and $\sigma_\theta \approx 41$. The within-region-sector labor supply elasticity $\varrho = 8$ matches Giroud et al. (2024).[13] Funding costs are set to 2.75% to match the spreads reported in Janus Henderson Investors (2019). The market size $\mathcal{M}_i$ equals the total observed application volume in market $i$. To account for the fact that there are significant recoveries on defaulted loans, we calibrate losses-given-default to 17.7% using Fannie Mae securitization data.[14]

**Internally Estimated Parameters.** The remaining parameters govern objects for which off-the-shelf estimates are unavailable: the borrower type distributions, the local-vs-remote screening technology, and the bank-specific demand and labor-cost shifters. We estimate these jointly by matching moments from the empirical analysis. We consider six product type buckets, $\{\text{subprime}, \text{near-prime}, \text{prime}\} \times \{\text{purchase}, \text{refi}\}$, and three bank types—"Brick and Mortar," "Fintech," and "Fringe"—mapping to the categories in Table A3.[15] The labor supply efficiency parameters $\{A_{i,j,k}\}$ and demand shifters $\{\xi_{ij}\}$ are estimated to exactly match observed labor shares and market shares using standard techniques from the IO and spatial economics literatures. We then jointly estimate the loan officer signal precisions $\{\sigma_{\text{local}}, \sigma_{\text{remote}}\}$, the correlation between default risk and price sensitivity $\gamma$, the borrower type distributions $\{\mu_i^x, \sigma_i^x\}$, and the realizations of the aggregate shocks $\epsilon_{i,t}$ to match the expected default rates, realized default rates, rejection rates, the local origination and default advantages, and the strength of the ex-post correlation between default and interest rates

[13] While this does imply relatively elastic labor supply, it is roughly consistent with figures from the macro-labor literature, e.g. 10.85 in Berger et al. (2022)

[14] Specifically, we take the realized average loss rate on all loans originated in 2000 and later over 10 years, for which there were 10 years of history available in 2018, after two missed payments in the first two years.

[15] To map model primitives to available data, we make two additional measurement assumptions. First, for simplicity, we assume demand shifters $\{\xi_{ij}\}_{\forall i,j}$ vary only at the bank-type level. Second, we assume that banks' expected default rates correspond to post-crisis historical average default rates (2012–2017).

reported in Tables 2 and A3 as well as Figures 3 and A1.

**Identification of Critical Parameters.** A natural concern is whether the novel loan officer parameters $\{A_{i,j,k}\}$ and $\{\sigma_k\}$ are jointly pinned down by the data. The signal precisions are identified by the local rejection rate and default advantages: holding fixed the default advantage of local screening, the rejection rate advantage falls as baseline noise rises, because higher noise pushes the lender toward a pooling equilibrium in which all loans are originated and improvements to precision reduce pooled originations rather than credit rationing. Figure 5 provides a numerical example illustrating this non-monotonicity, showing how the ratio of the rejection advantage to the default advantage changes with precision. Given the level of imprecision, the magnitude of the default advantage then pins down the overall informational advantage of local loan officers. The $\{A_{i,j,k}\}$ parameters capture the wage-adjusted physical efficiency of officers for each bank-market-type cell: their relative magnitudes are pinned down by the local share each bank hires, and their absolute level by the lender's first-order condition (10). Intuitively, a bank with higher physical efficiency for officer type $k$ hires more officers of that type, internalizing the impact on its expected profits.

## 5.3 Estimation Results

We report the estimated values of the borrower type distributions and the aggregate shocks in Table 8. For ease of interpretation, we transform the mean of the latent $x$ type into a "default rate" that captures what the expected per-year default rate would be in the relevant mortgage market if 100 percent of applications were approved.[16] The implied unconditional default rates and latent heterogeneity are substantially higher in the refi markets; the model requires this to jointly rationalize the combination of low realized default rates and low approval rates observed in those markets. Because the model is exactly identified, the estimated parameters reproduce the targeted moments exactly. Two results are particularly noteworthy: the joint estimation yields $\gamma = -0.4$, consistent with adverse selection, and signal precisions of $\sigma_{\text{local}} = 1.4$ and $\sigma_{\text{remote}} = 2.45$, consistent with a substantial local informational advantage.

[16] That is, the reported default rate is equal to $\int d_i(x_\eta) F_i^x(dx_\eta) \equiv \int_{-\infty}^{\infty} \Phi\left(2^{-1/2} x_\eta\right) f_i^x(x_\eta)\, dx_\eta$ for a standard normal CDF $\Phi$.

### 5.4 Model Validation

For simplicity, the parameterization above assumes that the information technology is the same in every market. This restriction leaves untargeted heterogeneity in effect sizes available as a tool to validate the model. To do so, we compute model-implied, market-specific rejection rate and default rate advantages and compare them to the data. The model generates a local rejection rate advantage about 3 percentage points higher in the refi market than the purchase market, and a local default rate advantage about 0.4 percentage points higher in the purchase market than the refi market—roughly consistent with the magnitudes in Table 2. The local rejection rate advantage (about 3 percentage points) and default rate advantage (about 1 percentage point) are also much larger for subprime loans than for prime loans, consistent with Figure 4, although the relevant coefficients are estimated noisily. These patterns are driven entirely by differences in borrower type distributions and aggregate shocks, which the model backs out from the observed default and origination data without targeting the heterogeneity itself.

## 6 Model Results and Counterfactuals

In this section, we use the model to quantify baseline informational efficiency and to study how shocks to physical efficiency alter equilibrium outcomes. We begin by showing that superior information is used primarily to offset credit rationing in equilibrium. We then consider a counterfactual increase in the physical efficiency of distant loan officers and show that this reduces informational efficiency and increases the aggregate risk borne by banks.

### 6.1 Credit Rationing and False Approvals

Lenders with more precise signals can use their information to (i) screen in creditworthy borrowers (reducing "credit rationing"), and (ii) screen out high–risk applicants (reducing "false approvals"). The estimated model provides quantitative magnitudes for these forces in equilibrium.

Consider a lender $j$ in market $i$ that hires a perfectly informed loan officer with $\sigma_k = 0$. This lender originates a loan if and only if $E[lgd_\eta * d(x_\eta)] \leq r_{ij} - f_{ij}$, where the borrower's

risk type $x_\eta$ is perfectly observed. Intuitively, an application is approved if and only if its full–information expected loss rate is below the lender's net interest margin. Credit rationing occurs when a low–loss loan is rejected due to noise in the signal—a "false" rejection. False approvals are the symmetric error: a high–loss borrower is approved due to an unusually favorable signal realization.

Table 9 reports the model–implied frequency of credit rationing and false approvals by market. Consistent with the large rejection–rate advantages, relative to default–rate advantages, documented in Table 2, the model implies substantial credit rationing, with up to 15 percent of applicants rationed in the subprime refinance market. Panel B shows that local officers eliminate roughly *half* of this rationing, with the largest effects in lower–credit–quality and refinance markets.

Panel B shows that local officers achieve this expansion in credit while also *reducing* false approvals, consistent with their default advantage. Because default risk in the model is highly convex, lenders behave conservatively: false approvals are relatively rare compared to rationing. Thus, informational advantages operate mainly through reductions in credit rationing.

## 6.2 Technology Shock

Having established that informational efficiency plays an important role in shaping credit access—especially for riskier borrowers—we now study the effects of a technological shock. We consider an increase in the labor efficiency $e_{ijk}$ of distant loan officers that does not affect their informational precision. We calibrate this shock as the difference in physical efficiency between the "Fintech" and "Brick and Mortar" banks and consider two counterfactuals.[17]

In counterfactual 1, only the Brick and Mortar bank receives the efficiency improvement. In counterfactual 2, all banks receive the same efficiency improvement. After applying each shock, we recompute the equilibrium, allowing banks to re–optimize their labor inputs and interest rates. Consistent with equation (12), shocked banks substitute distant labor for local labor.

[17] Given the structure in Section 4, the difference in physical efficiency is identified from the ratio of the $A_{ijk}$ parameters for the two banks. While the shock varies across markets, it corresponds to roughly a twenty percent increase in physical productivity.

**Credit Provision.** Table 10 presents the results. Panel A reports outcomes when only the Brick and Mortar bank is shocked; Panel B reports outcomes when all banks are shocked. For shock 1, rejection rates sometimes decline, but this is driven by a larger increase in false approvals offsetting a sizable rise in rationing. Across specifications, credit rationing increases meaningfully, including increases of up to two percentage points for subprime purchase borrowers.

**Expected Defaults and Rates.** The increase in false approvals naturally raises expected defaults. Table 10, Panel C reports the results. Default rates rise across all markets under both shocks, with particularly strong effects in the subprime and near–prime purchase segments—the same segments experiencing the largest increases in false approvals.

Do borrowers nonetheless benefit? As with standard productivity shocks, interest rates fall in equilibrium. Panel C also reports changes in monthly payments.[18] Effects are modest: at most $25 on a typical monthly payment. Screening is already physically efficient ex ante, so moderate improvements in the productivity of distant officers generate limited cost savings.

Interestingly, shocks to Brick and Mortar banks generate comparable increases in default to the aggregate shock, despite the fact that the aggregate shock produces larger cost reductions. Two forces drive this. First, substitution away from local labor is largest for the Brick and Mortar bank, since other banks employ little local labor initially. Second, the decline in informational efficiency restricts the Brick and Mortar bank's ability to lower rates: higher default and rejection rates increase its marginal cost. By contrast, shocking the fintech and fringe banks acts more like a standard TFP shock, with lower costs and relatively little substitution.

**Aggregate Shocks.** We next examine how the technology shock interacts with aggregate conditions. The model allows us to compute realized default rates across aggregate states. Figure 6 plots the difference in realized default rates between the baseline and shocked economies as a function of the aggregate state for the purchase markets.[19]

[18] Payments are computed for a median–priced home of $330,000 with 20 percent down and a 30–year fixed–rate mortgage.

[19] For refinancing markets, informational advantages are smaller and can be offset by smaller aggregate shocks. This is consistent with the model's prediction that the refinance market should have a relatively small default advantage, despite its large rejection rate advantage.

The effect is non–monotonic. For small aggregate shocks, falsely approved loans experience rapid increases in default risk, raising realized defaults. For sufficiently large aggregate shocks, however, default rates for these marginal loans exceed the point of inflection of the probit curve. At this point, loans that were rationed, which tend to have significantly higher baseline expected default rates than always-approved loans, start to see their default probabilities increase rapidly, leading to the attenuation or even reversal of the information advantage. In this sense, credit rationing seems to serve as a moderate protective force against very large aggregate shocks.

Given the short time series we have to calculate default rates, we cannot scale the aggregate shocks to relative frequencies. However, we can benchmark these aggregate shocks against realized default rates during the GFC. We include vertical lines in Figure 6 to show the size of the aggregate shock that matches the 2007 realized default rates in each market. In the subprime and near–prime markets, the informational advantage persists even under shocks larger than the GFC. In the prime market, informational effects are smaller and eliminated by a shock roughly the size of the GFC. Quantitatively, large aggregate shocks like the GFC can roughly double the effect on realized defaults.

**Economic Intuition.** The dominant effect of the technology shock is the increase in credit rationing. The intuition is straightforward. While banks internalize the cost of higher defaults and borrowers are rate–sensitive, credit rationing is largely an externality from the bank's perspective. Rationed loans lie close to the break–even point on net interest income, so rejecting them sacrifices relatively little revenue. On the other hand, because labor supply is highly elastic, even moderate relative cost shocks—such as improvements in distant–officer productivity—induce sizable reallocations of labor away from local officers. These reallocations reduce informational efficiency and increase default risk without providing commensurate reductions in mortgage rates.

# 7 Conclusion

We show that mortgage lenders can achieve an informational advantage by hiring local loan officers, who screen with greater informational efficiency than remote officers. Yet lenders do not hire local officers according to where this informational value is greatest:

relative to mortgage demand, they hire fewer local officers in high-wage markets, relying instead on cheaper, informationally less precise remote officers. We develop and estimate a structural model in which lenders' choice of how to produce underwriting information—rather than a fixed screening technology—is embedded in joint mortgage-market and labor-market equilibrium. Because much of the resulting cost is borne by the borrower rather than the lender, this imprecise information leads to substantial credit rationing in equilibrium—as high as 15 percent of applicants in high-risk markets—which local officers cut roughly in half. Technological progress can worsen this inefficiency: a shock that raises the physical efficiency of remote officers, holding their informational efficiency fixed, induces further substitution away from local screening, increasing both credit rationing and false approvals, and raising aggregate default risk, with only modest offsetting decreases in mortgage rates.

More generally, our results echo a general lesson: in markets with ex-ante imperfections such as informational frictions, improvements to physical efficiency need not raise welfare, since they can amplify the pre-existing inefficiency by more than they reduce costs. Our results show that this can be a first-order force in input-sourcing decisions more broadly. When an input is differentiated along more than one dimension and only one of those dimensions is priced, decentralized firms have no reason to weigh the other, and the resulting externality means that even a cost-reducing improvement in technology can decrease welfare.

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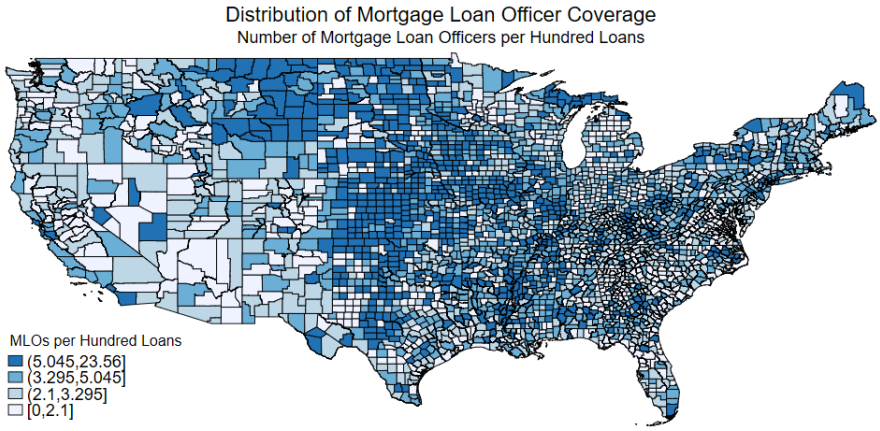
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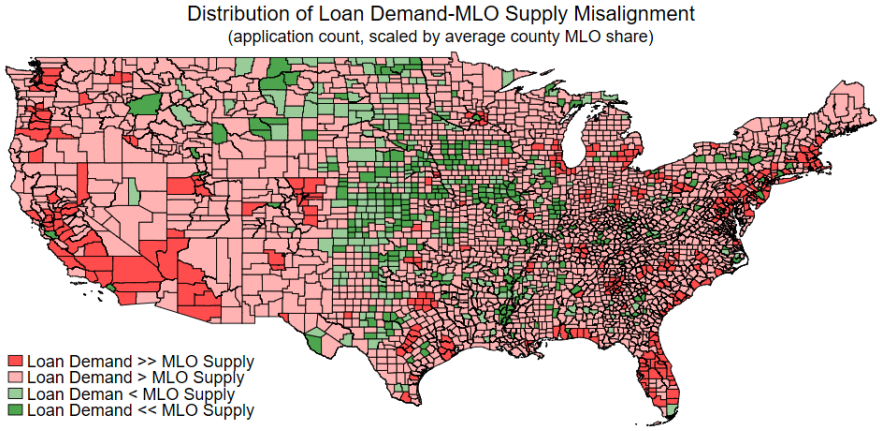
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**Figure 1.** Geographic Misalignment of Mortgage Demand and Loan Officer Supply



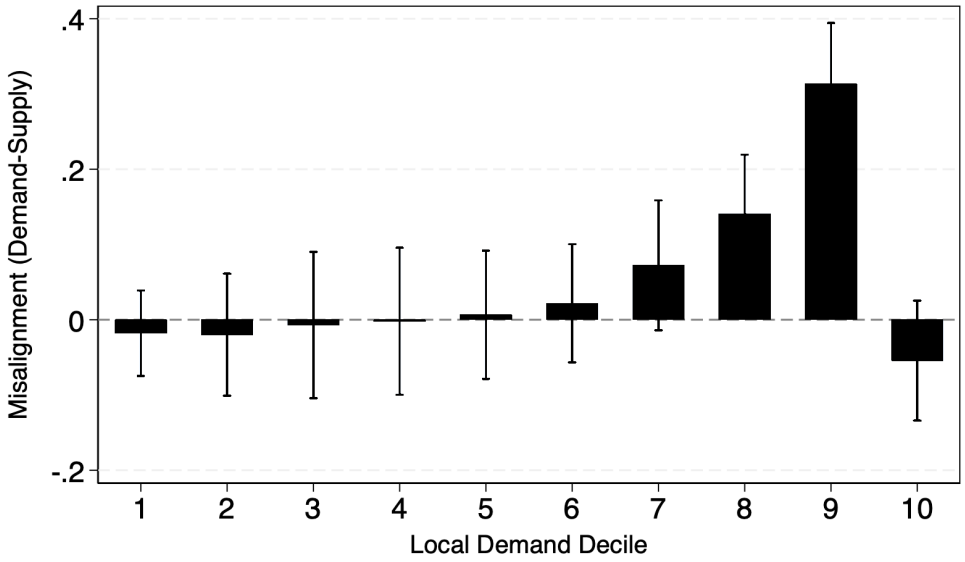

**(a)** Geographic Distribution of Mortgage Loan Officer Coverage




**(b)** Geographic Misalignment

*Note*: Panel A plots the county-level number of loan officers per hundred mortgage applications during 2018-2019, divided into 4 equal-sized buckets and highlighted with different color intensity. Panel B plots the county-level misalignment of mortgage demand and loan officer supply during 2018-2019. For every county, we calculate the county's share of mortgage applications out of national mortgage applications; similarly, we calculate the county's share of registered mortgage loan officers out of national total number of registered mortgage loan officers. Based on these shares, county-level misalignment index is computed as the difference between the county's share of loan demand and its share of mortgage loan officers. The index is then divided into four buckets, highlighted with two different colors in the figure. Red color marks counties with a positive value of the misalignment index, indicating that its loan demand exceeds its loan officer supply. Green color marks counties with a negative value of the misalignment index, indicating that its loan demand is below its loan officer supply.

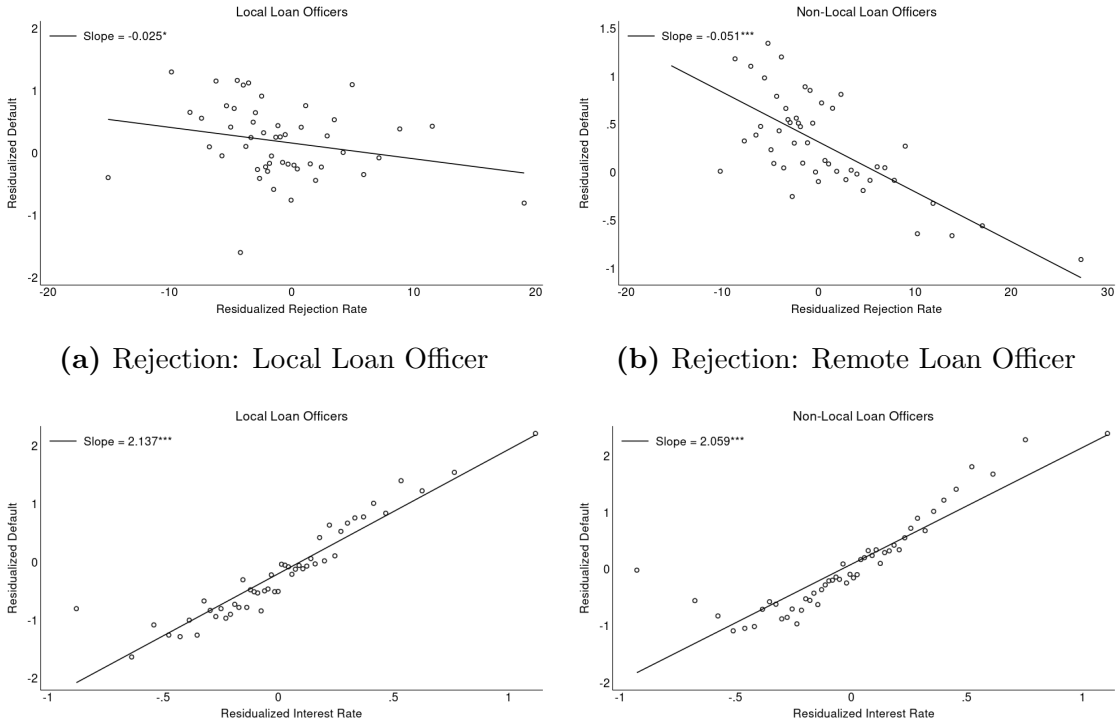
**Figure 2.** Loan Demand-Loan Officer Supply Misalignment Across Counties




**(a)** Excess Loan Demand Relative to Loan Officer Supply

*Note*: This figure plots the average county-level misalignment between mortgage demand and loan officer supply across county mortgage demand deciles for 2018–2019. For each county, we compute (i) the county's share of national mortgage applications and (ii) the county's share of registered mortgage loan officers; the misalignment index is defined as the difference between these two shares. Counties are then grouped into ten bins based on their share of national mortgage applications (from lowest to highest demand). The bars display the mean misalignment index within each demand decile, and the capped spikes depict 95% confidence intervals from a regression of the misalignment index on the ten demand-decile indicators (with no constant term). A value above zero indicates that mortgage demand exceeds local loan officer supply ("labor-short" areas), while a value below zero indicates an oversupply of underwriting labor relative to local demand.

**Figure 3.** Advantage of Local Information Production




**(a)** Rejection: Local Loan Officer

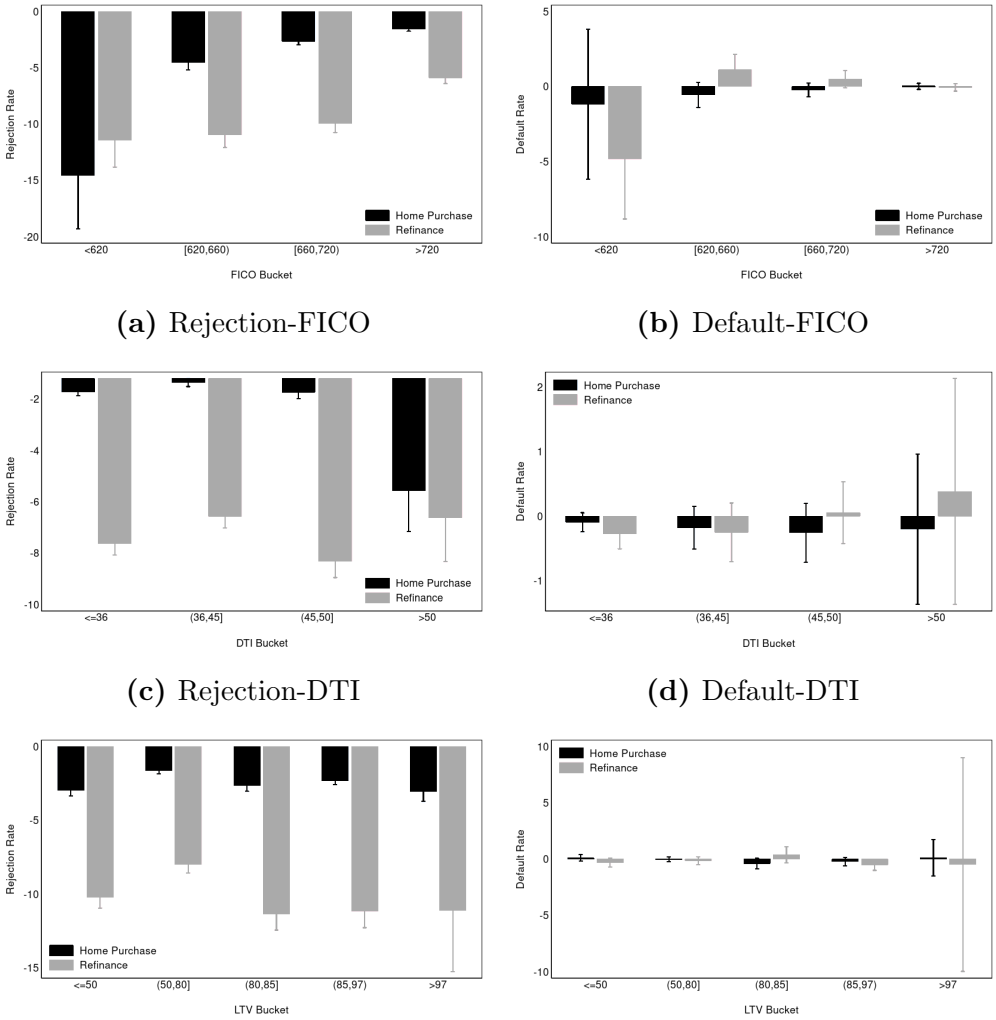
**(b)** Rejection: Remote Loan Officer

**(c)** Rate: Local Loan Officer

**(d)** Rate: Remote Loan Officer

*Note*: This figure compares local and remote loan officers along the approval and pricing margins. Panels A and B plot residualized default against residualized rejection rates for loans handled by local and remote loan officers, respectively. Panels C and D plot residualized default against residualized interest rates for originated home-purchase loans handled by local and remote loan officers, respectively. Residualized rejection rates, interest rates, and default outcomes are obtained by regressing the corresponding loan-level variables on borrower-level risk controls, including FICO, LTV, DTI, AUS status, and their flexible polynomials, as well as county-by-application-month fixed effects. Residuals are then averaged at the lender–county–local/remote level, so that each underlying observation represents the mean residualized outcome for a given lender in a given county, separately for local and remote officers. For visualization, these lender–county averages are sorted into 50 equally sized bins within each subsample, and each point plots the mean default residual against the mean rejection-rate or interest-rate residual within a bin. The fitted line shows the linear relationship estimated separately in each panel.

**Figure 4.** Rejection and Default by Hard Credit Information: Local vs Remote



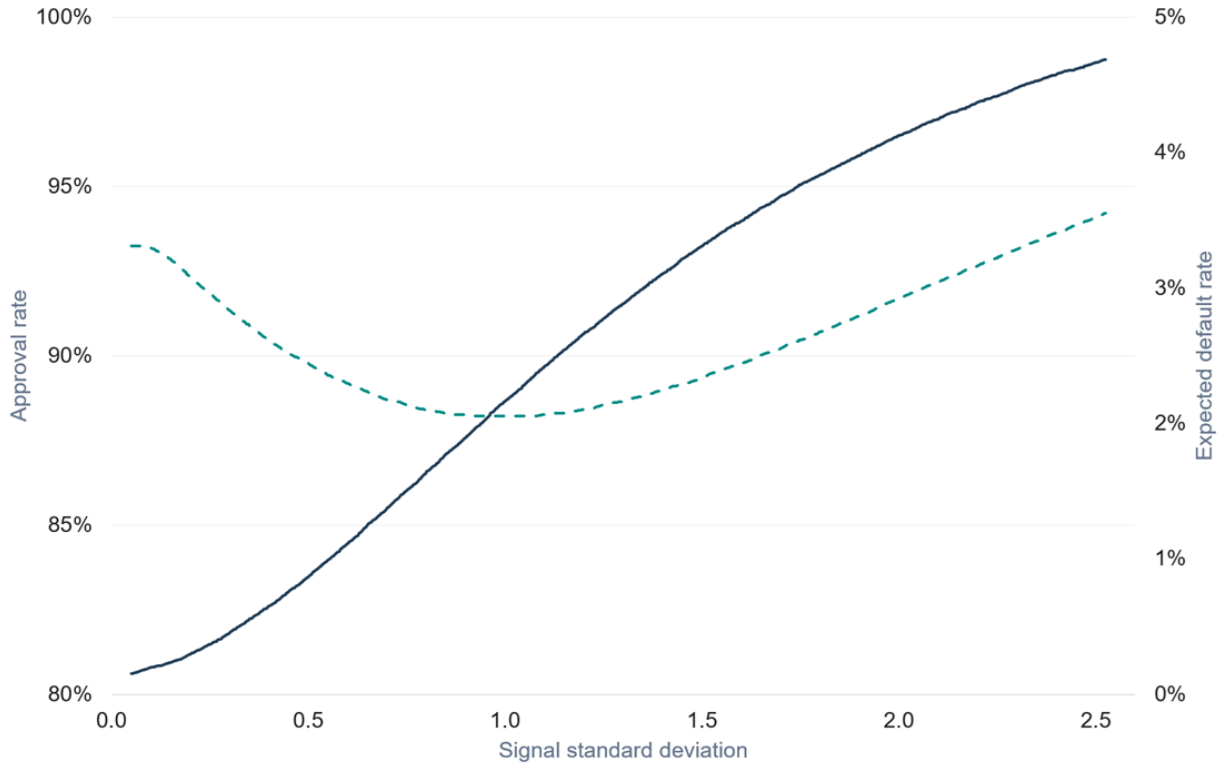

**(a)** Rejection-FICO **(b)** Default-FICO

**(c)** Rejection-DTI **(d)** Default-DTI

**(e)** Rejection-LTV **(f)** Default-LTV

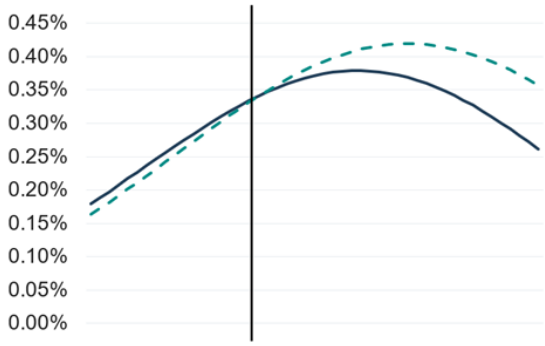
*Note*: This figure compares rejection rates (Panels A, C, and E) and two-year default rates (Panels B, D, and F) for home-purchase and refinance mortgages across discrete buckets of borrower hard information: FICO score (Panels A–B), debt-to-income (DTI) ratio (Panels C–D), and loan-to-value (LTV) ratio (Panels E–F). For each credit variable, the sample is divided into regulatory or industry-relevant buckets: four FICO groups ($< 620$, $[620, 660)$, $[660, 720)$, $\geq 720$), four DTI groups ($\leq 36\%$, $(36, 45]\%$, $(45, 50]\%$, $> 50\%$), and five LTV groups ($\leq 50\%$, $(50, 80]\%$, $(80, 85]\%$, $(85, 97]\%$, $> 97\%$). Within each bucket, we estimate separate regressions of rejection (or default) on indicators for loans handled by local versus remote loan officers. The plotted coefficients represent the average rejection (or default) rate for loans handled by local officers in each bucket, with 95% confidence intervals; analogous estimates for refinance loans are shown side-by-side for comparison. Standard errors are clustered at the borrower-county level.

**Figure 5.** Identification Intuition

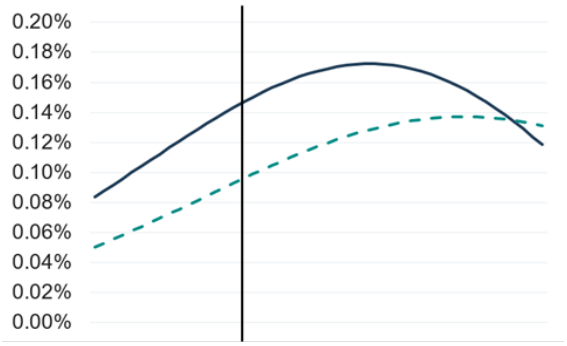



*Note*: This figure shows how the model-predicted approval rate and expected default rate vary with the standard deviation of the signal used to process loans. The dashed teal curve shows the approval rate (left axis), and the solid navy curve shows the expected default rate (right axis). The interest rate is 5%, the funding cost is 2.75%, the population-average default rate is 5.5%, and loss given default is 17%.

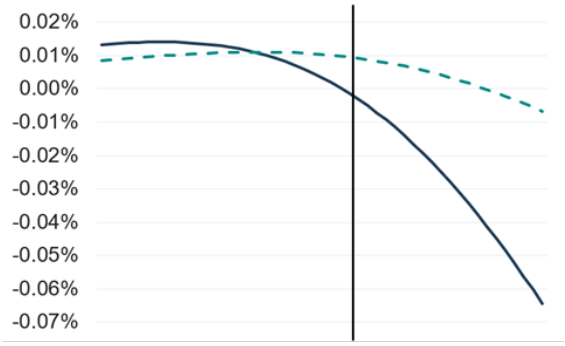
**Figure 6.** Technology Shock and Aggregate Risk




**(a)** Subprime Purchase Market




**(b)** Near-Prime Purchase Market




**(c)** Prime Purchase Market

*Note*: This figure shows how realized default rates change, given a technological shock, for different realizations of the (unscaled) aggregate shock on the x-axis. Credit markets are differentiated by borrower credit quality. The black line indicates the value of the aggregate shock that generates a default rate equivalent to the Global Financial Crisis in 2007. See Section 6.2 for more details.

**Table 1**: Summary Statistics

This table reports summary statistics. Panel A reports statistics for the full application sample. Panel B reports statistics for originated loans. Panel C reports statistics for the HMDA–McDash matched sample used to study ex-post loan performance. Continuous variables are winsorized at the 1st and 99th percentiles. Local share, rejection rate, default rate, and interest rate are reported in percentage points. Local share is based on an indicator equal to one if the reviewing loan officer is located in the same county as the borrower.

| | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|
| | Mean | Median | SD | Mean | Median | SD |
| *Panel A: Full Application Sample* | | | | | | |
| Local Share (%) | 40.79 | - | - | 31.14 | - | - |
| Log Distance | 2.64 | 3.18 | 2.47 | 3.78 | 3.94 | 2.88 |
| Rejection Rate (%) | 7.52 | 0.00 | 26.36 | 24.72 | 0.00 | 43.14 |
| FICO | 730 | 739 | 59 | 719 | 726 | 65 |
| DTI | 38.42 | 39.23 | 10.58 | 38.77 | 39.18 | 12.52 |
| LTV | 87.14 | 93.55 | 13.67 | 71.63 | 75.00 | 17.48 |
| Observations | | 5,346,682 | | | 3,036,391 | |
| *Panel B: Originated Loans* | | | | | | |
| Local Share (%) | 41.48 | - | 49.27 | 34.63 | - | 47.58 |
| Log Distance | 2.59 | 3.15 | 2.45 | 3.48 | 3.61 | 2.86 |
| Interest Rate (%) | 4.45 | 4.50 | 0.59 | 4.33 | 4.25 | 0.66 |
| FICO | 732 | 742 | 57 | 732 | 740 | 56 |
| DTI | 37.89 | 38.91 | 9.94 | 36.66 | 37.83 | 10.30 |
| LTV | 87.07 | 93.00 | 13.64 | 70.84 | 74.89 | 17.06 |
| Observations | | 4,811,565 | | | 2,201,219 | |
| *Panel C: HMDA–McDash Matched Sample* | | | | | | |
| Local Share (%) | 40.77 | 0.00 | 49.14 | 32.59 | 0.00 | 46.87 |
| Log Distance | 2.65 | 3.17 | 2.47 | 3.65 | 3.82 | 2.87 |
| Default Rate (%) | 8.70 | 0.00 | 28.18 | 6.22 | 0.00 | 24.15 |
| Interest Rate (%) | 4.43 | 4.50 | 0.58 | 4.33 | 4.25 | 0.63 |
| FICO | 730 | 739 | 57 | 730 | 736 | 54 |
| DTI | 38.41 | 39.52 | 9.69 | 37.10 | 38.35 | 9.87 |
| LTV | 87.69 | 95.00 | 13.04 | 71.82 | 75.00 | 15.76 |
| Observations | | 3,054,156 | | | 1,215,441 | |

**Table 2**

Local Information Production Across Approval, Pricing, and Default Margins

This table presents the results of the main local-indicator specifications across the three key outcome margins. In Panel A, the dependent variable is an indicator equal to 100 if a loan application is rejected. In Panel B, the dependent variable is the interest rate on the originated loan, in percentage points. In Panel C, the dependent variable is an indicator equal to 100 if a loan becomes 60 days delinquent within two years of origination. The sample in Panel A includes all HMDA applications in 2018–2019. Panel B includes all originated HMDA loans in 2018–2019. Panel C includes approved HMDA loans in 2018–2019 that are matched to McDash performance records. *Local* equals one if the reviewing loan officer's work location is in the same county as the applicant. All specifications include a saturated set of hard-information controls: loan type interacted with polynomials in FICO, LTV, and DTI (including squared terms), as well as AUS status indicators. Standard errors are clustered at the borrower–county level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Panel A. Rejection rate* | | | | | | |
| Local | -1.881*** | -0.643*** | -0.202*** | -7.898*** | -2.855*** | -0.655*** |
| | (0.09) | (0.05) | (0.03) | (0.22) | (0.15) | (0.10) |
| Observations | 3,721,849 | 3,716,598 | 3,704,260 | 1,915,240 | 1,907,786 | 1,886,996 |
| $R^2$ | 0.229 | 0.279 | 0.316 | 0.380 | 0.456 | 0.506 |
| *Panel B. Interest rate* | | | | | | |
| Local | 0.033*** | 0.010*** | -0.002** | 0.028*** | 0.037*** | 0.009*** |
| | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| Observations | 3,370,947 | 3,365,679 | 3,354,197 | 1,450,704 | 1,442,695 | 1,421,876 |
| $R^2$ | 0.564 | 0.661 | 0.707 | 0.546 | 0.655 | 0.735 |
| *Panel C. Default within two years* | | | | | | |
| Local | -0.332*** | -0.463*** | -0.344*** | 0.492*** | 0.037 | 0.000 |
| | (0.07) | (0.06) | (0.05) | (0.10) | (0.08) | (0.08) |
| Observations | 2,138,596 | 2,135,269 | 2,123,285 | 765,822 | 760,305 | 742,317 |
| $R^2$ | 0.107 | 0.124 | 0.165 | 0.079 | 0.110 | 0.195 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| County × month FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Lender × month FE | No | Yes | Yes | No | Yes | Yes |
| Loan officer FE | No | No | Yes | No | No | Yes |

**Table 3**: Local Advantage in Loan Processing Time

This table reports loan-level regressions examining how borrower–officer proximity affects mortgage processing time for originated loans. The dependent variable is processing time, defined as the number of days between the loan application date and the origination date. The explanatory variable is an indicator for whether the reviewing loan officer is local. Columns (1)–(3) report results for home-purchase loans; columns (4)–(6) report results for refinance loans. All specifications include a saturated set of hard-information controls: loan type interacted with polynomials in FICO, LTV, and DTI ratios (including squared terms), as well as AUS status indicators. The three specifications correspond to increasingly saturated fixed effects as indicated in the table. The sample includes all originated home-purchase and refinance loans in confidential HMDA for 2018–2019. Standard errors are clustered at the borrower–county level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

| | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local | -2.383*** | -0.176 | -0.028 | 0.500** | -1.652*** | -1.174*** |
| | (0.37) | (0.15) | (0.07) | (0.20) | (0.13) | (0.08) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| County-Month FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Lender-Month FE | | Yes | Yes | | Yes | Yes |
| Loan Officer FE | | | Yes | | | Yes |
| N | 3,380,205 | 3,374,927 | 3,363,438 | 1,452,425 | 1,444,421 | 1,423,612 |
| $R^2$ | 0.090 | 0.299 | 0.371 | 0.129 | 0.280 | 0.395 |

**Table 4**: Local Wage Conditions and the Allocation of Underwriting Capacity

This table examines how local wage conditions shape the allocation of underwriting capacity across markets. In columns (1)–(2), the dependent variable equals one if a mortgage application is handled by a loan officer whose work location is in the same county as the borrower. The explanatory variable is the standardized finance-sector hourly wage in the borrower's market. Column (1) includes year fixed effects. Column (2) includes lender × year and state × year fixed effects. All specifications in columns (1)–(2) include borrower and loan controls. Standard errors in columns (1)–(2) are clustered at the borrower-county level. In columns (3)–(5), the unit of observation is lender–MSA–year and the dependent variable is the *Misalignment Index*, defined as $(m_{jkt}/M_{jt}) - (l_{jkt}/L_{jt})$, where $m_{jkt}/M_{jt}$ is the share of lender $j$'s mortgage applications from MSA $k$ and $l_{jkt}/L_{jt}$ is the share of its registered loan officers located there. A higher value indicates that a market contributes more to a lender's mortgage demand than to its local underwriting capacity. MSA-level controls include employment rates, income per capita, and earnings per job. Standard errors in columns (3)–(5) are clustered at the lender level. In all columns, a higher wage indicates a more expensive local labor market. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

| | Local Assignment | | Misalignment Index | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Finance-Sector Hourly Wage (std.) | -0.0388*** | -0.0197** | 1.589*** | 1.814*** | 2.326*** |
| | (0.010) | (0.009) | (0.21) | (0.25) | (0.27) |
| Borrower / Loan Controls | Yes | Yes | | | |
| Year FE | Yes | | Yes | | |
| State × Year FE | | Yes | | | |
| Lender × Year FE | | Yes | | Yes | Yes |
| MSA Controls | | | | | Yes |
| N | 4,970,686 | 4,970,611 | 187,671 | 186,631 | 185,709 |
| $R^2$ | 0.0263 | 0.1573 | 0.002 | 0.049 | 0.050 |

**Table 5**: Soft Information Used in Loan Approval Decisions

This table presents the $R^2$ analysis results from regressions of loan rejection on hard-information variables, estimated separately for applications processed by local and remote loan officers. Panel A reports $R^2$, while Panel B reports adjusted $R^2$. The dependent variable in all specifications is an indicator for whether a home purchase loan application is rejected. The underlying sample includes all home purchase loan applications in the confidential HMDA for 2018–2019. All specifications include a saturated set of hard-information: loan type interacted with a polynomial in FICO, loan-to-value (LTV), and debt-to-income (DTI) ratios (including squared terms), as well as indicators for automated underwriting system (AUS) status. We estimate six increasingly saturated specifications. Specification 1 includes only these hard-information. Specification 2 adds application-month fixed effects. Specification 3 replaces month fixed effects with borrower-county-by-month fixed effects. Specification 4 adds lender-by-month fixed effects in addition to borrower-county-by-month fixed effects. Specification 5 replaces these with lender-by-county-by-month fixed effects. Specification 6 further adds loan officer fixed effects. The first two columns report the $R^2$ (or adjusted $R^2$) from the full sample. The final three columns report results from 100 bootstrap replications, each using a random 10% subsample of applications. For each specification, we report the mean $R^2$ (or adjusted $R^2$) for local and remote officers, and the mean difference between the two. Bootstrap standard errors are reported in parentheses, and $t$-statistics for the mean difference are reported in brackets. Standard errors are clustered at the borrower-county level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: $R^2$

| | Full Sample | | Bootstrap Sample | | |
|---|---|---|---|---|---|
| | Local Loan Officer | Remote Loan Officer | Local Loan Officer | Remote Loan Officer | Difference |
| Specification 1 | 0.191 | 0.217 | 0.191 | 0.217 | -0.026*** |
| | | | (0.004) | (0.003) | [-51.36] |
| Specification 2 | 0.191 | 0.217 | 0.191 | 0.217 | -0.026*** |
| | | | (0.004) | (0.003) | [-51.49] |
| Specification 3 | 0.214 | 0.246 | 0.269 | 0.316 | -0.046*** |
| | | | (0.004) | (0.003) | [-93.23] |
| Specification 4 | 0.265 | 0.303 | 0.376 | 0.409 | -0.034*** |
| | | | (0.004) | (0.003) | [-65.54] |
| Specification 5 | 0.340 | 0.438 | 0.478 | 0.561 | -0.082*** |
| | | | (0.005) | (0.004) | [-136.08] |
| Specification 6 | 0.374 | 0.477 | 0.589 | 0.695 | -0.106*** |
| | | | (0.004) | (0.004) | [-182.83] |
| Bootstrap Samples | | | 100 | 100 | |

Panel B: Adjusted $R^2$

| | Full Sample | | Bootstrap Sample | | |
|---|---|---|---|---|---|
| | Local Loan Officer | Remote Loan Officer | Local Loan Officer | Remote Loan Officer | Difference |
| Specification 1 | 0.191 | 0.217 | 0.191 | 0.217 | -0.026*** |
| | | | (0.004) | (0.003) | [-51.50] |
| Specification 2 | 0.191 | 0.217 | 0.191 | 0.217 | -0.026*** |
| | | | (0.004) | (0.003) | [-51.70] |
| Specification 3 | 0.198 | 0.226 | 0.191 | 0.225 | -0.034*** |
| | | | (0.005) | (0.003) | [-61.66] |
| Specification 4 | 0.231 | 0.271 | 0.216 | 0.262 | -0.046*** |
| | | | (0.006) | (0.003) | [-72.13] |
| Specification 5 | 0.244 | 0.284 | 0.234 | 0.280 | -0.046*** |
| | | | (0.007) | (0.006) | [-49.90] |
| Specification 6 | 0.249 | 0.299 | 0.145 | 0.226 | -0.081*** |
| | | | (0.010) | (0.009) | [-59.99] |
| Bootstrap Samples | | | 100 | 100 | |

**Table 6**: Cross-Sectional Heterogeneity in Local Officer Effects by Borrower Risk

This table examines how the impact of local loan officers varies with borrower risk across three outcomes: rejection (columns 1–3), default (columns 4–6), and posted interest rates (columns 7–9), all in percentage points. The sample consists of conventional and jumbo home-purchase mortgage applications in confidential HMDA for 2018–2019 (excluding FHA, VA, and RHS). Columns 1–3 use all applications; columns 4–6 use originated loans matched to McDash performance records; and columns 7–9 use all originated loans. Borrower risk is captured by (i) Subprime (FICO $< 670$), (ii) High DTI (DTI $> 43$), and (iii) High LTV (LTV $> 80$). Each specification includes indicators for Local, a high-risk indicator, and their interaction; loan-type interactions with polynomials in FICO, LTV, and DTI (including squared terms); AUS status indicators; county-month fixed effects; and lender-month fixed effects. Standard errors are clustered at the borrower–county level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| | Rejection (pp) | | | Default (pp) | | | Interest Rate (pp) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Subprime (1) | High DTI (2) | High LTV (3) | Subprime (4) | High DTI (5) | High LTV (6) | Subprime (7) | High DTI (8) | High LTV (9) |
| Local | -0.369*** | -0.336*** | -0.337*** | -0.242*** | -0.186*** | -0.165** | 0.015*** | 0.014*** | 0.017*** |
| | (0.06) | (0.07) | (0.09) | (0.06) | (0.06) | (0.07) | (0.00) | (0.00) | (0.00) |
| Local×Subprime | -2.927*** | | | -0.428 | | | -0.010* | | |
| | (0.24) | | | (0.30) | | | (0.01) | | |
| Local×High DTI | | -0.761*** | | | -0.273** | | | 0.003* | |
| | | (0.13) | | | (0.12) | | | (0.00) | |
| Local×High LTV | | | -0.386*** | | | -0.188* | | | -0.003 |
| | | | (0.10) | | | (0.11) | | | (0.00) |
| County-Month FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Lender-Month FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2,611,212 | 2,611,212 | 2,611,212 | 1,419,546 | 1,419,546 | 1,419,546 | 2,385,885 | 2,385,885 | 2,385,885 |
| $R^2$ | 0.252 | 0.250 | 0.250 | 0.093 | 0.092 | 0.092 | 0.670 | 0.664 | 0.665 |

**Table 7**: Testing for Borrower Sorting

This table tests borrower sorting. The dependent variable is an indicator for whether the mortgage application is rejected (scaled so coefficients are reported in percentage points). *Local* equals one if the loan officer handling the application works in the same county as the borrower, and zero otherwise. *Finance-Sector Hourly Wage (std.)* is the standardized finance-sector hourly wage in the borrower's market. Columns (1)–(2) restrict the sample to home-purchase applications, and columns (3)–(4) restrict the sample to refinance applications. Panel A uses the full sample of markets, while Panel B restricts attention to metropolitan (MSA) markets. All specifications include loan-type dummies fully interacted with borrower and loan controls (FICO, FICO$^2$, LTV, LTV$^2$, DTI, DTI$^2$, and AUS status). Columns (1) and (3) include borrower-county × application-month fixed effects; columns (2) and (4) additionally include lender × application-month fixed effects. Standard errors, reported in parentheses, are clustered at the borrower-county level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

| | Home Purchase | | Refinance | |
|---|---|---|---|---|
| | (1) | (2) | (4) | (5) |
| *Panel A: Full Sample* | | | | |
| Local | -4.2377*** | -1.2761*** | -18.3222*** | -4.3123*** |
| | (0.526) | (0.378) | (1.248) | (0.861) |
| Local×Finance-Sector Hourly Wage (std.) | 0.3215*** | 0.0859 | 1.3809*** | 0.1911 |
| | (0.070) | (0.052) | (0.164) | (0.118) |
| Borrower / Loan Controls | Yes | Yes | Yes | Yes |
| Borrower-County × Month FE | Yes | Yes | Yes | Yes |
| Lender × Month FE | | Yes | | Yes |
| N | 3,657,215 | 3,652,044 | 1,888,481 | 1,881,160 |
| $R^2$ | 0.2274 | 0.2779 | 0.3804 | 0.4561 |
| *Panel B: MSA-Area* | | | | |
| Local | -4.0562*** | -1.0904*** | -17.6405*** | -3.5586*** |
| | (0.597) | (0.410) | (1.385) | (0.919) |
| Local×Finance-Sector Hourly Wage (std.) | 0.2981*** | 0.0597 | 1.2913*** | 0.0909 |
| | (0.077) | (0.056) | (0.180) | (0.124) |
| Borrower / Loan Controls | Yes | Yes | Yes | Yes |
| Borrower-County × Month FE | Yes | Yes | Yes | Yes |
| Lender × Month FE | | Yes | | Yes |
| N | 3,253,393 | 3,247,847 | 1,714,927 | 1,707,332 |
| $R^2$ | 0.2177 | 0.2693 | 0.3727 | 0.4489 |

**Table 8**: Estimated Default Parameters

This table reports estimated default rates, latent heterogeneity, and aggregate shock values for each market for the model in Section 4. Markets are segmented based on borrower risk type (Subprime (FICO $<$ 660), Near Prime (660 $\leq$ FICO $<$ 720), and Prime (FICO $\geq$ 720)) and loan purpose (Purchase vs Refi). See Section 5.2 for more details.

| | | Baseline risk measures | | |
|---|---|---|---|---|
| Market | Risk tier | Default rate | $\sigma_i^x$ | $\epsilon_{i,t}$ |
| Refi | Subprime | 31.6% | 4.41 | -0.99 |
| | Near-Prime | 12.9% | 5.16 | -1.98 |
| | Prime | 8.0% | 9.19 | -2.95 |
| Purchase | Subprime | 7.9% | 1.21 | 0.12 |
| | Near-Prime | 3.9% | 1.92 | -0.68 |
| | Prime | 2.1% | 4.75 | -2.30 |

**Table 9**: Baseline Informational Efficiency: Credit Rationing and False Approvals

This table reports the amount of credit rationing and false approvals in the baseline equilibrium, as implied by the model in Section 4. Markets are segmented based on borrower risk type (Subprime (FICO $<$ 660), Near Prime (660 $\leq$ FICO $<$ 720), and Prime (FICO $\geq$ 720)) and loan purpose (Purchase vs Refi). Panel A reports aggregate credit-rationing and false-approval rates; Panel B breaks these out by loan officer type. See Section 6.1 for more details.

| | | Share of applications (%) | |
|---|---|---|---|
| Market | Risk tier | Credit rationing | False approvals |
| **Panel A: Overall rates** | | | |
| Refi | Subprime | 15.3% | 2.4% |
| | Near-Prime | 8.4% | 2.0% |
| | Prime | 3.6% | 0.5% |
| Purchase | Subprime | 10.3% | 10.6% |
| | Near-Prime | 5.6% | 4.3% |
| | Prime | 2.3% | 0.8% |

*Baseline Informational Efficiency (continued)*

| | | Credit rationing (%) | | False approvals (%) | |
|---|---|---|---|---|---|
| Market | Risk tier | Local officers | Distant officers | Local officers | Distant officers |
| **Panel B: By loan officer type** | | | | | |
| Refi | Subprime | 8.7% | 17.8% | 2.0% | 2.5% |
| | Near-Prime | 5.0% | 9.9% | 1.6% | 2.2% |
| | Prime | 1.9% | 4.4% | 0.4% | 0.6% |
| Purchase | Subprime | 10.1% | 10.4% | 8.6% | 12.2% |
| | Near-Prime | 5.1% | 6.0% | 3.2% | 5.1% |
| | Prime | 1.5% | 2.8% | 0.6% | 0.9% |

**Table 10**: Technology Shock and Lending Outcomes

This table reports the results of a counterfactual shock to the processing capacity of remote loan officers. Markets are segmented based on borrower risk type (Subprime (FICO $<$ 660), Near Prime (660 $\leq$ FICO $<$ 720), and Prime (FICO $\geq$ 720)) and loan purpose (Purchase vs Refi). The table reports the results of only shocking Brick and Mortar banks, as well as shocking all banks. See Section 6.2 for more details.

| | | Change (percentage points) | | |
|---|---|---|---|---|
| Market | Risk tier | Rejection rate | Credit rationing | False approvals |
| **Panel A: Shock 1 – Brick and Mortar** | | | | |
| Refi | Subprime | 0.32% | 0.34% | 0.02% |
| | Near-Prime | 0.29% | 0.30% | 0.01% |
| | Prime | 0.08% | 0.10% | 0.02% |
| Purchase | Subprime | -0.16% | 0.44% | 0.60% |
| | Near-Prime | -0.11% | 0.14% | 0.25% |
| | Prime | 0.11% | 0.13% | 0.02% |
| **Panel B: Shock 2 – All Banks** | | | | |
| Refi | Subprime | 1.13% | 1.13% | -0.01% |
| | Near-Prime | 0.91% | 0.87% | -0.04% |
| | Prime | 0.21% | 0.26% | 0.06% |
| Purchase | Subprime | 1.29% | 2.02% | 0.73% |
| | Near-Prime | 0.28% | 0.73% | 0.45% |
| | Prime | 0.33% | 0.37% | 0.05% |

*Technology Shock and Lending Outcomes (continued)*

| | | Change in expected default | | Change in monthly payment | |
|---|---|---|---|---|---|
| Market | Risk tier | Shock 1 | Shock 2 | Shock 1 | Shock 2 |
| **Panel C: Expected Defaults and Monthly Payments** | | | | | |
| Refi | Subprime | 0.06% | 0.03% | -$3.07 | -$16.55 |
| | Near-Prime | 0.02% | 0.01% | -$2.70 | -$14.09 |
| | Prime | 0.01% | 0.01% | -$1.87 | -$9.98 |
| Purchase | Subprime | 0.25% | 0.28% | -$4.74 | -$23.23 |
| | Near-Prime | 0.07% | 0.13% | -$3.10 | -$16.43 |
| | Prime | 0.01% | 0.02% | -$2.58 | -$13.45 |

# Appendix for Online Publication

# A Detailed Institutional Background

The U.S. residential mortgage market operates under a standardized and highly regulated origination process governed by the Truth-in-Lending Act (TILA), the Real Estate Settlement Procedures Act (RESPA), and their integration through the TILA–RESPA Integrated Disclosure (TRID) rules administered by the Consumer Financial Protection Bureau (CFPB).[20] Although internal procedures vary across lenders, the fundamental sequence is uniform:

rate setting $\rightarrow$ formal application $\rightarrow$ information collection $\rightarrow$ underwriting $\rightarrow$ origination.

A defining institutional feature is the separation between (i) the pricing stage, which occurs before verified information is available, and (ii) the underwriting stage, which evaluates the hard information assembled throughout the application pipeline.

## A.1 Rate Setting Prior to Information Acquisition

Origination begins with *rate setting*. Lenders publish rate sheets daily, and loan officers (LOs) quote interest rates based on borrower-reported characteristics, program eligibility, and prevailing market conditions.[21] At this stage, lenders know only self-reported borrower information; no verified income, asset, employment, or collateral documents have been collected.

Under TRID, lenders must issue a Loan Estimate (LE) within three business days of receiving a formal application.[22] After the LE is issued, TRID tightly restricts circumstances under which lenders may increase interest rates or fees. Upward repricing is allowed only in narrowly defined "changed circumstances" such as borrower-initiated changes or corrections to borrower-provided information.[23] Thus, lenders generally *cannot* reprice loans upward after underwriting reveals adverse information. This contrasts with canonical screening models in industrial organization, where lenders can always adjust prices after privately observing borrower risk.

[20] See CFPB, "TILA–RESPA Integrated Disclosure Rule (TRID): Guide to Forms" (2022).
[21] Mortgage Bankers Association (MBA), "Mortgage Origination Survey," various years.
[22] 12 C.F.R.§1026.19(e)(1)(iii).
[23] 12 C.F.R.§1026.19(e)(3)(iv).

## A.2 Formal Application and Information Collection

If the borrower proceeds, they submit a *formal application*, triggering the issuance of the LE and initiating the *information-collection* stage. Loan officers gather income documentation, bank statements, credit reports, appraisals, verifications of employment and assets, and third-party reports following detailed agency and investor requirements.[24]

Industry manuals consistently emphasize that loan officers are responsible for file completeness, accuracy, and timeliness. LOs coordinate with borrowers, employers, appraisers, title companies, and verification vendors; missing or inconsistent documents frequently delay or derail underwriting.

## A.3 Underwriting and the Role of Loan Officers in Approval

During *underwriting*, human underwriters and automated underwriting systems (AUS)—Fannie Mae Desktop Underwriter®, Freddie Mac Loan Product Advisor®, and proprietary lender systems—evaluate the collected information. Underwriters assess DTI, LTV, credit history, collateral value, and program eligibility.

Although underwriters hold formal approval authority, their decisions depend entirely on the information produced earlier in the pipeline. Underwriters do not independently collect additional documents; if LOs provide incomplete or inconsistent files, denials or conditional approvals frequently follow.[25] Thus, loan officers play a *first-order* role in shaping approval outcomes by determining the quality and completeness of the underwriting file.

## A.4 Local Versus Remote Loan Officers

The rise of centralized and online lending platforms has sharpened the distinction between *local* and *remote* LOs. Local LOs are based in the same geographic market as borrowers and interact regularly with local employers, real estate agents, appraisers, and title companies. This proximity reduces frictions in document collection, verification, and communication.

Remote LOs—often located in call centers or out-of-state hubs—communicate primarily

[24] See Fannie Mae Selling Guide B1–1–01 (2024); Freddie Mac Seller/Servicer Guide (2024).
[25] Freddie Mac Seller/Servicer Guide, Section 5101.2 (2024).

by phone or online channels and may face greater difficulty securing timely verifications or coordinating with local service providers.[26] Because lenders cannot freely raise rates after underwriting and because documentation quality affects approval outcomes, these information frictions translate directly into differences in rejection probabilities and processing times.

### A.5 Origination and Final Rate Setting

Once underwriting conditions are satisfied, the lender issues the Closing Disclosure (CD) and proceeds to *origination*. TRID restricts rate changes at this stage. Downward renegotiation is common when market rates decline or borrowers present competing offers, but upward repricing is generally prohibited absent a qualifying changed circumstance.[27]

Hence, the initial pricing decision carries independent economic significance, and underwriting preserves a meaningful approval margin that cannot be offset through ex-post price adjustments.

## B Sample Construction and Data Cleaning

This appendix describes how we construct the loan-level dataset used in the analysis by combining confidential HMDA application records, NMLS loan officer registrations, and McDash performance data. Our cleaning procedures follow standard practice in the mortgage literature, including Bhutta and Hizmo (2021), and impose additional restrictions to ensure comparability across borrowers and consistency in loan structure.

We begin with the confidential HMDA application files. To obtain a homogeneous sample of loans subject to consistent underwriting standards, we restrict attention to completed applications for first-lien, 30-year, fixed-rate mortgages secured by owner-occupied properties. Applications sourced through mortgage brokers or purchased from other lenders are excluded because these channels do not reflect the originating lender's internal screening technology or loan officer assignment. These filters remove products with distinct risk profiles, heterogeneous documentation requirements, or limited information on the underwriting process.

[26] MBA, "Technology & Origination Report," 2020.
[27] 12 C.F.R.§1026.19(e)(3).

We retain both home-purchase and refinance applications that meet these criteria. For originated loans in 2018–2019, the confidential version of HMDA provides the identity of the loan officer who processed the application. Using this identifier, we merge each application to the NMLS registry to obtain the officer's physical work location.

Next, we merge the HMDA originations to monthly loan-level performance data from the Black Knight McDash servicing database. Following the methodology of Rosen (2011), we treat a loan in HMDA and a loan in McDash as the same origination only when several characteristics match almost exactly. First, the reported origination dates in the two datasets must lie within five calendar days of each other, and the HMDA action date must be within five days of the McDash origination date to ensure consistent application–closing timing. Second, the origination amounts must differ by less than $10. Third, the property ZIP code, lien type, loan purpose (purchase or refinance), loan type, and occupancy type must agree exactly across datasets. These conditions minimize the possibility of false matches while retaining a large and representative subset of the market.

Using this procedure, we successfully merge approximately 36 percent of originated loans in confidential HMDA to 68 percent of loans in McDash. As in prior work, the imperfect overlap reflects the fact that not all HMDA-reporting lenders service loans in McDash and not all McDash servicers appear as HMDA reporters. For matched loans, we construct a two-year performance history and define a delinquency indicator equal to one if a loan becomes sixty or more days delinquent within twenty-four months of origination. To ensure complete performance histories for all loans, we restrict the analysis to applications submitted in 2018–2019.

The final dataset links each loan application to (i) borrower and loan characteristics at the time of application, (ii) the lender and loan officer responsible for the file, (iii) the physical location of the loan officer obtained from NMLS, (iv) underwriting decisions and posted interest rates, and (v) loan performance up to two years after origination. This merged dataset forms the basis for our analysis of geographic misallocation, screening efficiency, labor-input choices, and credit-access outcomes.

# C Conceptual Framework

## C.1 Primitives

This section presents a simple conceptual framework that rationalizes the reduced form tests in Section 3. There is a unit mass of ex-ante identical consumers. A bank sets an ex-ante rate $\bar{r}$ under a break-even constraint. A consumer is differentiated by their default rate $\theta \sim F$. Applications follow a cutoff rule: all consumers with default rate $\theta \geq \underline{d}(\bar{r})$ apply to the bank. Assume $\underline{d}'(r) \geq 0$. The bank pays a fixed processing cost of $c$ per application.

If the consumer applies, the bank observes a signal $\hat{\theta} = \theta + \epsilon$ with $\epsilon \sim G$, and can reject or approve. If the bank approves, it may adjust the rate to $r^*$, after which the loan is originated with probability $\varphi(r^*, r)$. The bank earns $r^* - \theta$ if the loan is originated and zero otherwise.

**Regularity Conditions:**

- $F$ and $G$ admit densities $f$ and $g$, respectively;
- $\theta \perp \epsilon$;
- The signal satisfies the MLRP. Since the noise is additive, this is equivalent to:

$$\frac{g(x)}{g(x+\Delta)} \text{ is decreasing in } x \text{ for all } \Delta > 0.$$

If $g$ is twice differentiable, this is equivalent to log-concavity: $\frac{\partial^2 lng}{\partial \epsilon^2} \leq 0$.

**Signal Precision**

Assume $G$ belongs to a family of noise distributions ordered by parameter $\sigma \in \mathbb{R}$ in the Blackwell sense. Formally: there exists a random variable $\eta \perp \epsilon$ with density $h_{\sigma',\sigma}$ such that $g(\epsilon; \sigma') = \int g(\epsilon - \eta; \sigma) h_{\sigma',\sigma}(\eta) d\eta$.[28] Let $m\left(\hat{\theta}, \sigma\right) := \mathbb{E}\left[\theta | \hat{\theta}, \sigma\right]$ denote the posterior mean.

[28] For example, if $G \sim \mathcal{N}\left(0, \sigma^2\right)$, then $\begin{bmatrix} \epsilon \\ \eta \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2 & 0 \\ 0 & (\sigma')^2 - \sigma^2 \end{bmatrix}\right)$

## C.2 Results With Ex-post Pricing

Suppose the bank faces no constraint in ex-post repricing, other than the fact that consumers may walk away if it ex-post raises prices. For simplicity, we can model this walking behavior through an exponential decay function:[29]

$$\varphi\left(r^*, \bar{r}\right) = exp\left\{-\lambda^{-1} r^*\right\}$$

for hazard rate $\lambda \geq 0$.

**Lemma 1.** *(Optimal Ex-Post Pricing).*The bank never rejects borrowers and sets $r^* = m\left(\hat{\theta}, \sigma\right) + \lambda$.

*Proof.* Given signal $\hat{\theta}$,the bank's expected profits from setting rate $r^*$ are:

$$\varphi\left(r^*; \bar{r}\right)\left(r^* - m\left(\hat{\theta}, \sigma\right)\right)$$

Taking the FOC wrt $r^*$ gives the interior solution:

$$r^* = m\left(\hat{\theta}, \sigma\right) + \lambda$$

Note that $\left(m\left(\hat{\theta}, \sigma\right) + \lambda - m\left(\hat{\theta}, \sigma\right)\right)\varphi\left(r^*; \bar{r}\right) = \lambda\varphi\left(r^*; \bar{r}\right) > 0 \ \forall r^* \in \mathbb{R}$, meaning rejection is never optimal. □

For the next result, we consider a setting without adverse selection to cleanly isolate the properties of ex-post risk pricing.

**Proposition 1.** *(A Test for Ex-Post Repricing).* Suppose $\underline{d}$'=0.Then the correlation between realized default rates and realized interest rates is decreasing in $\sigma$.

*Proof.* By the law of total covariance, given that $r^*$is fully determined by $\hat{\theta}$, $Cov\left(\theta, r^*\right) = Cov\left(m, r^*\right)$. Thus:

[29]It is straightforward to replace this parametric assumption with a set of general regularity conditions on consumer "walking" behavior. A sufficient set of conditions is weak log-concavity and a weakly convex hazard function. The necessary condition is that the hazard rate doesn't change "too fast" in the tails of the walking function.

$$corr\left(\theta, r^*\right) = \frac{cov\left(m, r^*\right)}{\sqrt{Var\left(\theta\right) Var\left(r^*\right)}}$$

Applying Lemma 1 gives:

$$\frac{cov\left(m, r^*\right)}{\sqrt{Var\left(\theta\right) Var\left(r^*\right)}} = \sqrt{\frac{Var\left(m\right)}{Var\left(\theta\right)}}$$

By the Blackwell ordering on $G$, and the law of iterated expectations, $Var\left(m\right)$ is decreasing in $\sigma$, completing the proof. □

## C.3 Results Without Ex-Post Repricing

Suppose regulatory constraints (e.g. TRID) make origination with an upward re-priced loan infeasible. Suppose also that consumers never walk from an approved loan.[30] Then:

$$\varphi\left(r^*, \bar{r}\right) = \begin{cases} 0 & r^* > \bar{r} \\ 1 & r^* \leq \bar{r} \end{cases}$$

For this section, let $\bar{d}$ denote the realized default rate on originated loans and let $\bar{p}$ denote the approval probability.

**Lemma 2.** *(Optimal Approval Rule).* The bank approves a loan if and only if $\hat{\theta} \leq \hat{\theta^*}\left(\bar{r}, \sigma\right)$

*Proof.* Approval is optimal if and only if expected profit is nonnegative. Upward repricing is infeasible and downward repricing yields no additional surplus. This implies the decision rule

$$\text{Approve} \iff m\left(\hat{\theta}, \sigma\right) \leq \bar{r}.$$

By the MLRP, $m\left(\hat{\theta}, \sigma\right)$ is weakly increasing in $\hat{\theta}$. Hence, the approval set, $\mathcal{D} \coloneqq \left\{\hat{\theta} : \text{approve}\right\}$ is an interval. Defining $\hat{\theta^*}\left(\bar{r}, \sigma\right) = \sup \mathcal{D}$ completes the proof. □

**Lemma 3.** *(Signal Precision and Default Rates).* Suppose $\sigma_2 < \sigma_1$. Then, for any approval cutoffs $\hat{\theta}_1^*$and $\hat{\theta}_2^*$such that $\bar{p}_2 \leq \bar{p}_1$, $\bar{d}_2 < \bar{d}_1$.

[30] In our sample, fewer than five percent of approved consumers walk away.

*Proof.* For expositional simplicity, assume $p_1 = p_2$. Let $A_i(\theta) = G\left(\hat{\theta}_i^* - \theta; \sigma_i\right)$ denote the approval probability of a consumer with true default rate $\theta$. Note that $A_i$ is strictly decreasing in $\theta$.

Since $\bar{p}_1 = \bar{p}_2$, $\int A_1(\theta) F(d\theta) = \int A_2(\theta) F(d\theta)$. Further, since $\sigma_2 < \sigma_1$, there exists $\eta$ such that $A_1(\theta) = \int G\left(\hat{\theta}_1^* - \theta - \eta; \sigma_2\right) H(d\eta)$. Thus, by the MLRP on G, $A_1(\theta) - A_2(\theta)$ satisfies a single crossing property from below: there exists a unique $\theta^*$ such that $A_1(\theta) - A_2(\theta) \geq 0$ for all $\theta \geq \theta^*$ and $A_1(\theta) - A_2(\theta) < 0$ for all $\theta < \theta^*$.

Note $\bar{d}_i = \frac{\int \theta A_i(\theta) F(d\theta)}{\bar{p}_i} = \frac{\int_{\underline{d}}^{\theta^*} \theta A_i(\theta) F(d\theta) + \int_{\theta^*}^{\infty} \theta A_i(\theta) F(d\theta)}{\bar{p}_i}$. Thus:

$$\bar{p}_1\left(\bar{d}_2 - \bar{d}_1\right) = \int_{\underline{d}}^{\theta^*} \theta\left(A_2(\theta) - A_1(\theta)\right) F(d\theta) + \int_{\theta^*}^{\infty} \theta\left(A_2(\theta) - A_1(\theta)\right) F(d\theta)$$
$$< \theta^* \int A_2(\theta) - A_1(\theta) F(d\theta) = 0$$

Finally, if $\bar{p}_2 < \bar{p_1}$, the required cutoff $\hat{\theta}_2^*$is strictly lower than the cutoff which equates approval probabilities. By the MLRP, $\bar{d}_2$ is strictly increasing in the cutoff, implying $\bar{d}_2$must be strictly lower. □

**Proposition 2.** *(Ex-Ante Pricing).* Realized prices depend on the ex-ante risk and signal distributions and are independent of the realized signal during origination.

*Proof.* Anticipating its optimal decision rule from Lemma 2, the bank sets $\bar{r} = \bar{d} + \frac{c}{\bar{p}}$ to satisfy its break even constraint. This price depends only on expectations over $F$ and $G$, and not on realized signal $\hat{\theta}$. □

**Proposition 3.** *A sufficient condition for informational superiority.*

Suppose two distinct underwriting technologies (either within or across banks) face the same potential applicant distribution. If underwriting technology 1 exhibits (i) (weakly) lower rejection rates, (ii) (weakly) lower realized default rates, and (iii) (weakly) higher interest rates than underwriting technology 2, with at least one inequality strict, then technology 1 must use a more precise signal than technology 2.

*Proof.* By way of contradiction, suppose $\sigma_1 \geq \sigma_2$. Since $r_1 \geq r_2$ and $\underline{d}$'$\geq$0,we have

$\underline{\mathrm{d}}(r_1) \geq \underline{\mathrm{d}}(r_2)$. Thus, the applicant pool for technology 1 is (weakly) riskier in a FOSD sense.

Case 1: If $\sigma_1 = \sigma_2$, since $\bar{p}_1 \geq \bar{p}_2$,it must be the case that technology 1 is originated with a (weakly) less strict cutoff. This contradicts $\bar{d}_1 \leq \bar{d}_2$, as long as at least one of the inequalities is strict.

Case 2: If $\sigma_1 > \sigma_2$, let $\bar{d}_i(\underline{\mathrm{d}})$denote the realized default rate of technology $i$ if it faced application cutoff $\underline{\mathrm{d}}$. Since $\bar{p}_1 \geq \bar{p}_2$, by Lemma 3, it must be the case that $\bar{d}_1\left(\underline{\mathrm{d}}(r_2)\right) > \bar{d}_2$. Yet, by the MLRP, lowering the lower cutoff of the default type integral can only lower the realized default rate, meaning $\bar{d}_2 < \bar{d}_1$. $\rightarrow\leftarrow$ . □

# D Structural Model Appendix

## D.1 Labor Supply Function

In this section, we fully describe and derive the labor supply function from the text.

**Environment.** There is a mass of $\bar{L}$ potential loan officers, who can choose to be either a loan officer, or an outside option. There are $N_k$ potential outside options in region $k$, which pay a wage of $w_{ook}$. We assume that the CDF of amenity draws, $A_{ijk}$ is given by:

$$\mathbb{P}\left(\left(\bigcap_{\forall i,j,k}\left\{a_{ijk} \leq t_{ijk}\right\}\right)\right) = exp\left\{\left(-\sum_k\left\{\left(\sum_{i,j} t_{ijk}^{-\frac{\epsilon}{(1-\rho)(1-\phi)}}\right)^{1-\rho} + N_{k,oo}t_{k,oo}^{-\frac{\epsilon}{1-\phi}}\right\}^{1-\phi}\right)\right\}$$

with composite parameter $\varrho := \frac{\epsilon}{(1-\rho)(1-\phi)}$. This CDF implies that loan officers idiosyncratic preference draws are correlated within living location, consistent with Giroud et al. (2024). This implies that, by posting a wage of $w_{ijk}$, bank $j$ hires:

$$l_{ijk}(w_{ijk}) = \bar{L}w_{ijk}^{\varrho}\Psi_k^{-\varrho},$$

for local wage index $\Psi_k$ following:

$$\Psi_k \coloneqq \left\{ \left( \sum_{i,j} w_{ijk}^{\frac{\epsilon}{(1-\rho)(1-\phi)}} \right)^{\rho} \left[ \left( \sum_{i,j} w_{ijk}^{\frac{\epsilon}{(1-\rho)(1-\phi)}} \right)^{1-\rho} + N_{k,oo} \left( w_{ook} \right)^{\frac{\epsilon}{1-\phi}} \right]^{\phi} \left( \sum_{m} \left[ \left( \sum_{i,j} w_{ijm}^{\frac{\epsilon}{(1-\rho)(1-\phi)}} \right)^{1-\rho} + N_{m,oo} \left( w_{m,oo} \right)^{\frac{\epsilon}{1-\phi}} \right]^{1-\phi} \right) \right\}^{\frac{1}{\varrho}}$$

It can be shown that this implies the labor cost function:

$$C_{ijk}(\tilde{l}_{ijk}) = \underbrace{\bar{L}^{\varrho^{-1}} \Psi_k e_{ijk}^{-1}}_{A_{ijk}^{-1}} \tilde{l}_{ijk}^{1+\varrho^{-1}}$$

.

Finally, note that, in the limit, as $\bar{L}$ and $N_{k,oo}$ jointly all approach infinity (i.e., loan officers are atomistic in the labor market), the local wage index becomes exogenous and heterogeneity in the index is driven entirely by heterogeneity in $w_{ook}$.

## D.2 Securitization

This subsection details how securitization decisions can be incorporated into the quantitative model. The level of distortion induced by securitization depends on the extent of information shared with the secondary market. While multiple channels encourage some degree of truth-telling, if these incentives are imperfect, the frictions exacerbate the informational externalities documented in the analysis.

Consider a loan with an interest rate $r$ and a full-information per-period default hazard rate $d$, at which point a fraction $lgd$ of the balance is lost and the loan stops making payments. If the loan is funded at cost $f$, the NPV of the loan is approximately proportional to its expected per-period excess interest income of $r - f - d \times lgd$.[31] When

[31] Formally, as a continuous-time perpetuity, the NPV is exactly $\frac{r-f-d\times lgd}{\rho+d}$ for discount rate $\rho$. In the empirically relevant range, where loan terms are long and default is relatively low, the distortion from the exact continuous-time

the loan is sold on a secondary market, the bank receives a lump sum payment proportional to $\mathbb{E}[r - f - d \times lgd \mid \mathcal{I}]$, where $\mathcal{I}$ represents the capital markets information set. Under full informational efficiency—where information generation effort is credibly communicated—the bank's problem remains consistent with the baseline specification in the main text.

**Informational Inefficiencies.** When informational inefficiencies persist, the bank's profit function can be specified as $r - f - \alpha(d \times lgd) - (1 - \alpha)(\overline{d \times lgd})$, where $\overline{d \times lgd}$ is the average loss rate on loans in the market. The parameter $\alpha$ captures the degree to which banks internalize their impact on expected default rates when making approval and rate decisions. If $\alpha < 1$, a new externality is introduced, which increases the distortions imposed by the under-employment of local labor and worsens the resulting inefficiencies. While it could be valuable to quantify the impact of this additional inefficiency, a major identification challenge arises: even perfectly exogenous variation in securitization behavior cannot identify $\alpha$. The intuition is straightforward. Securitizing a loan affects the lender's problem through two distinct channels. First, if $\alpha < 1$, the lower internalization of default risk leads to looser origination standards. On the other hand, *even if* $\alpha = 1$, securitization also affects origination standards through funding costs. Since both channels enter the bank's problem in the same way, and jointly affect two unobservables, additional variation would be required to identify $\alpha$. Thus, we work with the conservative assumption that $\alpha = 1$.

**Default Internalization Mechanisms.** Why might it be reasonable to assume that banks internalize default risk? The literature has shown that there are significant differences in banks' screening effort, even in securitization, consistent with skin-in-the-game (Bosshardt et al., 2025). Consistent with this, Securitization markets incorporate several mechanisms to improve the effective informativeness of signals, or alternatively, implement ex-post transfers that dynamically ensure the same outcome. Three prominent mechanisms are put-backs, reputational concerns, and servicing rights. Under put-back covenants, defaults from an unseasoned loan that did not follow proper underwriting procedures can be returned to the bank's balance sheet, requiring the bank to

perpetuity is minimal, meaning the proportionality to the numerator is nearly exact.

internalize the full ex-post default loss. Consequently, banks can signal informational efficiency through their stated underwriting processes. Motivated by this feature, default in the reduced-form analysis is defined as a typical put-back covenant violation (i.e., 60+ days past due within the first 24 months of the loan), with the LGD calibrated accordingly. Additionally, reputational concerns may constrain banks that diverge significantly from good-faith underwriting standards. Finally, most securitizing banks maintain servicing rights for their originated loans; these rights are valuable precisely when the loan is unobservably safer, since the servicer bears the liquidity and operational costs of delinquency. Notably, the empirical results of this paper control for automated underwriting system recommendations; the residual variation in rejection and default observed may therefore be driven by the resulting internalization of excess defaults induced by such informational efficiency measures.

## D.3 Welfare

In this subsection, we provide the proof of Proposition 1. First, we characterize the social value of the lender's screening errors. Then, we prove the proposition in five steps. Finally, we derive the three extensions referenced in Section 4.6.

Throughout, we fix a market $i$ and a lender $j$ and suppress these subscripts. As in the estimated model, there is one local region, $L = g(i)$, and one remote region, $R$; $\ell$ denotes the loss given default, which Section 4 sets to one; and $\theta_\eta > 0$. Let $m \coloneqq r_{ij} - f_{ij}$, $\tilde{l} \coloneqq \mathcal{M}_i s_{ij}(r_{ij})$, and $\tilde{l}_k \coloneqq \tilde{l}\mathcal{S}_k$. Since the wage bill $w_{ijk} l_{ijk}(w_{ijk})$ is increasing in $w_{ijk}$, the capacity constraint in (4) binds, and by Section 4.4 the wage bill of screening $\tilde{l}_k$ applications in region $k$ is $C_k(\tilde{l}_k) \propto A_k^{-1} \tilde{l}_k^{1+1/\varrho}$, so that $C_k'(\tilde{l}_k) = (1 + 1/\varrho) C_k(\tilde{l}_k)/\tilde{l}_k$ and $C_k''(\tilde{l}_k) = C_k'(\tilde{l}_k)/(\varrho \tilde{l}_k)$. For region $k$, let $q_k(x) \coloneqq \mathbb{P}(\hat{x}_\eta \in \hat{\Delta}_{ij}(r_{ij}, k) \mid x_\eta = x)$ be the approval probability of type $x$, $p_k \coloneqq \int q_k \, dF_{ij}^x$ the approval rate, $d_k \coloneqq p_k^{-1} \int q_k d_i \, dF_{ij}^x$ the default rate on approved loans, $n_k \coloneqq \int q_k (1 - d_i) \, dF_{ij}^x$ the number of performing loans per application, and $\pi_k \coloneqq p_k(m - \ell d_k)$ the expected gross profit per application. With $\ell$, a mortgage is socially optimal when $r_{ij\eta}^{\text{res}} \geq f_{ij} + \ell d_i(x_\eta)$, credit rationing is rejection when $\ell d_i(x_\eta) \leq m$, and pooled origination is approval when $\ell d_i(x_\eta) > m$.

**Lemma 4.** *(Screening Errors).* (i) $r_{ij\eta}^{\text{res}} \geq r_{ij}$ for every applicant, so every credit-rationed mortgage is socially optimal. (ii) A pooled origination is socially optimal if and only if

$\ell d_i(x_\eta) - m \le r^{\text{res}}_{ij\eta} - r_{ij}$. (iii) The social value of approving applicant $\eta$ exceeds the lender's expected profit from approving her by $[1 - d_i(x_\eta)](r^{\text{res}}_{ij\eta} - r_{ij}) > 0$.

*Proof.* (i) Applicant $\eta$ chose lender $j$ over the outside option, so $u_{ij\eta} \ge u_{i0\eta}$, which by (13) is $r^{\text{res}}_{ij\eta} \ge r_{ij}$; if also $\ell d_i(x_\eta) \le m$, then $r^{\text{res}}_{ij\eta} - f_{ij} - \ell d_i(x_\eta) \ge m - \ell d_i(x_\eta) \ge 0$. (ii) $r^{\text{res}}_{ij\eta} - f_{ij} - \ell d_i(x_\eta) = (r^{\text{res}}_{ij\eta} - r_{ij}) - (\ell d_i(x_\eta) - m)$. (iii) Approval changes the lender's expected profit by $m - \ell d_i(x_\eta)$. It raises the borrower's payoff, in rate units, from $u_{i0\eta}/\theta_\eta$ to $u_{ij\eta}/\theta_\eta$ with probability $1 - d_i(x_\eta)$ and leaves it unchanged otherwise, so her expected gain is $[1 - d_i(x_\eta)](u_{ij\eta} - u_{i0\eta})/\theta_\eta = [1 - d_i(x_\eta)](r^{\text{res}}_{ij\eta} - r_{ij})$, which is positive since $d_i < 1$ and $u_{ij\eta} - u_{i0\eta} > 0$ almost surely, completing the proof. □

*Proof of Proposition 1. Step 1: Express $b_k$ in terms of approval probabilities.* Conditional on $\theta_\eta$, the event that $\eta$ applies to $j$ and her surplus $r^{\text{res}}_{ij\eta} - r_{ij}$ depend only on the taste shocks $\{\epsilon_{ij'\eta}\}_{j'}$, which are independent of $x_\eta$, of the screening noise, and of the default shock. Hence $v(\theta) \coloneqq \mathbb{E}_{ij}[r^{\text{res}}_{ij\eta} - r_{ij} \mid \theta_\eta = \theta]$ is also the expected surplus of an applicant conditional on $(\theta_\eta, x_\eta)$, on approval, and on performance. Let $\hat{v}(x) \coloneqq \mathbb{E}_{ij}[v(\theta_\eta) \mid x_\eta = x]$ and $g(x) \coloneqq [1 - d_i(x)]\hat{v}(x) > 0$. Taking expectations of the gain in Lemma 4(iii), multiplied by the approval indicator, over the applicants screened in region $k$ gives

$$b_k = \int q_k(x)\, g(x)\, F^x_{ij}(dx). \tag{I.1}$$

At fixed rates, the surplus of lender $j$'s applicants is $\sum_k \tilde{l} b_k$ plus a term that does not depend on the assignment.

*Step 2: Characterize the lender's assignment.* At fixed rates, the lender chooses $(\mathcal{S}_L, \mathcal{S}_R)$ to maximize $\sum_k [\tilde{l}\mathcal{S}_k \pi_k - C_k(\tilde{l}\mathcal{S}_k)]$ subject to $\mathcal{S}_L + \mathcal{S}_R = 1$, as in (4). The objective is strictly concave, and with $\tilde{l}\omega$ the multiplier on the constraint, the first-order condition at the interior solution is

$$\pi_k - C_k'(\tilde{l}_k) = \omega, \qquad k \in \{L, R\}, \tag{I.2}$$

so that $\tilde{l}_k \propto [A_k(\pi_k - \omega)]^\varrho$ and $\mathcal{S}_k = [A_k(\pi_k - \omega)]^\varrho / \sum_{k'} [A_{k'}(\pi_{k'} - \omega)]^\varrho$.

*Step 3: Part (i).* Let $\Pi(\mathcal{S})$ denote the lender's objective in Step 2 as a function of the local share $\mathcal{S}$, with $\mathcal{S}_R = 1 - \mathcal{S}$, and let $W(\mathcal{S}) \coloneqq \Pi(\mathcal{S}) + \tilde{l}[\mathcal{S} b_L + (1 - \mathcal{S}) b_R]$ denote the planner's objective, lender $j$'s profit plus the surplus of its applicants. Then

$\Pi'(\mathcal{S}) = \tilde{l}[(\pi_L - C'_L) - (\pi_R - C'_R)]$ and $W'(\mathcal{S}) = \Pi'(\mathcal{S}) + \tilde{l}\tau$. By (I.2), $\Pi'(\mathcal{S}_L) = 0$ at the lender's assignment $\mathcal{S}_L$, so the planner's marginal value of moving one application from $R$ to $L$, $W'(\mathcal{S}_L)/\tilde{l}$, equals $\tau$. With a subsidy of $\tau$ per local application the lender's objective is $\Pi(\mathcal{S}) + \tilde{l}\mathcal{S}\tau = W(\mathcal{S}) - \tilde{l}b_R$, so its maximizer is the planner's. Both objectives have second derivative $-\tilde{l}^2(C''_L + C''_R) < 0$, and $W' - \Pi' = \tilde{l}\tau$ is constant, so the planner's assignment $\mathcal{S}_L^P$ exceeds $\mathcal{S}_L$ if and only if $\tau > 0$. Linearizing $W'$ around $\mathcal{S}_L$ and substituting $C''_k = (\pi_k - \omega)/(\varrho\tilde{l}_k)$ from (I.2),

$$\mathcal{S}_L^P - \mathcal{S}_L \approx \frac{\tau}{\tilde{l}\,(C''_L + C''_R)} = \frac{\varrho\,\tau\,\mathcal{S}_L\mathcal{S}_R}{(\pi_L - \omega)\mathcal{S}_R + (\pi_R - \omega)\mathcal{S}_L}. \tag{I.3}$$

*Step 4: Part (ii).* Let $M_+ \coloneqq \int (q_L - q_R)^+ dF_{ij}^x$ and $M_- \coloneqq \int (q_R - q_L)^+ dF_{ij}^x$, and let $\bar{g}_+$ and $\bar{g}_-$ denote the averages of $g$ under the weights $(q_L - q_R)^+$ and $(q_R - q_L)^+$. By (I.1), $\tau = M_+\bar{g}_+ - M_-\bar{g}_-$, and $p_L - p_R = M_+ - M_-$. The condition in part (ii) is $\bar{g}_+ \geq \bar{g}_-$, so $\tau \geq \bar{g}_-(p_L - p_R)$, and $\bar{g}_- > 0$. Since $\sigma_{iL} < \sigma_{iR}$, $q_L - q_R$ is positive below and negative above $x^* \coloneqq (\sigma_{iR}\hat{x}_L^* - \sigma_{iL}\hat{x}_R^*)/(\sigma_{iR} - \sigma_{iL})$ under normal noise, so the added approvals are the types below $x^*$ and the forgone ones those above it; in particular, the condition holds whenever $g$ is non-increasing.

*Step 5: Part (iii).* If $\theta_\eta$ is independent of $x_\eta$, then $F_{ij}^x = F_i^x$ does not depend on $r_{ij}$, and $\hat{v}(x) = \bar{v} \coloneqq \mathbb{E}_{ij}[v(\theta_\eta)]$ for every $x$. Let $\Pi^*(r)$ denote the lender's maximized profit in market $i$ at posted rate $r$; the lender's problem is separable across markets. By the envelope theorem applied to the assignment, (I.2), and $\sum_k \mathcal{S}_k = 1$,

$$\Pi^{*\prime}(r) = \tilde{l}'(r)\sum_k \mathcal{S}_k\left[\pi_k - C'_k(\tilde{l}_k)\right] + \tilde{l}\sum_k \mathcal{S}_k\frac{\partial \pi_k}{\partial r} = \omega\,\tilde{l}'(r) + \tilde{l}\sum_k \mathcal{S}_k p_k,$$

where $\partial\pi_k/\partial r = \int q_k\, dF_{ij}^x = p_k$ by the envelope theorem applied to the approval cutoff, which maximizes $\pi_k$ given the signal, and because $F_{ij}^x$ does not depend on $r$. Setting $\Pi^{*\prime}(r_{ij}) = 0$ and writing $\bar{p} \coloneqq \sum_k \mathcal{S}_k p_k$ gives

$$\mu_{ij} \coloneqq \frac{\omega}{\bar{p}} = -\frac{\tilde{l}}{\tilde{l}'(r_{ij})} = -\frac{r_{ij}}{\varepsilon_{s_{ij},r}}.$$

Summing (I.2) with weights $\mathcal{S}_k$, $\mu_{ij} = m - \sum_k \mathcal{S}_k[\ell p_k d_k + C'_k(\tilde{l}_k)]/\bar{p}$, the margin on an approved loan net of the expected default loss and the marginal screening cost per

approved loan. Finally, $\hat{v} = \bar{v}$ and (I.1) give $b_k = \bar{v} n_k$, so $\tau = \bar{v}(n_L - n_R)$, which is (15) with $\Lambda_{ij} \coloneqq \bar{v}/\mu_{ij}$, completing the proof. □

**Borrowers Who Keep Their Gain After Default.** Suppose instead that an approved borrower receives $u_{ij\eta}$ whether or not her loan defaults. Then the gain in Lemma 4(iii) is $r^{\text{res}}_{ij\eta} - r_{ij}$, (I.1) holds with $\hat{v}$ in place of $g$, and Steps 2 through 5 go through with $\hat{v}$ in place of $g$ and $p_k$ in place of $n_k$: part (i) is unchanged, part (iii) reads $\tau_{ij} = \Lambda_{ij}\mu_{ij}(p_L - p_R)$, and part (ii) holds if $\hat{v}$ is non-increasing. Without the last condition, Step 4 gives

$$\tau_{ij} \geq \hat{v}_- M_+ - \hat{v}_+ M_-, \qquad M_+ \coloneqq \int_{x \leq x^*} [q_L - q_R]\, dF^x_{ij}, \qquad M_- \coloneqq \int_{x > x^*} [q_R - q_L]\, dF^x_{ij},$$

where $\hat{v}_-$ and $\hat{v}_+$ are the infimum and supremum of $\hat{v}$ on the support of $x_\eta$, so $\tau_{ij} > 0$ whenever $M_+/M_- > \hat{v}_+/\hat{v}_-$.

**The Approval Cutoff.** Suppose the planner also chooses the approval rule at the posted rate. Adding the gain in Lemma 4(iii) to the lender's profit, it approves signal $\hat{x}$ in region $k$ if and only if $\ell\, \mathbb{E}[d_i(x_\eta) \mid \hat{x}, k] \leq m + \mathbb{E}[g(x_\eta) \mid \hat{x}, k]$, whereas the lender approves if and only if $\ell\, \mathbb{E}[d_i(x_\eta) \mid \hat{x}, k] \leq m$. Hence the planner approves every signal the lender approves, and at the lender's cutoff its marginal value of approval is $\mathbb{E}[g(x_\eta) \mid \hat{x}^*_k, k] > 0$.

**Securitization.** With the margin $r - f - \alpha\ell d - (1-\alpha)\ell\bar{d}_i$ of Appendix D.2, where $\bar{d}_i$ is the market-average default rate, which the lender takes as given, the lender's expected profit per application in region $k$ is $\tilde{\pi}_k \coloneqq \pi_k + (1-\alpha)\ell p_k(d_k - \bar{d}_i)$, with $(q_k, p_k, d_k)$ evaluated at its approval rule $\alpha\ell\, \mathbb{E}[d_i(x_\eta) \mid \hat{x}, k] + (1-\alpha)\ell\bar{d}_i \leq m$. The lender's first-order condition is (I.2) with $\tilde{\pi}_k$ in place of $\pi_k$, whereas the planner's objective counts $\pi_k + b_k$, the full default loss being a resource cost. Repeating Step 3, the planner's marginal value of moving one application from $R$ to $L$ at the lender's assignment is

$$\tau_{ij} + (1-\alpha)\,\ell \left[ p_R\big(d_R - \bar{d}_i\big) - p_L\big(d_L - \bar{d}_i\big) \right].$$

The added term equals $p_R(d_R - \bar{d}_i) + p_L(\bar{d}_i - d_L)$, which is positive if $p_L > p_R$, $d_L \leq d_R$, and $\bar{d}_i > d_L$: if $d_R \geq \bar{d}_i$, both terms are nonnegative and the second is positive; if $d_R < \bar{d}_i$, then $p_L(\bar{d}_i - d_L) \geq p_L(\bar{d}_i - d_R) > p_R(\bar{d}_i - d_R)$.

## D.4 Parametric Equilibrium Conditions

This subsection lists the objects of the calibrated model under the parameterization of Section 5.1. Loss given default $\ell$ is carried explicitly, so margins per approved loan read $r_{ij} - f_{ij} - \ell d_{ijk}$. Fix a market $i$; $\phi$ and $\Phi$ are the standard normal density and distribution function, $\phi_\sigma(\cdot) \coloneqq \sigma^{-1}\phi(\cdot/\sigma)$, and $m_{ij} \coloneqq r_{ij} - f_{ij}$.

**Primitives.** Borrower types are jointly normal, so that $x_\eta \sim \mathcal{N}(\mu_i^x, (\sigma_i^x)^2)$ with density $f_i^x$ and

$$\theta_\eta \mid x_\eta = x \;\sim\; \mathcal{N}\!\left(\mu_\theta + \gamma\sigma_\theta \frac{x - \mu_i^x}{\sigma_i^x},\; \sigma_\theta^2\left(1 - \gamma^2\right)\right). \tag{I.4}$$

Choice shocks $\epsilon_{ij\eta}$ are i.i.d. Type I extreme value across $j \in \mathcal{J}_i$; screening noise is $\tilde{x}_{\eta k} \sim \mathcal{N}(0, \sigma_{ik}^2)$ with $\sigma_{ik} = \sigma_{\text{local}}$ for $k = g(i)$ and $\sigma_{\text{remote}}$ otherwise; and $\eta$ defaults when $\epsilon_\eta + \epsilon_{it} \le x_\eta$ with $\epsilon_\eta, \epsilon_{it}$ i.i.d. standard normal, so

$$d_i(x) = \Phi\!\left(\frac{x}{\sqrt{2}}\right), \qquad d_i(x; \epsilon_{it}) = \Phi(x - \epsilon_{it}), \tag{I.5}$$

the first the expectation of the second over $\epsilon_{it}$.

**Demand and applicant pool.**

$$s_{ij}(\theta, r) = \frac{\exp\{\xi_{ij} - \theta r_{ij}\}}{\sum_{j' \in \mathcal{J}_i} \exp\{\xi_{ij'} - \theta r_{ij'}\}}, \qquad s_{ij}(r) = \int s_{ij}(\theta, r)\, dF_i^\theta(\theta), \tag{I.6}$$

with $F_i^\theta = \mathcal{N}(\mu_\theta, \sigma_\theta^2)$. The selection weight and the applicant density are

$$\varsigma_{ij}(x, r) \coloneqq \mathbb{E}\big[s_{ij}(\theta_\eta, r) \mid x_\eta = x\big], \qquad f_{ij}^x(x; r) = f_i^x(x)\, \frac{\varsigma_{ij}(x, r)}{s_{ij}(r)}, \tag{I.7}$$

the expectation taken under (I.4); $f_{ij}^x = f_i^x$ when $\gamma = 0$.

**Screening and the approval cutoff.** An officer in region $k$ observes $\hat{x} = x + \tilde{x}_{\eta k}$, and the lender approves if and only if $\hat{x} \leq \bar{x}_{ijk}$. The cutoff is the unique root of

$$\int_{-\infty}^{\infty} \left[ \ell \, \Phi\left( \frac{x}{\sqrt{2}} \right) - m_{ij} \right] \phi_{\sigma_{ik}}\big(\bar{x}_{ijk} - x\big) \, \varsigma_{ij}(x, r) \, f_i^x(x) \, dx = 0, \tag{I.8}$$

one equation in $\bar{x}_{ijk}$ alone. The normalization $s_{ij}(r)$ divides out, and the left side has the sign of $\ell \, \mathbb{E}[d_i(x_\eta) \mid \hat{x}_\eta = \bar{x}_{ijk}, k] - m_{ij}$, which is increasing in $\bar{x}_{ijk}$ by the monotone likelihood ratio property of normal noise, so the root is unique.

**Origination and default.** With $Q_{ijk}(x) \coloneqq \Phi\big((\bar{x}_{ijk} - x)/\sigma_{ik}\big)$ the probability that a type-$x$ applicant is approved,

$$p_{ijk} = \int Q_{ijk}(x) f_{ij}^x(x) \, dx, \qquad d_{ijk} = \frac{1}{p_{ijk}} \int Q_{ijk}(x) \, d_i(x) \, f_{ij}^x(x) \, dx, \tag{I.9}$$

and the realized rate is $d_{ijk}(\epsilon_{it}) = p_{ijk}^{-1} \int Q_{ijk}(x) \, d_i(x; \epsilon_{it}) \, f_{ij}^x(x) \, dx$.

**Labor.** Posting $w_{ijk}$ hires $l_{ijk} = \bar{L} w_{ijk}^{\varrho} \Psi_k^{-\varrho}$ officers processing $e_{ijk}$ applications each, so with $\tilde{l}_{ijk} = \mathcal{M}_i s_{ij}(r_{ij}) \mathcal{S}_{ijk}$,

$$C_{ijk}(\tilde{l}_{ijk}) = A_{ijk}^{-1} \tilde{l}_{ijk}^{1+1/\varrho}, \qquad A_{ijk} = \bar{L}^{1/\varrho} \frac{e_{ijk}}{\Psi_k}, \qquad w_{ijk} = \left( \frac{\tilde{l}_{ijk}}{e_{ijk}} \right)^{1/\varrho} \frac{\Psi_k}{\bar{L}^{1/\varrho}}, \tag{I.10}$$

with $(\sigma_{ik}, e_{ijk})$ taking their local or remote values. Remote officers are interchangeable across regions of residence, so $k \in \{L, R\}$.

**Equilibrium.** Given $\{r_{ij}\}$, equations (I.6)–(I.10) determine every other object. An equilibrium is a rate vector at which each lender satisfies the assignment rule (12),

$$\mathcal{S}_{ijk} = \frac{\Big[ A_{ijk} \, p_{ijk} \, \big( m_{ij} - \ell d_{ijk} \big) \Big]^{\varrho}}{\sum_{k' \in \{L,R\}} \Big[ A_{ijk'} \, p_{ijk'} \, \big( m_{ij} - \ell d_{ijk'} \big) \Big]^{\varrho}}, \tag{I.11}$$

and the rate condition (10),

$$\sum_k A_{ijk}^{\varrho} p_{ijk}^{\varrho+1} \left(m_{ij} - \ell d_{ijk}\right)^{\varrho} \Big\{ r_{ij} \left(\varepsilon_{p_{ijk},r} + \varepsilon_{s_{ij},r} + 1\right) - f_{ij} \left(\varepsilon_{p_{ijk},r} + \varepsilon_{s_{ij},r}\right) - \ell d_{ijk} \left(\varepsilon_{p_{ijk},r} + \varepsilon_{s_{ij},r} + \varepsilon_{d_{ijk},r}\right) - \varepsilon_{s_{ij},r} \left(1 + \varrho^{-1}\right) \bar{c}_{ij} \left(m_{ij} - \ell d_{ijk}\right) \Big\} = 0, \quad \text{(I.12)}$$

$$\bar{c}_{ij} = \left( \frac{\mathcal{M}_i s_{ij}}{\sum_k \left[A_{ijk} p_{ijk} (m_{ij} - \ell d_{ijk})\right]^{\varrho}} \right)^{1/\varrho}. \quad \text{(I.13)}$$

**Elasticities.** Write $\varsigma'_{ij}(x,r) \coloneqq -\mathbb{E}[\theta_\eta s_{ij}(\theta_\eta, r)(1 - s_{ij}(\theta_\eta, r)) \mid x_\eta = x]$ for the derivative of the selection weight in $r_{ij}$, and $\dot{f}_{ij}(x) \coloneqq f_{ij}^x(x)[\varsigma'_{ij}/\varsigma_{ij} - \varepsilon_{s_{ij},r}/r_{ij}]$ for that of the applicant density. Then

$$\varepsilon_{s_{ij},r} = -\frac{r_{ij}}{s_{ij}(r)} \int \theta \, s_{ij}(\theta, r) \left[1 - s_{ij}(\theta, r)\right] dF_i^{\theta}(\theta), \quad \text{(I.14)}$$

$$\frac{\partial \bar{x}_{ijk}}{\partial r_{ij}} = \frac{\displaystyle\int \phi_{\sigma_{ik}}(\bar{x}_{ijk} - x)\, \varsigma_{ij}(x,r) f_i^x(x)\, dx - \int \left[\ell d_i(x) - m_{ij}\right] \phi_{\sigma_{ik}}(\bar{x}_{ijk} - x)\, \varsigma'_{ij}(x,r) f_i^x(x)\, dx}{\sigma_{ik}^{-2} \displaystyle\int \left[\ell d_i(x) - m_{ij}\right] \left(x - \bar{x}_{ijk}\right) \phi_{\sigma_{ik}}(\bar{x}_{ijk} - x)\, \varsigma_{ij}(x,r) f_i^x(x)\, dx}, \quad \text{(I.15)}$$

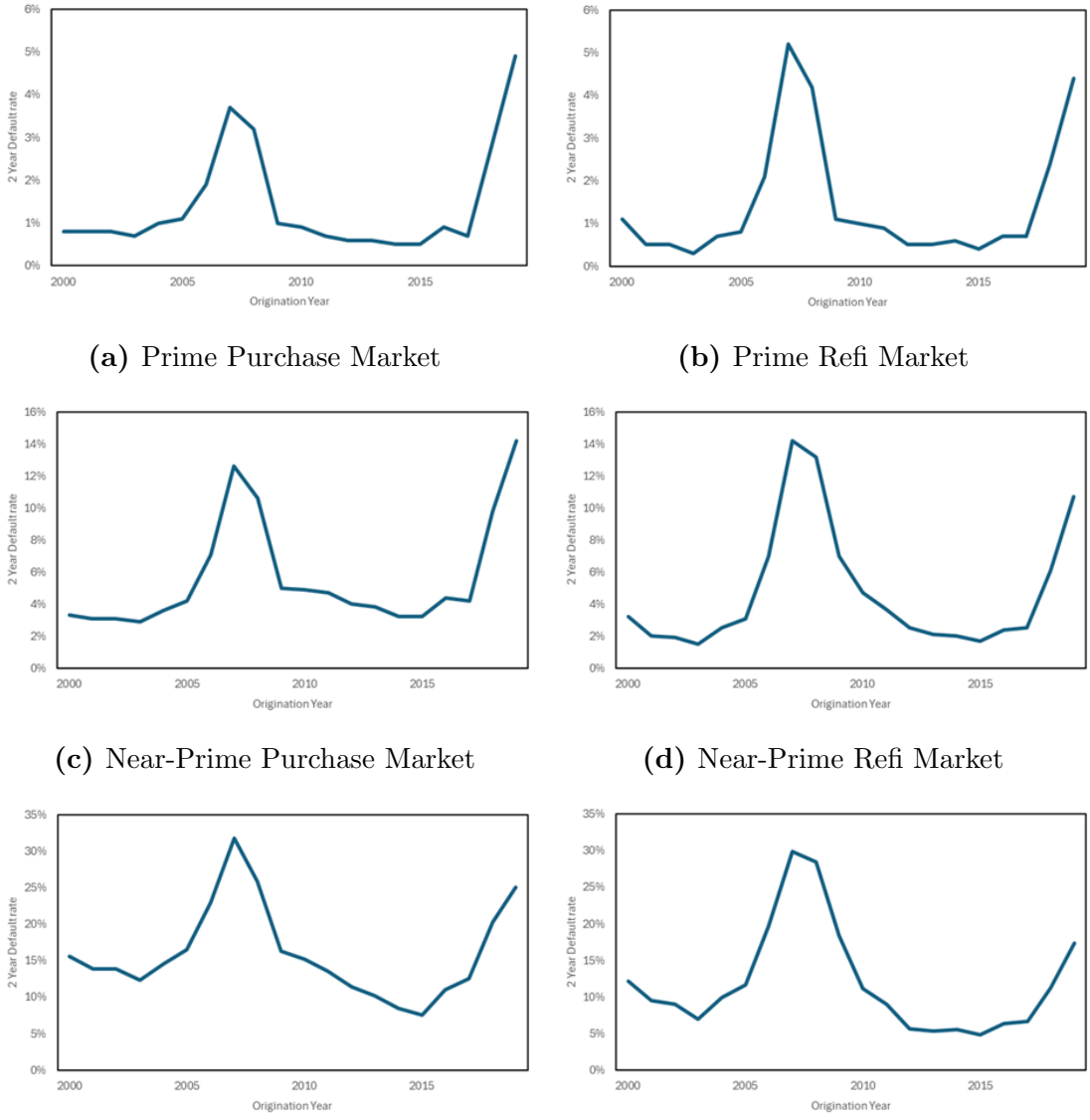
by implicit differentiation of (I.8); the denominator is positive at the root, where the first numerator term nets the wider margin against the worse pool carried by the second. With $Q'_{ijk}(x) = \phi_{\sigma_{ik}}(\bar{x}_{ijk} - x)$,

$$\varepsilon_{p_{ijk},r} = \frac{r_{ij}}{p_{ijk}} \left[ \frac{\partial \bar{x}_{ijk}}{\partial r_{ij}} \int Q'_{ijk}(x) f_{ij}^x(x)\, dx + \int Q_{ijk}(x) \dot{f}_{ij}(x)\, dx \right], \quad \text{(I.16)}$$

$$\varepsilon_{d_{ijk},r} = \frac{r_{ij}}{p_{ijk} d_{ijk}} \left[ \frac{\partial \bar{x}_{ijk}}{\partial r_{ij}} \int Q'_{ijk}(x) d_i(x) f_{ij}^x(x)\, dx + \int Q_{ijk}(x) d_i(x) \dot{f}_{ij}(x)\, dx \right] - \varepsilon_{p_{ijk},r}. \quad \text{(I.17)}$$

# E Additional Figures and Tables

**Figure A1.** Time Series of Default by Credit Grade and Loan Purpose




**(a)** Prime Purchase Market

**(b)** Prime Refi Market

**(c)** Near-Prime Purchase Market

**(d)** Near-Prime Refi Market

**(e)** Subprime Purchase Market

**(f)** Subprime Refi Market

*Note*: This figure plots the time series of 2 year mortgage default rates in the McDash data, by credit grade, loan purpose, and origination year

**Table A1**Distance and Loan Outcomes

This table reports the log-distance specifications corresponding to the main-text results. In Panel A, the dependent variable is an indicator equal to 100 if a loan application is rejected. In Panel B, the dependent variable is the interest rate on the originated loan, in percentage points. In Panel C, the dependent variable is an indicator equal to 100 if a loan becomes 60 days delinquent within two years of origination. The sample in Panel A includes all HMDA applications in 2018–2019. Panel B includes all originated HMDA loans in 2018–2019. Panel C includes approved HMDA loans in 2018–2019 that are matched to McDash performance records. *Log Distance* is the log distance between the borrower's location and the reviewing loan officer's office. All specifications include a saturated set of hard-information controls: loan type interacted with polynomials in FICO, LTV, and DTI (including squared terms), as well as AUS status indicators. Standard errors are clustered at the borrower–county level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Panel A. Rejection rate* | | | | | | |
| Log Distance | 0.592*** | 0.228*** | 0.069*** | 1.822*** | 0.797*** | 0.236*** |
| | (0.02) | (0.01) | (0.01) | (0.05) | (0.03) | (0.02) |
| Observations | 3,721,799 | 3,716,547 | 3,704,210 | 1,915,218 | 1,907,764 | 1,886,977 |
| $R^2$ | 0.231 | 0.279 | 0.316 | 0.387 | 0.457 | 0.506 |
| *Panel B. Interest rate* | | | | | | |
| Log Distance | -0.010*** | -0.003*** | 0.000** | -0.004*** | -0.007*** | -0.002*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Observations | 3,370,902 | 3,365,633 | 3,354,152 | 1,450,692 | 1,442,684 | 1,421,868 |
| $R^2$ | 0.565 | 0.661 | 0.707 | 0.545 | 0.655 | 0.735 |
| *Panel C. Default within two years* | | | | | | |
| Log Distance | 0.033*** | 0.096*** | 0.098*** | -0.105*** | 0.008 | 0.010 |
| | (0.01) | (0.01) | (0.01) | (0.02) | (0.01) | (0.02) |
| Observations | 2,138,585 | 2,135,258 | 2,123,274 | 765,821 | 760,304 | 742,317 |
| $R^2$ | 0.107 | 0.124 | 0.165 | 0.079 | 0.110 | 0.195 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| County × month FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Lender × month FE | No | Yes | Yes | No | Yes | Yes |
| Loan officer FE | No | No | Yes | No | No | Yes |

**Table A2**: Distance and Loan Processing Time

This table reports loan-level regressions examining how borrower–officer distance affects mortgage processing time for originated loans. The dependent variable is processing time, defined as the number of days between the loan application date and the origination date. The explanatory variable is the log distance between the borrower and the reviewing loan officer. Columns (1)–(3) report results for home-purchase loans; columns (4)–(6) report results for refinance loans. All specifications include a saturated set of hard-information controls: loan type interacted with polynomials in FICO, LTV, and DTI ratios (including squared terms), as well as AUS status indicators. The three specifications correspond to increasingly saturated fixed effects as indicated in the table. The sample includes all originated home-purchase and refinance loans in confidential HMDA for 2018–2019. Standard errors are clustered at the borrower–county level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

| | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log Distance | 0.565*** | -0.017 | -0.021 | -0.207*** | 0.349*** | 0.312*** |
| | (0.07) | (0.03) | (0.02) | (0.03) | (0.02) | (0.02) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| County-Month FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Lender-Month FE | | Yes | Yes | | Yes | Yes |
| Loan Officer FE | | | Yes | | | Yes |
| N | 3,380,160 | 3,374,881 | 3,363,393 | 1,452,413 | 1,444,410 | 1,423,604 |
| $R^2$ | 0.091 | 0.299 | 0.371 | 0.130 | 0.280 | 0.396 |

**Table A3**: Model Descriptive Moments

This table reports market-level summary statistics used to discipline the structural model. A "market" is defined by year × borrower county × loan purpose (home purchase vs. refinance) × FICO bin. Borrowers are grouped into three risk tiers: Subprime (FICO $<$ 660), Near Prime (660 $\leq$ FICO $<$ 720), and Prime (FICO $\geq$ 720). Within each market, each lender's market share is computed. Lenders with market share $\geq$ 1% are designated "major" lenders. Among major lenders, those above the median of lender-specific *local-share* (the fraction of loans in that market processed by loan officers located in the same county as the borrower) are classified as *Local*, and those below median as *Distant*. All lenders with market share $<$ 1% form the *Fringe* category. For each borrower risk tier × lender type, we compute weighted averages across markets using county–year application volume as weights. For outcome variables — rejection rate, processing time, interest rate, and default rate — the reported standard deviations are *not* the dispersion of raw values. Instead, they reflect the standard deviation of *residualized* outcomes, constructed by first regressing each variable on borrower risk controls (FICO, LTV, DTI, AUS status, and their flexible polynomials) and then computing the dispersion of the resulting residuals at the market level. Thus, the means report average raw outcomes, while the parentheses contain the variability of risk-adjusted (residual) outcomes. This construction matches the moments used for model calibration. Columns (1)–(3) report home purchase markets; columns (4)–(6) report refinance markets. Standard deviations appear in parentheses.

| | | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|---|
| Variable | Risk tier | Local | Distant | Fringe | Local | Distant | Fringe |
| **Total market applications** | | | | | | | |
| | Prime | 5091 | 5091 | 5091 | 3789 | 3789 | 3789 |
| | | (6311) | (6311) | (6311) | (6973) | (6973) | (6973) |
| | Near prime | 1266 | 1266 | 1266 | 1402 | 1402 | 1402 |
| | | (1696) | (1696) | (1696) | (2414) | (2414) | (2414) |
| | Subprime | 257 | 257 | 257 | 469 | 469 | 469 |
| | | (356) | (356) | (356) | (694) | (694) | (694) |
| **Number of active lenders** | | | | | | | |
| | Prime | 9.40 | 13.91 | 160.55 | 8.77 | 11.38 | 133.60 |
| | | (3.88) | (3.86) | (106.10) | (3.40) | (3.74) | (101.75) |
| | Near prime | 10.16 | 14.15 | 90.15 | 9.77 | 11.69 | 92.68 |
| | | (4.01) | (4.22) | (71.36) | (3.84) | (4.40) | (81.03) |
| | Subprime | 10.66 | 13.76 | 34.86 | 8.75 | 12.94 | 52.17 |
| | | (5.51) | (5.92) | (40.61) | (4.62) | (5.03) | (55.64) |
| **Market share of lender type** | | | | | | | |
| | Prime | 0.32 | 0.43 | 0.25 | 0.31 | 0.44 | 0.25 |
| | | (0.09) | (0.12) | (0.10) | (0.09) | (0.13) | (0.11) |
| | Near prime | 0.33 | 0.44 | 0.23 | 0.31 | 0.45 | 0.23 |
| | | (0.10) | (0.14) | (0.12) | (0.11) | (0.14) | (0.13) |
| | Subprime | 0.34 | 0.49 | 0.15 | 0.30 | 0.49 | 0.18 |
| | | (0.15) | (0.18) | (0.14) | (0.15) | (0.16) | (0.13) |

*Descriptive Statistics (continued)*

| | | Home Purchase | | | Refinance | | |
|---|---|---|---|---|---|---|---|
| Variable | Risk tier | Local | Distant | Fringe | Local | Distant | Fringe |
| **Share of loans handled by local officers** | | | | | | | |
| | Prime | 0.73 | 0.28 | 0.23 | 0.68 | 0.17 | 0.22 |
| | | (0.22) | (0.25) | (0.18) | (0.20) | (0.20) | (0.16) |
| | Near prime | 0.76 | 0.27 | 0.26 | 0.67 | 0.09 | 0.24 |
| | | (0.20) | (0.26) | (0.19) | (0.20) | (0.16) | (0.16) |
| | Subprime | 0.81 | 0.24 | 0.32 | 0.67 | 0.05 | 0.26 |
| | | (0.17) | (0.27) | (0.19) | (0.21) | (0.13) | (0.15) |
| **Rejection rate (pp)** | | | | | | | |
| | Prime | 3.64 | 5.58 | 5.12 | 11.52 | 16.51 | 12.77 |
| | | (3.54) | (3.07) | (2.23) | (5.56) | (5.65) | (3.82) |
| | Near prime | 7.36 | 9.95 | 9.76 | 23.92 | 28.49 | 22.38 |
| | | (4.52) | (3.90) | (3.34) | (7.90) | (6.98) | (4.91) |
| | Subprime | 18.89 | 22.68 | 23.01 | 57.77 | 55.48 | 45.24 |
| | | (8.62) | (8.30) | (6.19) | (10.28) | (8.58) | (6.88) |
| **Processing time (days)** | | | | | | | |
| | Prime | 47.54 | 51.55 | 45.93 | 46.39 | 40.99 | 44.69 |
| | | (10.76) | (10.94) | (6.94) | (6.48) | (6.65) | (5.09) |
| | Near prime | 45.88 | 48.57 | 45.49 | 45.95 | 39.35 | 44.96 |
| | | (10.40) | (10.13) | (7.00) | (6.93) | (6.38) | (5.63) |
| | Subprime | 42.76 | 46.52 | 41.73 | 32.70 | 31.15 | 37.44 |
| | | (10.56) | (12.67) | (6.69) | (7.41) | (5.83) | (5.71) |
| **Interest rate (%)** | | | | | | | |
| | Prime | 4.34 | 4.30 | 4.36 | 4.27 | 4.31 | 4.27 |
| | | (0.32) | (0.32) | (0.28) | (0.36) | (0.36) | (0.36) |
| | Near prime | 4.62 | 4.59 | 4.64 | 4.61 | 4.68 | 4.62 |
| | | (0.31) | (0.30) | (0.27) | (0.35) | (0.34) | (0.34) |
| | Subprime | 4.94 | 4.86 | 4.97 | 4.92 | 5.00 | 4.96 |
| | | (0.32) | (0.31) | (0.24) | (0.38) | (0.32) | (0.31) |
| **Two-year default rate (pp)** | | | | | | | |
| | Prime | 3.85 | 3.49 | 4.31 | 3.90 | 3.23 | 4.42 |
| | | (3.70) | (2.31) | (3.03) | (4.75) | (2.96) | (3.42) |
| | Near prime | 10.11 | 10.16 | 11.22 | 9.14 | 7.57 | 10.15 |
| | | (7.26) | (5.68) | (6.02) | (9.47) | (6.08) | (7.13) |
| | Subprime | 16.49 | 16.08 | 17.23 | 14.67 | 12.04 | 14.36 |
| | | (13.97) | (12.60) | (10.96) | (16.65) | (11.31) | (11.64) |