Financial Constraints and the Racial Housing Gap*

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Abstract

We show that financial constraints lead to spatial misallocation and contribute to racial disparities in housing and wealth accumulation. Using bunching and difference-in-differences designs, we document that down payment constraints disproportionately limit the ability of Black households to access housing in high-opportunity areas. We build a dynamic life-cycle model to examine the long-term wealth effects of these leverage distortions on group differences in wealth accumulation. Black households are more affected by financial and spatial frictions, limiting wealth building opportunities. Improving mortgage access and housing supply in high-opportunity areas helps reduce racial wealth disparities, emphasizing the need for access to geographic opportunities rather than homeownership alone.

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1 Introduction

Standard models of spatial equilibrium (e.g., Rosen, 1979; Roback, 1982) assume that any durable advantages to living in particular regions should be arbitraged away through moving. However, a large literature points to persistent differences in access to opportunity across areas in the form of labor market prospects and human capital accumulation (e.g., Chetty & Hendren, 2018; Bilal & Rossi-Hansberg, 2021; Boustan, 2016). In this paper, we argue that down payment constraints act as a key friction generating spatial misallocation, rationing households with limited initial resources out of more expensive housing markets. Because high-cost areas typically offer better jobs, schools, and intergenerational prospects, geographic sorting leads to persistent differences in access to wealth building opportunities.

We combine quasi-experimental evidence with a new spatial life-cycle model to show how financial constraints can result in persistent group differences in wealth and access to geographical opportunities. We do so by building and calibrating a rich dynamic model which generates realistic choices for migration, home ownership, and mortgage leverage decisions. In the model, households with low starting wealth and worse initial conditions remain persistently disadvantaged because down payments requirements create frictions to accessing high-opportunity areas. Leverage constraints therefore generate a spatial poverty trap that sustains historically determined differences in outcomes between groups.

We apply this framework to a particularly salient and well-measured example of persistent inequality: racial differences in wealth and homeownership. We begin by presenting empirical evidence that down payment constraints differentially bind for Black households, distorting borrowing, home purchase, and location choices. Black households tend to start life with less wealth and are more likely to grow up in under-resourced neighborhoods, making it difficult to come up with the down payment necessary to buy homes in high-opportunity areas (see, e.g., Bhutta *et al.*, 2020; Chetty & Hendren, 2018). We document a striking stylized fact in the form of a racial leverage gap, with Black borrowers taking on substantially more leverage when purchasing homes. Black households are more likely to reach the maximum allowable leverage limit, which is suggestive of a tighter overall borrowing constraint.

We then implement two reduced form empirical strategies to show that leverage constraints are more likely to bind for Black households, distorting their location and housing choices away from neighborhoods with better income prospects. Both approaches exploit regulatory limits on loans insured by the Federal Housing Administration (FHA). FHA loans come with less stringent down payment requirements—3.5% instead of 20% for conventional mortgages—but are subject to maximum loan caps so can only be used for relatively inexpensive homes. These caps are set yearly at the county level, generating variation in the size of the down payment requirement across the housing stock. Our first strategy is a bunching estimator showing that Black borrowers disproportionately cluster precisely at the FHA loan cap, indicating a greater distortion in borrowing relative to a frictionless benchmark.

Our second strategy focuses on a natural experiment created by a major reduction in FHA caps, which occurred when temporary measures put in place during the global financial crisis were rolled back in 2014. This unforeseen policy reversal caused down payment requirements to increase sharply in many high-cost areas, while access to leverage was effectively unchanged in low-cost areas. Difference-in-differences estimates indicate sizable impacts on home buying and location choices. After losing access to high leverage mortgages, the share of new mortgage originations to Black borrowers in affected areas dropped by roughly 8 percent. These prospective borrowers did not switch to the rental market, leading to a decline in the overall Black population. We show that high-cost areas provide better income prospects and test scores, highlighting the disproportionate impact of down-payment requirements on access to opportunity for Black households.

Motivated by this evidence, we build a dynamic model to evaluate and quantify the role of financial constraints in perpetuating racial group differences in wealth and housing. The economy consists of high- and low-opportunity areas, which are populated by overlapping generations of heterogeneous risk-averse households that are divided into Black and white demographic groups. Throughout their life-cycles, households choose to either purchase housing or rent in one of the two types of areas. Households have an intergenerational wealth accumulation motive with voluntary bequests, which are redistributed to the next cohort within the same racial group and create an incentive for the current cohort to move to opportunity. Purchases are financed with long-term defaultable mortgages that are subject to the same down payment constraint across areas.

The down payment requirement is lower (3.5%) for relatively small mortgages below a fixed geography-specific loan cap to match the structure of FHA mortgages. It is higher for mortgages above the cap (20%). Households also face idiosyncratic moving and homeownership shocks, which capture residual exogenous motives for relocating and owning (including moving frictions, discriminatory barriers, and location-specific housing quality). The two areas differ in their loan caps, their levels and price elasticities of housing supply, and in their income processes which endogenously depend on the local composition of households through the presence of high-productivity workers via an agglomeration externality. The two groups differ in their initial wealth, income processes, and the probabilities of being born in each area. In equilibrium, differences in house prices and rents arise endogenously across areas as a result of local housing supply and demand.

The central friction we analyze comes from down payment requirements. Low-wealth agents, many of whom are current and future Black borrowers, cannot access homeownership because of high prices in high-opportunity areas. As a result, Black households are caught in a spatial version of a poverty trap: they cannot afford down payments to own housing in high-opportunity areas, and hence are limited in their ability to accumulate wealth and afford down payments to begin with.

This new framework accounts for spatial and racial heterogeneity in the data from which life-cycle models typically abstract (see, e.g., Gomes (2020) for a survey). The model generates 2×2 cross-sectional distributions over individual state variables for the two area types and demographic groups, which are key for evaluating the effects of spatial misallocation on wealth accumulation across groups.

We calibrate the model using indirect inference to match our quasi-experimental estimate of the elasticity of Black borrowing to the level of the down payment constraint, which is obtained from our difference-in-differences approach. To do so, we replicate the same experiment in the model that we examine in our reduced form analysis, a change in the loan cap in high-opportunity areas, as part of our calibration. This is a numerically challenging step which significantly improves the realism of the model.[1] The model matches targeted differences in income, homeownership, and moving rates across groups and areas. In our calibration, income differences arise due to both the endogenous spatial income shifter and endogenous skill sorting across areas. One component of the difference in income across areas is due to the causal effect of place while the other is due to sorting of higher-productivity workers to higher-income areas (see, e.g., Bilal & Rossi-Hansberg, 2021; Card *et al.*, 2021). Overall, the model is able to closely match racial differences in leverage and more than 75% of the racial gap in wealth, despite not targeting these moments. We then use the model as a laboratory and run several counterfactual experiments to quantify the role of financial constraints as a driver of racial disparities in U.S. data.

The first counterfactual experiment demonstrates the importance of leverage constraints by relaxing the down payment requirement. Specifically, we compare our baseline model with an economy in which the loan cap is raised in the high-opportunity area, which allows borrowers in the high-opportunity area to purchase more expensive homes with as little as 3.5% down. Relaxing the constraint has positive effects for Black households across financial and real measures, reducing Black-white gaps in wealth, income, homeownership, leverage, and consumption. On average, Black household wealth is higher by 9.6%. To help contextualize the effect of financial constraints in terms of spatial mobility, we show that a 15% reduction in the costs to moving to high-opportunity areas is necessary to generate a comparable increase in Black wealth.

The key mechanism is a flow of Black households to high-opportunity areas. This result underscores the main insight of our paper: the presence of leverage requirements adversely impacts Black borrowers

[1] This paper is the first to calibrate a dynamic spatial model with endogenous house prices and rents and heterogeneous households to match an empirically identified elasticity, which is itself endogenous in the model. This step that can help discipline the quantification of this class of models (see, e.g., Nakamura & Steinsson (2018)).

and leads to spatial misallocation, which in turn persistently impairs income prospects and wealth building. Importantly, our estimates account for equilibrium price adjustments, and we find that house prices grow much more than rental prices in high-opportunity areas. Reductions in the wealth gap are in part driven by an influx of Black homeowners. Due to a complementarity between the individual and location-specific components of the income process, high productivity Black households particularly benefit in this counterfactual.

High home prices in high-opportunity areas are at the core of the spatial distortion created by down payment requirements. Our second set of counterfactual experiments examines the role of spatial constraints, in the form of housing supply restrictions, in exacerbating this distortion (see also Hsieh & Moretti, 2019). We consider an economy where the level of housing supply is increased by 10% in high-opportunity areas, relative to the baseline model. This modification corresponds, for example, to less stringent regulatory requirements on zoning. Our contribution is to show that the impact of changes in housing supply is strongly heterogeneous across demographic groups. The expansion—and corresponding decline in home prices—results in 1.7% higher average wealth for Black households, more of whom are able to overcome the down payment requirement and purchase homes (or rent more cheaply) in high-opportunity areas. The consequences are different for white households because they are more likely to own homes in the baseline. The reduction in home prices actually increases their average wealth by less, further reducing the racial gap. Furthermore, we show that increasing only rental housing supply in high-opportunity areas can also address the spatial mismatch and increase Black income, but has a less pronounced impact on Black wealth and actually reduces Black homeownership.

Finally, our third set of counterfactual experiments combines the first two modifications to consider the interaction of financial and housing supply constraints. We simultaneously relax the loan cap and increase housing supply by 10% jointly in high-opportunity areas. A higher level of housing supply alleviates one of the main drawbacks of relaxing leverage constraints: an increase in prices due to higher housing demand. As a result of the complementarity between the two modifications, the increase in the average wealth of Black households (12.4%) is larger than the sum of the changes that occur in each experiment individually (11.3%), largely owing to their much higher presence in high-opportunity areas in the combined experiment.

Our results are robust to various alternative specifications of the baseline model. First, the effects of relaxing the FHA loan cap are nearly identical when introducing discrimination in mortgage rates. The spatial misallocation due to leverage constraints generates persistent wealth gaps even absent explicit racial discrimination in the financial system. Our results remain comparable when idiosyncratic moving and homeownership shocks are the same across groups, which shows that preference differences are not the main driver of racial disparities in the model. We also that show our findings are stronger when households have access to a higher rate of return on financial assets as a complementary way to accumulate wealth. Higher returns make it easier to build the down payment necessary to access housing, pointing to important complementarities between housing and financial assets. Finally, extending the model to allow for Payment-to-Income (PTI) limits in addition to LTV limits leads to very similar conclusions.

There are two important caveats to our analysis. First, our conclusions should not be construed as advocating for the unrestricted expansion of access to leverage. The results highlight important tradeoffs between down payment requirements and considerations of equity across groups. However, analyzing the implications for the optimal design of mortgage policy would require taking into account a range of factors that go beyond the scope of our model, particularly the consequences for financial stability.[2] Nevertheless, the model does account for the effects of financial constraints on house prices and default risk, and we find that the effects on credit risk vary substantially across areas. Default rates increase when the FHA down-payment requirement is lowered (from 3.5% to 1%), which disproportionately impacts low-opportunity areas. Alternatively, relaxing the FHA cap by $75,000 in the high-opportunity area actually improves spatial allocation and incomes. This, in turn, helps borrowers absorb shocks and lowers average default rates. These findings suggest that while increasing leverage may add to household risk, all else equal, it is also critical where borrowers locate.

Second, the reduced form analysis exploits variation in FHA limits and down payment constraints in the model that replicate the FHA system. While these choices are useful for identification, they do not imply that the distortions we examine are only a consequence of the availability of FHA lending (or lack thereof). Given the distribution of wealth for Black households, even a 3.5% down payment requirement puts a large fraction of the housing stock out-of-reach (see Appendix Figure A.I). As such, the spatial distortion we highlight is first and foremost a consequence of down payment requirements and relevant even within areas that are entirely eligible for the FHA. A related concern is that, in principle, the FHA system relaxes credit score requirements alongside leverage constraints. However, average credit scores for FHA borrowers have consistently exceeded 660 since the financial crisis, suggesting that a large fraction of FHA borrowers have the option to access mortgage lending through conventional channels, and that leverage is the key driver of demand for FHA loans.[3]

Related literature Our paper contributes directly to several broad literatures. The first is a resurgence of work studying the Black-white wealth gap and the role of housing. While there has long been both empirical and theoretical work considering disparities in housing wealth (see, e.g. Gyourko *et al.*, 1999; Charles & Hurst, 2002; Collins & Margo, 2011; Garriga *et al.*, 2017; Stein & Yannelis, 2020), including older work exam-

[2] This exercise would require fully modeling the banking system, and introducing aggregate risk and default externalities.
[3] See Goodman & Kaul (2017).

ining FHA borrowing by race (e.g. Canner *et al.*, 1991), a new wave of studies using rich historical microdata has brought new insights into both the historical persistence of the racial wealth gap overall (Derenoncourt *et al.*, 2022; Boerma & Karabarbounis, 2021; Bartscher *et al.*, 2022) and the nature of housing gaps faced by Black borrowers (Bayer *et al.*, 2021, 2014; Eldemire *et al.*, forthcoming). This literature has emphasized specific barriers to the accumulation of housing wealth for Black households based on differences in house price appreciation (Kermani & Wong, 2021; Kahn, 2021; Wolff, 2022), property tax assessments (Avenancio-Leon & Howard, 2022), refinancing propensities (Gerardi *et al.*, 2021a,b), and credit supply (Fuster *et al.*, 2022). Recent studies have also explored the role of racial disparities in mortgage access, with mixed results—Ghent *et al.* (2014) and Giacoletti *et al.* (2022) show evidence of discrimination in pricing and approvals and Bartlett *et al.* (2021) finds evidence of disparities in interest rates, while Bhutta & Hizmo (2021) argues rate differences can be accounted for by racial differences in the take-up of mortgage points.

We add to this literature by highlighting the racial leverage gap, and analyzing its consequences for wealth accumulation using a dynamic model that accounts for home price responses and endogenous moving decisions. Combined with our reduced-form evidence, the model allows us to quantify a new channel that perpetuates wealth differences: the spatial misallocation generated by leverage constraints. By analyzing the role of leverage, our paper also relates to recent work that has emphasized the ambiguous effects of financial variables on wealth inequality, focusing particularly on interest rates (e.g. Gomez & Gouin-Bonenfant, 2020; Greenwald *et al.*, 2021).

Second, we add to the macro-finance literature that analyzes the impacts of financial constraints in life-cycle models with heterogeneous households and incomplete markets. This includes Cocco (2005), Ortalo-Magne & Rady (2006), Corbae & Quintin (2015), Greenwald (2018), Gete & Zecchetto (2018), Chen *et al.* (2019), and Greenwald *et al.* (2020). We depart from existing models by introducing a new type of 2×2 heterogeneity across geographic areas and demographic groups, which accounts for spatial and racial differences in the data that these models typically abstract from. Endogenizing prices and location decisions in this context is a challenging exercise, which we tackle using methods from the dynamic demand literature. The resulting richness is key for evaluating the real effects of financial and spatial constraints for long-run outcomes, which would be difficult to measure and identify in the data. Another contribution of our work is to significantly improve the quantification of this class of models by calibrating the model to match an empirically identified elasticity, which is endogenous in our setting. This approach can help improve the realism of recent spatial macro-finance models with heterogeneous agents (e.g., Favilukis & Van Nieuwerburgh, 2021; Favilukis *et al.*, 2023; Mabille, 2023) and with identification in macro-finance more broadly (e.g. Nakamura & Steinsson, 2018).

Many of these papers explicitly focus on collateral constraints and inequality. On the housing side, Favilukis *et al.* (2017), Kaplan *et al.* (2020) emphasize the role of down payments constraints in limiting housing access for poor households, thereby contributing to inequality. Kiyotaki *et al.* (2024) and Kiyotaki *et al.* (2011) highlight the role of down payment constraints on wealth and housing consumption. We complement these papers by focusing on the spatial consequences of down payment constraints, and the resulting misallocation due to lost income generation and wealth building prospects. On the firm side, Midrigan & Xu (2014) analyze how collateral constraints limit firm entry decisions and drive misallocation. Chaney *et al.* (2012) have estimated this channel empirically, focusing on firms' real estate collateral. Constrained entrepreneurship decisions have also been studied for smaller firms, as in Schmalz *et al.* (2017). While this literature has demonstrated the relevance of collateral constraints for inequality in the distribution of firms on the corporate finance side, we focus on the role of down payment requirements for homeownership and location choice.

Finally, the persistence of a racial wealth gap in the data is at odds with the predictions of workhorse frameworks such as infinite-horizon models in which initial conditions dissipate in steady state. Theoretical and empirical work has emphasized the role of self-saving to overcome financial constraints (e.g., Moll, 2014; Blattman *et al.*, 2020), suggesting the possibility of long-run convergence for agents who begin with low initial wealth. Our findings suggest a possible resolution of this tension by highlighting the role of leverage constraints, which can generate persistent wealth differences through spatial misallocation.

The paper proceeds as follows. In Section 2, we present stylized facts on the Black-white leverage gap. In Section 3, we present quasi-experimental evidence on the contribution of down payment requirements to the spatial allocation of Black households. Section 4 describes our dynamic model of housing choice and Section 5 discusses the calibration. Section 6 reports the results and Section 7 provides robustness around these estimates. We conclude in Section 8.

2 Data and Stylized Facts: The Black-White Leverage Gap

We begin by documenting the main stylized fact that motivates our analysis: Black borrowers have substantially higher leverage than white borrowers at the time of mortgage origination. We exploit recent changes in Home Mortgage Disclosure Act (HMDA) data reporting to accurately and comprehensively measure this racial leverage gap. We show that higher leverage comes because Black households make smaller down payments in dollar terms, and that it is facilitated by mortgages originated through the Federal Housing Administration (FHA), which are disproportionately used by Black borrowers. The differential use of high leverage mortgages and the FHA suggests that leverage constraints—the maximum size of home a buyer can purchase with a given down payment—bind more tightly for Black households.

2.1 Data

We combine several sources of micro-data. Our primary source is loan-level HMDA data. HMDA captures close to the full universe of mortgage originations and contains comprehensive information on race and ethnicity. Crucially for our analysis, HMDA began to include home prices and loan-to-value ratios in 2018, allowing a direct window into leverage differences by race in recent years. Our benchmark sample focuses on owner-occupied, first-lien, new origination mortgages. We supplement this with American Community Survey (ACS) 5-year estimates at the census tract and county level. We use a series of additional datasets for the calibration our model. To connect information on borrowers over time and measure moving rates, we use Infutor data (as discussed in Diamond *et al.*, 2019). We also use the Current Population Survey (CPS), the Survey of Consumer Finances (SCF), and the Survey of Consumer Finances Plus (SCF+) as described in Kuhn *et al.* (2020).

2.2 The Racial Leverage Gap

Panel A of Figure 1 presents the racial leverage gap: Black borrowers have strikingly higher leverage ratios at mortgage origination. This plot shows the distribution of combined loan-to-value ratios at origination for Black and white borrowers from HMDA in 2018. A substantial fraction of Black borrowers—roughly 60%—have initial combined loan-to-value-ratios (CLTV) above 95 (implying a down payment of less than 5%). This stands in contrast to less than 30% of white borrowers. Indeed, the median CLTV for Black borrowers is 96.5 (vs. 90 for white borrowers). These differences persist and even grow beyond origination. For example, the median LTV for Black borrowers with mortgage debt in the SCF+ in 2016 is roughly 66, compared to 52 for white borrowers.[4]

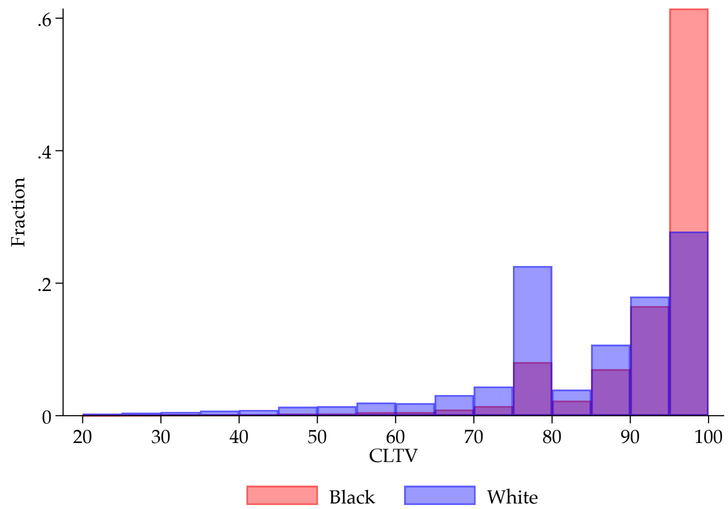
The presence of large Black-white differences in leverage shows that racial housing gaps go beyond well-studied differences in homeownership. A disproportionate share of black borrowers take effectively the maximum leverage available in the U.S. mortgage system (an initial CLTV of 96.5). This suggests that Black households are more likely to be close to their leverage limits.[5]

Appendix Table A.I shows that leverage differences are robust to controlling for geography, income, or other borrower characteristics (although wealth is not observable in our data). This is not to suggest that the leverage gap represents a causal effect of race. Differences in leverage likely reflect pre-existing

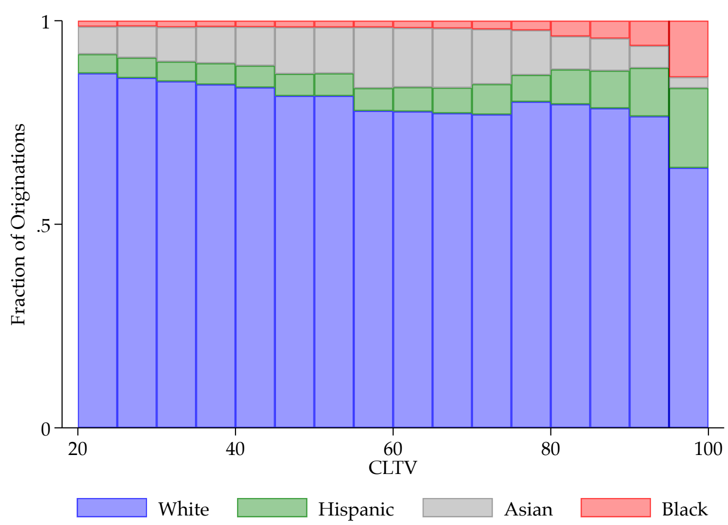
[4]The concentration of minority borrowers in high leverage loans—particularly Black borrowers, but also Hispanic borrowers—is especially stark when examining the composition of borrowers across the LTV distribution by race and ethnicity. As shown in Panel B of Figure 1, white borrowers make up roughly 80% of the total borrower pool across the distribution below 90 LTV, but only 64% of the borrower pool among those with CLTV over 95.

[5]Borrowers typically face two explicit financial constraints when originating a mortgage. One is a leverage (LTV) constraint, which reflects the extent to which borrowers have access to capital to make a down payment. The other is a payment-to-income (PTI) constraint, which captures the loan burden relative to current flow income. We find that racial differences in PTI are significantly less salient than for LTV (see Appendix Figure A.II), which motivates our focus on the LTV constraint.

Figure 1: The Black-White Leverage Gap



Panel A: Leverage at Origination by Race



Panel B: Borrower Composition Across the Leverage Distribution

Notes: Panel A plots the distribution of leverage at origination for Black and white borrowers. Panel B plots the share of borrowers by race and ethnicity across the leverage distribution. Data includes all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2018 HMDA data with combined loan to value ratios from 20–100. In Panel A Black and white categories are inclusive of Hispanic households, while in Panel B these categories refer to non-Hispanic households.

and historically determined disparities in wealth and access to capital that go beyond current income.[6] Racial disparities also persist when analyzing down payments in dollar terms—Black borrowers typically purchase homes with much smaller down payments, and are much more likely to post less than $10,000 when purchasing a home. This confirms that the leverage gap is not a consequence of Black households choosing more expensive homes.

In the presence of a down payment requirement, available wealth determines the set of possible housing and location choices for prospective homeowners. As a result, the very presence of a leverage gap suggests that down payment requirements have differential spatial consequences for Black households. There are two potential concerns with this this interpretation. First, higher leverage by Black borrowers could potentially reflect higher preferences for debt or other demand side factors. Second, it could reflect supply-side factors, like the availability of FHA loans in Black neighborhoods. An examination of the wealth distribution in the SCF data helps to mitigate these concerns. Panel A of Figure A.I shows the fraction of households with enough liquid wealth to post the required down payment at various points in the national wealth distribution. A large fraction (nearly 70%) of Black individuals appear constrained in their ability to purchase a house in the 25th percentile of the national distribution, and less than 10% have the wealth to meet the down payment requirement for the median home. Panel B of this figure indicates that constraints also bind within MSAs.

2.3 The FHA Provides the Dominant Channel for High Leverage Loans

The Federal Housing Administration (FHA) is the largest source of high leverage loans for all borrowers, including Black households. Panels A and B of Appendix Figure A.III show that the majority of very high leverage loans are originated through the FHA (and that nearly all FHA loans are high leverage). In our 2018 sample, FHA loans represent under 2 percent of mortgages with initial CLTV below 80 but nearly 70 percent of those with initial CLTV over 95.

The FHA system was created in the wake of the Great Depression, when private lenders typically required much higher down payments for private mortgages. In its current form, the FHA provides approved lenders with 100% guarantees against default for qualifying loans. In exchange for an upfront fee and recurring insurance payment, borrowers with credit scores above 580 may make down payments as low as 3.5% (an initial LTV of 96.5).[7] While it is possible to get a high leverage loan through a conventional channel

[6] For example, SCF data from 2019 shows that Black and Hispanic families are much less likely to receive inheritances, gifts, and other family support (Bhutta *et al.*, 2020). Close to 30% of white families received an inheritance in the survey, compared to 10% of Black families and just 7% of Hispanic families. Charles & Hurst (2002) emphasize the role of parental transfers as drivers of racial differences in housing behavior (see also Benetton *et al.*, 2022). Expected family transfers are much higher for white households in the SCF as well. In addition to formal bequests, which tend to be received later in the life-cycle, white families also experience higher levels of family support; 72% report being able to receive $3,000 from family or friends, compared to just 41% of Black households.

[7] Borrowers with credit scores as low as 500 can also qualify for FHA mortgages, but must have down payments of 10 percent.

(including conforming loans sold to Fannie Mae or Freddie Mac) doing so requires costly private mortgage insurance that varies substantially with borrower risk. There is a significant clustering precisely at the limit of 96.5 for FHA loans, while the modal conventional loan has an initial CLTV of 80.

Given the relatively high leverage taken by Black borrowers, the FHA is the key origination channel. As panel C of Appendix Figure A.III shows, more that 50% of loans to Black households in our 2018 sample were through the FHA, compared to roughly 20 percent of loans to white households. While the FHA allows borrowers a relatively low-cost way of accessing high leverage loans, only certain loans qualify. Perhaps the most important constraint is that the FHA imposes county-specific loan caps that limit the amount a household is able to borrow. As it currently stands, these caps are set at 115 percent of last year's median home price for the local area subject to a nationwide floor ($356,362 for the year 2021) and a nationwide ceiling ($822,375 in 2021).[8] As a consequence, the relaxed down-payment requirement enabled by the FHA is only relevant for a portion of the housing stock.

3 Reduced Form Evidence: Leverage Constraints Bind More for Black Households

We next show direct evidence that leverage limits differentially distort the borrowing, purchase, and location choices of Black borrowers, with real consequences for access to opportunity. The presence of a leverage constraint forces borrowers to make large down payments to access homeownership. The upfront burden tends to be largest in geographic areas with strong labor markets, good schools, and high intergenerational mobility. Leverage constraints may therefore generate spatial rationing on the basis of current wealth, rather than productivity or permanent income. We exploit variation in the down payment requirement generated by FHA loan caps using bunching and difference-in-difference approaches. Ultimately, we also produce moments from this estimation that help calibrate our model.

3.1 Down Payment Requirements Distort Loan Sizes for Black Borrowers

We begin by showing that Black households are more likely to choose a loan precisely at the FHA cap, generating excess bunching for Black versus white borrowers. Below the cap, most borrowers qualify to put as little as 3.5 percent down, but lenders typically require larger down payments—often 20 percent—for loans above the cap. This generates a kink in the down payment requirement at the county-specific loan cap. The concentration of borrowers at the threshold indicates that the leverage constraint disproportionately binds

[8] See: https://archives.hud.gov/news/2020/pr20-201.cfm.

for Black households, and that loan sizes are differentially restricted relative to a world with no leverage limit.

We present graphical evidence of this excess bunching in Figure 2. The solid lines and dots present the distribution of originated loans for Black and white borrowers in \$10,000 intervals, relative to the county-specific FHA cap (which is normalized to 0). The dashed lines represent estimates of the counterfactual distribution for each group in the absence of the cap, calculated following Chetty *et al.* (2011) and explained in more detail below.[9]

A first observation is that there is more mass in the left portion of the distribution for Black borrowers. These households tend to choose smaller loans (relative to the FHA cap) but the proportion of white borrowers begins to exceed that of Black borrowers for loans roughly \$50,000 below the limit. Following this trend, the counterfactual distributions indicate that a substantially greater share of white borrowers would choose loans in the vicinity of the FHA cap in the absence of a limit.

The presence of the FHA cap generates substantial bunching for both groups, but there is noticeably more bunching for Black households. Despite the fact that the counterfactual density for Black households is well below that for white, the fraction of loans at the limit is effectively identical. A relatively standard bunching estimator allows us to quantify this excess mass. We first fit a 7th order polynomial to the number of loans in each \$10,000 bin of loan sizes, considering \$150,000 on either side of the county-specific FHA threshold

$$C_j = \sum_{i=0}^{7} \beta_i^0 (Z_j)^i + \sum_{i=-1}^{1} \gamma_i^0 \cdot \mathbf{1}\{Z_j = i\} + \varepsilon_j^0. \tag{1}$$

Here, Z_j is the loan size relative to the threshold in \$10,000 intervals. The inclusion of the γ_i^0 coefficients allows us to exclude a bunching region (the threshold itself and the \$10,000 bins above and below) from influencing our β_i^0 estimates. A basic estimate of the counterfactual distribution is then $\widehat{C}_j = \sum_{i=0}^{7} \hat{\beta}_i^0 (Z_j)^i$:

$$C_j \cdot \left(1 + \mathbf{1}\{j > R\} \frac{\widehat{B}_N}{\sum_{j>1} C_j}\right) = \sum_{i=0}^{q} \beta_i (Z_j)^i + \sum_{i=-1}^{1} \gamma_i \cdot \mathbf{1}\{Z_j = i\} + \varepsilon_j \tag{2}$$

where $\widehat{B}_N = \sum_{i=-1}^{1} \hat{\gamma}_i$. This is computed with an iterative, fixed point approach, and standard errors are bootstrapped following Chetty *et al.* (2011). Our bunching estimates are the excess mass in the bunching region

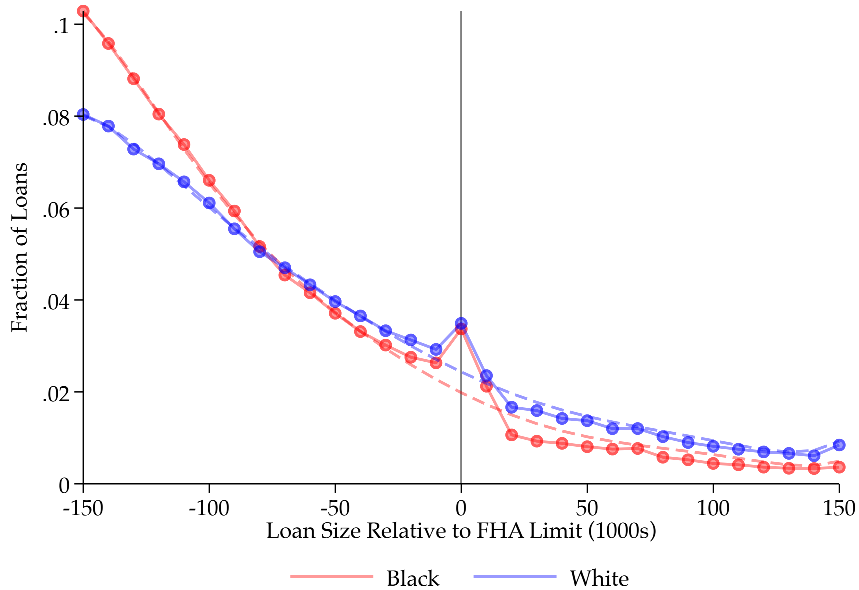
$$\hat{b} = \frac{\widehat{B}_N}{\sum_{i=-1}^{1} \frac{\hat{C}_j}{3}}.$$

We compute this separately for Black and white households.

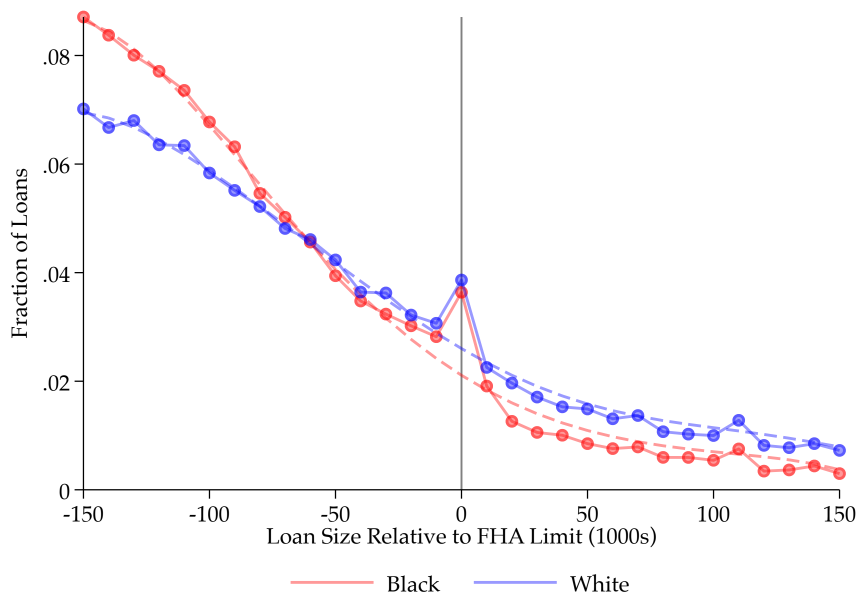
Figure 3 presents the estimates of $\hat{b}$ separately for both groups. The excess mass near the threshold is over

[9] See Heilbron (2022) for further analysis on unconditional bunching at the FHA cap.

FIGURE 2: DIFFERENTIAL BUNCHING AT COUNTY FHA LIMITS FOR BLACK HOUSEHOLDS



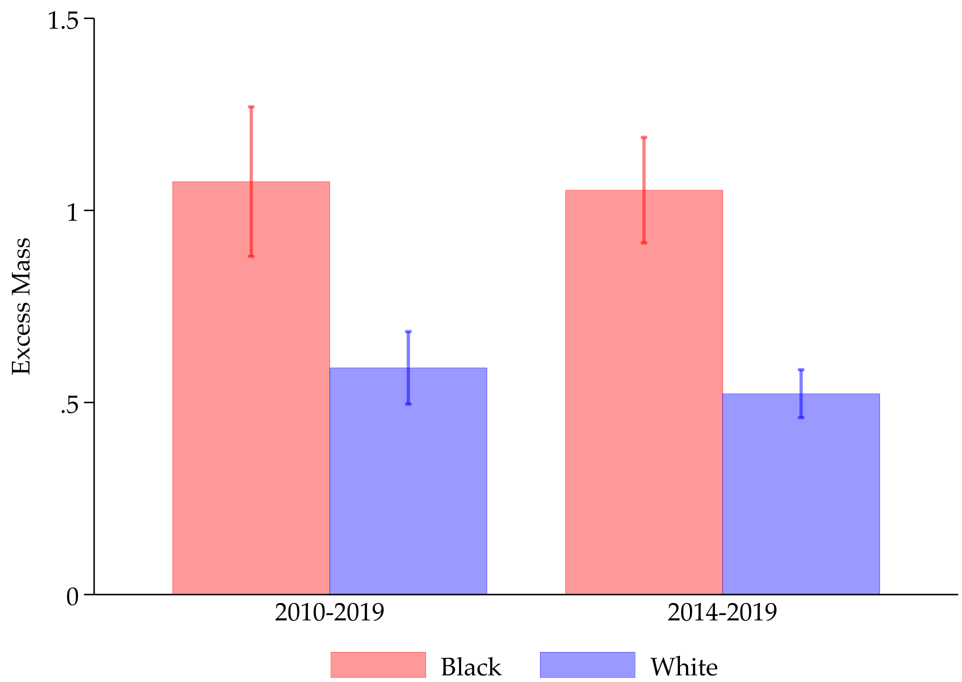
Panel A: Benchmark Sample (2010-2019)



Panel B: 2020 Only

Notes: Solid lines and dots show the fraction of Black and white households in with mortgages in each $10,000 interval surrounding the county specific FHA limit. Dashed lines denote counterfactual distributions constructed following Chetty *et al.* (2011), with the excluded bunching region defined as the $10,000 above or below the limit itself. Data includes all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2010–2020 HMDA data.

FIGURE 3: EXCESS MASS AT THE FHA THRESHOLD FOR BLACK AND WHITE BORROWERS



	2010–2019		2014–2019	
	Black	White	Black	White
Excess Mass	1.075***	0.590***	1.053***	0.523***
	(0.099)	(0.048)	(0.070)	(0.032)

Notes: Estimates of excess mass at the county specific FHA limit for Black and white borrowers. Estimates and bootstrapped standard errors (shown in parenthesis) constructed following Chetty *et al.* (2011), with the excluded bunching region defined as the $10,000 bin above or below the limit itself. Sample includes all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2010–2019 HMDA data within $150,000 of the FHA limit. Error bars in plots represent 95% confidence intervals. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

107% of the counterfactual mass for black households, and under 60% of the counterfactual mass for white households. We get similar estimates when considering only a period in which FHA limits were relatively tight (2014–2019). This evidence indicates that FHA caps are differentially binding for Black households. Strict leverage constraints above the threshold lead Black borrowers to take smaller loans than they would in an unconstrained world.

To clarify the concept of leverage constraints for Black households, we draw a distinction between the leverage constraint itself and the leverage limit. The leverage constraint sets a maximum borrowing amount relative to house value, while the leverage limit defines the required down payment. When we say Black households face tighter leverage constraints, we mean they are relatively more likely to take loans near the maximum allowed loan-to-value ratio, even if this maximum is higher through programs like the FHA.

The binding nature of these leverage requirements is amplified as a consequence of minimum housing requirements and down payment constraints. Houses are not available in a continuous price distribution, resulting in a minimum cost for starter homes. This fact, combined with down payment requirements, means Black households are more likely to hit their borrowing limit when purchasing homes. Therefore, the higher leverage ratios observed for Black borrowers cannot be interpreted as indicating fewer financial constraints. Instead, it reflects households using the maximum available leverage to afford even lower-cost housing, indicating a more binding overall financial constraint compared to other groups who might have more flexibility in their borrowing and housing choices.

3.2 Down Payment Requirements Distort Location Choices for Black Households

We next ask whether leverage limits have real consequences for the home buying and location choices of Black households. It is possible, in principle, that the distortions in loan size shown in Subsection 3.1, have minimal geographic consequences. Prospective buyers may select less expensive housing in the same location, finance the purchase with other means, or switch to the rental market.

The basic descriptive patterns in the data suggest that leverage constraints meaningfully impact where Black households buy and live. The analysis in Appendix Tables B.I and B.II, which we describe in detail in Appendix B, shows that looser leverage limits, as measured by access to 3.5% down FHA loans, are closely related to the presence of Black borrowers. Less restrictive FHA loan caps coincide with a greater share of Black mortgage borrowers, and increases in loan caps correlate with increases in the Black share. Furthermore, when a given location or property value becomes eligible for an FHA loan (e.g., because FHA loan caps rise) the likelihood a buyer is Black increases. These patterns hold even with rich fixed effects aimed at isolating within-location variation in eligibility driven by year-to-year changes in FHA loan caps.

Natural Experiment: A Major Reduction in FHA Loan Caps

The main concern with the descriptive patterns presented in Appendix B is that FHA loan caps are not exogenously given. They are determined, to some degree, by local home prices, and are thus closely associated with gentrification, urbanization, and other factors that co-vary with local demographics. To address these potential endogeneity concerns, we present results from a natural experiment to demonstrate that leverage constraints causally impact where Black households choose to buy and live. Specifically, we show that plausibly exogenous changes in FHA caps impact the composition of borrowers and residents in a geographic area. When leverage constraints are tighter (FHA caps are lower) fewer Black households originate mortgages and the Black population falls.

Our strategy is built around a major *reduction* in FHA loan caps that came when temporary measures enacted during the 2008 financial crisis were rolled back. The Economic Stimulus Act of 2008 expanded loan caps for high cost areas, temporarily setting the cap at 125% of the area median, with a nationwide ceiling of \$729,250. From 2009–2013, these caps remained at 125% of the pre-2008 median price, even in areas that experienced declining home prices over the intervening period. In 2013, the Department of Housing and Urban Development (HUD) announced that these expansions would expire at the beginning of 2014, with FHA caps dropping to 115% of the local median and the nationwide ceiling dropping to \$625,500.[10]

This drop is evident in the red line in Panel A of Figure 4, which shows the average FHA cap for *treated* census tracts (all those that experienced a 2014 decline in the FHA cap, representing 41% of tracts that appear in our 2014 HMDA sample). The limits were effectively unchanged from 2008 to 2013, but fell sharply in 2014 (by roughly \$75,000) after the expansions were rolled back. The blue line, which captures all other tracts, is similarly flat from 2008 to 2013, but displays no corresponding reduction in 2014. We label these *control* tracts.[11]

A Difference-in-Differences Approach

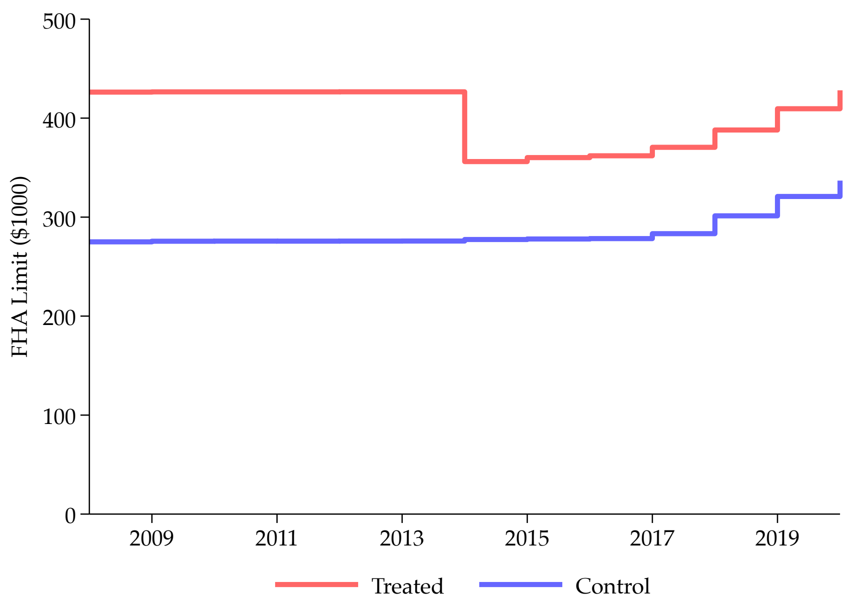
We implement a difference-in-differences approach to test whether this reduction in FHA caps differentially impacted Black households. We consider the following regression specification for tract j in year t:

$$\text{Share Black}_{jt} = \alpha_j + \gamma_t + \beta(\text{Treated}_j \times \mathbf{1}_{\{t \geq 2014\}}) + \varepsilon_{jt}. \quad (3)$$

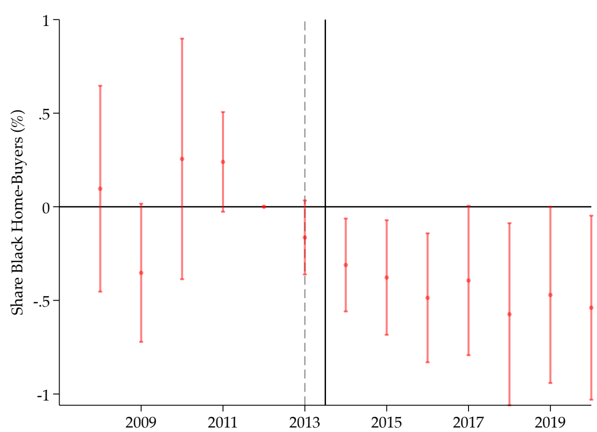
[10] See https://www.hud.gov/sites/documents/EFFFHALLIADJUST2014-FINAL.PDF.

[11] Defining treatment vs. control in this manner invites a potential endogeneity concern. For example, a moderately high cost area that experiences a sharp increase in home prices in 2013 might be labeled as control if 115% of median prices exceeds the limits set in 2008. In principle, this could induce a correlation between treatment status and post-2008 home price trends. To address this, we consider an alternative ex-ante definition in our regressions, defining all tracts above the nationwide minimum in 2008 as treated and assigning all others to the control group. This assigns in 38% of tracts to the treatment group. The plot in Panel A and our results below are essentially unchanged under this definition.

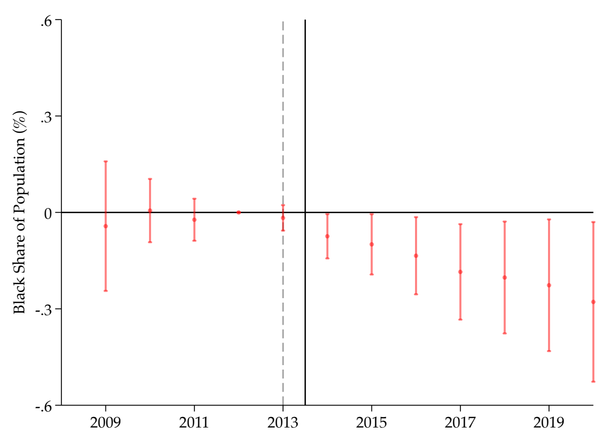
FIGURE 4: Reduction in FHA Caps Alter Mortgage and Location Choices for Black Households



Panel A: Time Series of FHA Caps



Panel B: Black Share of Mortgage Borrowers



Panel C: Black Share of Population

Notes: Panel A shows the average FHA cap for single unit properties across treated (in red) and control (and blue) census tracts. Treated units are with reductions in the FHA cap in 2014. Panels B and C show coefficients from event study regressions comparing treated and control units. Specifically, we plot β_k from the following regression, with 2012 as the omitted year.

$$y_{jt} = \alpha_j + \gamma_t + \sum_{k=2008}^{2020} \beta_k (\text{Treated}_j \cdot \mathbf{1}_{\{t=k\}}) + \varepsilon_{jt}.$$

In panel B, y_{jt} is the *share of black borrowers* $\times 100$ at the tract level in our HMDA sample, which includes all owner occupied, first lien, new purchase mortgages. In Panel C, y_{jt} is the *share of black residents* $\times 100$ in the tract in the 5 year ACS (which began to be reported in 2009). Solid vertical line denotes 2014 reduction in FHA caps, dashed vertical line denotes announcement of the reduction in 2013.

Here, α_j and γ_t are tract and year fixed effects, respectively. We define Share Black_{jt} either as the share of originations in the tract by Black households in HMDA data (to examine the impact on mortgage borrowing) or as the share of Black residents relative to the tract population in ACS data (to examine the impact on the spatial allocation of households).

Results: Black Home-Buying and Population Share Fall

Panels B and C of Figure 4 present event study versions of the specification in Equation 3 that interact the $\textit{Treated}_j$ indicator with each calendar year. We do not see evidence of pre-trends in either outcome (although there are fluctuations in the Black share of mortgage borrowers in the years immediately following the financial crisis). However, we see meaningful declines in treated tracts in terms of mortgage borrowing and residency for Black households after the FHA caps were reduced. This effect appears to grow over time, particularly when considering the population share (perhaps unsurprising, given that this variable represents a stock rather than a flow and the structure of the ACS).

The results in Panel A of Table 1 show that tighter leverage constraints differentially impact the homeownership choices of Black households. The dependent variable is the tract-level share of mortgage borrowers. Our estimates indicate that the 2014 reduction in FHA caps caused the share of Black borrowers to drop by roughly half a percentage point in treated tracts (relative to controls). Because Black borrowers are responsible for a small share of all mortgage originations, this represents a decline of nearly 8 percent of the mean. When restricting to tracts with comparatively large Black populations (those above the national median in 2010), the impact is even larger: a decline of over 1.1 percentage points, almost 10 percent of the mean. The fact that the Black share of all mortgage borrowing declined indicates that Black households did not substitute to other conventional high-leverage mortgage products as access to FHA lending declined.

This drop in homeownership in turn distorts location choices for Black households (Panel B). Our estimates suggest that treated areas experienced a decline in the Black share of the population, with even larger effects in areas with a high initial concentration of Black residents. Our findings therefore indicate that the tightening of leverage constraints has real geographic consequences. Adjustment to the rental stock does not substitute for homeownership, so the impacts of tighter leverage affect where Black households live.

Sensitivity of Mortgage Borrowing to the FHA

The implicit assumption underlying our difference-in-differences approach is that reductions in FHA lending were the source of changes in borrowing and location decisions for Black borrowers. Panel A of Appendix Table A.II shows a basic prerequisite for this assumption to hold: the 2014 tightening in FHA caps

Table 1: Impact of FHA Cap Reduction on Mortgage Origination and Location Choices for Black Borrowers

	Treated=Any Reduction in 2014		Treated=Above Floor in 2008	
Panel A: Impact of FHA Cap Reduction on Share Black Mortgage Borrowers (%)				
	Full Sample	High Black Pop.	Full Sample	High Black Pop.
Treated × Post	-0.487***	-1.159***	-0.545***	-1.176***
	(0.179)	(0.378)	(0.173)	(0.353)
Mean of Dep. Var.	6.20	12.1	6.20	12.0
N	700778	252281	699710	226774
Tract FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Panel B: Impact of FHA Cap Reduction on Share Black Population (%)				
	Treated=Any Reduction in 2014		Treated=Above Floor in 2008	
	Full Sample	High Black Pop.	Full Sample	High Black Pop.
Treated × Post	-0.128**	-0.353**	-0.154**	-0.405***
	(0.065)	(0.140)	(0.063)	(0.138)
Mean of Dep. Var.	13.3	26.1	13.3	26.1
N	603405	228576	602469	228315
Tract FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Notes: Coefficients from difference-in-difference regressions comparing treated census tracts before and after the 2014 reduction in FHA caps. Specifically, we show β from the following regression:

$$y_{jt} = \alpha_j + \gamma_t + \beta(\text{Treated}_j \cdot \mathbf{1}_{\{t \geq 2014\}}) + \varepsilon_{jt}.$$

We consider two definitions of treatment. *Any reduction in 2014* refers to all tracts that experience a reduction in the FHA cap in 2014. *Above floor in 2008* refers to all tracts with an FHA cap above the nationwide floor in 2008. In panel A, y_{jt} is the *share of black borrowers* ×100 at the tract level in our HMDA sample, which includes all owner occupied, first lien, new purchase mortgages. In Panel B, y_{jt} is the *share of black residents*×100 in the tract in the 5 year ACS. Standard errors, clustered at the county level, are included in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

led to a differential reduction in FHA lending in treated areas. FHA lending fell by 5 percentage points, or roughly 15 percent of the mean, in impacted census tracts. This effect is statistically significant at any conventional level, with an F-statistic over 65. In Panel B of Appendix Table A.II , we combine this result with our previous evidence to estimate the sensitivity of mortgage borrowing by Black households to the presence of the FHA. Specifically, we estimate the following IV regression:

$$\text{Share Black}_{jt} = \alpha_j + \gamma_t + \beta \widehat{\text{FHA Share}}_{jt} + \varepsilon_{jt}.$$

In the first stage, we predict the fraction of originations in a tract that are originated through the FHA channel using our difference-in-difference approach.

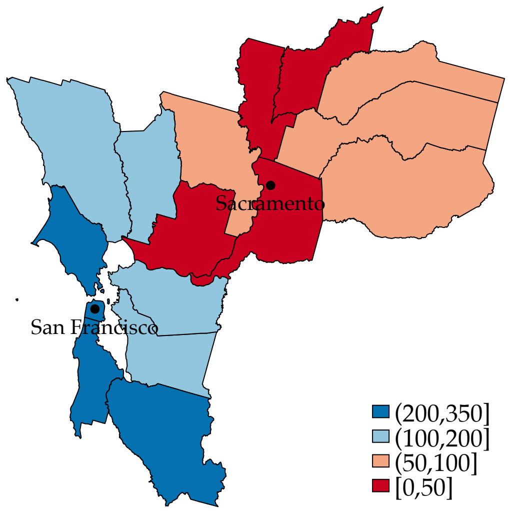
This provides an estimate of $\frac{\Delta(\pi^{jt}_{\text{Black}})}{\Delta(\ell^{LTV+}_{jt})}$, a (linearized) version of the sensitivity. Our estimates indicate that a 10 percentage point reduction in the share of FHA loans generates a roughly 1 percentage point reduction in the share of Black borrowers. Crucially, this also provides us with a moment that we are directly able to match in our structural model. We discuss our calibration in more detail in Section 5.

3.3 Leverage Constraints and Opportunity

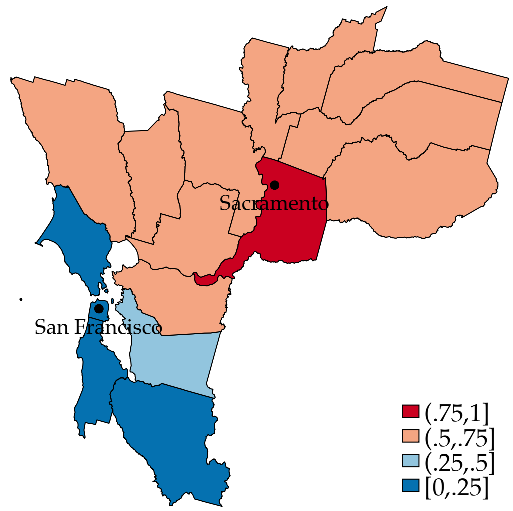
Treated census tracts have stronger labor markets, compared to control tracts. For example, median income was 30 percent higher in treated versus control areas in 2014. The reduction in the Black population in treated tracts generated by the 2014 FHA cap reduction therefore represents a shift of Black households away from more prosperous locations. While the causal effect of place is a complex notion that we consider in more detail in our structural model, the pattern in this natural experiment reflects a broader relationship across the country. Leverage constraints bind most tightly in locations with more robust labor markets, better test scores, and greater intergenerational mobility.

In particular, larger down payments are required in locations that appear to offer the greatest opportunity. Panel A of Appendix Table A.III shows that borrowers make larger down payments in census tracts with higher incomes, a larger number of reachable high-paying jobs, higher test scores for children, and greater intergenerational mobility (as measured by the predicted income rank of local children with parents in the 25th percentile of the distribution, as estimated in Chetty *et al.* (2018)). These higher down payments reflect two factors. The first is simply higher home prices. Unsurprisingly, labor market prospects and other amenities are capitalized into home values. The second is the tightness of the leverage constraint. Given the structure of the mortgage market and the FHA system, access to high-leverage loans disappears as prices rise and, consequentially, as labor markets, test scores, and mobility improve. The remaining panels of Appendix Table A.III show that these measures of opportunity negatively correlate with (i) borrower leverage,

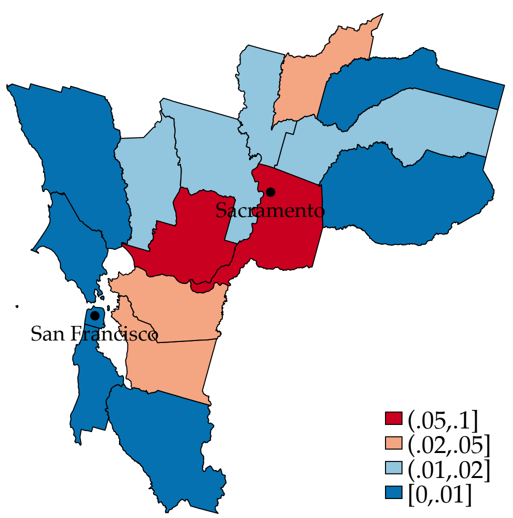
FIGURE 5: OPPORTUNITY AND LEVERAGE CONSTRAINTS IN THE SAN FRANCISCO BAY AND SACRAMENTO METRO AREAS



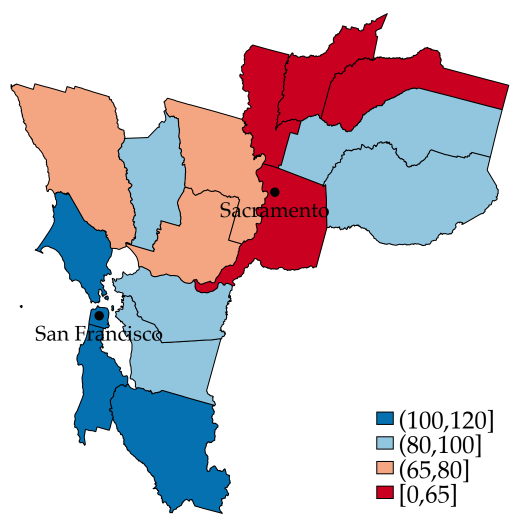
PANEL A: MEDIAN DOWN PAYMENT ($1000S)



PANEL B: SHARE FHA ELIGIBLE



PANEL C: BLACK SHARE OF MORTGAGES



PANEL D: MEDIAN INCOME ($1000S)

Notes: County level characteristics in the San Francisco Bay and Sacramento Metro Area. Median down payment, share FHA eligible, and Black share of mortgages derived from 2018 owner occupied, new purchase mortgages in HMDA, where share FHA eligible refers to the fraction properties that satisfy $0.965 \times \text{Price}_{ijt} \leq \text{FHA Limit}_{jt}$. Median income based on 2018 5-year ACS county level estimates.

(ii) the fraction of the housing stock that is eligible for FHA loans, and (iii) the fraction of mortgages that are actually originated through the FHA.

This pattern indicates that leverage constraints may ration access to opportunity, at least for those who value homeownership. Buying in a high-opportunity area requires substantial upfront wealth. Because potential buyers cannot borrow against future earnings to finance the down payment, this creates differences in access to homeownership, and therefore opportunity, on the basis of current liquidity rather than lifetime earnings. The maps in Figure 5 provide one example of this phenomenon, contrasting the San Francisco Bay Area—one of the nation's most expensive and productive regions—with the Sacramento Metro Area.

There is a substantial leverage burden in San Francisco: the median down payment exceeded $300,000 in much of the region in 2018, in part because a small fraction of homes can be purchased via the FHA. In contrast, the median down payment in Sacramento county was close to $25,000 in 2018 and a large fraction of homes were eligible for financing via the FHA, at least in principle. The leverage burden goes hand in hand with labor markets: median income in San Francisco county exceeds $100,000, but falls below $65,000 in Sacramento. Finally, these patterns reflect to where Black households ultimately choose to buy and live. Less than 1% of mortgage originations in core Bay Area counties went to Black households, compared to over 5% in Sacramento County. While the Bay Area provides a particularly striking case, the same pattern exists in relatively strong labor markets across the country.

4 Dynamic Model of Housing Markets

This section describes a life-cycle model of the cross-section of housing markets with overlapping generations of heterogeneous households, incomplete markets, and endogenous house prices and rents. Motivated by our empirical findings, the key feature is a new type of 2×2 heterogeneity. Households belong to two *demographic groups*, which correspond to Black and white populations. Over their life-cycles, they move and locate across two types of *housing areas*, which correspond to low- and high-opportunity locations. The degree to which households accumulate wealth depends jointly on their choices of area, housing, leverage, and financial assets. These choices, in turn, depend on their initial groups and areas, and within those, on their age, income, wealth, and homeownership.

The main friction is that, in the presence of leverage constraints, groups with low levels of initial wealth will find it difficult to access more expensive properties in high-opportunity areas, especially when expensive properties have tighter leverage requirements. This limits income opportunities and wealth accumulation for households with worse initial conditions for two reasons. First, these areas offer more valuable housing units as investment assets in dollar terms. Because households have a finite lifespan, the value of the house that they are able to buy determines the wealth they accumulate over their life-cycles, and the value of bequests left to the next generation in the same group. Second, these areas offer higher labor market returns, which allow households to save more every period and accumulate wealth faster for themselves and for future cohorts within the same group.

4.1 Environment

The economy is populated by overlapping generations of heterogeneous risk-averse households. Markets are incomplete, and house prices and rents are endogenous. Population size is stationary, and there is a continuum of measure 1 of households with rational expectations. Time is discrete.

Life-cycle Households live for twenty periods, which each correspond to four years. They work for the first eleven periods and then retire. Workers earn labor income and retirees earn pension income, which is lower on average. Shares π_g of households are born into demographic groups $g = B, W$ (Black or white). In each of those, shares π_g^j of households are born into areas $j = L, H$ (low- or high-opportunity).

Preferences Households have constant relative risk aversion (CRRA) preferences over a constant elasticity of substitution (CES) aggregator of nondurable consumption c_{it} and housing services h_{it}. Homeowners can own one home in a single size, which delivers a fixed flow of services $\overline{h}$. Renters consume continuous quantities of housing services $h_{it} \in \left(0, \overline{h}\right]$. Homeownership status and location are determined by households' optimal discrete choices and two i.i.d. idiosyncratic shocks, whose realizations differ across households, which capture residual exogenous motives for owning and moving.[12] The instantaneous utility function of household i at date t is given by:

$$u\left(c_{it}, h_{it}\right) = \frac{\left[\left((1-\alpha)c_{it}^{\epsilon} + \alpha h_{it}^{\epsilon}\right)^{\frac{1}{\epsilon}}\right]^{1-\gamma}}{1-\gamma} + \widetilde{\Xi}_{it} - \widetilde{m}_{it}. \tag{4}$$

Idiosyncratic shocks The homeownership shock $\widetilde{\Xi}_{it}$ captures residual unmodeled benefits (when positive) and costs (when negative) of homeownership. The moving cost shock $\widetilde{m}_{it}$ affects households' propensity to switch between areas, in addition to local fundamentals. The two shocks follow type I Extreme Value distributions, and cancel out in the aggregate. Their respective means Ξ_g^j and m_g^j differ between groups and areas if they own or move (they are zero otherwise). The scale parameters are fixed to 1.

[12] Idiosyncratic shocks are a standard feature of structural models of housing (e.g., Guren & McQuade, 2020) and migration (e.g., Kennan & Walker, 2011). As we show in the robustness section, group variability in these shocks is helpful for the quantitative fit of the model but is not necessary for the mechanism. They are calibrated to match the residual home ownership and moving rates for each demographic group and area type that are not accounted for by households' rational discrete choices.

Intergenerational wealth accumulation Households face mortality risk, with survival probabilities $\{p_a\}$ that vary over the life-cycle. They make realistic voluntary and accidental bequests that account for each cohort's intergenerational wealth accumulation motive, which creates an incentive for moving to opportunity. The voluntary bequest motive captures the fact that some parents sacrifice their own non-durable and housing consumption for the next cohort to be richer.[13] Households derive utility $u^{\mathcal{B}}$ from leaving a bequest B_{t+1}:

$$\begin{aligned} & u^{\mathcal{B}}(B_{t+1}) = \Psi \frac{\left(1+\frac{B_{t+1}}{\overline{B}}\right)^{1-\gamma}}{1-\gamma}, \\ & \text{where } B_{t+1} = \text{Wealth}_{t+1} - \tau_B \max\left(0, \text{Wealth}_{t+1} - B_{ex}\right) \\ & \text{and Wealth}_{t+1} = \text{Financial Wealth}_{t+1} + \text{Housing Wealth}_{t+1}. \end{aligned} \tag{5}$$

Bequests consist of financial and housing wealth, net of estate taxes τ_B that apply to wealth levels above the exemption threshold B_{ex}. The parameter Ψ reflects parents' concern for leaving wealth to the next cohort, which differ between demographic groups g, and $\overline{B}$ measures the extent to which bequests are a luxury good. When households die, bequests $B_{g,t+1}$ are redistributed to young households within the same group as a function of their age, which accounts for how the probability of receiving a transfer varies with age. The bequest redistribution schedule determines households' initial endowments by age, $B_{g,a}$.

Income and agglomeration externality Households face idiosyncratic income risk. For workers, the logarithm of income for a household of age a whose demographic group is g and whose current area type is j is given by:

$$\begin{aligned} & \log\left(y_{i,a,j,g,t}\right) = g_a + e_{i,t} + \mu^j, \\ & e_{i,t} = \rho_e e_{i,t-1} + \varepsilon_{i,t}, \\ & \varepsilon \overset{iid}{\sim} \mathcal{N}\left(\mu_g, \sigma_\varepsilon^2\right). \end{aligned} \tag{6}$$

Households receive income depending on their age, idiosyncratic productivity, demographic group, and area. First, g_a is the log of the deterministic, hump-shaped life-cycle income profile. Second, workers from different demographic groups have different income processes: $e_{i,t}$ is the log of the persistent idiosyncratic component of income, and $\varepsilon_{i,t}$ is the log of the corresponding shock, which is drawn from a Normal distribution whose mean μ_g differs between Black and white households. Importantly, a lower mean μ_g for the log of income e for Black households implies both a lower mean and more downside risk for the level of income y that enters the household problem (given the same volatility of idiosyncratic log income σ_ε), which matches the data. Third, μ^j is an *endogenous* spatial income shifter that differs between low- and

[13] We consider a warm-glow bequest motive as in most life-cycle models with overlapping generations, following De Nardi (2004). A more sophisticated form of altruism would generate strategic interactions between cohorts and increase the number of state variables (already six in this setup).

high-opportunity areas as a function of their respective shares of high-productivity workers:

$$\mu^j = \zeta_0^j \times (\text{Share high } e \text{ in } j)^{\zeta_1}, \tag{7}$$

where Share high e in j is the area share of high-productivity workers, and ζ_0^j and ζ_1 respectively determine average income differences between areas and the strength of the agglomeration externality (e.g., Moretti (2004)). Households living in different areas, as a consequence, receive different income boosts (e.g., Bilal & Rossi-Hansberg, 2021). The distribution of income across areas reflects a dynamic relationship between spatial income shifters and population composition, with the shifters themselves reflecting endogenous skill sorting. This creates a feedback loop where area incomes and resident skill levels mutually reinforce each other. For retirees, income is modeled to replicate the main features of the U.S. pension system (see Appendix C).

Financial asset Households can invest in a financial asset with an exogenous rate of return $r > 0$ to accumulate wealth. Investments in the financial asset face a no-borrowing constraint, such that households cannot borrow against their future income unless they buy a house.

Mortgages Households can invest in housing. Home buyers can use long-term amortizing mortgages to borrow, subject to LTV constraints which only apply at origination. As in the data, the LTV constraints are the same across areas but they depend on loan sizes. Loans (negative positions $b_{t+1} < 0$) that are below the area-dependent FHA loan cap b_j^{FHA} are subject to a looser LTV limit θ_{LTV}^{FHA} (equivalently, a lower down payment requirement), which corresponds to FHA loans, than loans that are above the cap and are subject to a tighter LTV limit θ_{LTV}^{CONV}, which corresponds to conventional loans:

$$\theta_{LTV}(b_{t+1}) = \begin{cases} \theta_{LTV}^{FHA}, & \text{if } |b_{t+1}| \leq b_j^{FHA}. \\ \theta_{LTV}^{CONV} < \theta_{LTV}^{FHA}, & \text{otherwise.} \end{cases} \tag{8}$$

Borrowers face an exogenous mortgage rate $r^b > r$, which depends on the loan size such that $r_{FHA}^b > r_{CONV}^b$. We denote $\tilde{r} = r^b$ if households borrow, and $\tilde{r} = r$ if net savings b_{t+1} are positive. The amortization schedule of mortgages is exogenous, and they must be fully repaid when old households die. Default is endogenous and mortgages are non-recourse. If borrowers default, they face a utility cost d and subsequently become renters in the same area.

Homeownership Homeownership comes with three benefits. First, owning allows buyers to access larger homes producing more valuable housing services, as the owner-occupied and the rental markets are segmented (e.g., Greenwald & Guren, 2021). Second, owning can improve consumption smoothing, since buying with a mortgage allows owners to only pay a fraction of the purchase price in the current period while renters have to pay the full rent.[14] Third, owning gives households idiosyncratic utility benefits captured by $\widetilde{\Xi}$. These motives are consistent with the empirical literature on the benefits of homeownership (e.g., Goodman & Mayer, 2018; Sodini *et al.*, 2021).

2×2 **housing markets** The two demographic groups differ in the probability that a household is born in low- or high-opportunity areas π_g^j, in their initial wealth $b_{0,g}$, and in income processes.

Every period, households can move and choose to live in either of the two area types. Areas differ in their income boost μ^j, in the level I^j and the price-elasticity ρ^j of housing supply, and in the FHA loan cap b_j^{FHA}. They also differ in the shares of mortgages with the two LTV limits θ_{LTV}^{FHA} and θ_{LTV}^{CONV}, which are endogenous. Equilibrium differences in house prices P_j and rents R_j across areas arise endogenously as a result of differences in local housing supply and demand due to these features.

Housing supply The total quantities of owner-occupied housing H_j^o and rentals H_j^r in area j, in square feet, are supplied according to a reduced form function of the house price,

$$\begin{aligned} H_j^o &= I^{oj} P_j^{\rho_j}, \\ H_j^r &= I^{rj} P_j^{\rho_j}. \end{aligned} \tag{9}$$

The levels $I^{\mathcal{H}j}$ and the price-elasticities ρ_j of the housing supply curves differ between owner-occupied and rental housing $\mathcal{H} = o, r$ as well as areas $j = L, H$. The higher I, the lower the price level required to produce a given level of housing supply. The higher ρ, the lower the price change required to induce a given change in housing supply.

Household choices Every period, households make discrete choices on whether to move between areas, to buy or own within each area, and to default on their mortgage if they have one. They choose their housing size h_t, nondurable consumption c_t, and save in a liquid and risk-free financial asset $b_{t+1} > 0$ or borrow with a long-term mortgage $b_{t+1} < 0$. Fixed costs of moving and of housing transactions lead to inaction

[14] When the owner-occupied and rental markets are integrated, the price is a multiple of the rent given by the user cost equation, such that households are indifferent between renting and owning. With segmented markets and long-term mortgages, buying may be cheaper, hence more attractive than renting, since it allows buyers to slowly pay for their homes. The fact that owners can better smooth their housing expenditures captures the fact that owner-occupied housing is a hedge against rent risk (Sinai & Souleles (2005)).

regions (e.g., Arrow *et al.*, 1951), in which households with a given combination of state variables keep their current discrete choices, while others switch between areas and homeownership statuses.

Timing A household located in a given area chooses their next area and homeownership, earns labor and financial income in their area of origin, and then chooses consumption and housing size, as well as debt or savings.

4.2 Household Problem

This subsection describes the household problem in recursive form. The individual state variables are their demographic group $g = B, W$ (Black or white), area type $j = L, H$ (low- or high-opportunity), homeownership status $\mathcal{H} = o, r$ (renter or owner), age a, net savings b, and endowment y. We describe the problem for low-opportunity areas L and any group g. The problem is similar for high-opportunity areas H.

4.2.1 Renter

A renter chooses the area where they will move at the end of the period, and whether to rent or own in this new area. Denote the value function of a renter from group g, age a, with savings b_t and income y_t, who starts the period in an area L, as $V_g^{rL}(a, b_t, y_t)$. The envelope value of the value functions for each option is:

$$V_g^{rL}(a, b_t, y_t) = \max \left\{ V_g^{rL,rL}, V_g^{rL,rH}, V_g^{rL,oL}, V_g^{rL,oH} \right\}. \tag{10}$$

Denote $d_g^{rL} \in \{rL, rH, oL, oH\}$ the resulting policy function for the discrete choice problem. Then, renters choose consumption, housing size, and savings or mortgage debt if they borrow to purchase a house.

Inactive renter. The value of being inactive and staying a renter in housing stock L is given by the Bellman equation:

$$V_g^{rL,rL}(a, b_t, y_t) = \max_{c_t, h_t, b_{t+1}} u\left(c_t, h_t\right) + \beta \mathbb{E}_t \left[p_a V_g^{rL}(a+1, b_{t+1}, y_{t+1}) + (1 - p_a) u^{\mathcal{B}}(B_{t+1}) \right], \tag{11}$$

subject to the constraint that the household's total income, which consists of income labor earnings, financial income, and intergenerational transfers must be sufficient to cover, and at the optimum exactly match, the combined costs of consumption, rental housing, and savings:

$$c_t + R_L h_t + b_{t+1} = y_t + (1 + r) b_t + B_{g,a}, \tag{12}$$

and subject to a no-borrowing constraint, as well as a constraint on the size of rental housing:

$$b_{t+1} \geq 0, \quad h_t \in \left(0, \overline{h}\right]. \tag{13}$$

Expectations are taken with respect to the conditional distribution of idiosyncratic income, homeownership, and moving shocks at date t. Since the household does not own a house, voluntary and accidental bequests B_{t+1} only consist of financial wealth $(1+r)b_{t+1}$.

Renter moving between areas. When moving to an area H while remaining a renter, a household incurs an idiosyncratic moving cost shock with mean m_H included in utility u and faces the continuation envelope value function in area H:

$$\begin{aligned}
&V_g^{rL,rH}(a, b_t, y_t) = \max\nolimits_{c_t, h_t, b_{t+1}} u\left(c_t, h_t\right) + \beta \mathbb{E}_t \left[p_a V_g^{rH}(a+1, b_{t+1}, y_{t+1}) + (1-p_a) u^{\mathcal{B}}(B_{t+1})\right], \\
&\text{s.t. } \; c_t + R_L h_t + b_{t+1} = y_t + (1+r)b_t + B_{g,a}, \\
&b_{t+1} \geq 0, \quad h_t \in \left(0, \overline{h}\right].
\end{aligned} \tag{14}$$

Home buyer in the same area. When buying a house in the same area, the renter's value function is:

$$V_g^{rL,oL}(a, h_t, b_t, y_t) = \max_{c_t, h_t, b_{t+1}} u\left(c_t, h_t\right) + \beta \mathbb{E}_t \left[p_a V_g^{oL}(a+1, b_{t+1}, y_{t+1}) + (1-p_a) u^{\mathcal{B}}(B_{t+1})\right]. \tag{15}$$

In addition to rental housing purchased at rate R_L, the household buys a house at price P_L,

$$c_t + R_L h_t + F_m + P_L \overline{h}(1+f_m) + b_{t+1} = y_t + (1+r^f)b_t + B_{g,a}, \quad h_t \in \left(0, \overline{h}\right], \tag{16}$$

using a mix of savings accumulated over the life-cycle, and of long-term mortgage debt b_{t+1} at rate r^b, subject to fixed and proportional origination fees F_m and f_m, and an LTV limit that depends on the loan size,

$$b_{t+1} \geq -\theta_{LTV}(b_{t+1}) P_L \overline{h}. \tag{17}$$

$\theta_{LTV}(b_{t+1})$ is the maximum fraction of the house price that the household can borrow, so $1 - \theta_{LTV}(b_{t+1})$ is the down payment requirement. If the loan size $|b_{t+1}|$ is below the area-dependent FHA loan cap b_L^{FHA}, then the borrower is subject to a looser LTV limit θ_{LTV}^{FHA}, otherwise it is subject to a tighter limit θ_{LTV}^{CONV}. As in the data, the constraint only applies at origination, and may be violated in subsequent periods if income and house prices change.

Equation 17 indicates the leverage *constraint* faced by borrowers, while $\theta_{LTV}(b_{t+1})$ indicates the leverage *limit*. The leverage constraint sets a maximum limit on borrowing relative to the value of the house, while the leverage limit expresses the down payment requirement.

Every period, homeowners with a mortgage pay interests and roll over their current debt subject to the requirement of repaying at least a fraction $1-\theta_{am}$ of the principal,

$$b_{t+1} \geq \min\left[\theta_{am} b_t, 0\right]. \tag{18}$$

The lowest payment that households can make in a period therefore equals $\left(1+r^b-\theta_{am}\right)b_t$. Since the household is now a homeowner, voluntary and accidental bequests B_{t+1} consist of both financial and housing wealth $(1+\tilde{r})b_{t+1}+P_L\overline{h}$.

Home buyer moving between areas. The value of moving to an area H and buying a house is similar, with the addition of an idiosyncratic moving cost shock with mean m_H included in u:

$$V_g^{rL,oH}(a,b_t,y_t) = \max_{c_t,h_t,b_{t+1}} u\left(c_t,h_t\right) + \beta\mathbb{E}_t\left[p_a V_g^{oH}(a+1,b_{t+1},y_{t+1}) + (1-p_a)u^{\mathcal{B}}(B_{t+1})\right], \tag{19}$$

subject to the budget constraint, and an LTV limit that depends on the loan size. If the loan size $|b_{t+1}|$ is below the area-dependent FHA loan cap b_H^{FHA}, then the borrower is subject to a looser LTV limit θ_{LTV}^{FHA}, otherwise it is subject to a tighter limit θ_{LTV}^{CONV}.

$$\begin{aligned} &c_t + R_L h_t + F_m + P_H\overline{h}(1+f_m) + b_{t+1} = y_t + (1+r^f)b_t + B_{g,a}, \quad h_t \in \left(0,\overline{h}\right], \\ &b_{t+1} \geq -\theta_{LTV}(b_{t+1})P_H\overline{h}. \end{aligned} \tag{20}$$

4.2.2 Homeowner

The problem for existing homeowners has a similar structure. The value function for an owner starting the period in an area L is $V_g^{oL}(a,b_t,y_t)$. They choose to either default, remain an owner, or sell the house and become a renter. If they leave their residence, they choose the area to which they move over the period:

$$V_g^{oL}(a,b_t,y_t) = \max\left\{V_g^{oL,oL}, V_g^{oL,oH}, V_g^{oL,rL}, V_g^{oL,rH}, V_g^{oL,d}\right\}. \tag{21}$$

Denote the resulting policy function for the discrete choice problem as $d_g^{oL} \in \{oL, oH, rL, rH, d\}$.

Inactive owner. The value of staying a homeowner in an area L is given by the Bellman equation with fixed housing services $\overline{h}$:

$$V_g^{oL,oL}(a,b_t,y_t) = \max_{c_t,b_{t+1}} u\left(c_t,\overline{h}\right) + \beta\mathbb{E}_t\left[p_a V_g^{oL}(a+1,b_{t+1},y_{t+1}) + (1-p_a)u^{\mathcal{B}}(B_{t+1})\right], \tag{22}$$

subject to the budget constraint:

$$c_t + b_{t+1} = y_t + (1+\tilde{r})b_t + B_{g,a}, \tag{23}$$

and the mortgage amortization constraint:

$$b_{t+1} \geq \min\left[\theta_{am} b_t, 0\right]. \tag{24}$$

Voluntary and accidental bequests B_{t+1} consist of both financial and housing wealth, $(1+\tilde{r})b_{t+1} + P_L\overline{h}$.

Owner moving between areas. When selling their house and purchasing a house in another area H, an owner incurs an idiosyncratic moving cost with mean m_H included in u:

$$V_g^{oL,oH}(a,b_t,y_t) = \max_{c_t,b_{t+1}} u\left(c_t,\overline{h}\right) + \beta\mathbb{E}_t\left[p_a V_g^{oH}(a+1,b_{t+1},y_{t+1}) + (1-p_a)u^{\mathcal{B}}(B_{t+1})\right]. \tag{25}$$

The new house is purchased with a mix of housing equity, savings in liquid assets (if they have no debt), and a new mortgage b_{t+1}, subject to the same origination fees F_m and f_m and an LTV limit that depends on the loan size. If the loan size $|b_{t+1}|$ is below the area-dependent FHA loan cap b_H^{FHA}, then the borrower is subject to a looser LTV limit θ_{LTV}^{FHA}, otherwise it is subject to a tighter limit θ_{LTV}^{CONV}. In addition, they face sales transaction costs f_s on the house sold in area L.

$$\begin{aligned} &c_t + F_m + P_H\overline{h}(1+f_m) + b_{t+1} = y_t + (1+\tilde{r})b_t + (1-f_s)\,P_L\overline{h} + B_{g,a}, \\ &b_{t+1} \geq -\theta_{LTV}(b_{t+1})P_H\overline{h}. \end{aligned} \tag{26}$$

Home seller. An owner selling their house and becoming a renter in the same area incurs a proportional selling transaction cost f_s:

$$V_g^{oL,rL}(a,b_t,y_t) = \max_{c_t,b_{t+1}} u\left(c_t,\overline{h}\right) + \beta\mathbb{E}_t\left[p_a V_g^{rL}(a+1,b_{t+1},y_{t+1}) + (1-p_a)u^{\mathcal{B}}(B_{t+1})\right], \tag{27}$$

subject to the budget and no-borrowing constraints

$$\begin{aligned} c_t + b_{t+1} &= y_t + (1+\tilde{r})b_t + (1-f_s)\, P_t\overline{h} + B_{g,a}, \\ b_{t+1} &\geq 0. \end{aligned} \tag{28}$$

Because owners sell their houses during the period, voluntary and accidental bequests B_{t+1} only consist of financial wealth $(1+r)b_{t+1}$.

Home seller moving between areas. The value of selling their house to move and become a renter in another area H is similar to the previous one, with the subtraction of an idiosyncratic moving cost shock with mean m_H.

Mortgage defaulter. Owners who default on their mortgages immediately incur a utility cost of default d, are only left with their current income to consume, and become renters in the same area in the next period:

$$V_g^{oL,d}(a, b_t, y_t) = \max_{c_t, b_{t+1}} u\left(c_t, \overline{h}\right) - d + \beta\mathbb{E}_t\left[p_a V_g^{rL}(a+1, b_{t+1}, y_{t+1}) + (1-p_a)u^{\mathcal{B}}(B_{t+1})\right], \tag{29}$$

subject to the budget and no-borrowing constraints

$$\begin{aligned} c_t + b_{t+1} &= y_t, \\ b_{t+1} &\geq 0. \end{aligned} \tag{30}$$

Because they lose their houses during the period, voluntary and accidental bequests B_{t+1} left only consist of financial wealth $(1+r)b_{t+1}$.

4.3 Equilibrium

This subsection defines a spatial equilibrium for this economy.

Definition A stationary competitive spatial equilibrium consists of the following objects, which are defined for demographic groups g, areas $j = L, H$, and homeownership $\mathcal{H} = o, r$:

(i) prices and rents $\{P_j, R_j\}$

(ii) value functions $\left\{V_g^{\mathcal{H}j}\right\}$

(iii) policy functions $\left\{d_g^{\mathcal{H}j}, c_g^{\mathcal{H}j}, h_g^{\mathcal{H}j}, b_{g,t+1}^{\mathcal{H}j}\right\}$

(iv) 2×2 cross-sectional distributions of households $\lambda\left(g, j, \mathcal{H}, a, b, y\right)$ over groups g, areas j, homeownership $\mathcal{H}$, age a, net savings b, and income y, such that households optimize given prices, the distributions of households are consistent with their choices and prices, markets clear, and intergenerational transfers made and received are consistent with each other.[15]

Housing markets The market-clearing conditions for owner-occupied housing in areas $j = L, H$ are

$$\int_{\Omega^{oj}} \overline{h} d\lambda = \underbrace{pop_j \times ho_j^{hh} \times \overline{h}}_{\text{owner-occupied housing demand in } j} = \underbrace{H_j^o}_{\text{owner-occupied housing supply in } j}. \tag{31}$$

The market-clearing conditions for rental housing in areas $j = L, H$ are

$$\underbrace{\int_{\Omega^{rj}} h_j d\lambda}_{\text{rental demand in } j} = \underbrace{H_j^r}_{\text{rental supply in } j}. \tag{32}$$

$pop_j = pop_j(\mathbf{P}, \mathbf{R})$ denotes the population share of areas j and $ho_j^{hh} = ho_j^{hh}(\mathbf{P}, \mathbf{R})$ the homeownership rate. $\Omega^{oj} = \Omega^{oj}(\mathbf{P}, \mathbf{R})$ and $\Omega^{rj} = \Omega^{rj}(\mathbf{P}, \mathbf{R})$ are the sets of households who are owners and renters in areas j. They depend on the vectors of prices and rents in both area types, because households sort across areas in spatial equilibrium.

Intergenerational wealth transmission Within each demographic group $g = W, B$, voluntary and accidental bequests that are left should be equal to the bequests that are received:

$$\int_{\Omega^g} B_{g,t+1} d\lambda = \int_{\Omega^g} B_{g,a} d\lambda. \tag{33}$$

Solving such a rich model is numerically challenging. Appendix C describes the solution. As in the dynamic demand literature, we use the additive idiosyncratic shocks to households' value functions to smooth the computation of the laws of motion for the cross-sectional distributions implied by policy functions.

5 Calibration and Baseline Results

In this section, we describe the calibration and the fit of the dynamic model outlined in Section 4, and how it is connected to the quasi-experimental evidence from Section 3.

[15] We write the market-clearing conditions in terms of the total housing stocks supplied and demanded, which eases computations. Given the structure of the model, it is strictly equivalent to write them in terms of flows and focus on new housing purchased, sold, and built.

5.1 Calibration

Table 2 summarizes the calibration. Parameters are split between external and internal parameters. Within each category, they are split between aggregate and area- and group-dependent parameters that are specific to our 2×2 model. Tables 3 and 4 report the results.

5.1.1 Approach

We proceed in four steps. First, we fix the externally calibrated parameters from the data.

Second, we choose the internally calibrated parameters to match empirical targets. There are 20 parameters and targets, so the model is exactly identified conditional on the external parameters. We compute the vector of percentage differences between the model moments $\mathbf{M}_{model}$ and their empirical counterparts $\mathbf{M}_{data}$, and we iteratively update internal parameters to minimize the L^{∞} norm (i.e., the largest absolute value) of that vector, $\mid \frac{\mathbf{M}_{model}-\mathbf{M}_{data}}{\mathbf{M}_{data}} \mid_{\infty}$. Thus, for the fit of the main aggregate moments of the model, we rely on the same calibration approach as for other life-cycle models without housing or with a single housing market, as described in Gomes (2020). All moments are jointly determined, but some parameters have a larger effect on specific moments (e.g., Andrews *et al.*, 2017). For the moments that are specific to our 2×2 structure, and to exactly match house prices and rents by area, we exploit two technical features of our model. First, the assumption of additive i.i.d. idiosyncratic shocks to households' value functions; second, the homogeneity of the housing supply functions in the price P_j and the structure of the market-clearing conditions as in Mabille (2023). Appendix C.2 describes this step in detail.

Third, we calibrate the model to match the empirical effect identified in Section 3, which measures the elasticity of Black borrowing to the availability of high-leverage mortgages in the data. This new step involves computing the model counterpart of this elasticity. Our baseline sets b_H^{FHA} to be \$388,000, which is the average FHA cap in 2018 in the treatment areas from the difference-in-differences analysis in Section 3. We compare this baseline to a model which sets a looser FHA loan cap in high-opportunity areas. Specifically, we raise b_H^{FHA} by \$75,000, which replicates the policy shift discussed in Section 3. We keep the FHA loan cap in low-opportunity areas fixed at \$301,000 throughout, corresponding to the average FHA loan cap in the control areas in 2018 from the same reduced form analysis.

This step requires adding an outer loop to the calibration and running the corresponding counterfactual experiment for each combination of parameters tried until convergence. Specifically, we compute both our baseline model with the tighter high-opportunity loan cap b_H^{FHA} and a counterfactual experiment with the looser high-opportunity loan cap. The effect of comparing the counterfactual with the baseline corresponds to the effect of the reduction in the FHA cap in high-opportunity areas in the data. Then, we measure the

TABLE 2: CALIBRATION

Parameter	Description	Value	Source/Target
		External	
		Preferences, income, bequests:	
γ	Risk aversion	2	Standard value
ρ_e	Autocorrelation income process	0.70	From Floden & Lindé (2001)
σ_ε	Std. dev. income process	0.39	From Floden & Lindé (2001)
ζ_1	Agglomeration externality high-opportunity	0.40	From Moretti (2004)
$\{B_{g,a}\}$	Bequest redistribution schedule by group and age	See text	Expected bequest received by age (2019 SCF)
τ_B	Estate tax rate	0.10	From De Nardi (2004)
B_{ex}	Estate tax exemption threshold	\$2,600,000	From De Nardi (2004)
		Mortgages:	
r	Financial asset rate of return	4.00%	Median return on 60–40 portfolio of stocks and bonds
r^b_{FHA}	Mortgage rate FHA loans	4.93%	Avg 30-year mortgage rate (Freddie Mac Primary Mortgage Survey)
r^b_{CONV}	Mortgage rate conventional loans	4.08%	Avg 30-year mortgage rate (Freddie Mac Primary Mortgage Survey)
F_b	Selling transaction cost	6.00%	Share of purchase price (Freddie Mac Primary Mortgage Survey)
F_s	Proportional buying transaction cost	0.60%	Share of mortgage size (Favilukis *et al.*, 2017)
f_s	Fixed buying transaction cost	1,200	Mortgage origination fee (Favilukis *et al.*, 2017)
θ_{am}	One minus amortization rate	0.96	Minimum amortization (Greenwald *et al.*, 2020)
		Housing areas:	
b^{FHA}_H	FHA loan cap in high-opportunity	\$388,000	Average FHA Cap in Treatment Group (Section 3)
b^{FHA}_L	FHA loan cap in low-opportunity	\$301,000	Average FHA Cap in Control Group (Section 3)
θ^{FHA}_{LTV}	LTV limit on loans below cap	0.965	FHA mortgage LTV limit (2018)
θ^{CONV}_{LTV}	LTV limit on loans above cap	0.800	Conforming mortgage LTV limit (2018)
π^H_W	Share white born in high-opportunity	0.19	Share white born in high-opportunity (2018 5-Year ACS)
π^H_B	Share Black born in high-opportunity	0.08	Share Black born in high-opportunity (2018 5-Year ACS)
ρ^H	Housing supply elasticity high-opportunity	0.594	Elasticity in high-opportunity (Baum-Snow & Han, 2023)
ρ^L	Housing supply elasticity low-opportunity	0.590	Elasticity in low-opportunity (Baum-Snow & Han, 2023)
		Demographic groups:	
π_B	Population share Black	0.15	Population share Black (2018 5-Year ACS)
		Internal	
		Preferences and bequests:	
β	Discount factor	0.88	Avg wealth/avg income (2019 SCF)
α	Housing utility weight	0.41	Avg rent/avg income (Decennial Census)
ϵ	CES housing and consumption	0.42	Quasi-exp. treatment effect (Section 3)
d	Utility cost of default	1.25	Avg default rate (RealtyTrac)
Ψ_W	Voluntary bequest weight white	4.22	Avg bequests white/Black (2019 SCF)
$\underline{B}$	Voluntary bequest as luxury good	1.00	Median bequest/income (2019 SCF)
Ξ^H_W	Mean homeownership shock white in high-opportunity	1.46	Avg high-opportunity homeownership white (2018 5-Year ACS)
Ξ^L_W	Mean homeownership shock white in low-opportunity	0.90	Avg low-opportunity homeownership white (2018 5-Year ACS)
Ξ^H_B	Mean homeownership shock Black in high-opportunity	0.86	Avg high-opportunity homeownership Black (2018 5-Year ACS)
Ξ^L_B	Mean homeownership shock Black in low-opportunity	-0.42	Avg low-opportunity homeownership Black (2018 5-Year ACS)
		Housing areas and demographic groups:	
ζ^H_0	Income shifter intercept high-opportunity	0.21	Avg income high/low-opportunity (2018 5-Year ACS)
μ_W	Mean income process white	0.16	Avg income white/Black (2018 Current Population Survey)
I^{oH}	Supply curve intercept high-opportunity owner-occupied	0.12	Avg house price high-opportunity (2018 5-Year ACS)
I^{oL}	Supply curve intercept low-opportunity owner-occupied	0.73	Avg house price low-opportunity (2018 5-Year ACS)
I^{rH}	Supply curve intercept high-opportunity rentals	0.05	Avg rent high-opportunity (2018 5-Year ACS)
I^{rL}	Supply curve intercept low-opportunity rentals	0.37	Avg rent low-opportunity (2018 5-Year ACS)
m^H_W	Mean moving cost shock white to high-opportunity	4.60	Moving rate white to high-opportunity (Infutor)
m^H_B	Mean moving cost shock Black to high-opportunity	7.13	Moving rate Black to high-opportunity (Infutor)
m^L_W	Mean moving cost shock white to low-opportunity	-1.84	Share white living in high-opportunity (2018 5-Year ACS)
m^L_B	Mean moving cost shock Black to low-opportunity	-5.30	Share Black living in high-opportunity (2018 5-Year ACS)

Notes: One model period corresponds to four years. Targets and interest rates are annualized.

reduction in the share of high-leverage loans in high-opportunity areas in the model with a tighter loan cap (in percentage points), $\Delta(\ell_{sh}^{LTV+})$. We also measure the reduction in the share of Black households in high-opportunity areas (in percentage points), $\Delta(\pi_{Black}^{high})$. Finally, we compare $\frac{\Delta\left(\pi_{Black}^{high}\right)}{\Delta\left(\ell_{sh}^{LTV+}\right)}$ in the model and the data.

Fourth, we evaluate the out-of-sample fit of the model using additional moments.

5.1.2 External Parameters

We start by highlighting *aggregate parameters* common to the two demographic groups and area types.

Preferences and income. We set risk aversion γ to 2, a standard value. The persistence of the labor income process is set to $\rho_e = 0.700$, and its volatility to $\sigma_e = 0.387$, which are the four-year equivalents of the estimates in Floden & Lindé (2001). We follow Moretti (2004) to endogenize the the spatial income shifter μ^H, which is increasing in the share of high-productivity workers in high-opportunity areas and generates a positive agglomeration externality. The strength of the externality depends on the share of workers in the top 50% of the productivity distribution, and it is controlled by $\zeta_1 = 0.40$. The intercept of the spatial income shifter is internally calibrated as described below.

Intergenerational wealth accumulation. Bequests are redistributed within each group as a function of age, which determines households' endowments at each stage of their life cycles. We calibrate the bequest redistribution schedule by age $\left\{B_{g,a}\right\}$ to replicate how the probability of receiving a bequest varies with age in each demographic group. In the SCF data, this probability increases with age until retirement and ranges from 5% for households under 26 years old to 12% for households aged 56–65 years old (in annual terms). We also account for the taxation of large bequests. The estate tax rate $\tau_{\mathcal{B}}$ is 10% and the exemption threshold B_{ex} is 40 years of average income as in De Nardi (2004).

Mortgages. The LTV caps are the same across areas but they depend on loan size. We set the area-dependent FHA loan caps b_H^{FHA} and b_L^{FHA} to \$388,000 and \$301,000, respectively, to match average 2018 FHA caps across treatment and control areas as defined in Section 3. The caps on FHA loans are set to $\theta_{LTV}^{FHA} = 0.965$ and the caps on conventional loans are set to $\theta_{LTV}^{CONV} = 0.80$. These values are consistent with the LTV thresholds of 96.5 for FHA mortgages and 80 for conforming loans. The mortgage rate r^b is 4.08% for conventional loans and 4.93% for FHA loans. The 85 basis point premium captures the required annual ongoing mortgage insurance premium (MIP) for FHA borrowing above 95 LTV in 2018. The level of both rates are centered around the average 30-year U.S. mortgage rate since 1975 of roughly 4.5% (Freddie Mac Primary Mortgage Market Survey). Using evidence from Favilukis *et al.* (2017), we set the fixed transaction cost of buying a house to \$1,200 and the proportional cost to 0.6% of the loan value. Following Boar *et al.*

(2022), we set the proportional transaction cost of selling to 6%, its value in the Freddie Mac Primary Mortgage Market Survey after 2000. The minimum amortization rate θ_{am} is set to 0.96, such that the fraction of the principal to be repaid each period, $1 - \theta_{am}$, is at least 4%, close to the four-year equivalent of the value reported by Greenwald *et al.* (2020).

Financial asset. The real rate of return r at which households can save in financial assets is 4% net of fees. This is computed as the average of 30-year Treasury rates since 1975 (Board of Governors of the Federal Reserve System, H.15 Selected Interest Rates).

Next, we consider 2×2 *parameters* which differ between areas and demographic groups. While, in general, access to opportunity (defined as labor market prospects which raise the income of current and future generations) varies continuously across regions, we group regions into two types of areas for tractability. Following the empirical evidence in Appendix Table A.III, we classify areas into high- and low-opportunity by contrasting regions with high and low availability of FHA loans. We classify census tracts as high-opportunity areas if the tract-level median house price in HMDA (2018) is above the applicable county-level FHA limit for that year, indicating that the typical house is out of reach for most FHA buyers. Low-opportunity areas are similarly classified as those tracts for which the median house price is below the FHA limit. While high-opportunity areas defined in this way account for 18% of the population, they are disproportionately responsible for income prospects (accounting for 28% of aggregate household income) and especially for wealth building prospects (43% of housing equity). The goal of this geographic classification is to capture an important aspect of neighborhood choice that is tied to income and wealth-building prospects.

Housing Areas. We use the data from Baum-Snow & Han (2023) to compute the price elasticity of housing supply in each area. To correspond to the model, we use the elasticity in terms of floor space, and compute the average across tracts within each area type. To measure the shares of Black and white households born in each area type, we consider the racial composition of individuals in the 5-year 2018 ACS data across high- and low-opportunity areas.

Demographic Groups. We define the overall Black population share as the Black population share divided by the white population share, which in the U.S. is slightly below 15% from the 2018 5-year ACS. We also measure initial wealth for Black and white households, under the age of 35, using 2019 SCF data (Bhutta *et al.*, 2020).

5.1.3 Internal Parameters

The remaining parameters are calibrated internally to match targeted moments in the data, which are reported in Table 3 along with their model counterparts.

Preferences. We calibrate the discount factor β to match the average wealth to income ratio of 5.60 in the economy (SCF). We choose the preference for housing α to match the average rent to income ratio of 0.20 (decennial Census data, Davis & Ortalo-Magne, 2011). The utility cost of default d is chosen to match the average default rate of 2% on U.S. mortgages in a recent sample of foreclosures which includes the Great Recession (RealtyTrac).

We calibrate the CES parameter ϵ, which governs the elasticity of substitution between consumption and housing, to match the empirical effect measured in Section 3. The response of Black borrowers to a change in the FHA cap is determined both by area- and group-dependent parameters and by households' willingness to substitute between consumption and housing. A higher ϵ implies that more financially-constrained Black households are willing to sacrifice some consumption to live in high-opportunity areas when the LTV limit is looser. They may, as a result, have a higher willingness to pay for housing in the high-opportunity area either immediately, or after accumulating enough savings to overcome down payment requirements. Conversely, when the LTV limit is tighter, a higher ϵ may make living in that area less valuable, leading to a larger decrease in the share of Black households. The value that we obtain corresponds to an elasticity of substitution between consumption and housing that is close to standard estimates (for instance, our estimate of 1.72 is very close to the estimate of 1.75 in McGrattan *et al.* (1997) and slightly higher than the estimate in Piazzesi *et al.* (2007)).

Intergenerational wealth accumulation. We calibrate the strength of the voluntary bequest motive Ψ^W for white relative to Black households to match the ratio of average bequests between these groups in the data. Bequests in each group are computed from Jones & Neelakantan (2022) as the probability of receiving a bequest (35% for white and 13% for Black households) times the median bequest conditional on receiving one ($100,830 for white and $74,460 for Black households). We choose the extent to which bequests are a luxury good, $\underline{B}$, to match the average bequest to income ratio at the lowest 30th percentile as in De Nardi (2004).

Housing Areas: We normalize the spatial income shifter μ^L in low-opportunity areas to zero, and we choose the intercept $\zeta_0^H = 0.21$ of the shifter in high-opportunity areas μ^H to match the ratio of average income between the two area types in the baseline, including the agglomeration effects described earlier. In spatial equilibrium, the higher income distribution in high-opportunity areas results both from skill sorting, with higher income households choosing to live in more expensive areas, and from the residual income boost in those areas created by the spatial income shifter. Our estimates imply that high-opportunity areas deliver an average income boost of 23%, in line with quasi-experimental evidence in the literature (e.g Bilal & Rossi-Hansberg, 2021). Combined with the effect of sorting, these estimates imply a total income difference of 74% between areas that closely matches our data. This approach explicitly accounts for the fact that part of the income differences across areas is attributable to selection, rather than causal treatment effects.

We choose the levels $I^{\mathcal{H}j}$ of the housing supply curves for owner-occupied and rental units to match equilibrium house prices and rents across areas. When examining non-targeted moments, we verify that the resulting quantities of housing, in terms of square feet, are in line with the data.

Income Differences. We calibrate the racial income shifter μ_W for white households to match the ratio of average incomes between white and Black households of 1.73 (Current Population Survey, 2018).[16] The resulting value implies a boost of 17% for white households. The remaining income difference arises due to the location choices of Black and white households across high- and low-opportunity areas, as well as pensions. In spatial equilibrium, the complementarity between the racial and the spatial income shifters in workers' income processes creates an incentive for more productive households (in terms of idiosyncratic and group-level productivity) to locate in high-productivity areas.[17]

Because the average log income μ_g differs across race, we find that the income process for Black households has both a lower mean as well as higher income risk, which is consistent with empirical patterns (e.g., Kermani & Wong, 2021).

Areas $\times$ demographic groups. The remaining parameters depend on both households' groups and areas.

The 2×2 vector for the means Ξ_g^j of the idiosyncratic homeownership shocks is chosen to match the residual differences in homeownership rates relative to the data (SCF) that are not accounted for by households' optimal homeownership choices. The resulting values account for unmodeled exogenous motives for owning or renting, such as changes in family size, the mortgage interest rate deduction, the behavioral motive of committing to saving in anticipation of lower income in retirement, or a "warm glow" motive of owning their own shelter.

The 2×2 vector for the means m_g^j of the idiosyncratic moving cost shocks is chosen to match, first, the shares of Black and white households living in high-opportunity areas (computed from ACS data); second, their respective moving rates to those areas (computed from Infutor data). These shocks allow to match the residual differences in these shares and moving rates relative to the data that are not explained by households' optimal location choices. They account for exogenous motives for or barriers to moving, such as unmodeled household life events (e.g., marriage with someone from another area, post-retirement moves driven by weather or tax differences), the accumulation of neighborhood-specific capital (e.g., Diamond *et al.*, 2019), and reference dependence in the housing market (e.g., Andersen *et al.*, 2022).

[16] In 2018, the real median income of non-Hispanic white households was \$70,642, compared to \$41,361 for Black households.

[17] This property comes from the log-supermodularity of the income process for workers in the age, idiosyncratic, racial, and spatial components.

5.2 Baseline Results

Table 3 reports targeted moments, which are divided into four panels. The first and second panels report area- and group-dependent moments that are specific to the 2×2 model. The third panel reports aggregate wealth and housing market moments. The fourth panel presents the model counterpart of the quasi-experimental treatment effect in Section 3.

Table 4 reports moments that are not targeted by the calibration. The first panel describes differences between housing areas. The second panel describes mortgage differences between Black and white borrowers. The third panel reports the resulting gaps between Black and white households, in terms of housing and total wealth.

Targeted moments. As shown in Table 3, the model exactly matches house prices and rents in both low- and high-opportunity areas. Equilibrium prices and rents are higher on average in high-opportunity areas ($455,000 and $1,588 per month) than in low-opportunity areas ($225,000 and $1,008). These differences arise endogenously as a result of differences in local housing supply and demand for owner-occupied units and rentals. These are important moments to match because they are key determinants of the location choices of Black and white households across areas, and ultimately of differences in wealth accumulation patterns between groups.

The model also closely matches the income difference between high- and low-opportunity areas of $\times 1.70$ in the data, which results both from the higher spatial income shifter μ^H in high-opportunity areas, and from skill sorting that induces more productive households to locate there. In spatial equilibrium and with risk aversion, productive households choose to stay in or move to those areas because it is less costly for them to sacrifice non-durable consumption to benefit from a higher income and higher idiosyncratic utility shocks on average.[18] In addition, these households benefit relatively more than less productive households from the productivity boost μ^H because of the complementarity between the spatial income shifter and their individual productivity in the income process.

Similarly, the model generates almost the same *income gap* between Black and white households of $\times 1.73$ as compared to the data. This difference arises, first, because of the higher racial income shifter of white households μ_W; second, because of differences in initial locations $\pi_W^H > \pi_B^H$; third, because of subsequent location choices of Black and white households. We target the shares of Black and white households living in each area type (0.08 vs. 0.19 for high-opportunity areas), and also their average moving rates between areas (on average 2% of households move every year to high-opportunity areas, while 10% move to low-

[18] In contrast, in standard urban economics models with linear utility, households with different wealth are indifferent across locations in equilibrium because it is not more costly for poor than for rich households to sacrifice consumption to locate in an area with expensive housing.

opportunity areas). In spatial equilibrium, group shares in each area are determined both by the share of each group that is born there and by their propensity to move over their life-cycle. Moving frictions add to the difficulty of accessing the more valuable housing stock, especially for Black households who need to overcome a higher average moving cost shock m_B^H, both in absolute terms and compared to their lower average level of utility.

Our model estimates that 12% of Black households reside in the high-opportunity area, compared to 8% in the data. This is a reasonably accurate estimate, particularly given the challenge of jointly estimating moving rates and location shares by group. However, our estimate does slightly overstate the proportion of Black households in high-opportunity areas. As a result, when we analyze policy counterfactuals, we might slightly underestimate the impact of policies aimed at encouraging Black households to move to high-opportunity areas. This is because our baseline calibration already places a higher number of such households in these areas compared to the data.

Importantly, the model matches differences in intergenerational wealth transfers, which create an additional incentive for moving to opportunity. Because of differences in housing wealth and savings, the bequests left by white households are 3.57× higher on average than for Black households in the data, which we match closely at 3.59 in our model. Because they are redistributed within groups and affect households' wealth endowment, bequests tend to perpetuate differences in initial conditions between racial groups.

In aggregate, the model successfully replicates wealth and housing patterns in the data. It generates a high average wealth to income ratio (6.76 in the model, compared to 5.60 in the data), and also matches the ratios of average house price and rent to income (4.13 and 0.19 in the model, very close to their data counterparts of 4.05 and 0.20), which are key determinants of the financial constraints faced by households. In addition, the model closely matches the average default rate of 2% in the data.

Across demographic groups and areas, the model also successfully replicates differences in housing wealth. As in the data, it generates a large *homeownership gap* between Black (with a homeownership rate of roughly 45%) and white households (with a homeownership rate of roughly 70%), both in high- and low-opportunity areas.

Finally, the model matches the elasticity of Black borrowers to the LTV limit in high-opportunity areas that we estimated empirically in Section 3. Our calibration produces an elasticity of 0.089 that is very close to the value of 0.098 in the data.[19]

Non-targeted moments. Table 4 shows that the model also successfully matches moments that are not targeted by the calibration.

[19] We do not vary this parameter by race because we observe similar expansions in living space corresponding to increases in household income across both white and Black households in the data (Appendix Figure A.IV).

TABLE 3: MODEL FIT: TARGETED MOMENTS

Variable	Data	Model
Avg house price high-opportunity	455,000	455,000
Avg house price low-opportunity	225,000	225,000
Avg rent high-opportunity	1,588	1,588
Avg rent low-opportunity	1,008	1,008
Avg income high/low-opportunity	1.70	1.74
Avg income white/Black	1.73	1.73
Avg intergenerational wealth transfer white/Black	3.57	3.59
Share white living in high-opportunity	0.19	0.20
Share Black living in high-opportunity	0.08	0.12
Moving rate white to high-opportunity	0.02	0.02
Moving rate to Black high-opportunity	0.02	0.02
Avg high-opportunity homeownership white	0.68	0.72
Avg high-opportunity homeownership Black	0.48	0.53
Avg low-opportunity homeownership white	0.67	0.68
Avg low-opportunity homeownership Black	0.45	0.45
Avg wealth/avg income	5.60	6.76
Avg house price/avg income	4.05	4.13
Avg rent/avg income	0.20	0.19
Avg default rate	0.02	0.01
Quasi-exp. treatment effect: $\frac{\Delta\left(\pi^{high}_{Black}\right)}{\Delta\left(\ell^{LTV+}_{sh}\right)}$	0.098	0.089

Notes: Moments are annualized. For sources, see Table 2.

First, it generates realistic shares of owner-occupied and rental housing in terms of square footage across areas, which are very close to the values in the data of 65% and 68% in high- and low-opportunity areas, as well as realistic moving rates from high- to low-opportunity areas (around 10%).

Second, the model generates substantial racial inequality in the mortgage market. Despite not targeting it, the model exactly matches the *leverage gap*, measured here as the ratio between the average LTV of Black and white households. Across areas, Black borrowers have a higher average LTV, and the high LTV limit of 0.965 binds for both groups at the 90th percentile of the LTV distribution. As in the data, there is considerable bunching in the leverage distributions of Black buyers at the two LTV limits $\theta^{FHA}_{LTV} = 0.965$ and $\theta^{CONV}_{LTV} = 0.80$. Accessing home ownership in high-opportunity areas requires many Black buyers to lever up as much as possible. Because they have lower savings as the result of initial wealth and income conditions, some buyers borrow as much as the LTV limit allows. An even larger fraction is rationed out of high-opportunity areas altogether. The LTV constraint forces them to exit of the owner-occupied market. Since house prices are on average 2× higher in high-opportunity ($455,000) than in low-opportunity areas ($225,000), those that do purchase in the former tend to be relatively richer due to endogenous sorting. Finally, as Kermani & Wong (2021) document, Black borrowers in the U.S. are exposed to higher labor market risk, resulting in higher default rates. Our model captures this phenomenon. Despite not targeting default rates, our calibration generates greater default probabilities for Black borrowers (3%) relative to white borrowers (1%), as in the data. In the model, default wipes out existing housing wealth.

Ultimately, the combination of the racial gaps generated by the model lead to differences in wealth accumulation between groups, and in particular to a substantial *housing gap*. On average, the model generates 1.88× greater housing wealth for white households. This is more than 50% of the corresponding gap in the data. Combined, differences in housing wealth, intergenerational wealth transfers, and savings between groups generate a sizable gap in total wealth, which is around 3.12× higher for white households and represents more than 75% of the corresponding gap in the data.

The model replicates a large fraction the total wealth gap in the data without including explicit sources of discrimination in the financial system. These and other forces outside of our model can likely account for the remaining fraction of the wealth gap, including racial disparities in housing returns (Kermani & Wong, 2021), in savings rates and equity investments (Derenoncourt *et al.*, 2022), property taxes (Avenancio-Leon & Howard, 2022), rents (Early *et al.*, 2018) and housing market expectations (Adelino *et al.*, 2018), as well as other unmodeled labor market factors. However, the 2 × 2 structure of U.S. housing markets that we highlight can alone generate a large racial wealth gap.

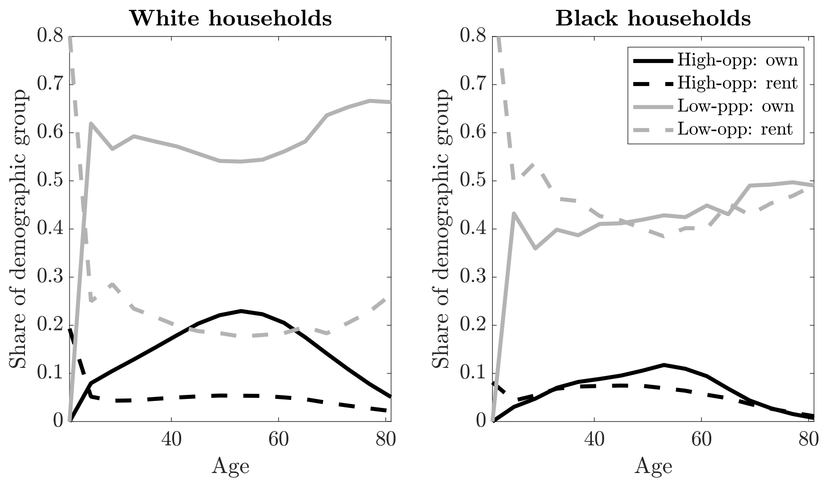
TABLE 4: MODEL FIT: NON-TARGETED MOMENTS

Variable	Data	Model
Share owned sq. ft. high-opportunity	0.65	0.73
Share owned sq. ft. low-opportunity	0.68	0.66
Avg moving rate to low-opportunity white	0.10	0.09
Avg moving rate to low-opportunity Black	0.10	0.12
Avg LTV Black/white	1.08	1.08
P90 LTV Black/white	1.01	1.00
Avg default rate white	0.01	0.01
Avg default rate Black	0.03	0.03
Avg housing wealth white/Black	3.30	1.88
Avg total wealth white/Black	4.12	3.12

Notes: Moments are annualized. Sources: SCF+ (2016), HMDA (2018). Total wealth is computed from Derenoncourt *et al.* (2022), excluding businesses, equity, other financial and non-financial assets, and educational debt to correspond to the model.

Finally, the model provides estimates of the life-cycle profiles for homeownership and renting across groups and areas, that are displayed in Figure 6. It generates a hump-shaped pattern for homeownership in high-opportunity areas, as agents accumulate wealth to make down payments, before moving to low-opportunity areas in retirement (when the income benefits of geographic location are diminished). The age of first home purchase is higher for Black households compared to white households, particularly in high-opportunity areas. This delay is because, with worse initial wealth and income, it takes Black households more time to accumulate savings for a down payment. This is particularly the case in high-opportunity areas where prices and resulting down payments are high. These statistics broadly match the empirical lifecycle distributions for households (ACS data, shown in Appendix Figure A.V). In particular, we match two key stylized facts about racial differences in accessing homeownership: white households are more likely to be present in high-opportunity areas across the lifecycle, and home ownership transitions are accelerated for white households.

FIGURE 6: LIFE-CYCLE PROFILE OF LOCATION AND HOUSING CHOICES



Notes: This figure shows the model implied rates of ownership and renting, across the two housing stocks (low and high-opportunity), for the two demographic groups (Black and white agents). The four lines sum up to 1 for a given demographic group and age.

Our model abstracts from two details about housing markets. We match the average levels of house prices and rents across regions in the cross-section, and allow for shifts in prices and rents based on relative demand and observed housing supply elasticities in our counterfactuals. However, we do not allow for other kinds of aggregate trends in house prices over time. To the extent that homeowners are exposed to such house price trends in addition to the shocks we consider, that will lead to further changes in housing wealth, which may affect the extent to which financial constraints bind across groups. Additionally, while our model does not explicitly incorporate differences in housing quality across regions, it indirectly accounts for these through calibrated area-specific moving shocks (both positive and negative) and homeownership shocks whose means vary across area and race. However, future research could explore more direct modeling of housing quality differences to potentially refine our understanding of their impact on spatial allocation and wealth accumulation.

6 Structural Estimation: Financial and Spatial Constraints Exacerbate Racial Gaps

This section outlines our main results, which consist of three sets of counterfactual experiments. First, we demonstrate the impact of financial constraints on racial inequality—the central contribution of our paper—by analyzing a counterfactual economy with a higher FHA loan cap in high-opportunity areas. Second, we study the role of spatial constraints—focusing on housing supply—and show that the the high prices resulting from restricted supply amplify the geographic and wealth distortions created by leverage constraints. Finally, we analyze the interaction of these two constraints, and show that jointly relaxing them has complementary benefits for the wealth accumulation of Black households.

6.1 Changing Leverage Limits

To demonstrate the importance of financial constraints for Black-white disparities, our first set of experiments analyzes the equilibrium of a counterfactual economy where the leverage constraint on high-value loans is relaxed in high-opportunity areas. Relative to our baseline calibration with an FHA loan cap b_H^{FHA} of $388,000, we increase this by $75,000 to match the policy change in our reduced form analysis in Section 3. This means that borrowers can take out higher loan balance mortgages with an LTV limit of 0.965, rather than 0.80, up to the new cap.

Figure 7 reports the main results of this counterfactual, with a more comprehensive accounting in Table 5. We find that relaxing the leverage constraint leads to substantial improvements in outcomes for both groups, but the improvements are far more significant for Black households. This shows that financial constraints differentially distort choices across demographic groups. Each sub-panel shows the percentage change in outcomes for Black and white households under this counterfactual, relative to the equilibrium of the baseline model.

Our central result is that Black wealth increases substantially in response to the relaxation of the leverage constraint, leading to a reduction in the wealth gap. Average wealth for Black households across both areas rises by 9.6% in response to the experiment. Average wealth for white households also rises, but by a much smaller amount (roughly 0.7%). This confirms that financial constraints play an important role in perpetuating wealth disparities in the data.

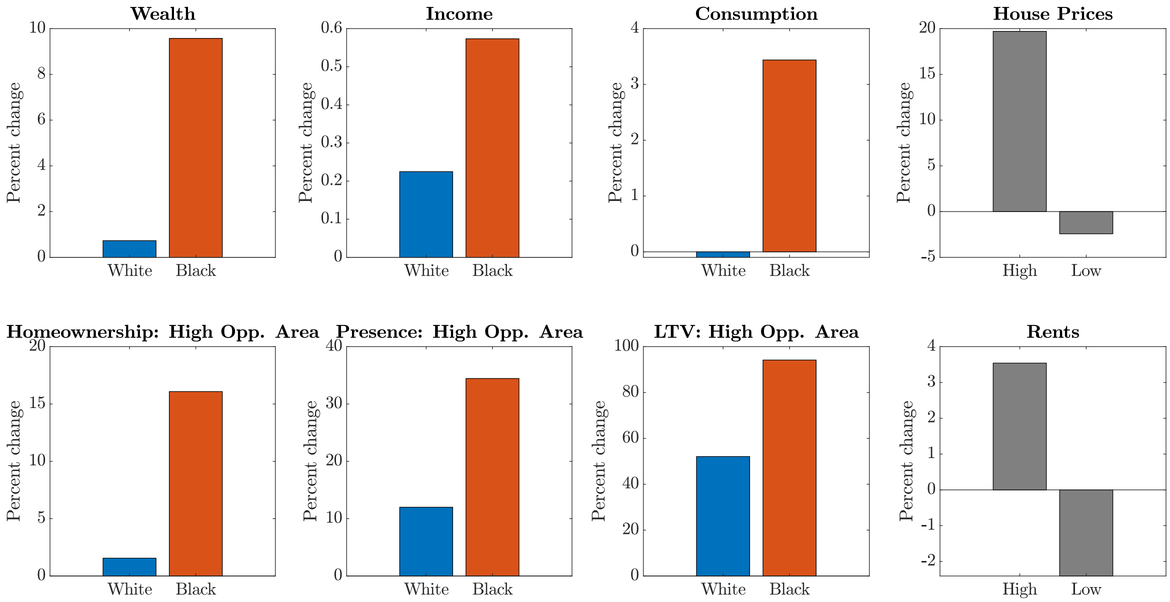
Wealth gains are driven by two main channels. First, increased homeownership for Black households, especially in high-opportunity areas, leads to wealth accumulation through the forced savings generated by mortgage amortization (as in Bernstein & Koudijs, 2021). For Black households, homeownership grows

TABLE 5: DETAILED MODEL RESULTS

Variable (% change)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Wealth Black (white)	9.6 (0.7)	-1.6 (-0.9)	10.0 (1.0)	1.7 (0.8)	10.1 (-0.2)	12.4 (1.3)	10.0 (0.7)	22.2 (0.6)	0.3 (0.3)
Income Black (white)	0.6 (0.2)	0.0 (-0.0)	0.5 (0.1)	0.1 (0.1)	1.1 (-0.0)	1.0 (0.6)	0.8 (0.4)	1.4 (0.1)	0.0 (-0.0)
Presence high opp. Black (white)	34.4 (12.0)	-2.0 (-1.2)	33.4 (9.3)	8.7 (5.4)	46.5 (-2.2)	53.5 (26.0)	43.2 (18.8)	74.5 (8.2)	4.8 (0.7)
Homeownership Black (white)	5.0 (1.0)	7.4 (1.4)	5.1 (1.2)	0.7 (0.3)	-0.5 (0.1)	6.8 (1.5)	5.5 (1.0)	6.2 (1.0)	-0.2 (0.1)
Homeownership high opp. Black (white)	16.1 (1.6)	2.7 (0.8)	14.2 (1.2)	1.2 (0.8)	-3.3 (0.1)	20.8 (3.6)	18.3 (2.4)	15.2 (1.0)	-3.6 (-0.4)
Homeownership low opp. Black (white)	1.4 (0.6)	8.2 (1.6)	1.9 (1.1)	0.3 (0.1)	-1.1 (0.2)	1.2 (0.2)	0.9 (0.2)	0.9 (0.9)	0.3 (0.3)
LTV Black (white)	-1.0 (0.6)	4.9 (4.3)	-0.8 (0.7)	0.3 (-0.2)	-1.5 (0.2)	-1.4 (0.2)	-1.1 (0.5)	-1.8 (0.7)	0.1 (-0.2)
LTV high opportunity Black (white)	94.2 (52.1)	2.7 (0.5)	98.8 (52.5)	-0.5 (6.2)	-5.9 (-7.4)	99.9 (55.9)	98.4 (55.2)	68.7 (51.9)	4.0 (7.8)
LTV low opportunity Black (white)	-1.4 (-1.3)	4.8 (4.2)	-1.4 (-1.3)	0.4 (-0.1)	-0.9 (0.1)	-1.9 (-2.0)	-1.5 (-1.5)	-1.9 (-1.2)	0.1 (-0.2)
Buyer consumption Black (white)	7.9 (5.8)	-3.9 (-2.7)	6.4 (3.9)	-0.0 (-0.6)	13.6 (0.4)	9.5 (6.4)	8.9 (5.9)	19.4 (5.2)	-0.9 (-1.3
Buyer consumption high opp. Black (white)	-27.3 (-13.1)	0.5 (0.4)	-29.8 (-15.7)	-6.6 (-8.6)	21.4 (14.8)	-32.4 (-18.9)	-30.4 (-17.4)	-11.8 (-11.3)	-9.0 (-11.4)
Buyer consumption low opp. Black (white)	7.0 (3.8)	-3.8 (-2.5)	6.0 (3.1)	0.2 (-0.1)	11.5 (-0.7)	8.8 (4.4)	8.0 (3.8)	18.8 (3.3)	-0.4 (-0.3)
Renter consumption Black (white)	2.8 (-0.2)	3.2 (0.7)	2.9 (-0.1)	1.2 (0.7)	2.0 (-0.1)	4.8 (0.7)	3.2 (-0.1)	6.5 (-0.3)	0.0 (0.0)
Renter consumption high opp. Black (white)	4.3 (0.6)	0.9 (-0.0)	4.3 (0.6)	1.1 (1.0)	3.0 (-0.3)	6.9 (2.1)	5.1 (1.1)	8.4 (0.3)	-0.0 (0.2)
Renter consumption low opp. Black (white)	-0.1 (-1.3)	7.9 (1.7)	0.2 (-1.0)	1.1 (0.4)	0.2 (0.1)	0.7 (-1.2)	-0.4 (-1.7)	3.7 (-1.1)	0.1 (-0.2)
Renter housing Black (white)	0.4 (0.1)	4.8 (1.5)	0.8 (0.3)	0.2 (0.1)	-0.4 (0.0)	0.6 (0.1)	0.4 (0.0)	0.4 (0.2)	0.2 (0.1)
Renter housing high opp. Black (white)	0.3 (0.1)	2.7 (1.1)	0.7 (0.4)	0.2 (0.1)	-0.4 (0.0)	0.5 (0.2)	0.3 (0.1)	0.4 (0.2)	0.2 (0.2)
Renter housing low opp. Black (white)	0.7 (0.0)	8.8 (2.1)	0.9 (0.1)	0.1 (0.1)	-0.4 (0.1)	1.0 (0.0)	0.6 (-0.0)	0.6 (0.1)	0.1 (0.0)
Default rate Black (white)	-15.4 (-7.1)	41.3 (25.8)	-16.4 (-8.3)	-3.2 (-2.6)	-17.5 (-0.3)	-20.2 (-10.0)	-16.8 (-7.4)	-28.3 (-7.0)	-0.8 (-1.0)
House prices high (low) opportunity	19.7 (-2.4)	0.0 (0.0)	23.5 (-3.1)	-5.2 (-0.7)	1.8 (-0.4)	4.6 (-2.7)	12.1 (-1.8)	24.3 (-3.0)	0.3 (-0.0)
Rents high (low) opportunity	3.5 (-2.4)	0.0 (0.0)	-5.5 (-4.8)	-10.0 (-0.6)	19.5 (-3.2)	-0.9 (-2.4)	2.4 (-1.6)	4.9 (-3.7)	-14.3 (-0.4)

Notes: Variables are conditional averages in percentage deviations from the baseline model equilibrium. Column (1): Increase in FHA loan cap in high-opportunity areas. (2): Increase in FHA maximum LTV ratio from 0.965 to 0.99. (3): Increase in FHA loan cap in high-opportunity areas + PTI constraint. (4): Higher housing supply in high-opportunity areas. (5): Lower moving costs for Black households. (6): Increase in FHA loan cap in high-opportunity areas + higher housing supply in high-opportunity areas. (7): Increase in FHA loan cap in high-opportunity areas + higher housing supply elasticity in high-opportunity areas. (8): Increase in FHA loan cap in high-opportunity areas + lower moving costs for Black households. (9): Higher rental supply in high-opportunity areas.

FIGURE 7: INCREASE IN THE FHA LOAN CAP IN HIGH-OPPORTUNITY AREAS



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. This figure plots the result for a counterfactual economy with an expanded FHA loan cap, so that mortgages are subject to an LTV limit of 0.965 in high-opportunity areas. We plot outcomes including: wealth, income, consumption, and house prices and rents across areas for white (blue) and Black borrowers (red). We also plot home ownership in high-opportunity areas, the fraction of each group that is present in high-opportunity areas, and the LTV at origination for purchases made in high-opportunity areas. Column 1 of Table 5 shows a fuller set of results for this counterfactual.

by 16.1% in high-opportunity areas and by 1.4% in low-opportunity areas. Second, Black households move to high-opportunity areas and benefit from higher incomes on average across the life-cycle (+ 0.6%). The presence of Black households goes up by over 34.4% when the FHA loan cap is relaxed (compared to around 12.0% for white households). The effect is especially large for high-productivity households with little initial wealth. The migration of households demonstrates the spatial misallocation generated by leverage constraints. In an unconstrained economy, a larger fraction would live, earn, consume, and own in high-opportunity areas.

Interestingly, moving patterns are not only driven by homebuyers taking advantage of relaxed leverage limits. The increase in the number of Black households in high-opportunity areas overall is larger than the increase in homeownership. This reflects an increase Black renters in high-opportunity areas. Some Black households move in response to an increase in the option value of purchasing housing. These households incur the costs of moving even before they can fully afford a down payment, anticipating the greater feasibility of homeownership in the future.

One caveat behind these results is that they are based on a baseline calibration which slightly overstates the number of Black households in high-opportunity areas (12% vs. 8% in the data). If this difference is results in lower fraction of Black households in low-opportunity areas that are sensitive to down-payment requirements, then we likely underestimate the impacts of our policy counterfactual.

The net effect of relaxed leverage constraints depends on the responses of prices and rents. Home prices in high-opportunity areas rise by 19.7% in this counterfactual, reflecting the entry of new homeowners, while rents increase by much less. In low-opportunity areas, both prices and rents fall due to a migration accelerator effect: both owners and renters shift to becoming owners now or later in high-opportunity areas. These results are consistent with theoretical and empirical evidence that changing credit conditions can affect house prices (e.g., Favilukis *et al.*, 2017; Johnson, 2020; Greenwald & Guren, 2021). Our contribution is to emphasize the consequences for the spatial allocation of financially constrained agents, especially Black borrowers, who are sensitive to such changes.

Finally, beyond closing gaps in homeownership, wealth, and income, relaxed leverage constraints substantially increase consumption for Black households (over 3%). While we would generically expect relaxing the constraint to improve households' outcomes in partial equilibrium (and absent externalities), the key finding is that these benefits disproportionately accrue to Black households, even accounting for price adjustments and agglomeration externalities, indicating their greater sensitivity to financial constraints.

To quantify the effect of financial constraints on spatial mobility, we next show that a 15% reduction in the costs of moving to high-opportunity areas for Black households is necessary to generate a similar increase in Black wealth. In Appendix Figure D.I, we show results from an alternative counterfactual where the moving cost is lowered (detailed results are reported in column 5 of Table 5). This experiment mirrors the impact of natural shocks that induce migration (Nakamura *et al.*, 2021; McIntosh, 2008), and more directly, explicit policy incentives for migration (Bergman *et al.*, 2019; Bryan *et al.*, 2014). Given our focus, this counterfactual also relates to the Great Migration studied in Derenoncourt (2022). When moving costs are lower, more households move to high-opportunity areas, resulting in an increased presence of Black households. With lower moving frictions, spatial misallocation is reduced, which significantly increases income (+1.1%) and wealth (+10.1%) for Black households and reduces the corresponding gaps. However, white income falls slightly reflecting the agglomeration externalities generated by migration.

While this first experiment allows us to quantify the contribution of leverage constraints to spatial misallocation and racial gaps in the data, it does not necessarily imply that relaxing constraints is desirable from a policy viewpoint. Relaxing constraints as a standalone policy may have adverse implications for the stability of asset prices and default risk, which have been explored in prior work (e.g., Greenwald, 2018; DeFusco *et al.*, 2019; Adelino *et al.*, 2012; Johnson, 2020; Gupta & Hansman, 2022). Nevertheless, the model does account for the effects of financial constraints on prices and rents, and on households' endogenous default. In fact, default rates decrease for both Black and white households (by –15.4% and –7.1%, respectively) as shown in Table 5. The decrease in defaults is due to higher incomes, a major determinant of default decisions (e.g. Ganong & Noel, 2023), which in turn come from the improved spatial allocation of workers. This suggests that relaxing constraints can be reconciled with lower credit risk, at least in principle, if it allows borrowers to improve labor market prospects. However, beyond this channel, the model does not allow us to study further consequences of modifying constraints for financial stability. Given these limitations, our emphasis in this experiment is to highlight the contribution of leverage constraints to inequality and racial wealth gaps in the data; not to directly advocate for changes in leverage unconditionally, which would require modeling the banking system, aggregate risk, and default externalities.

Policymakers who wish to take equity considerations into account may be interested in alternative forms of macro-prudential regulation that impose less stringent requirements in terms of up-front wealth. To illustrate this idea, we consider a counterfactual in which we introduce PTI constraints alongside the relaxation in the leverage constraint. Doing so results in similar impacts on house prices, and lowers Black default risk by -16.4%. Despite the additional leverage restriction, we still observe a large increase in Black wealth under this counterfactual (+10.0%; see Appendix Figure D.II).[20] Similar policies have been studied in the literature that seek to address leverage constraints with minimal macro-prudential implications. For example, financial assistance to first-time buyers (Berger *et al.*, 2020; Mabille, 2023), or equity assistance to top up down payments (Benetton *et al.*, 2018) can relieve down payment constraints, in line with our experiment, without depleting borrower equity. Finally, the locations in which borrowers have access to leverage matters a lot. In Appendix Figure D.III, we show that relaxing leverage constraints in the FHA program overall (from 0.965 to 0.99) increases household defaults, as this leads to higher leverage by borrowers concentrated in low-opportunity areas. Increasing homeownership in areas with weaker labor markets has adverse consequences for credit risk. Thus, it is critical *where* households are able to buy when credit is easier.

6.2 Housing Supply Restrictions

Down payment constraints are more likely to bind when home prices are high. As a result, the spatial frictions that lead to high prices are at the core of the distortions generated by financial constraints. We next consider counterfactual experiments that analyze the role of housing supply. We first consider a 10% upward shift in the level of the housing supply curve in high-opportunity areas, detailed in column 4 of Table 5. This modification can be interpreted as the result of policies that seek to address housing affordability by removing regulatory barriers to construction in these areas (Glaeser & Gyourko, 2002; Gyourko *et al.*, 2008). Such policies are frequently proposed and endorsed by both policymakers and economists. We are interested in their implications for wealth building through financial constraints and spatial allocation.

[20] As in the data, the constraint only applies at origination: $b_{t+1} \geq -\frac{\theta^j_{PTI}}{1+r^b-\theta_{am}} y_t$.

The key feature of this modification, as shown in Figure 8, is its heterogeneous impact across demographic groups, despite not targeting them separately. Increasing housing supply increases Black wealth on average (+1.7%), but has a weaker impact on white wealth (+0.8%). The policy has similar effects on the income and consumption of Black and white households, though Black presence increases substantially more in high-opportunity areas (+8.7%, compared to +5.4% for white households).

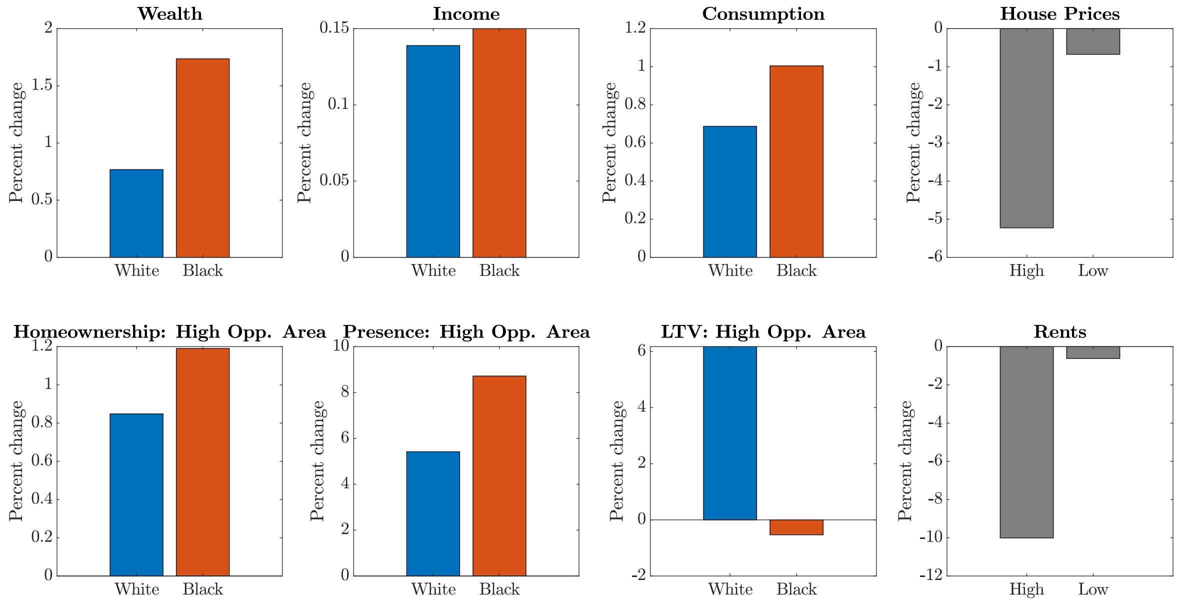
While both Black and white borrowers respond to the change in housing supply due to its relaxation of financial constraints, Black households are more sensitive in migrating in response to the change in housing conditions, and their wealth increases by more as a result. White households also see a boost in wealth from a greater presence in high-opportunity areas, but this gain is offset by a decrease in home equity due to a drop in house prices in these areas. Contrasting gains for entrants and losses for homeowners mitigate the overall impact on white wealth.

These findings have direct implications for the distributional consequences of housing supply policies. While both racial groups benefit on average from changes in housing supply, our results suggest that wealth and locational outcomes improve more for Black households and for households who do not currently live in high-opportunity areas. House price declines in such areas, by contrast, may lead incumbent homeowners to oppose such policies. More broadly, our results underscore the importance of considering financial constraints and heterogeneity in the population when studying the incidence of housing supply policies.

In addition to examining the effects of increasing overall housing supply, we also consider a targeted increase in rental housing supply in high-opportunity areas. Column 9 of Table 5 (also see Appendix Figure D.IV) shows the results of this counterfactual, in which we increase the supply of rental housing by 10% in the high-opportunity area. This policy leads to a substantial decrease in rents in high-opportunity areas, resulting in increased presence of both Black and white households. The effect is more pronounced for Black households, consistent with our previous findings that they are more responsive to changes in housing market conditions. Interestingly, this policy increases wealth for both groups, with a slightly larger effect for white households. This is partly due to Black households substituting away from homeownership in high-opportunity areas towards renting, which may limit their wealth accumulation through housing equity.

However, the rental supply increase has some unexpected effects on income and consumption. Unlike our previous counterfactuals, we observe minimal income gains for Black households and even slight declines in white household income. Consumption also decreases for both groups. These results can be attributed to the agglomeration economies incorporated in our model. The increase in rental supply disproportionately attracts lower-productivity workers to high-opportunity areas, diluting agglomeration effects and leading to lower average incomes. For Black households, the income gains from migration to high-opportunity areas outweigh the losses among Black homeowners, resulting in a small net positive effect.

FIGURE 8: HIGHER HOUSING SUPPLY IN HIGH-OPPORTUNITY AREAS



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of a vertical shift in the supply curve in high-opportunity areas that increases the quantity of housing by 10%. We plot outcomes including: wealth, income, consumption, and house prices and rents across areas for white (blue) and Black borrowers (red). We also plot homeownership in high-opportunity areas, the fraction of each group that is present in high-opportunity areas, and the LTV at origination for purchases made in high-opportunity areas. Table 5 shows a fuller set of results for this policy counterfactual.

White households, by contrast, experience slight income declines on average.

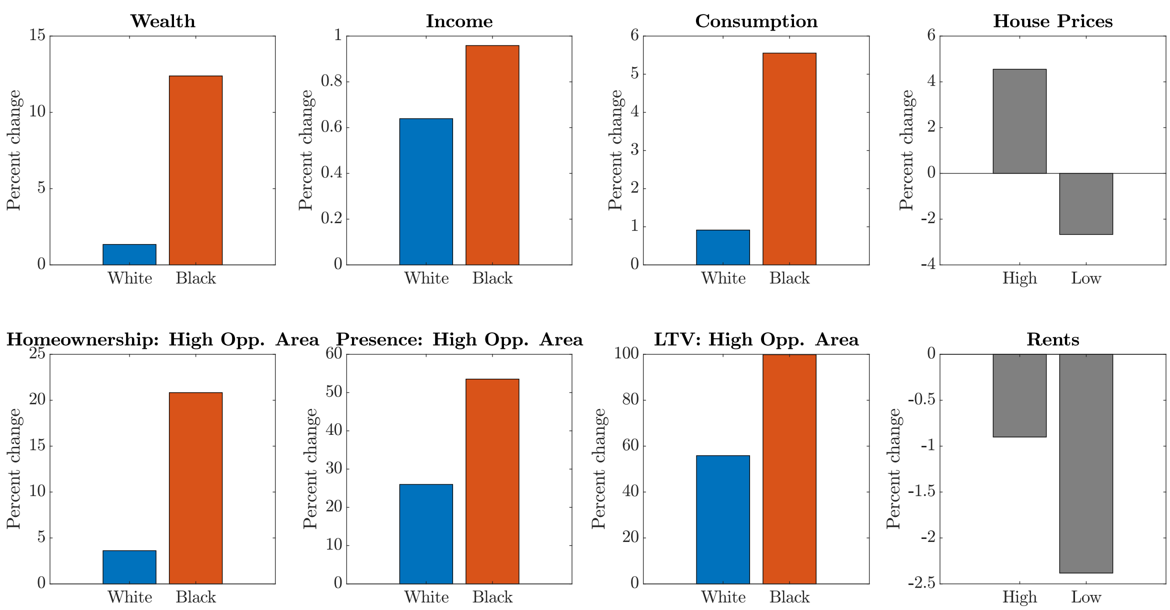
These findings highlight the importance of considering population composition effects when evaluating different policies. While increasing rental housing supply can also address spatial mismatch, it may have different effects on productivity and income compared to policies that affect leverage constraints. In our model, policies which affect housing leverage or increases in housing supply broadly appear to select relatively higher-productivity workers, minimizing possible negative agglomeration effects on destination areas.

6.3 Interaction of Financial and Spatial Constraints

Finally, we analyze the joint role of financial and spatial constraints for two reasons. First, this set of counterfactual experiments allows us to understand the relationship between financial and spatial frictions. Housing supply constraints may be more distortionary if households are also unable to finance mortgages. Second, a relaxation of financial and spatial constraints in tandem may alleviate asset pricing concerns that come with an increase in household debt by keeping prices low. Indeed, unless housing supply is allowed to respond, increasing leverage may be self-defeating if it causes equilibrium house price run-ups that erode affordability.

Leverage Limits and Housing Supply Restrictions In this counterfactual, we combine an increase in the FHA loan cap in high-opportunity areas (resulting in a maximum LTV limit of 0.965, as in subsection 6.1) with a 10% vertical shift in the level of the housing supply curve also in high-opportunity areas (as in subsection 6.2). Figure 9 reports the main results and column 6 of Table 5 presents detailed results. The first takeaway is that spatial constraints amplify the effect of leverage constraints alone: Black wealth increases by *more* in this policy counterfactual (+12.4%) than in the sum of the two experiments individually (+11.3%). This is not ex ante obvious: increases in leverage limits increase housing access to high-opportunity areas (raising house prices), while increases in housing supply reduce house prices; hence, the net effect on the wealth position may be ambiguous. Furthermore, the relocation of Black households to high-opportunity areas (+53.5%) is greater than in the sum of the two counterfactuals separately (+43.1%), further demonstrating the complementarity of the two constraints.

FIGURE 9: INCREASE IN FHA CAP AND HIGHER HOUSING SUPPLY IN HIGH-OPPORTUNITY AREAS



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. This figure plots the result for a counterfactual economy with a higher FHA loan cap (resulting in a max LTV limit of 96.5%) combined with a 10% higher housing supply curve in high-opportunity areas. We plot outcomes including: wealth, income, consumption, and house prices and rents across areas for white (blue) and Black borrowers (red). We also plot home ownership in high-opportunity areas, the fraction of each group that is present in high-opportunity areas, and the LTV at origination for purchases made in high-opportunity areas. Table 5 shows a fuller set of results for this policy counterfactual.

The complementary effect on Black households' location decisions can be attributed to the more moderate increase in housing prices in this counterfactual. Specifically, when both down payment requirements and housing supply are adjusted, house prices rise by 4.6% in the high-opportunity areas rather than the 19.7% increase observed when only leverage requirements are relaxed. Because there is more housing supply, the increase in housing demand is more easily accommodated on the quantity side rather than through prices. As a result, more Black households are present in high-opportunity areas. Many of these households are renters as more housing supply also induces substantially lower rents.

We also find similar effects in a counterfactual simulation in which we increase housing elasticity in the high-opportunity area by 50% as well as the FHA cap in high-opportunity areas in tandem (column 7 of Table 5), rather than shifting the level of housing supply. We see increases in Black wealth, income, presence in high-opportunity areas, and homeownership as a result of the combination of changes in both FHA loan caps and the housing supply elasticity.

From a policy viewpoint, jointly relaxing financial and spatial frictions addresses several problems. First, reducing financial frictions—though valuable in improving housing market access—also increases housing demand and house prices, which has the potential to undo the benefits of credit access through higher prices. Accommodating housing demand through increased supply addresses this challenge, thereby enabling the same loosening in leverage limits to go further in improving wealth accumulation. Second, increasing housing supply alone also improves housing access, but still leaves many households unable to afford housing in high-opportunity areas. Even households who always remain renters are indirectly affected by financial constraints, which influence the size of the total renter population and hence result in pressure on rents. Providing additional financing opportunities therefore allows households to take advantage of increased housing supply. Finally, increased prices which result from more leverage may be seen as undesirable or unsustainable in other ways. The combination of both supply expansion and looser financial constraints mitigates the house price increases, hence limiting the adverse macroeconomic implications of credit expansions.

Leverage Limits and Black Households' Moving Costs To further illustrate the complementarity between financial and spatial constraints, we analyze the interaction of leverage constraints with Black households' moving costs. We consider an economy in which the FHA loan cap is increased in the high-opportunity area and moving costs are 10% lower for Black households. This type of experiment can be motivated by the need to jointly address moving and financing frictions; for instance, through a first time homebuyer credit accompanied by a moving credit. The results are reported in Appendix Figure D.V and column 8 of Table 5.

Of all the experiments we consider, this one is the most effective at reducing the racial wealth gap, with average wealth increasing by a large 22.2% for Black households but only by 0.6% for white households. The reason is that leverage constraints and moving costs are strongly complementary. Relaxing them jointly increases average Black wealth by more than in the sum of the underlying policies separately (+19.7%), and the same is true for their presence in high-opportunity areas. There are policy synergies in jointly addressing financial and moving frictions. Even when purchasing homes is made financially more viable, many Black households may be disinclined to migrate due to pecuniary and non-pecuniary moving costs. Similarly, reducing moving frictions may not address challenges faced by households who lack the down payments to purchase homes in high-opportunity areas, especially with potential negative agglomeration externalities. Addressing both frictions at the same time allows for greater reallocation than either policy considered individually.

7 Robustness

In this last section, we show that our results are robust to various alternative specifications of the baseline model. In each case, we fully recalibrate the model to match the same targets as in Section 5, and repeat our main counterfactual experiment: increasing the FHA loan cap in high opportunity areas.

We consider eight robustness tests. First, we consider the possible role of mortgage market discrimination, which increases borrowing costs for Black buyers. Second, we extend the model with PTI limits. Third, we allow households to save in a financial asset with a higher rate of return than in the baseline. Fourth, we eliminate differences in idiosyncratic moving and homeownership shocks across groups to show that they do not drive our results. Fifth, we explore the sensitivity of our results to racial differences in income processes. Sixth, we allow the present value of the next cohort's future income to enter the bequest motive. Seventh, we study an economy where the income benefits of moving to opportunity accrue immediately to the current cohort of movers, instead of being delayed as in the baseline. Eighth, we consider a higher interest rate premium for FHA loans of $100bps$. The results are summarized in Table 6. In Appendix E, we also consider a comparison with reparation-style policies that equate initial conditions across demographic groups to serve as a point of reference.

Mortgage rate discrimination We follow Bartlett *et al.* (2021) and assume that the rate paid by Black borrowers is 10 basis points higher than for white borrowers, i.e., $r^b_B = r^b_W + 10bps$. Outcomes of our counterfactual experiment are almost identical after accounting for mortgage rate discrimination.

PTI limit We add PTI limits $\theta_{PTI}(b_{t+1}) = 0.43$ if $|b_{t+1}| > b^{FHA}_j$ and $\theta_{PTI}(b_{t+1}) = 0.57$ otherwise, which correspond respectively to PTI limits for Fannie Mae and Freddie Mac and for FHA mortgages. As in the data, we consider a case where PTI limits apply only at origination:

$$b_{t+1} \geq -\frac{\theta^j_{PTI}}{1 + r^b - \theta_{am}} y_t. \tag{34}$$

TABLE 6: ROBUSTNESS

Variable (% change)	Main model	Mortgage rate discrimination	PTI limit	High financial rate of return	Same shock means	Higher Black income risk	Bequest high-opp. income	Immediate inc. boost	Higher spread
Wealth Black (white)	9.6 (0.7)	9.3 (0.7)	9.2 (0.6)	17.7 (2.0)	10.1 (2.3)	8.5 (1.4)	10.1 (0.7)	10.2 (-0.3)	10.2 (0.6)
Income Black (white)	0.6 (0.2)	0.6 (0.2)	0.5 (0.2)	0.3 (0.1)	0.4 (0.1)	0.5 (0.1)	0.6 (0.2)	0.5 (0.2)	0.6 (0.2)
Consumption Black (white)	3.4 (-0.1)	3.4 (-0.1)	3.2 (-0.0)	6.6 (0.4)	3.6 (0.1)	2.3 (-0.4)	3.7 (-0.2)	3.7 (-0.5)	3.5 (-0.2)
Homeownership high opp. Black (white)	16.1 (1.6)	16.2 (1.6)	16.5 (2.1)	19.7 (2.1)	6.0 (2.6)	16.5 (1.1)	17.2 (1.4)	14.4 (0.5)	17.2 (1.5)
Presence high opp. Black (white)	34.4 (12.0)	34.6 (12.0)	34.2 (11.7)	35.6 (11.4)	30.9 (10.5)	26.3 (9.1)	34.5 (12.4)	26.6 (10.3)	35.4 (11.6)
LTV high opportunity Black (white)	94.2 (52.1)	95.9 (52.2)	94.7 (55.8)	7.7 (58.7)	112.3 (63.1)	137.9 (55.0)	92.4 (50.6)	105.5 (64.9)	101.3 (56.1)
House prices high (low) opportunity	19.7 (-2.4)	19.7 (-2.4)	21.6 (-2.0)	29.6 (-1.7)	27.0 (-2.6)	25.3 (-2.5)	20.5 (-2.7)	17.0 (-2.4)	19.5 (-2.4)
Rents high (low) opportunity	3.5 (-2.4)	3.5 (-2.4)	3.2 (-2.1)	-14.5 (-5.2)	-21.0 (-11.3)	-14.6 (-9.0)	3.9 (-2.6)	4.3 (-2.6)	3.5 (-2.4)

Notes: Variables are conditional averages in percentage deviations from the baseline model equilibrium. Results are for a counterfactual economy with a higher FHA loan cap which relaxes LTV limits.

The impact on Black wealth of relaxing LTV limits in high-opportunity areas through a higher FHA loan cap remains large, and it is only partly dampened by PTI constraints now rationing some low-income borrowers. Between the two constraints, LTV limits generate more spatial misallocation because they ration high-productivity households with low wealth out of high-opportunity areas. As a caveat, PTI amounts can exceed these limits for loans with certain underwriting characteristics, especially for conforming loans. In the case of these higher limits, PTI constraints are less likely to bind, and therefore less likely to impact on our results as LTV remains the main binding constraint.

Higher financial rate of return Our baseline model focuses on a risk-free asset for computational tractability. In reality, households have also access to risky financial assets. To explore the robustness of our results, we introduce financial assets with a higher rate of return than in the baseline to capture their role for wealth accumulation.[21] This assumption provides a conservative upper bound: real world assets, which carry greater risk, will be less beneficial for households for wealth-building purposes. An alternative interpretation is that this asset reflects a bundle of a genuinely risk-free as well as a risky asset with a guaranteed high expected rate of return as in Favilukis & Van Nieuwerburgh (2021).

Our robustness test raises the rate of return on the financial asset to 4.5%. We then fully recalibrate the model while giving households access to this new savings vehicle. Table 6 reports the results for this analysis. Notably, the results of our main experiment of increasing FHA loan caps in high-opportunity areas is *stronger* compared to our baseline model. Increasing FHA loan availability increases wealth for Black households by more when they have access to a higher rate of return. The reason for this amplification is that households, in this new economy, have access to a better savings technology, and so can more easily attain the down payment requirements for housing in high-opportunity areas.

Because of the limitations in fully modeling the risk associated with the higher rate of return asset, we view these results as an upper bound, since in practice risk-averse households would likely not invest as much in this asset as as in the alternative model. Importantly, however, these results qualitatively highlight an economic channel that operates with an improved savings technology that is complementary to homeownership. In particular, they underscore the complementarity between financial and housing wealth.

Moving and homeownership shocks We show that our results are not driven by differences in idiosyncratic moving (m) and homeownership shocks (Ξ) between Black and white households. We compute our main experiment in a model where the means Ξ and m are identical across groups. The results are similar

[21] Fully incorporating a risky asset would require introducing aggregate risk, which is currently not feasible in a spatial life-cycle model with endogenous housing prices due to computational limitations. For instance, Favilukis & Van Nieuwerburgh (2021) incorporates spatial heterogeneity to consider aggregate risk, but abstracts from racial heterogeneity, which is central to our analysis, and assumes that financial assets are risk-free. We follow the same approach in this robustness test.

to the baseline model: wealth, income, homeownership and presence in high-opportunity areas improve substantially, and particularly so for Black households. This leads to a reduction in disparities across outcomes. Financial constraints play an important role in limiting access to high-opportunity areas even in this simpler model. Differences in idiosyncratic shocks across groups, while important for the quantitative fit of the model, are not solely responsible for spatial misallocation.

Black households' income risk Black and white households have different income processes in the baseline model. The higher racial income shifter μ_W for the log income process of white households implies that the level of income for Black households has both a lower mean and higher risk. In this robustness test, we further explore the sensitivity of our results to the income risk of Black households by increasing the volatility of their income process $\sigma_{\varepsilon,B}$ by 10%, while fixing it at the baseline level for white households. We find that the results are essentially unaffected. The response of Black households to a relaxation of the FHA loan cap in high-opportunity areas is weaker than in the baseline, because facing a higher income risk makes these households more reluctant to move to high-opportunity areas for precautionary reasons.

Including children's income benefits from moving to opportunity into parents' bequest motive In our baseline model, households can sacrifice their current non-durable and housing consumption to move into high-opportunity areas and leave higher bequests to the next cohort within the same racial group. They internalize the value for the next cohort of starting off with more wealth when deciding whether to move into high-opportunity areas and how much consumption to sacrifice.

However, households may also move to high-opportunity areas to improve the income prospects of the next generation. In this robustness test, we assume that households internalize the income benefits for the next cohort of living in high-opportunity areas. To do so, we incorporate the present value of the spatial income shifter μ^H in households' bequest motive $u^{\mathcal{B}}$, weighted by the next cohort's age-dependent survival rates p_a and discounted at the interest rate r. We assume that households have utility over an augmented form of bequests ($\widetilde{B}$) which are calculated as the sum of wealth and the net present value of the next generation's income benefits. However, the following generation only receives the wealth component of this transfer as a bequest. Specifically we modify the bequest utility as follows, with an additional term $NPV(\mu^H)$ corresponding to this present value component:

$$
\begin{aligned}
u^{\mathcal{B}}(\widetilde{B}_{t+1}) &= \Psi \frac{\left(1+\frac{\widetilde{B}_{t+1}}{\overline{B}}\right)^{1-\gamma}}{1-\gamma}, \\
\text{where } \widetilde{B}_{t+1} &= \text{Wealth}_{t+1} - \tau_B \max\left(0, \text{Wealth}_{t+1} - B_{ex}\right) + NPV(\mu^H) \\
\text{and Wealth}_{t+1} &= \text{Financial Wealth}_{t+1} + \text{Housing Wealth}_{t+1} \\
\text{and } NPV(\mu^H) &= \sum_{a=1}^{20} \frac{p_a \mu^H}{(1+r)^a}.
\end{aligned}
$$

We find that the effect of a higher FHA loan cap in high-opportunity areas on average Black wealth is slightly amplified because of stronger intergenerational motives (+10.1% increase in wealth for Black households, compared to +9.6% in our baseline).

Immediate income boost from moving to opportunity In the baseline model, the income benefits of moving into high-opportunity areas are delayed by four years. Therefore, as in the data, households cannot immediately use their higher income in these areas to finance their home purchase in the exact period when they move. In this robustness test, we assume that households immediately receive the higher spatial income shifter μ^H when moving to high-opportunity areas. We find that the effect on Black wealth of increasing the FHA loan cap in high opportunity areas is slightly stronger than in the baseline (+0.6 pp). Households have an extra incentive to move to high-opportunity areas because they immediately receive a higher income boost, which also makes it easier for them to move and afford more expensive housing. Our baseline results can be interpreted as a lower bound relative to this alternative scenario.

Incorporating Higher FHA Loan Premiums Our baseline assumption is that differences in loan pricing between FHA and non-FHA loans are captured by the 85 basis point annual MIP which borrowers pay through the life of their mortgage. Borrowers may also be subject to additional origination fees, which are commonly rolled into the loan balance. In this robustness analysis, we approximate additional charges by assuming that FHA borrowers are subject to a 100 basis point higher interest relative to conventional loan borrowers, representing a 15 basis point higher rate than our baseline. We find a slightly larger impact on the average wealth of Black households from increasing the FHA loan cap in high opportunity areas under this counterfactual.

8 Conclusion

Our paper highlights the role of financial constraints resulting from down payment requirements as a driver of spatial misallocation and hence persistent wealth disparities across groups with different initial allocations of wealth and location. Though our analysis focuses on racial disparities as a setting in which differences in housing and wealth are salient, our approach can also be applied broadly to understand group differences in other contexts. The main contributions of our work are to uncover a racial leverage gap—Black borrowers purchase homes with substantially higher LTV ratios than white borrowers—and show that down payment restrictions limit the ability of Black borrowers to purchase homes in high-opportunity neighborhoods. Empirically, we consider regulatory variation in loan caps in the FHA system to identify the impacts of down payment constraints on the spatial allocation of Black borrowers using bunching and difference-in-differences estimators.

We quantify the implications of the resulting spatial mismatch for wealth accumulation across groups using a new dynamic life-cycle model. The model explicitly accounts for geographic and racial heterogeneity, and is calibrated using our quasi-experimental estimates of the sensitivity of Black borrowing to the availability of high leverage mortgages. Access to leverage is a necessary condition to access both valuable housing and high-quality job opportunities. Down payment requirements distort the choices of Black borrowers, leading them to purchase homes and live in areas with reduced opportunities. This, in turn, generates a spatial poverty trap that perpetuates initial differences in wealth.

Potential policies to address financial and spatial constraints, through better mortgage access or higher housing supply in high-opportunity neighborhoods, can therefore lower spatial misallocation and help reduce racial wealth disparities. In contrast, policies that alleviate leverage constraints in low-opportunity areas turns out to be detrimental for credit risk and, ultimately, minority wealth. Thus, our analysis points to the need for access to geographic opportunities rather than increasing leverage and homeownership unconditionally.

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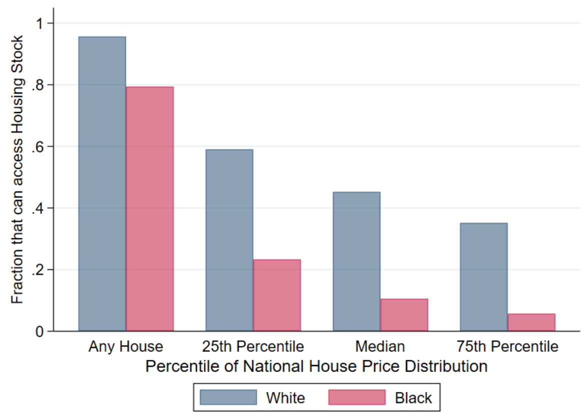
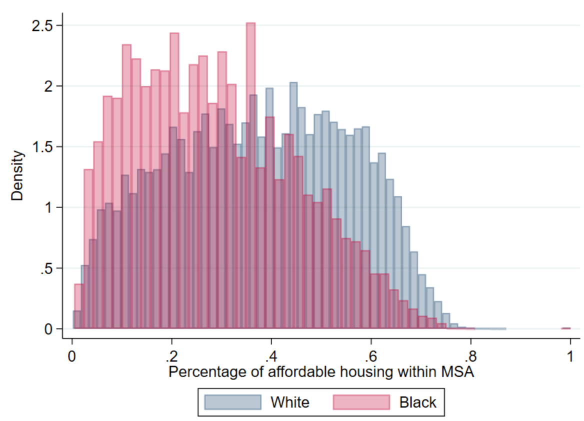
Internet Appendix

A Additional Figures and Tables

FIGURE A.I: DOWN PAYMENT CONSTRAINTS, WEALTH, AND HOUSING ACCESS



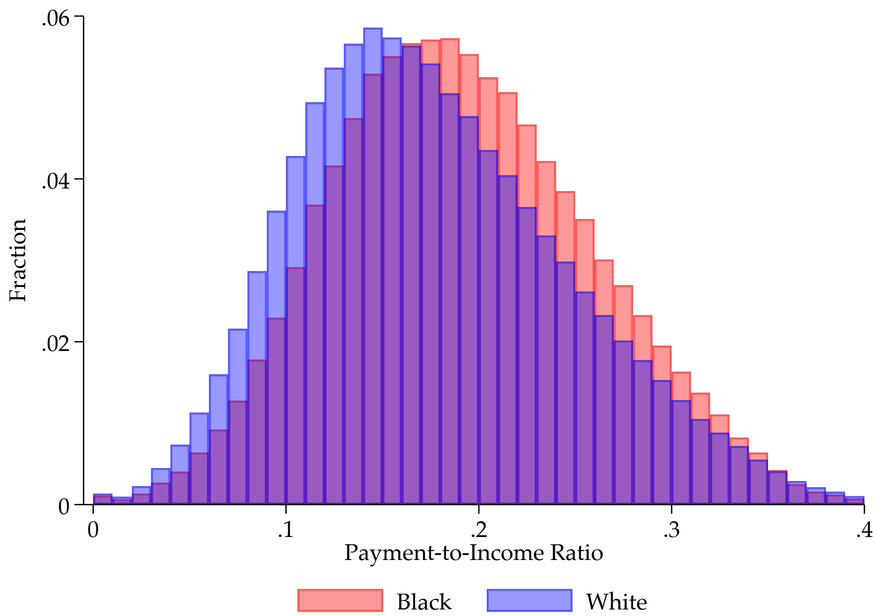
PANEL A: ACCESSIBILITY OF HOMEOWNERSHIP NATIONALLY GIVEN WEALTH



PANEL B: ACCESSIBILITY OF HOMEOWNERSHIP WITHIN MSA GIVEN DOWNPAYMENT

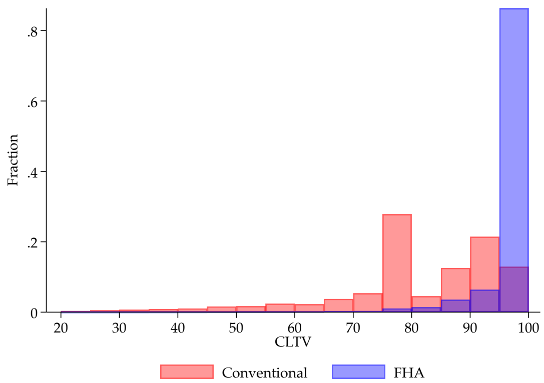
Notes: Panel A plots the fraction of homes potentially accessible to households who provide as a down payment all liquid assets measured using the 2019 SCF data. Liquid assets include: checking accounts, savings accounts, CDs, savings bonds, MBS market value, state or municipal bonds, T-bills, foreign bonds, corporate bonds, stocks, and foreign stocks.We use the total amount of liquid assets as the down payment, and allow households to borrow up to a 96.5% LTV as long as the house price is below the national FHA loan cap floor, and require a 80% LTV above that. We show the fraction of households by race that can afford a minimum house ($1k) or a house at various points in the national house price distribution taken from the 5-year ACS in 2019 (25th percentile is $130,000, 50th is $230,000, and 75th is $400,000). Panel B plots the distribution of houses potentially accessible within the MSA by 2018 mortgage borrowers if they were to provide the same downpayment and were subject to the same down payment requirement. Down payments and LTV ratios are taken from all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2018 HMDA data with combined loan to value ratios from 20–100. Race data is taken from HDMA. These are compared against house prices measured using the 5-year ACS data from 2018.

FIGURE A.II: PAYMENT-TO-INCOME BY RACE

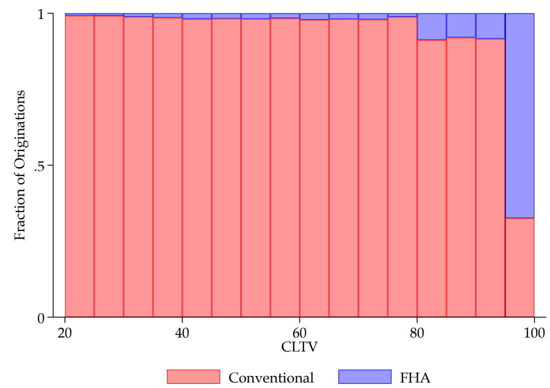


Notes: This graph shows the distribution of front end payment to income ratios for Black and white borrowers. Data includes all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2018 HMDA data with CLTV<=100 and payment-to-income between 0 and 0.4. Ratios are calculated assuming a fully amortizing mortgage payment.

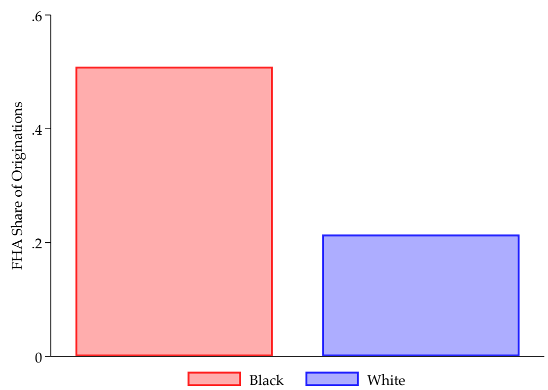
FIGURE A.III: THE FHA FACILITATES HIGH LEVERAGE LENDING



PANEL A: LEVERAGE DISTRIBUTION FOR FHA AND CONVENTIONAL LOANS



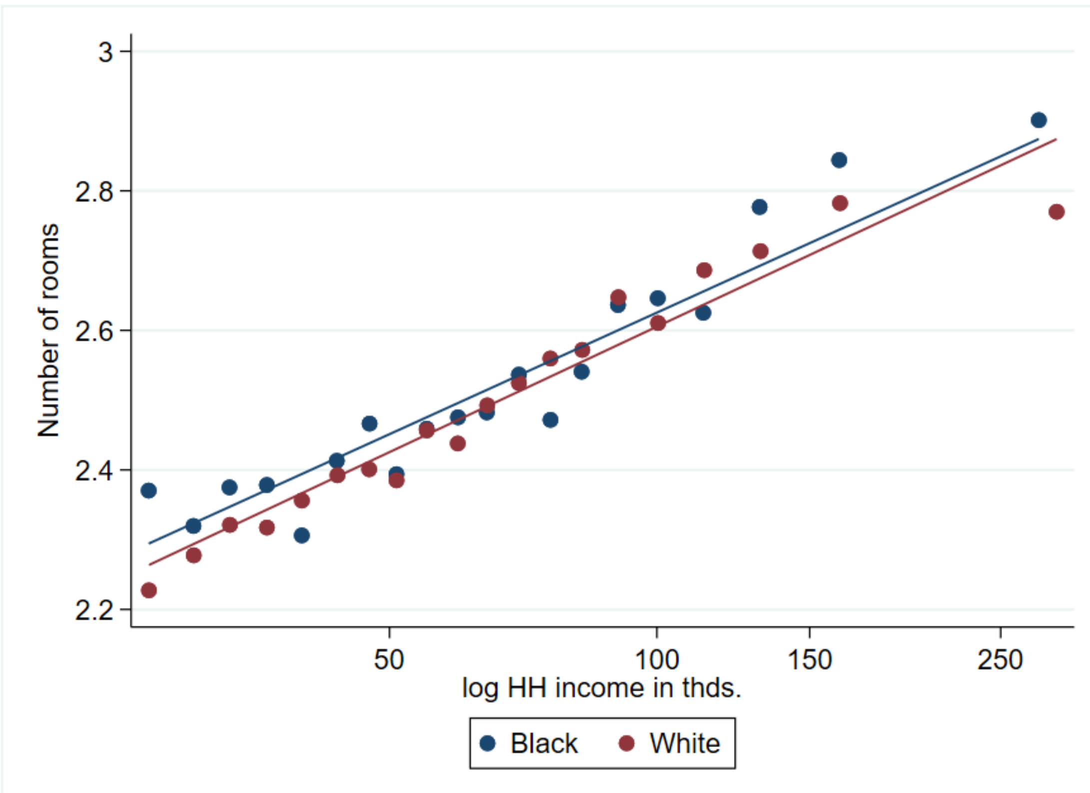
(A) PANEL B: CONVENTIONAL VS. FHA SHARE BY LEVERAGE



(B) PANEL C: FHA SHARE BY RACE

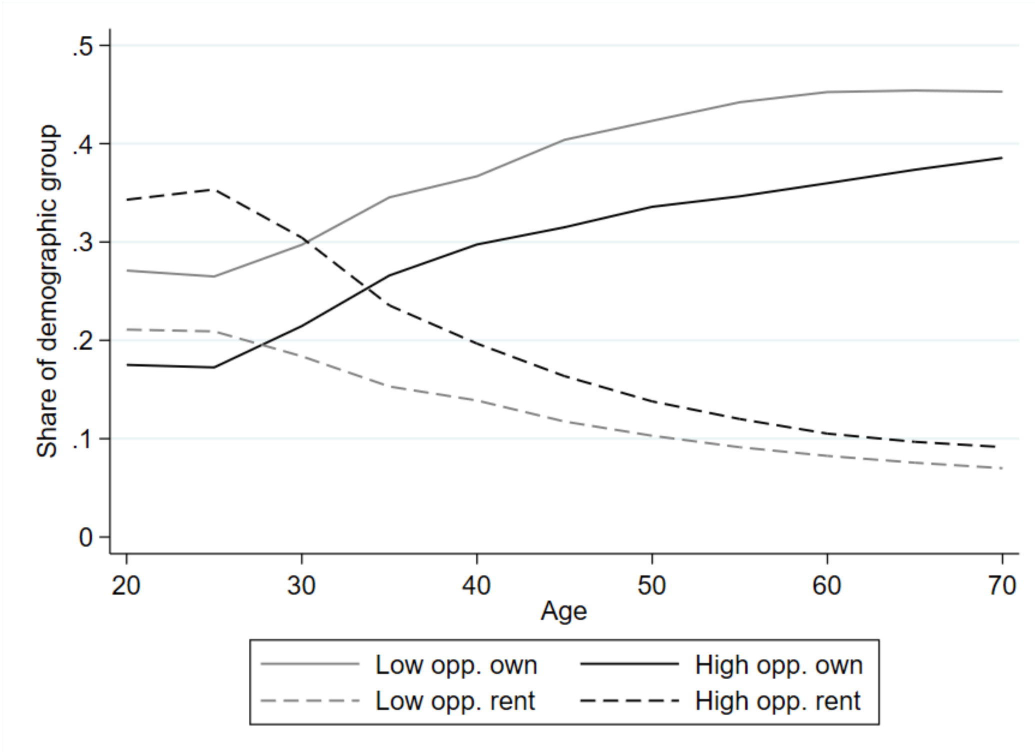
Notes: These plot shows the leverage distribution for FHA and conventional loans, as well as the share of FHA loans by leverage and race. Data includes all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2018 HMDA data. Panels A and B restrict to loans with CLTV between 20 and 100.

FIGURE A.IV: COMPARABLE HOUSING-INCOME GRADIENTS FOR BLACK AND WHITE HOUSEHOLDS

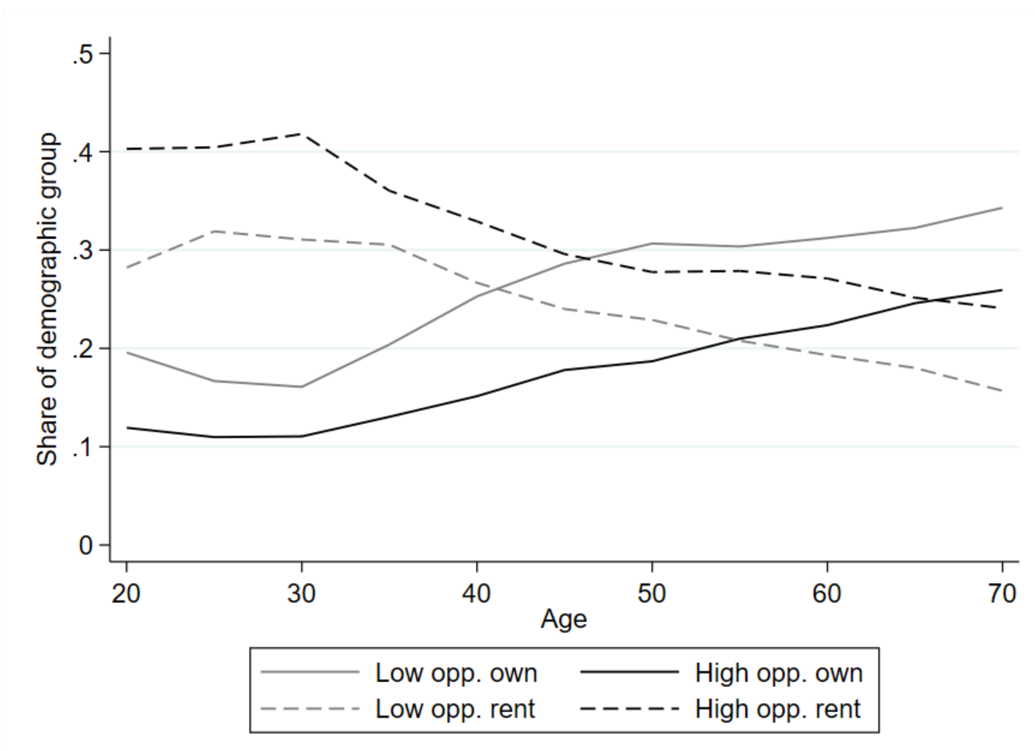


Notes: We show the relationship between household income and the number of rooms reported in ACS microdata using the 5-year ACS sample from 2018. We show this relationship separately for Black and white households, plotting binscatter points as well as the OLS fit.

FIGURE A.V: OWNERSHIP AND RENTING SPELLS ACROSS LIFECYCLE
PANEL A: LIFE-CYCLE OF HOUSING CHOICE FOR WHITE HOUSEHOLDS



PANEL B: LIFE-CYCLE OF HOUSING CHOICE FOR BLACK HOUSEHOLDS



Notes: This figure shows the rates of home ownership and renting from the 5-year ACS data in 2018, across the two housing stocks (low- and high-opportunity), for the two demographic groups (white households in Panel A, and Black households in Panel B).

TABLE A.I: THE RACIAL LEVERAGE GAP

	Dependent Variable: CLTV				Dependent Variable: **I**(CLTV≥95)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Black Household	8.355***	7.553***	5.054***	3.461***	0.339***	0.298***	0.205***	0.186***
	(0.025)	(0.025)	(0.028)	(0.037)	(0.001)	(0.001)	(0.001)	(0.002)
Mean of Dep. Var.	84.9	84.9	84.9	89.1	0.42	0.42	0.42	0.53
N	2945333	2915768	2906353	1096123	2945333	2915768	2906353	1096123
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Census Tract FE	No	No	Yes	Yes	No	No	Yes	Yes
Young Buyer Sample	No	No	No	Yes	No	No	No	Yes
	Dependent Variable: Down Payment ($1000s)				Dependent Variable: **I**(Down Payment≤$10,000)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Black Household	-29.613***	-18.194***	-8.971***	-6.161***	0.303***	0.243***	0.156***	0.156***
	(0.102)	(0.093)	(0.092)	(0.137)	(0.001)	(0.001)	(0.001)	(0.002)
Mean of Dep. Var.	46.1	45.7	45.7	31.0	0.32	0.32	0.32	0.43
N	2945333	2915768	2906353	1096123	2945333	2915768	2906353	1096123
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Census Tract FE	No	No	Yes	Yes	No	No	Yes	Yes
Young Buyer Sample	No	No	No	Yes	No	No	No	Yes

Notes: This table shows regressions of borrower leverage and down payments against an indicator for Black households using 2018 HMDA data. Leverage is defined as the combined loan to value ratio at origination(CLTV) in columns 1-4 of Panel A, and as a dummy for CLTV≥95 in columns 5-8. Downpayments are shown in 1000s of dollars in columns 1-4 of Panel B, and as a dummy if ≤ $10,000 in columns 5-8. Data includes all owner occupied, first lien, new purchase mortgages, excluding VA, FSA, and RHS loans in the 2018 HMDA data with CLTV<=100. Controls include income decile, sex and age. The young buyer sample restricts to borrowers under 35 years. Robust standard errors are included in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

TABLE A.II: THE SENSITIVITY OF BLACK BORROWERS TO THE FHA

	Impact of FHA Limit Reduction on FHA Lending			
	Treated=Any Reduction in 2014		Treated=Above Floor in 2008	
	Full Sample	High Black Pop.	Full Sample	High Black Pop.
Treated × Post	-4.954***	-4.308***	-5.091***	-4.083***
	(0.606)	(0.879)	(0.619)	(0.844)
Mean of Dep. Var.	32.0	40.4	32.0	41.6
N	700778	252281	699710	226774
Tract FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
	Impact of FHA Lending on Share of Black Borrowers			
	Treated=Any Reduction in 2014		Treated=Above Floor in 2008	
	Full Sample	High Black Pop.	Full Sample	High Black Pop.
FHA Share	0.098**	0.269***	0.107***	0.288***
	(0.038)	(0.099)	(0.037)	(0.095)
Mean of Dep. Var.	0.062	0.12	0.062	0.12
N	700778	252281	699710	252001
Tract FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Notes: Panel A shows coefficients from difference-in-difference regressions comparing treated census tracts before and after the 2014 reduction in FHA limits. Specifically, we show β from the following regression:

$$y_{jt} = \alpha_j + \gamma_t + \beta(\text{Treated}_j \cdot \mathbf{1}_{\{t \geq 2014\}}) + \varepsilon_{jt}.$$

We consider two definitions of treatment. *Any reduction in 2014* refers to all tracts that experience a reduction in the FHA limit in 2014. *Above floor in 2008* refers to all tracts with an FHA limit above the nationwide floor in 2008. y_{jt} is the *share of FHA loans* $\times$100 at the tract level in our HMDA sample, which includes all owner occupied, first lien, new purchase mortgages. Standard errors, clustered at the county level, are included in parentheses. Panel B presents IV regressions with the specifications in Panel A acting as a first stage for a regression of the share of Black borrowers in tract j on the share of FHA loans. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

TABLE A.III: LEVERAGE BURDEN IN HIGH OPPORTUNITY AREAS

	Panel A: Median Down Payment ($100,000s)				
	Share Black	Income	High Paying Jobs	Math Scores	Intergen. Income Rank
Median Down Payment	-0.027***	15.354***	53.640***	0.107***	0.018***
	(0.001)	(0.106)	(0.524)	(0.003)	(0.000)
Mean of Dep. Var.	0.13	64.5	56.7	3.20	0.43
N	71428	71359	70496	70314	70495
	Panel B: Median Combined Loan-to-Value (0-100)				
	Share Black	Income	High Paying Jobs	Math Scores	Intergen. Income Rank
Combined Loan to Value	0.006***	-2.099***	-6.384***	-0.025***	-0.004***
	(0.000)	(0.014)	(0.069)	(0.000)	(0.000)
Mean of Dep. Var.	0.13	64.5	56.7	3.20	0.43
N	71432	71363	70499	70317	70498
	Panel C: Share FHA Eligible (0-1)				
	Share Black	Income	High Paying Jobs	Math Scores	Intergen. Income Rank
Share FHA Eligible	0.174***	-67.158***	-127.290***	-0.719***	-0.090***
	(0.003)	(0.358)	(1.989)	(0.012)	(0.001)
Mean of Dep. Var.	0.13	64.4	56.6	3.20	0.43
N	71696	71616	70762	70572	70736
	Panel D: Share Originated Through FHA (0-1)				
	Share Black	Income	High Paying Jobs	Math Scores	Intergen. Income Rank
Share Originated Through FHA	0.358***	-68.235***	-120.778***	-1.326***	-0.138***
	(0.004)	(0.562)	(2.907)	(0.017)	(0.001)
Mean of Dep. Var.	0.13	64.4	56.6	3.20	0.43
N	71696	71616	70762	70572	70736

Notes: Coefficients from regressions of tract level characteristics on measures of the tract level leverage burden for owner occupied new purchase mortgages in the 2018 HMDA data (in $100,000s). Share FHA eligible refers to the fraction of properties in HMDA in tract j and year t that satisfy $0.965 \times \text{Price}_{ijt} \leq \text{FHA Limit}_{jt}$. Share Black refers to the Black population as a proportion of the total population and income refers to the median tract level income in $1000s, both in the 2018 ACS. High paying jobs refers to the number of jobs with earnings greater than $3,333 per month in the tract and in neighboring tracts whose centroids fall within a radius of 5 miles from the tract centroid in 2015, measured in thousands. Math scores refer to mean 3rd grade math test scores in 2013. Intergen. income rank refers to the predicted income rank between 31-37 for children born between 1978 and 1983 that grew up in the tract, as estimated in Chetty *et al.* (2018) . The latter three variables are provided by Opportunity Insights.

B FHA Limits and the Share of Black Borrowers

This appendix outlines a set of descriptive analyses regarding FHA limits and the share of mortgage originations by black borrowers. We begin by presenting basic correlations showing that the share of black borrowers is higher in the counties or tracts with with more generous FHA limits. This is true unconditionally, when controlling for local home prices, and when considering first-differences to removed fixed cross-sectional differences between counties or tracts. We then show that the share of black borrowers increases when a tract becomes FHA eligible (and that the probability a given home is purchased by a Black household increases when its price falls under the FHA limit).

B.1 Increased Share of Black Borrowers in Areas with High FHA Limits

Raw Correlations

A larger share of mortgages are originated by Black households in areas with more generous FHA limits. This can be seen through the simple regression for county j and year t:

$$\text{Share Black}_{jt} = \beta_0 + \beta_1 \text{FHA Limit}_{jt} + \varepsilon_{jt}. \tag{35}$$

Results from regressions of this form are shown in the first column of Table B.I. At the county level, a \$100,000 larger FHA cap is associated with a 0.5 percentage point larger share of Black borrowers, roughly 15 percent of the mean across counties. There is no discernible difference at the tract level.

Controlling for Local Prices

The most obvious potential confound is the level of home prices. FHA limits are directly influenced by local affordability: FHA limits tend to be higher in high priced, urban areas. Because home prices and urbanization are intertwined with location choices by race, it is difficult to take these correlations at face value.

To address this possibility, we next directly control for home prices, by including a county level price index in equation 35. Specifically, we consider regressions of the form:

$$\text{Share Black}_{jt} = \beta_0 + \beta_1 \text{FHA Limit}_{jt} + \beta_2 HPI_{jt} + \varepsilon_{jt}. \tag{36}$$

The FHA Limit is not collinear with local home prices for two reasons. First, the limits are not a linear or deterministic function of local home prices. In fact, the formulas governing the relationship between home prices and the FHA limit change substantially within our sample period (a fact that we exploit directly in our later specifications). Furthermore, these limits are sometimes determined at an MSA level, rather than a county level. As a consequence, there is variation in home prices across counties within an MSA (which share the same FHA limit).

Columns 2 and 3 of Table B.I show that the relationship between FHA limits and the share of black borrowers is larger after conditioning on home prices. This likely reflects the fact that black borrowers tend to purchase homes in less expensive neighborhoods. At the tract level, a \$100,000 larger FHA cap is associated with a nearly 2 percentage point higher share of mortgage borrowers. This is just under 30 percent of the mean across tracts. This is true whether we control for contemporaneous or lagged home prices.

Within-Location Changes in FHA Limits

Conditioning on home prices only addresses only a portion of the potential confounds that come about due to the connections between home prices, urbanization, and race. For example, relatively low-priced counties or tracts within an expensive metro may have a larger share of Black home-buyers when compared to a similarly priced location in a rural area or a less expensive metro. Additionally, there are numerous other unobserved, location specific factors that may influence both FHA limits and the racial composition of home buyers.

To account for unobserved heterogeneity across locations, we consider the relationship between changes in FHA limits and changes in the share of Black borrowers within geographic areas. Specifically, we consider first-difference regressions of the form:

$$\Delta\text{Share Black}_{jt} = \beta_0 + \beta_1 \Delta\text{FHA Limit}_{jt} + \beta_2 \Delta HPI_{jt} + \varepsilon_{jt}. \tag{37}$$

Changes in FHA limits within a location are positively correlated with changes in the share of Black borrowers at both the county and tract level. Columns 4, 5, and 6 of Table B.I present the results of specifications following Equation 37. A \$100,000 change in the FHA limit is associated with a 0.3–0.4 percentage point change in the share of black borrowers. This is true whether we condition on $\Delta\text{FHA Limit}_{jt}$ or not. As a whole, this provides suggestive evidence that higher FHA limits may help enable black households to purchase housing.

B.2 FHA Eligibility Increases Representation of Black Households

We next turn to analyzing whether a given census-tract or property becoming eligible for FHA lending relates to the choices of Black borrowers. For this analysis, we restrict our attention to the years 2018–2020, when home prices are visible in HMDA.

Tract Level: Raw Correlations

For our analysis at the tract level, we ask whether a tract being *eligible* for FHA lending correlates with the share of Black borrowers. We define eligibility based on the median loan in a tract-year. Specifically, tract j is eligible in year t if

$$0.965 \times \text{Median Price}_{jt} \leq \text{FHA Limit}_{jt}.$$

In other words, if the median property could be purchased with a 3.5% down FHA loan. We first compare all eligible versus non-eligible tracts with regressions of the form

$$\text{Share Black}_{jt} = \beta_0 + \beta_1 \text{Eligible}_{jt} + \varepsilon_{jt}. \tag{38}$$

The results, shown in column 1 of the first panel of Table B.II show that the share of black mortgage borrowers in eligible tracts is 5.8 percentage points higher than non-eligible tracts, nearly 85 percent of the mean.

Tract Level: Two-Way Fixed Effects

We next modify our regressions to focus on within-tract changes in eligibility using a two-way fixed effects approach. specifically, we consider tract-level regressions of the form:

$$\text{Share Black}_{jt} = \beta \text{Eligible}_{jt} + \gamma_j + \delta_t + \varepsilon_{jt}. \tag{39}$$

The results, shown in column 2 of the first panel of Table B.II show that changes in FHA eligibility are related to the share of black borrowers. On average, going from eligible to non-eligible is associated with a 0.4 percentage point increase in the share of black borrowers. This is roughly 6 percent of the mean.

Tract Level: Two-Way Fixed Effects + County $\times$ Year Fixed Effects

A major concern with the two-way fixed effects approach is that the underlying local economic trends that lead to changes in eligibility (e.g. factors that influence local home prices) might also influence the racial composition of borrowers. To partially account for this, the specification shown in column 3 adds county $\times$ year fixed effects to Equation 39. This restricts identifying variation to be across tracts within the same county and year, allowing us to set aside the potential confounds (e.g. gentrification) that might simultaneously be driving changes in FHA limits. Effectively, β is identified by comparing tracts that change eligibility within a county to others that do not, given the same change in FHA limits. This distinction might arise because some tracts are relatively close to the margin when limits change, while others are far away (and hence unaffected). Results are effectively the same as in column 2.[22]

Tract Level: Raw Correlations + Ineligible in 2018

We next limit our analysis only to tracts that were ineligible, according to our definition, in 2018. Within this group, those that become eligible must due so either because FHA limits rise in 2019 or 2020, or because home prices fall. This eliminates tracts that become ineligible due to gentrification or other factors that rapidly increase home prices, but restricts to a relatively high priced sample overall.

In the raw correlations, shown in column 4, we see that eligibility is associated with a roughly 2 percentage point increase in the share of black borrowers in this group. This is close to 100 percent of the mean. Including both census tract and year fixed effects, the coefficient drops by roughly 75 percent. This suggests that becoming eligible is associated with a 0.5 percentage point increase. We find a similar coefficient when also including county $\times$ year fixed effects.

Loan Level: Raw Correlations

We next turn our focus to the loan level. We ask how the probability a borrower is Black varies depending on the eligibility of a property. We are able to be slightly more precise at the loan level, and define a given property property i in tract j and year t to be eligible if

$$0.965 \times \text{Price}_{ijt} \leq \text{FHA Limit}_{jt}.$$

In words, property i is eligible if its sales prices is low enough that it could have been purchased with a 3.5% down FHA loan.

Our dependent variable is a binary outcome, equal to one if the borrower is Black. We consider regressions of the form:

[22] Of course, this does not eliminate all potential concerns. For example, if FHA limits rise because one tract in a county experiences extreme gentrification (and becomes ineligible) while another remains stagnant, we may not be surprised that a relative decline in the share of Black homeowners occurs in the gentrifying tract.

$$\text{Black}_{ijt} = \beta \text{Eligible}_{ijt} + \gamma_j + \delta_t + \varepsilon_{ijt}. \tag{40}$$

Column 1 of the lower panel of Table B.II shows the results of this specification without fixed effects. Unsurprisingly, the share of Black borrowers in eligible homes is higher, by roughly 4.3 percentage points. In column 2, we add tract and year fixed effects and consider within-tract variation in eligibility. Again there is a strong positive relationship. A loan for an eligible home is 0.8 percentage points more likely to be to a black borrower.

Loan Level: Comparing Similarly Priced Homes

We next try to compare similarly priced homes by including flexible controls for the property value. We consider the following regression:

$$\text{Black}_{ijt} = \beta \text{Eligible}_{ijt} + \gamma_j + \delta_t + f(\text{Price}_{ijt}) + \varepsilon_{ijt}. \tag{41}$$

We control non-parametrically for home prices by including dummy variables for each \$10,000 increment between \$200,000 and \$1,000,000 (property values are reported in \$10,000 bins in HMDA). Column 4 shows the specification shown in Equation 41. This indicates a similarly priced home in an area with a more lenient FHA limit is 0.4 percentage points more likely to be purchased by a black household.

Loan Level: Comparing Similarly Priced Homes Within a County or Tract

Of course, \$300,000 home in New York City is different from a \$300,000 home in rural Georgia. We next modify Equation 41 to consider variation in eligibility for similarly priced homes within the same county or tract. We do so by non-parametrically controlling for price separately within each location. Specifically, we consider regressions of the form:

$$\text{Black}_{ijt} = \beta \text{Eligible}_{ijt} + \gamma_j + \delta_t + f_j(\text{Price}_{ijt}) + \varepsilon_{ijt}. \tag{42}$$

In practice, we interact dummy variables for each \$10,000 price bin with county or census tract fixed effects. This allows us to compare two homes with the same price, in the same location, one of which becomes eligible when the FHA limit changes. We present our results in columns 5 and 6 of Table B.II. The coefficient suggests that a property with the same price is 0.2 percentage points more likely to be purchased by a Black household when it is eligible.

TABLE B.I: HIGHER FHA LIMITS ASSOCIATED WITH A GREATER SHARE OF BLACK BORROWERS

	Outcome: Share of Black Borrowers in County					
	Levels			First-Differences		
FHA Limit (100k)	0.005***	0.021***	0.021***			
	(0.000)	(0.001)	(0.001)			
Δ FHA Limit (100k)				0.003***	0.004***	0.004***
				(0.001)	(0.001)	(0.001)
County HPI		-0.021***				
		(0.001)				
Lagged County HPI			-0.022***			
			(0.001)			
Δ County HPI					0.003***	
					(0.001)	
Lagged Δ County HPI						0.002
						(0.001)
Mean of Dep. Var.	0.036	0.037	0.037	0.00048	0.00038	0.00034
N	32054	26030	24935	31978	24886	23286

Notes: The first three columns present coefficients from the regression for county j and year t: Share Black$_{jt} = \beta_0 + \beta_1$FHA Limit$_{jt} + \varepsilon_{jt}$, with controls for contemporaneous or lagged county-level home prices included in the latter two columns (measured as Zillow's smoothed, seasonally adjusted all homes county ZHVI). The remaining three columns show a first differenced version of the same regression. Sample includes all owner occupied new purchase mortgages in the 2010-2019 HMDA data . $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

TABLE B.II: FHA ELIGIBILITY AND THE PRESENCE OF BLACK MORTGAGE BORROWERS

	Panel A: Tract Level Share of Black Borrowers					
	All Tracts			Above Limit in 2018		
FHA Eligible	0.058***	0.004***	0.004***	0.019***	0.005***	0.005***
	(0.004)	(0.001)	(0.001)	(0.005)	(0.001)	(0.001)
Mean of Dep. Var.	0.069	0.068	0.068	0.020	0.020	0.020
N	215329	214646	213930	32826	32778	32200
Census Tract FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	No	No	Yes	No
County × Year FEs	No	No	Yes	No	No	Yes
	Panel B: Loan Level Borrower Race (**1**=Black Borrower)					
FHA Eligible	0.043***	0.008***	0.025***	0.004***	0.002***	0.002***
	(0.003)	(0.001)	(0.005)	(0.001)	(0.001)	(0.001)
Mean of Dep. Var.	0.060	0.060	0.060	0.060	0.060	0.060
N	15403018	15395900	15403018	15395900	15373811	14905383
Census Tract FE	No	Yes	No	Yes	Yes	No
Year FE	No	Yes	No	Yes	Yes	Yes
Property Value FEs	No	No	Yes	Yes	No	No
County × Property Value FEs	No	No	No	No	Yes	No
Tract × Property Value FEs	No	No	No	No	No	Yes

Notes: Coefficients from regressions of tract level share of black borrowers or loan level borrower race on FHA eligibility of the tract or property. Tract j is defined as eligible in year t if $0.965 \times \text{Median Price}_{jt} \leq \text{FHA Limit}_{jt}$. Property i in tract j defined as eligible if $0.965 \times \text{Price}_{ijt} \leq \text{FHA Limit}_{jt}$. Sample includes all owner occupied new purchase mortgages in the 2018-2020 HMDA data. Standard errors, clustered at the county level, are shown in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

C Model Appendix

C.1 Environment

Pension schedule. The pension schedule replicates key features of the U.S. pension system by relating last period income to average income over the life-cycle to compute retirement benefits (Guvenen & Smith (2014)). Denote economywide average lifetime labor income as $\overline{Y}$, and household i's relative lifetime income as $\tilde{Y}_{i,R} = \widehat{Y}_{i,R}/\overline{Y}$, where $\widehat{Y}_{i,R}$ is the predicted individual lifetime income implied by a linear regression of i's lifetime income on its income at retirement age. Using income at retirement to define pension benefits allows us to save a state variable in the dynamic programming problem. Retirement income is equal to:

$$Y_{i,R} = \overline{Y} \times \begin{cases} 0.9\tilde{Y}_{i,R} & \text{if } \tilde{Y}_{i,R} \leq 0.3 \\ 0.27 + 0.32(\tilde{Y}_{i,R} - 0.3)\tilde{Y}_{i,R} & \text{if } 0.3 < \tilde{Y}_{i,R} \leq 2 \\ 0.81 + 0.15(\tilde{Y}_{i,R} - 2)\tilde{Y}_{i,R} & \text{if } 2 < \tilde{Y}_{i,R} \leq 4.1 \\ 1.13 & \text{if } 4.1 \leq \tilde{Y}_{i,R} \end{cases} \tag{43}$$

C.2 Numerical Solution

C.2.1 Value Functions

Value functions are subject to i.i.d. idiosyncratic shocks, which cancel out in the aggregate up to a normalization. This standard assumption from the dynamic demand literature is also used in Mabille (2023). Given value functions, it allows us to compute closed forms for transition probabilities between discrete choices and for the expectations of continuation value functions, which are smooth functions of parameters and of individual and aggregate states. This feature is key to calibrate the 2×2 model with discrete choices and solve for market-clearing prices when computing counterfactual experiments without generating jumps in targeted moments.

The value of each option of the discrete choice problem is subject to an idiosyncratic logit error taste shock. For instance, the value of being an inactive renter in area L for a household in group g is equal to:

$$V_g^{rL}(a, b_t, y_t) = \overline{V}_g^{rL}(a, b_t, y_t) + \tilde{\varepsilon}_g^{rL}(a, b_t, y_t) \tag{44}$$

where $\tilde{\varepsilon}$ follows a type I Extreme Value distribution with a state-dependent location parameter and scale fixed to 1. In the cases where households are owners and/or movers, the location parameters are equal to Ξ_g^j and/or $-m_g^j$, otherwise to zero.

This assumption smooths out the computation of the expectation of the continuation value function, which is the envelope value of the options available next period, given the household's current state (not the same options are available for owners and renters in the various areas). It smooths out policy and value functions, and makes them more monotonic with respect to parameters when searching numerically during the calibration and counterfactual experiments. This allows us to reduce the size of the state space and makes the problem tractable. Without it, an untractably high number of grid points would be needed to avoid jumps in value functions upon parameter changes. The expectation of the envelope value has a closed form, for instance for area L renters in group g:

$$\mathbb{E}_g^{rL}\left[V^r\right] = \mathbb{E}_g^{rL}\left[\int V^r\left(\tilde{\varepsilon}\right)\mathbf{dF}\left(\tilde{\varepsilon}\right)\right] = \mathbb{E}_g^{rL}\left[\log\left(\sum_j e^{V^{r,j}}\right)\right] \tag{45}$$

where $V^r \equiv \max\left\{V^{r,j}\right\}_j$. The outside expectation $\mathbb{E}_{L,t}\left[.\right]$ is taken over the distribution of idiosyncratic income shocks (identical across areas in the baseline). For simplicity, V^r denotes the ex-ante value function, after integrating over the vector of idiosyncratic errors (there is one realization for each individual state and option).

We then obtain closed-form expressions for the probabilities of choosing the various options. They are useful when computing the transition matrix for the law of motion of the cross-sectional distribution over race $\times$ location $\times$ tenure $\times$ age $\times$ income $\times$ wealth, which we approximate with a histogram. The probabilities have the multinomial logit closed-form, for instance:

$$\Pr\left(V_g^r = V_g^{r,j}\right) = \frac{e^{V_g^{r,j}}}{\sum_{j'} e^{V_g^{r,j'}}}. \tag{46}$$

C.2.2 Calibration

The second step of the calibration algorithm consists of three sub-steps.

First, we fix the local house prices P_L, P_H to exactly replicate the regional distribution of prices in the data, and the housing supply elasticity parameters ρ_j, which are directly measured from the data.

Second, we vary the local rents R_L, R_H to match the homeownership rates by area in the data, $ho_L^{hh}\left(\mathbf{P},\mathbf{R}\right)$ and $ho_H^{hh}\left(\mathbf{P},\mathbf{R}\right)$. Homeownership rates in the model are obtained by solving the household's problem with a global nonlinear solution method, computing the stationary distribution of households (using a histogram approach), and aggregating it across areas, races, and tenure groups. For given local prices, homeownership rate are increasing in local rents. If moving rates are not too high, R_L and R_H can be separately chosen in areas L and H, otherwise they must be jointly solved for. Then, we choose the amenity benefit means Ξ to match rents by area, and the moving cost shock means $\mathbf{m^L}$ to match the share of households pop_H living in high-opportunity areas.

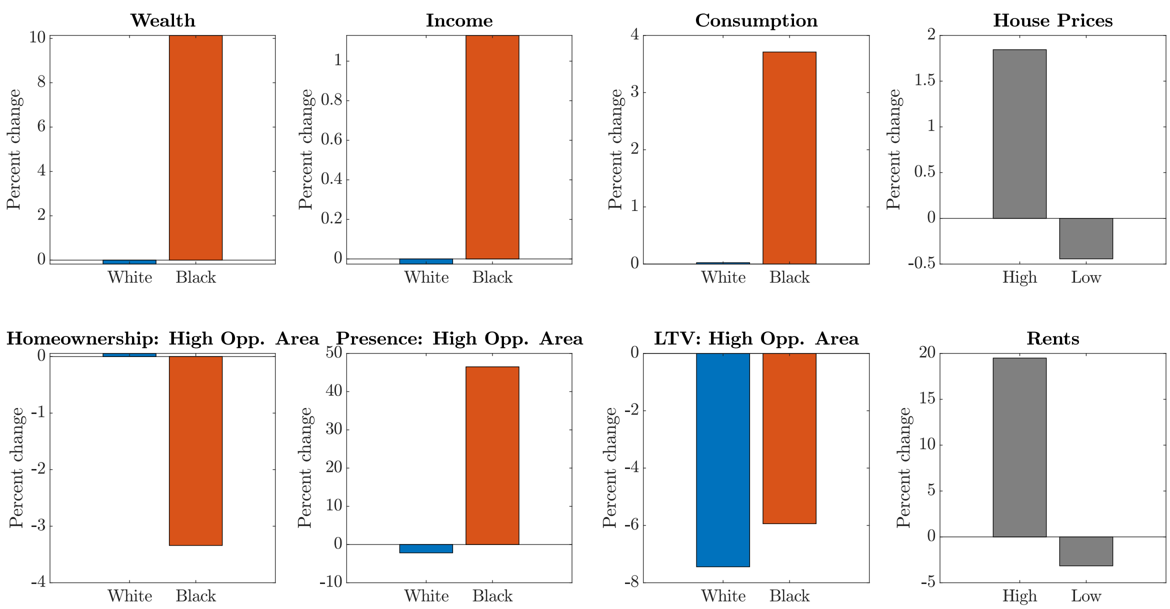
Third, we use the homogeneity of the housing supply functions in **P** to solve for the intercepts of the housing supply functions in closed-form by inverting the market-clearing conditions:

$$\overline{I}_j = \frac{pop_j ho_j^{hh} \overline{h}}{P_j^{\rho_j}}. \tag{47}$$

Given the new $\overline{I}_j$, we go back to the first step and iterate until convergence.

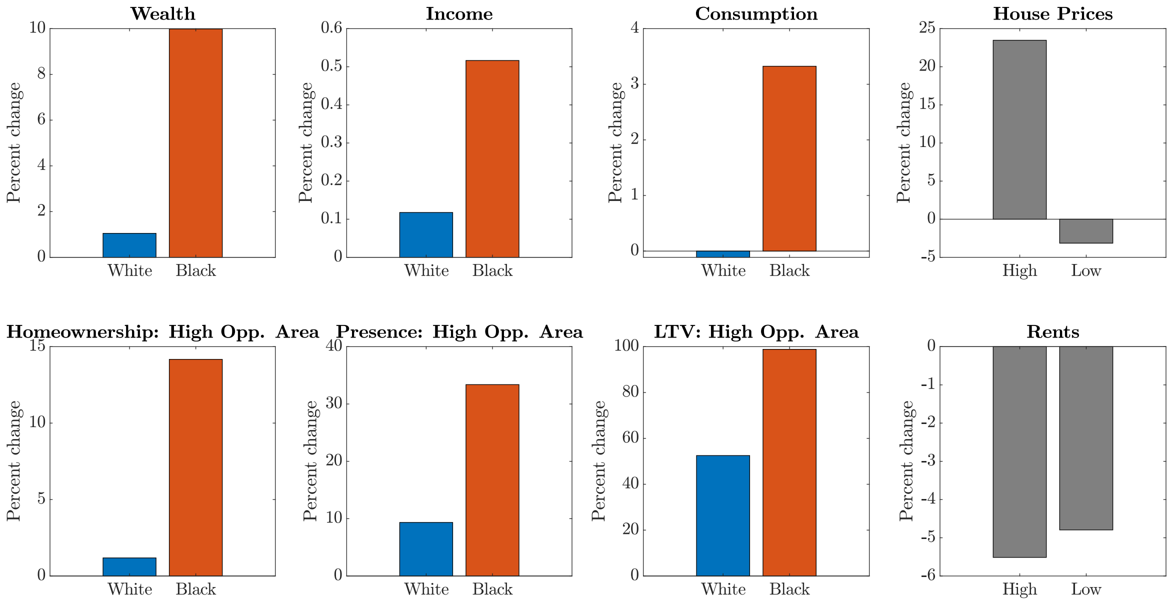
D Additional Counterfactual Experiments

FIGURE D.I: LOWER BLACK HOUSEHOLDS' MOVING COSTS



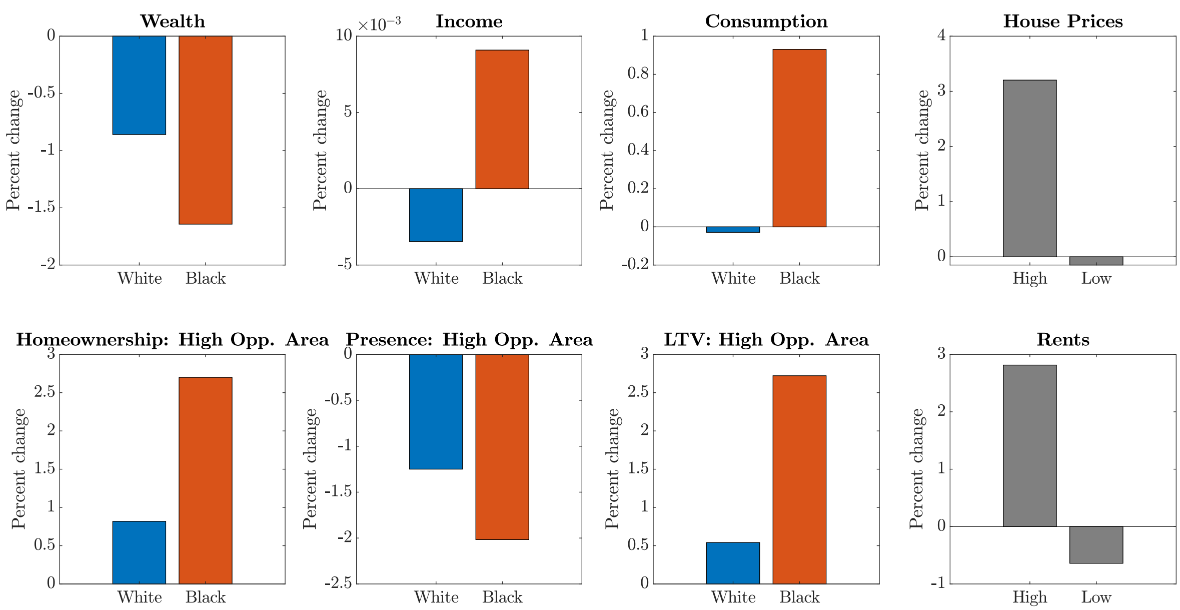
Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of decreasing Black households' moving costs by 15%. We plot outcomes including wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity zone, the fraction of each group that is present in the high-opportunity zone, and the LTV at origination for purchases made in the high-opportunity zone. Table 5 shows a fuller set of results for this policy counterfactual.

FIGURE D.II: HIGHER FHA LOAN CAP IN HIGH-OPPORTUNITY AREAS AND PTI CONSTRAINT



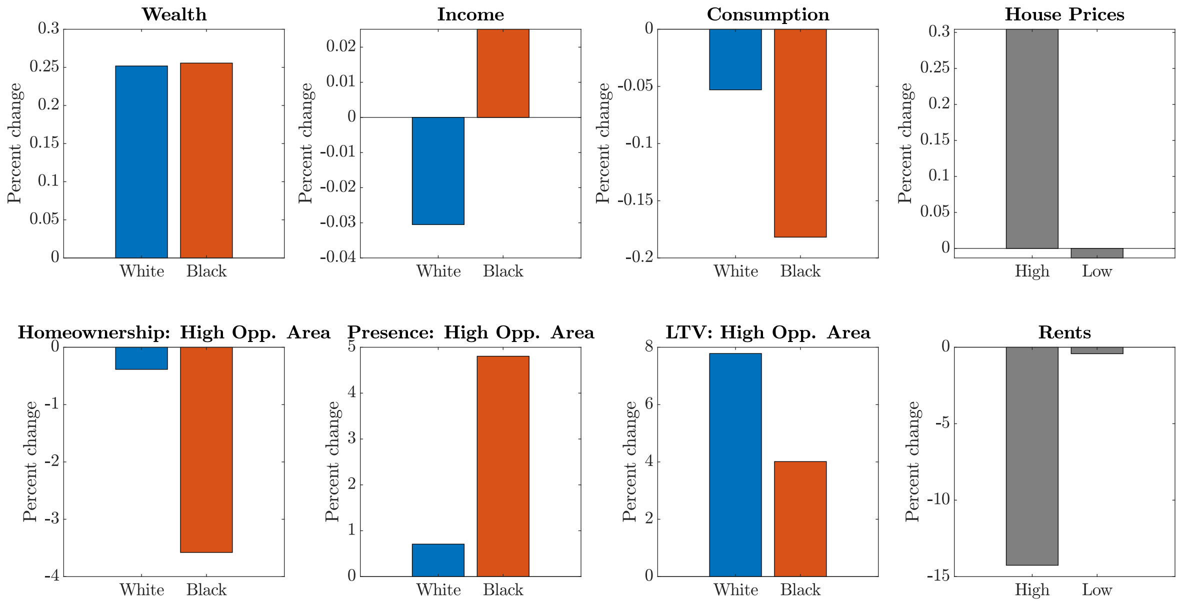
Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the results for a counterfactual economy with a higher FHA loan cap in high-opportunity areas and where households face a PTI constraint ($\theta_{PTI} = 1$). We plot outcomes including: wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity zone, the fraction of each group that is present in the high-opportunity zone, and the LTV at origination for purchases made in the high-opportunity zone. Table 5 shows a fuller set of results for this policy counterfactual.

FIGURE D.III: HIGHER LEVERAGE LIMIT ON FHA LOANS



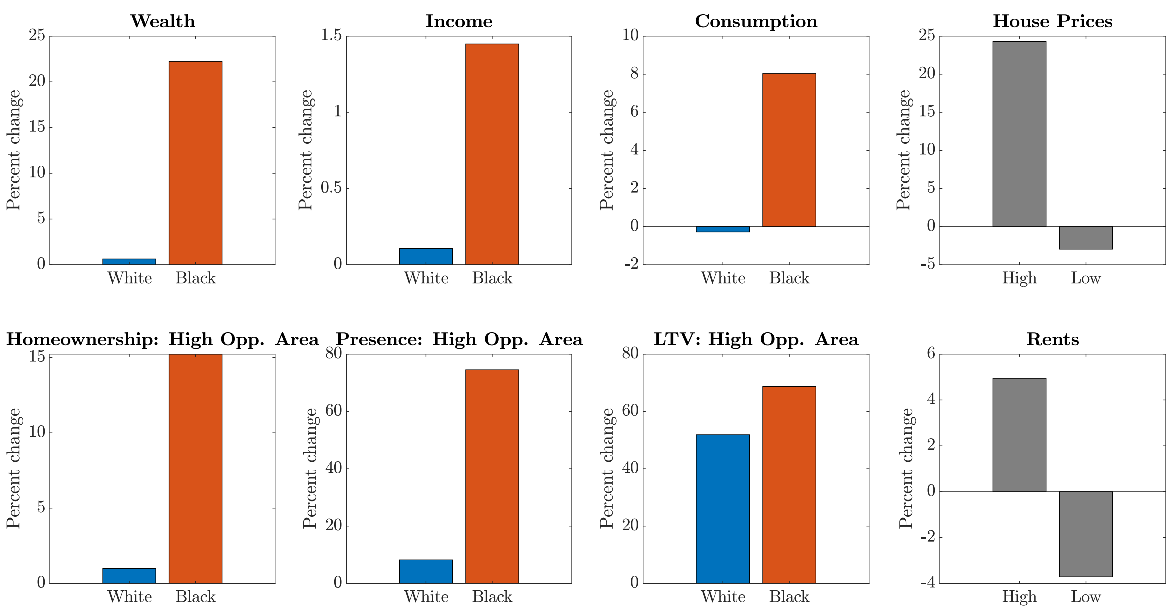
Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of increasing the LTV limit on FHA loans to 100% ($\theta_{LTV}^{FHA} = 1$). We plot outcomes including: wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity zone, the fraction of each group that is present in the high-opportunity zone, and the LTV at origination for purchases made in the high-opportunity zone. Table 5 shows a fuller set of results for this policy counterfactual.

Figure D.IV: Higher rental supply in high-opportunity areas



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of increasing the supply of rental housing in high-opportunity areas by 10%. We plot outcomes including wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity zone, the fraction of each group that is present in the high-opportunity zone, and the LTV at origination for purchases made in the high-opportunity zone. Table 5 shows a fuller set of results for this policy counterfactual.

Figure D.V: Higher FHA loan cap in high-opportunity areas and lower Black households' moving costs



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. This figure plots the result for a counterfactual economy with a higher FHA loan cap in high-opportunity areas and where Black households' moving costs are 10% lower. We plot outcomes including wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity zone, the fraction of each group that is present in the high-opportunity zone, and the LTV at origination for purchases made in the high-opportunity zone. Table 5 shows a fuller set of results for this policy counterfactual.

E Comparison with Reparations Policies

This section considers a series of reparations-style policies that specifically target Black households and seek to equate initial conditions across demographic groups. We use these results as a benchmark to compare with our main findings.

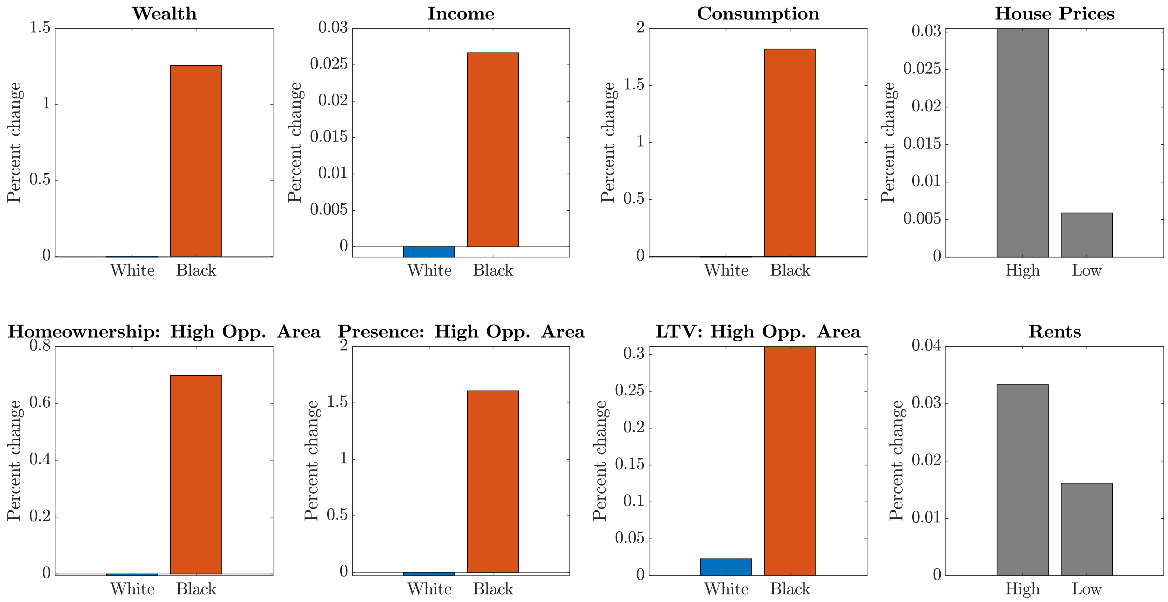
Initial Wealth Figure E.I shows detailed results for a change that equates initial wealth for Black households with white households. Perhaps unsurprisingly, raising initial wealth increases Black wealth over the life-cycle. It also increases income and homeownership, particularly in high-opportunity areas. Part of the wealth is also consumed, and we observe consumption rising much more than income. Because Black buyers are a small fraction of the population, this change is not large enough to have meaningful general equilibrium effects on rents or prices.

Probability of Being Born in High-Opportunity Area We also consider addressing initial location differences in Figure E.II by equating them across Black and white households. This policy has much smaller effects on Black wealth, but by construction has much larger impacts on Black presence in the high opportunity area, and so also impacts income to a greater degree.

Income Process Finally, we examine a policy that gives Black households the same income process as white households, (Figure E.III). Such a policy might represent, for instance, targeted human capital development policies or a reduction in labor market discrimination. This significantly improves Black wealth and income, while also reducing racial gaps in homeownership and leverage. The latter result is due to a combination of lower Black leverage in the low-opportunity areas, and higher home ownership in high-opportunity areas.[23] Of all the policy experiments considered, this one has the largest impact but is perhaps the least implementable policy in practice. Therefore, we consider it as a theoretical benchmark for the impact of our main experiments on racial inequality.

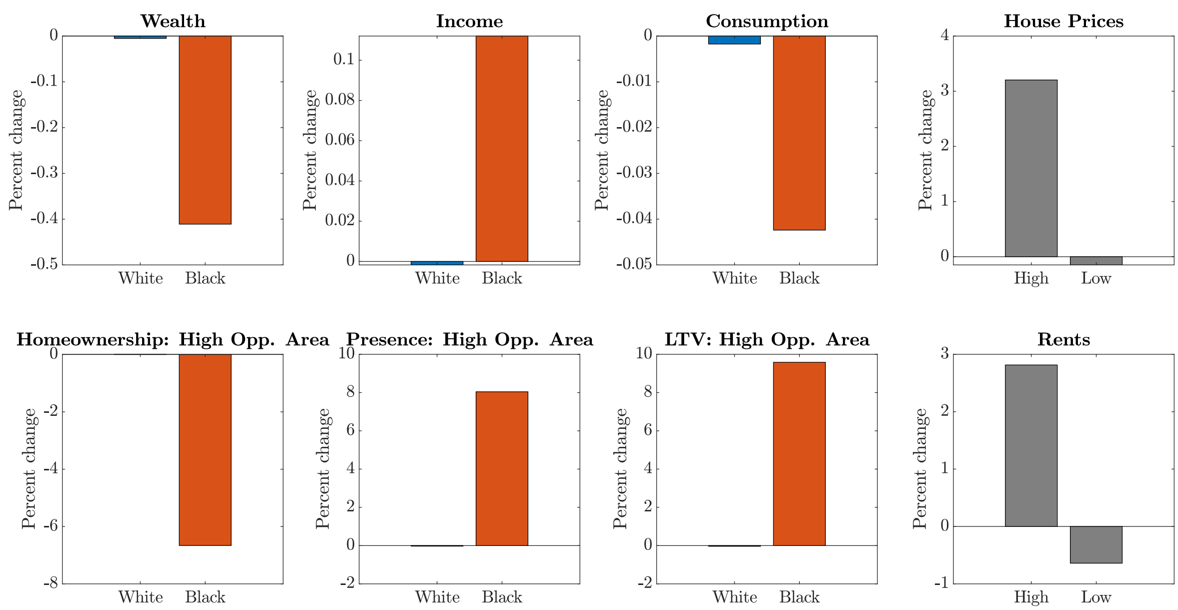
[23] Small impacts on white borrowers are evident because aggregate earnings impact pensions for all households, which in turn impacts choices earlier in life.

FIGURE E.I: REPARATIONS REMOVING INITIAL WEALTH DIFFERENCES



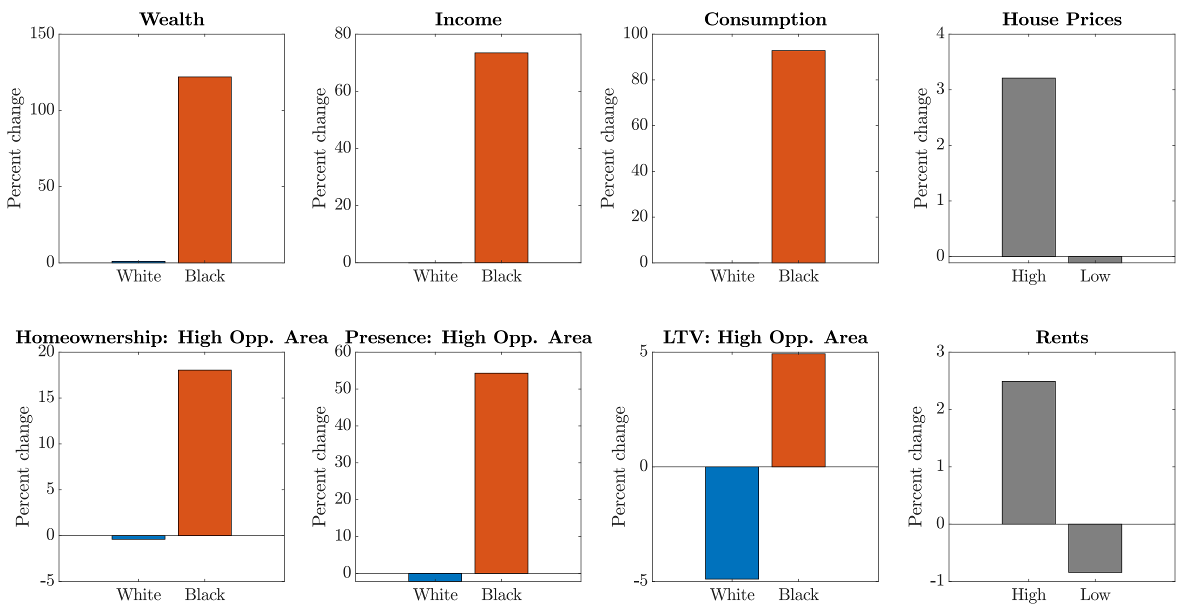
Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of increasing Black households' initial wealth to remove differences with white households. We plot outcomes including: wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity area, the fraction of each group that is present in the high-opportunity area, and the LTV at origination for purchases made in the high-opportunity area.

FIGURE E.II: REPARATIONS REMOVING INITIAL LOCATION DIFFERENCES



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of increasing Black households' probability of being born in the high-opportunity area to remove differences with white households. We plot outcomes including: wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity area, the fraction of each group that is present in the high-opportunity area, and the LTV at origination for purchases made in the high-opportunity area.

FIGURE E.III: REPARATIONS REMOVING INCOME PROCESS DIFFERENCES



Notes: Variables are conditional averages in percentage deviation from the baseline model equilibrium. The panels show the consequences of equating Black households' income process with white households. We plot outcomes including: wealth, income, consumption, and house prices and rents across both areas for white (blue) and Black borrowers (red). We also plot home ownership in the high-opportunity area, the fraction of each group that is present in the high-opportunity area, and the LTV at origination for purchases made in the high-opportunity area.