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# Financial Constraints and the Racial Housing Gap

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We highlight the contribution of financial constraints to persistent disparities in wealth and access to geographic opportunities across demographic groups. We document a racial leverage gap—Black borrowers have substantially higher LTV ratios at mortgage origination, reflecting differences in pre-existing wealth and family transfers. We use a spatial life-cycle model to analyze the impacts of initial conditions on home purchase decisions, location choices, and long-term wealth accumulation for minority borrowers. Leverage constraints channel Black borrowers into less valuable housing choices and less lucrative labor markets. Targeted mortgage policies and reductions in moving frictions help close income and wealth gaps across groups.

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# 1 Introduction

Racial disparities in homeownership and wealth accumulation are well documented, but their ultimate causes and the effectiveness of policies intended to narrow these gaps remain a topic of considerable debate (Charles & Hurst, 2002; Goodman & Mayer, 2018). While historical barriers in access to housing and finance have profoundly impacted the Black-white wealth gap, the degree to which existing financial constraints—such as leverage requirements—perpetuate or amplify wealth differences over time is unclear. Considerable empirical and theoretical work has emphasized the role of self-saving to overcome financial constraints (Moll, 2014; Blattman *et al.*, 2020), suggesting the possibility of long-run convergence for Black borrowers. In particular, the persistence of a racial wealth gap is at odds with the predictions of standard infinite-horizon models in which initial wealth and income conditions ultimately dissipate. In this paper, we develop a novel spatial life-cycle model with heterogeneous demographic groups and housing stocks to address this important puzzle for household finance.

Our central mechanism highlights the interaction between leverage constraints and location choice, and its impact on wealth accumulation across groups. Households with limited wealth find it difficult to access homeownership in high-opportunity areas, which typically have more expensive housing and more stringent leverage requirements. This limits labor market and wealth building opportunities for groups with lower initial wealth and income for two reasons. First, more expensive housing markets typically offer greater opportunities, as measured by higher labor market returns, which allow households to save and accumulate wealth more quickly. Second, the ability to purchase valuable homes shapes wealth accumulation over the life-cycle and future bequests. In other words, low-wealth households facing leverage constraints are spatially misallocated in ways that hinder their opportunities to build wealth.

We evaluate this mechanism in the context of the Black-white wealth gap, which we focus on for two reasons. First, the striking racial disparities in wealth that exist the United States present a stark case for the role of financial constraints. Second, Black-white housing and wealth gaps are interesting to understand in their own right and are a focus of considerable policy attention.[1] Our model demonstrates that financial constraints perpetuate initial disparities between Black and white households. Because of baseline differences in wealth, location, and income, Black households have more difficulty overcoming leverage constraints and reaching high-opportunity areas. This limits their ability to access valuable real estate assets and job opportunities and, as a result, to build wealth over time. Our calibration is able to explain a signif-

[1]See the proposed actions by the Biden-Harris Administration to narrow the racial wealth gap, which note: "The U.S. is home to stark and persistent disparities in homeownership and wealth. Across the country, just 49 percent of Hispanic Americans and 45 percent of Black Americans own their own homes, compared to 74 percent of White Americans. Hispanic and Black households also have just a fraction of the wealth of their White counterparts." www.whitehouse.gov/briefing-room/statements-releases/2021/06/01/fact-sheet-biden-harris-administration-announces-new-actions-to-build-black-wealth-and-narrow-the-racial-wealth-gap/.

icant fraction of Black-white gaps in leverage and wealth, suggesting that housing markets play a critical role in determining economic inequalities by race.

We begin our analysis by empirically documenting a previously neglected dimension of Black-white housing disparities: a substantial racial leverage gap. In 2020, more than 50 percent of white buyers put at least 10 percent down for new purchase mortgage originations, compared to less than 20 percent of Black buyers.[2] To access high leverage mortgages, Black borrowers disproportionately rely on mortgages originated through the Federal Housing Administration (FHA), which enables loan-to-value (LTV) ratios as high as 96.5 percent. By contrast, white borrowers more commonly rely on interfamily transfers to make sizable down payments. Though FHA mortgages enable mortgage access for financially constrained borrowers, they come with loan caps which constrain access to more expensive homes—which are generally located in higher-opportunity areas with better income prospects— for high leverage and minority borrowers.[3]

We then develop a novel structural model that accounts for these facts and allows us to evaluate the role of financial constraints in perpetuating racial differences in wealth, income, location and housing choices. We construct a $2 \times 2$ endowment economy with incomplete markets and overlapping generations of heterogeneous risk-averse households with a life-cycle. Households exogenously belong to two demographic groups, which correspond to Black and white households. Across their life-cycles, they endogenously purchase housing (or choose to rent) in one of two different stocks, which are respectively located in high- and low-opportunity areas.[4] Households may finance a home purchase with a mortgage (and may default) but face a constraint in the form of a leverage limit.

This framework generates a rich environment in which to explore the dynamics of housing and location decisions. The degree to which households accumulate wealth depends jointly on their choices of housing stock, home ownership, leverage, and savings. These in turn depend on their initial demographic groups and housing stocks, and within those, on households' age, income, and wealth. The two housing stocks differ in five dimensions: house prices, rents, average income, leverage requirements (LTV limit), and moving costs. The two demographic groups differ in four dimensions: initial wealth, average income, the net taste for homeownership (which captures all unmodeled costs and benefits of homeownership, including any discriminatory barriers), and the probability of being born in each location. Our methodological contribution comes from introducing persistent differences in initial conditions and locations—two key dimensions for housing markets—in a canonical life-cycle model with heterogeneous households, incomplete markets, and discrete choices. We compute the resulting cross-sectional distribution of households, which is numer-

[2]Indeed, the median combined loan to value at origination (CLTV) for new purchase mortgages was 96.5 percent for Black households.

[3]The FHA loan cutoff was a nation-wide cap of $356,362 for 2021, with varying eligibility by county. See https://www.hud.gov/program_offices/housing/sfh/lender/origination/mortgage_limits.

[4]High-opportunity and low-opportunity refer to labor income prospects within the model.

ically challenging, using methods from the dynamic demand literature.

To calibrate the model, we base heterogeneity across demographic groups on observed Black-white differences in income, leverage, homeownership, and wealth. We base the two housing stocks on FHA eligible and non-FHA eligible homes throughout the U.S. and allow less stringent leverage requirements in the FHA-eligible (low-opportunity) area. Our calibration successfully matches a series of targeted moments, including differences in homeownership, income, and moving rates across demographic groups and housing stocks, as well as over the life-cycle. We are also able to match key non-targeted moments, including a significant fraction of racial differences in leverage and 52% of the racial wealth gap. While there are undoubtedly a number of other unmodeled factors that play a role in determining aggregate Black-white disparities, the fit of the model suggests that accounting for financial constraints is crucial for understanding racial differences in housing and wealth. With the calibrated model in hand, we next turn to quantifying the role of financial constraints as a driver of observed differences by race, and to evaluating the effectiveness of various policies.

Our first set of counterfactual experiments demonstrates the importance of financial constraints in determining observed Black-white disparities by exogenously raising or lowering leverage limits. The most striking evidence comes from comparing our baseline model with a counterfactual economy with a relaxed leverage constraint in the high-opportunity area, allowing borrowers to purchase homes in this region with relatively low down payments. Specifically, we allow LTV ratios as high as 95% (matching the benchmark limit in the low-opportunity area). This change has unambiguously positive effects for Black households across financial and real measures, reducing Black-white gaps in wealth, income, homeownership, leverage and consumption. On average, Black households' incomes and wealth grow by nearly 5% and 20%, respectively. The key driver is a flow of Black households to the high opportunity housing stock. This experiment underscores the main insight of our paper, that the presence of leverage constraints adversely impacts Black borrowers and leads to persistent spatial misallocation, which in turn impairs income prospects and wealth building. Of course, while this result highlights the role of leverage constraints for Black-white disparities in the current U.S. mortgage system, it cannot be readily interpreted as a policy recommendation. Evaluating the aggregate consequences of such a change, which sharply impacts economy-wide leverage, is beyond the scope of our paper as it would require weighing the equity benefits described above against macro-prudential effects that are outside of our model.[5]

In addition to initial wealth, house prices are a key determinant of the tightness of leverage constraints. Our next set of experiments analyzes the consequences of house price growth—one of the largest trends in housing markets since the 1990s, which has further accelerated since Covid-19—on wealth accumulation

[5]Accounting for these effects would require modeling the banking system, default externalities, and endogenizing asset prices.

and Black-white gaps. These experiments also help shed light on the impacts of price shifts in our partial equilibrium model with exogenous house prices (our partial equilibrium approach follows a large literature on portfolio choice with housing, e.g., Campbell & Cocco (2003), and more recently Berger *et al.* (2017)). In our $2 \times 2$ setting, the impacts are strongly heterogeneous across demographic groups and housing stocks, and much more severe for Black households in high opportunity areas. In particular, an exogenous increase in house prices in the high opportunity area has little effect on white households' wealth, but it decreases average wealth, income, homeownership, and consumption for most Black households in the steady state, as they transition out of homeownership and into the lower-opportunity area.[6] Ultimately worsening the racial wealth gap, the impact is larger because Black borrowers tend to be closer to the leverage constraint, and hence less able to increase their mortgage debt and remain owners.

Our final step is to study a series of policy experiments aimed at addressing housing and wealth disparities. To address the spatial mismatch of Black borrowers into the low-opportunity housing stock that our model highlights, we first consider policies that lower moving frictions between areas and help households "move to *wealth* opportunity."[7] Our results show that such approaches are effective in reducing Black-white wealth gaps but, interestingly, do so by decreasing homeownership among Black households. When moving frictions fall, some households choose to forgo homeownership in the low-opportunity area to rent and earn higher incomes in the high-opportunity area. These households save more of their labor income, and those that do ultimately choose homeownership are wealthier and have lower leverage. In this sense, reducing moving frictions lowers misallocation by putting workers in locations where they are more productive.

Beyond this policy, we further analyze a set of more conventional tools such as mortgage rate subsidies and place-based labor market policies, as well as reparation-style transfers to Black buyers. As a whole, these policies demonstrate that relaxing Black households' constraints leads them to relocate to high-opportunity areas, which ultimately results in improved wealth accumulation. They also highlight a set of tensions that stem from the fact that wealth, homeownership, and welfare are not synonymous. It is possible for housing policies to simultaneously increase wealth, homeownership, and consumption, such as with mortgage rate subsidies or reparations. Policies that lower moving frictions can increase wealth and consumption while decreasing homeownership. Other policies can also increase wealth, but lower both homeownership and consumption, hence welfare, because households are forced to save, such as with the phasing out of FHA mortgages. These tensions underscore the pitfalls of a narrow focus on improving homeownership gaps, as often advocated by policymakers, at the expense of underlying gaps in wealth,

[6] Increases in house prices in high opportunity areas can be thought of as a "gentrification" shock (Guerrieri *et al.*, 2013), to the extent that they ultimately stem from increased demand for areas with strong labor markets, and have potential displacement consequences.

[7] Policies promoting "moving to opportunity" traditionally focus on income. They typically combine improving movers' information about geographic areas, search assistance, and financial incentives (e.g., Bryan *et al.* (2014), Bergman *et al.* (2019)).

consumption, or welfare.

Our model makes several assumptions to match key moments and preserve tractability, each of which we relax in robustness tests. First, and perhaps most importantly, the takeaways from our model are not driven by differences in preference parameters across groups. We find qualitatively similar results when equating tastes for homeownership and moving shocks across areas and races. Second, our baseline model focuses on the central role of LTV constraints, and so does not include payment-to-income (PTI) limits; our results are robust to this additional feature. Third, while our model features differences between racial groups along several dimensions, we do not consider explicit racial discrimination in the mortgage supply decision. Our results are consistent, and even exacerbated, when introducing discrimination in mortgage rates. Fourth, our baseline assumption is that individuals receive the full geographic income difference when they move across areas, which may overstate the causal role of place. We weaken this assumption using recent evidence drawn from mover designs. Fifth, we accommodate the possibility that higher leverage comes with higher interest rates, which makes debt less attractive. Finally, our results are robust to including risky housing returns, which provide additional wealth building benefits to homeownership.

**Related literature** Our paper contributes directly to two broad literatures. The first is a resurgence of work studying the Black-white wealth gap generally, and the Black-white housing gap in particular. While there has long been both empirical and theoretical work considering the gap in housing wealth (see, e.g. Gyourko *et al.*, 1999; Charles & Hurst, 2002; Collins & Margo, 2011; Garriga. *et al.*, 2017; Stein & Yannelis, 2020), 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), and refinancing propensities (Gerardi *et al.*, 2021a,b). Recent studies have also explored the role of racial disparities in mortgage access, with mixed results—Giacoletti *et al.* (2022) shows evidence of discrimination in approvals and Bartlett *et al.* (2021) finds evidence of racial disparities in interest rates, while Bhutta & Hizmo (2021) argues these rate differences can be accounted for by racial differences in the take-up of mortgage points.

We add to this literature by providing a sufficiently rich structural framework in which to evaluate policy experiments aimed at explaining and tackling the racial wealth gap via the housing channel. Our model addresses the identification challenge of quantifying the contributions of housing and mortgage factors to the wealth gap in the absence of a counterfactual in the data. In particular, we bring the role of leverage differences to the forefront in considerations of the Black-white housing gap. Prior literature has emphasized the ambiguous effects of financial variables on wealth inequality; and in particular of lower interest rates on increasing wealth inequality through a discount rate channel (Gomez & Gouin-Bonenfant, 2020; Greenwald *et al.*, 2021). We also consider the role of valuation effects in the context of variation across groups in the extent to which financial constraints bind.

Second, we also connect to a large literature modeling housing decisions with heterogeneous households and incomplete markets which analyzes mortgage regulation. This includes Favilukis *et al.* (2017), Greenwald (2018), Corbae & Quintin (2015), Kaplan *et al.* (2020), Greenwald *et al.* (2020), Gete & Zecchetto (2018), Halket & Vasudev (2014), Cocco (2005), Chen *et al.* (2019), Mabille (forthcoming), and Favilukis *et al.* (forthcoming). Our contribution to this literature comes from the $2 \times 2$ structure of our spatial life-cycle model, which allows heterogeneity in both demographic groups and location choices. The result is a novel analysis of the interaction of leverage constraints and moving frictions, and how they affect wealth accumulation between demographic groups.

Our paper proceeds as follows. In Section 2, we present stylized facts on the Black-white leverage gap and the role of the FHA. In Section 3, we describe our structural life-cycle model of housing choice, and we discuss the calibration in Section 4. Section 5 presents the results and policy implications, and Section 6 discusses robustness. We conclude in Section 7.

# 2 Stylized Facts: The Black-White Leverage Gap and the FHA

We begin by documenting the central stylized fact that motivates our analysis: minority borrowers have substantially higher leverage than white borrowers at the time of mortgage origination. The ability to accurately and comprehensively measure these racial differences in leverage has been made possible by recent changes in Home Mortgage Disclosure Act (HMDA) data reporting. We then show that high leverage loans are, in turn, facilitated by mortgages originated through the Federal Housing Administration (FHA), which are disproportionately used by minority borrowers. White borrowers, by contrast, are often able to rely on intrafamily transfers or other sources of wealth to make sizable down payments. The reliance on FHA mortgages, and the existence of caps on the size of FHA loans, constrains the price of homes that high leverage and minority borrowers are able to purchase, limiting access to high-cost, high-opportunity neighborhoods.

## 2.1 Data Description

We combine several sources of micro-data to document stylized facts and calibrate our structural model. To establish basic facts about racial housing gaps on a relatively comprehensive sample, we make use of

HMDA data, which captures close to the full universe of mortgage originations. Financial institutions report HMDA data under a range of requirements, such as assets above a limit, which vary for depository and non-depository institutions. Because HMDA was developed due to concerns about possible disparities in credit access for minority and urban borrowers, it contains comprehensive race information which we use extensively. Key limitations in HMDA, however, include historic gaps in coverage of LTV (because house price was not collected). This variable was collected from 2018 onwards, allowing us to measure the relationship between race and leverage in more recent periods.

To connect information on borrowers over time and measure moving rates, we use Infutor data (as discussed in Diamond *et al.*, 2019). Unlike most traditional housing datasets, this is distinctive in having information on renters, as well as homeowners, and in measuring transitions across housing stocks over time. We also use Deeds records, taken from Zillow's Transaction and Assessment (ZTRAX) dataset, and draw on local income and demographic information from the American Community Survey (ACS).[8] Finally, we draw on the Survey of Consumer Finance and the Survey of Consumer Finances Plus (SCF+)—a recently created compilation of historical extracts of the SCF survey going back to 1949 (as described in Kuhn *et al.* (2020), and used to explore long-term racial differences in wealth in Derenoncourt *et al.* (2022)).

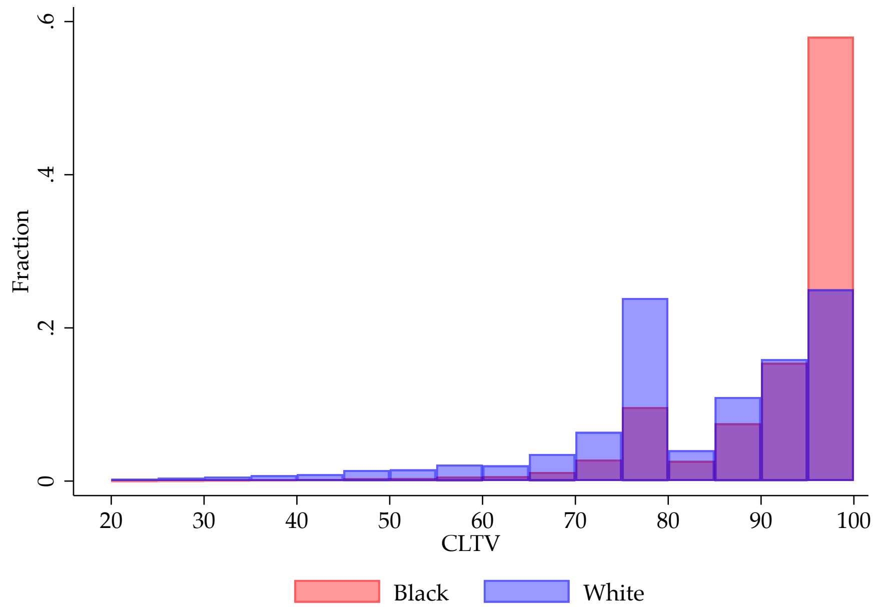
## 2.2 Racial Gaps in Leverage

Our first step is to establish the core motivating fact of our analysis: the existence of a substantial gap in leverage between Black and white homeowners. Panel A of Figure 1 presents direct evidence of this gap, plotting the distribution of leverage at origination across the two groups. A substantial fraction of Black borrowers—nearly 60%—have initial combined loan-to-value-ratios (CLTV) above 95 (percent). By contrast, less than 30% of white borrowers have this level of high leverage. Indeed, the median CLTV for Black borrowers is 96.5 (vs. 90 for white borrowers).[9] These differences persist and even grow beyond origination. For example, median LTV for Black borrowers with mortgage debt in the SCF+ in 2016 is roughly 66, compared to 52 for white borrowers. The concentration of minority borrowers with high leverage—particularly Black borrowers, but also Hispanic borrowers—is especially stark when examining the racial composition of borrowers across the LTV distribution. 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. The association between Black borrowers and leverage—especially very high leverage—persists after including other natural controls, as we show in Appendix Table A.I.

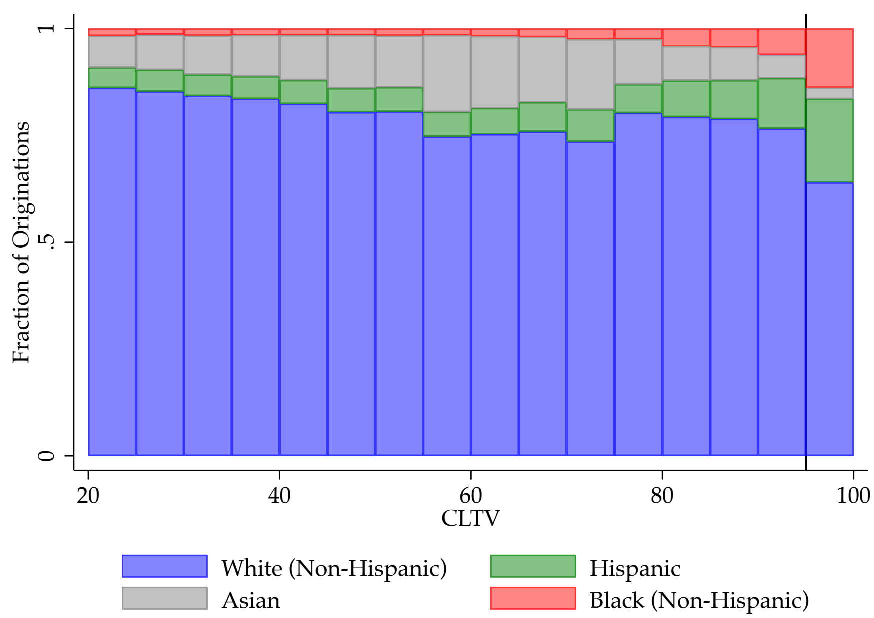
[8] See: `www.Zillow.com/data`.

[9] High leverage mortgages are also common among Hispanic borrowers, although to a lesser extent. See Appendix figure A.I. These statistics, and all others in this section, except where otherwise indicated, are drawn from the 2018 HMDA sample of new purchase mortgages, excluding VA, FSA and RHS loans.

FIGURE 1: THE BLACK-WHITE LEVERAGE GAP




PANEL A: COMBINED LTV AT ORIGINATION FOR BLACK AND WHITE BORROWERS




PANEL B: BORROWER COMPOSITION ACROSS THE LEVERAGE DISTRIBUTION

*Notes:* Panel A plots the distribution of leverage at origination for Black and white borrowers with new purchase mortgages from 2018 HMDA data. Panel B plots the fraction of borrowers across racial and ethnic groups within 5-point bins of initial combined loan-to-value. In both figures, the sample excludes VA, FSA, and RHS loans.

Origination leverage is one of the two main margins on which borrowers may face constraints in the mortgage application process. LTV reflects the extent to which borrowers have pre-existing savings to make down payments. The other constraint is typically in terms of payment-to-income (PTI), which captures the loan burden relative to current flow income. Greenwald (2018) shows that both LTV and PTI constraints matter across the time-series. We find, however, that that racial differences in PTI appear to be less salient than for LTV (see Appendix Figure A.II).[10] This motivates our focus on an LTV constraint in our baseline structural model. In Section 6 we extend our results to include a PTI constraint.

The presence of large Black-white differences in leverage indicate that the racial housing gap goes beyond well-studied differences in home ownership. Disparities exist not just in whether Black and white households own their homes, but also in how buyers finance their purchase. These differences are likely the consequence, at least in part, of pre-existing and historically determined differences in wealth. For example, SCF data from 2019 shows (Bhutta *et al.*, 2020) that Black and Hispanic families are much less likely to receive inheritances, gifts, and other family support. 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. Naturally, households' financing choices for the home purchase decision and expected inheritance income may impact wealth accumulation, location, income and mobility, all of which we explore in more detail below.

### 2.3 The FHA Provides a Dominant Channel for High Leverage Loans

We next turn to examining the channels through which borrowers, and particularly Black borrowers, access high leverage loans. While conventional mortgages through Fannie Mac and Freddie Mae do allow high leverage mortgages; down payments of less than 20 percent require costly private mortgage insurance. Mortgages originated through the Federal Housing Administration (FHA) system, by contrast, enable down payments as little as 3.5—an initial LTV of 96.5—for borrowers with credit scores of at least 580.[11] The FHA system was created in the wake of the Great Depression, when private lenders typically required much higher down payments for private mortgages. The popularity of the FHA mortgage system has varied over

[10] An important caveat is that we are only able to measure front-end ratios, given our data. An important question for future research is whether racial differences exist in the degree to which constraints on back-end ratios bind.

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

time—it was quite low, for example, prior to the financial crisis of 2008 given the availability of subprime and Alt-A mortgages—but it has generally performed an important role in mortgage access for first-time and low-income borrowers. While FHA mortgages do also charge mortgage insurance for high leverage borrowers (including both an upfront, as well as a recurring insurance payment)—the size of the insurance payment is inflexible to changes in borrower risk.[12]

As a result, a significant fraction of high leverage loans are originated through the FHA. While FHA loans represent only 2 percent of mortgages with initial CLTV below 90, they make up nearly 40 percent of those with initial CLTV over 90, and over 50 percent of those with initial CLTV over 95. The reliance of borrowers on the FHA for very high leverage loans can be seen in more detail in Appendix Figure A.III, which plots the distribution of initial leverage for both conventional and FHA loans. There is a significant clustering precisely at the limit of 96.5 for FHA loans. Alternatively, the modal conventional loan has an initial CLTV of 80.

Given their relatively high leverage, the FHA is a key channel for black borrowers—it is not a coincidence that the median CLTV is precisely 96.5. Roughly 45 percent of all new originations for Black Households are FHA loans (compared to under 20 percent for white households).

### 2.4 FHA Loan Limits Constrain Housing Choices for High Leverage Borrowers

While the FHA allows borrowers a relatively low-cost way of accessing high leverage loans, it is not available for all home purchases. The FHA imposes loan caps that limit the amount a household is able to borrow. These limits are similar in spirit to more commonly studied conforming loan caps (see, e.g. Buchak *et al.*, 2018). The FHA loan limit varies across counties, with (i) a nationwide floor ($356,362 for the year 2021), a nationwide ceiling ($822,375 in 2021), and thresholds set at 115 percent of last year's median home price for counties between the floor and ceiling.[13]

A consequence of these limits is that borrowers who choose high leverage mortgages through the FHA system are constrained to the FHA-eligible housing stock. As a result, homes buyers with high LTVs at origination are typically concentrated in housing below the local FHA limit, and there is evidence of bunching at the limit itself. This pattern is evident in Panel A of Figure 2, which shows the distribution of loan sizes for high leverage loans (initial CLTV greater than 95), relative to county-specific loan limits.[14]

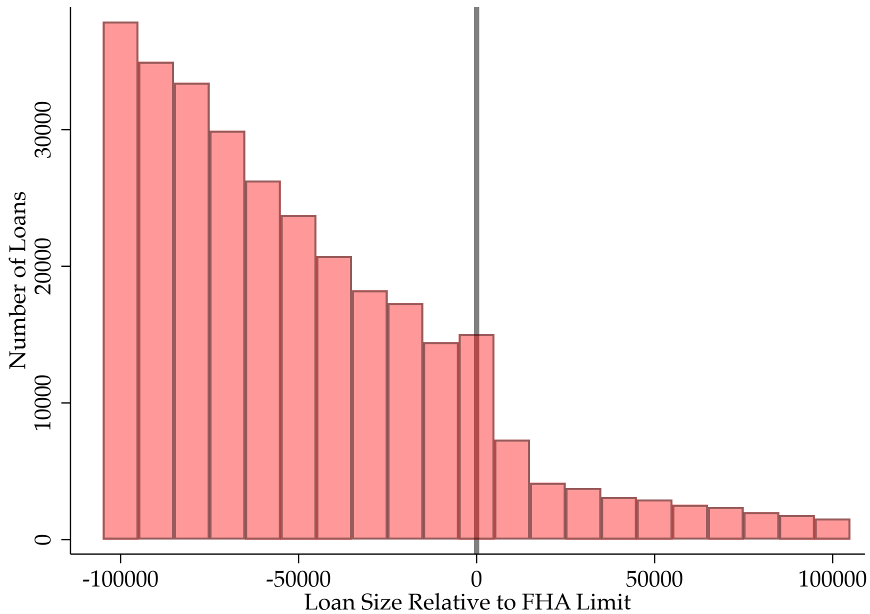
This loan cap also constrains the housing stock accessible to Black homeowners. Panel B of Figure 2

[12] Another possible justification for the need for the FHA's high leverage limits is greater uncertainty about collateral values for the older and less-standardized homes in which constrained borrowers tend to be located, which limits private mortgage access (Jiang & Zhang, 2022).

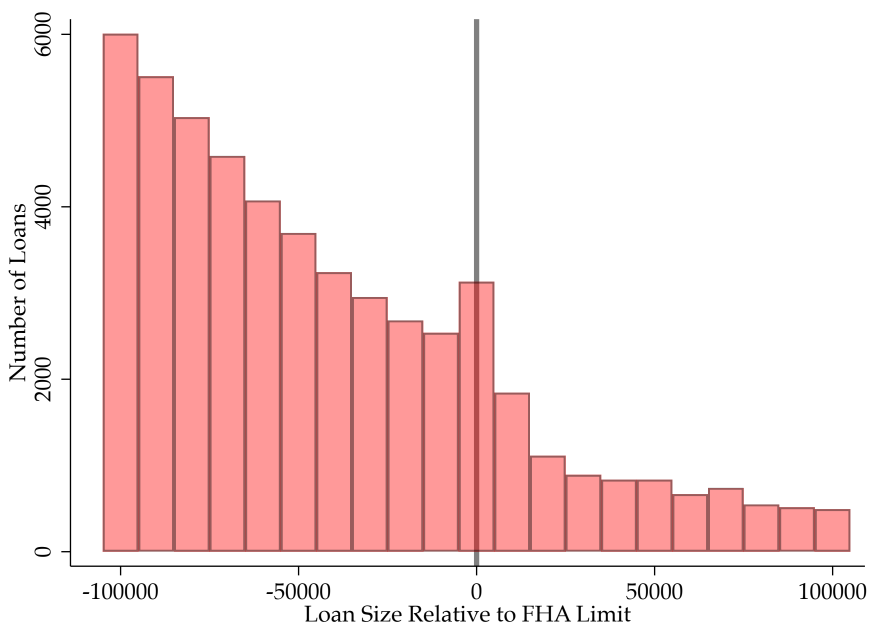
[13] See: `https://www.hud.gov/press/press_releases_media_advisories/HUD_No_20_201`. Appendix Figure A.IV shows changes in the nationwide limit over time.

[14] A similar bunching pattern is also evident in raw loan sizes around the nationwide floor, as shown in Appendix Figure A.V.

**FIGURE 2: HIGH LEVERAGE AND BLACK BORROWERS ARE CONSTRAINED BY THE FHA LIMIT**




**PANEL A: HIGH LEVERAGE LOANS (95+ CLTV) – LOAN SIZE RELATIVE TO THE FHA LIMIT**




**PANEL B: BLACK BORROWERS – LOAN SIZE RELATIVE TO THE FHA LIMIT**

*Notes:* Panel A plots the distribution of loan size at origination relative to the local county FHA limit for loans with initial combined LTV at or above 95. Panel B plots the distribution of loan size at origination relative to the local county FHA limit for Black borrowers. In both figures, the sample is drawn from 2018 HMDA data and excludes VA, FSA, and RHS loans.

shows evidence of substantial bunching for Black borrowers at the FHA loan limit, with a large fraction also choosing loans below the limit itself. This indicates that Black households' home purchase decisions are distorted by the availability of high-leverage loans provided through the FHA. The FHA appears to facilitate home purchases and allow relatively low wealth households to become homeowners, underscoring the role that access to leverage plays in the choice to purchase a home. However, bunching suggests that the lack of a corresponding channel for relatively high priced homes prevents otherwise interested Black buyers from accessing significant portions of the housing stock.[15]

## 2.5 Leverage Constraints, Geographic Sorting, and the FHA

We next show that the lack of access to high-leverage mortgages distorts the location choices of homeowners—and particularly Black homeowners—across communities.[16] The reliance of Black borrowers on high leverage mortgages, and the limitations of the FHA program, suggest that Black households may face challenges in accessing high opportunity geographic areas. The idea that minority borrowers face spatial segregation with consequences for labor market participation is a central feature of standard models of urban economics, going back at least to Kain (1968) (see Glaeser *et al.*, 2004, for a more recent appraisal of this work). Housing markets feature strong segregation, as a consequence both of active discrimination in housing markets and borrower sorting. This allocation, in turn, reduces access to high-quality jobs and other opportunities for minority borrowers within and across metropolitan areas.

Our contribution to this literature is to highlight that sorting is amplified by leverage constraints (and by the variation in leverage constraints generated by the FHA). If home prices are correlated with local labor market opportunities, the existence of any leverage constraint will ration access to homeownership (and associated local opportunities in the labor market and other domains) on the basis of current wealth.[17] While households may be able to partially access local amenities via the rental market, doing so forces a tradeoff between place based opportunities and the benefits of homeownership. Consequently, location choices will be distorted relative to a world in which households can borrow against lifetime wealth.

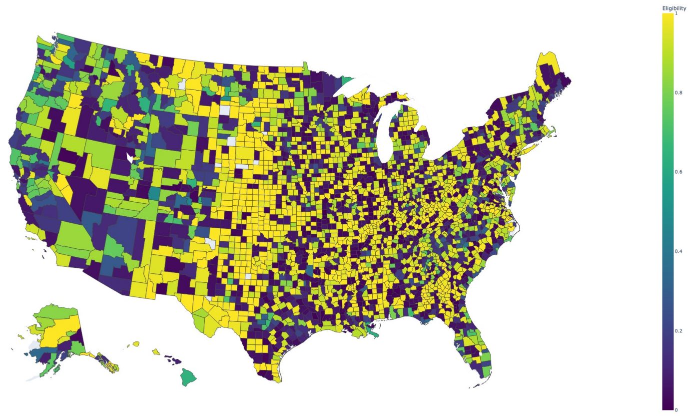
The structure of FHA limits further amplifies sorting, because a significant fraction of homes in higher priced areas may be ineligible for purchase with a high leverage FHA loan. Typically, widespread ineligibility occurs because either (i) most house prices in these areas are above the nationwide ceiling, or (ii) prices

[15] These estimates suggest that borrowers are not neutral across all loan origination channels; but that the FHA plays a unique role in facilitating high-leverage borrowing by individuals who, as a consequence, are clustered at lower loan and house sizes. We see further evidence of this sorting in Appendix Figure A.VI, which shows the fraction of borrowers at each part of the loan size distribution by race. Minority borrowers are disproportionately represented in the lower part of the loan size distribution; higher loan sizes largely go to white borrowers.

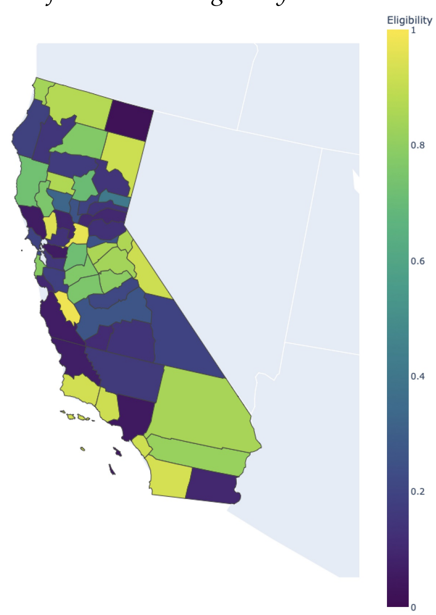
[16] Of course, sorting across housing stocks even within metro-areas can have important consequences for inequality. See, e.g., Fogli & Guerrieri (2019).

[17] Assuming workers are also unable to borrow against future labor income.

*Panel A: National FHA Eligibility*



*Panel B: California FHA Eligibility*




*Panel C: San Francisco FHA Eligibility*

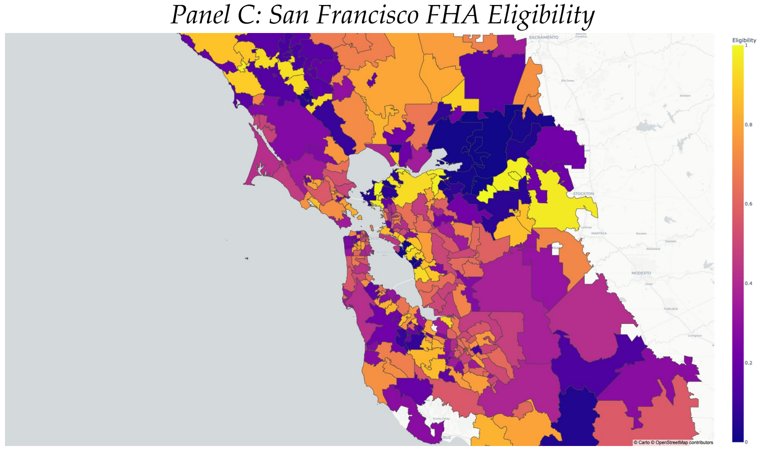


**FIGURE 3: FHA ELIGIBILITY BY GEOGRAPHY**

*Notes:* This figure shows the fraction of homes from 2018 HMDA data eligible to be purchased with a 96.5% FHA loan. To determine eligibility, we compare the house purchase price against the county-specific FHA loan limit.

in desirable communities are significantly above the median cap for the county as a whole. This generates a barrier to accessing high priced areas. In Figure 3, we highlight the fraction of mortgage financed purchases across the United States in 2018 (also zooming in on California and San Francisco, as an example) which, in principle, could have been financed with a 96.5% FHA loan. In many counties, especially rural counties, virtually all homes are theoretically accessible through the FHA, because the federal FHA loan cutoff is not binding. The cutoff, however, is much more likely to bind in urban areas that feature high quality jobs. Despite the fact that high-cost counties have higher localized FHA limits, we still observe that centers of dense high-income metropolitan areas such as San Francisco have a small fraction of transacting properties that are accessible through the FHA program.

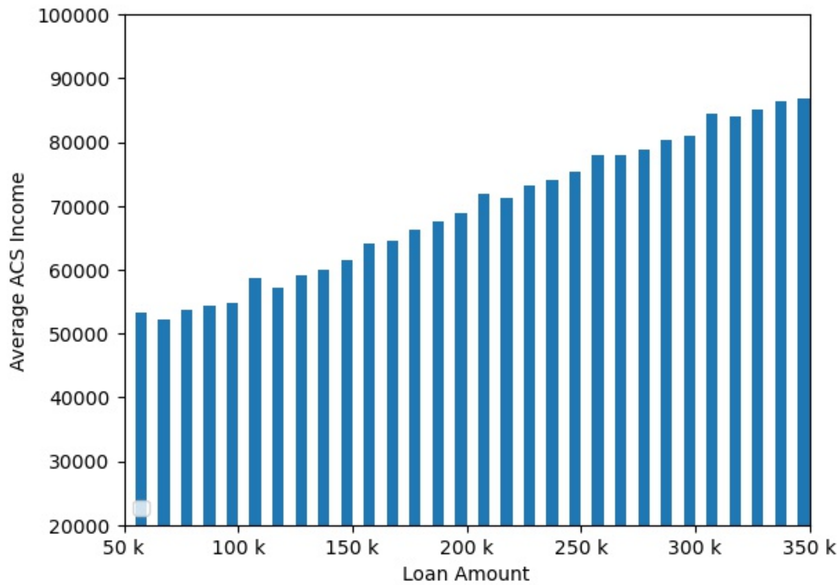
The distortions in location choices generated by leverage constraints impact labor market access. Unlike other assets, residential real estate is unique in combining a financial return and a fixed residence. Because individuals are limited by commute times, access to centrally located housing stock is an essential prerequisite for job opportunities. In Panel A of Figure 4, which plots loan sizes against zip-level income, we show that larger loans are indeed associated with higher income areas in the data. This is unsurprising, as labor market opportunities should be capitalized into housing prices, and higher prices require larger loans. Of course, there is likely to also be selection of productive workers into higher-priced housing stocks, but recent research (Card *et al.*, 2021; Bilal & Rossi-Hansberg, 2021) suggests that a non-trivial portion of income differences is causally driven by location.[18]

Leverage constraints appear to shift borrowers away from locations with strong labor market opportunities. Despite the positive relationship between loan sizes and income, Panel B of Figure 4 shows that high leverage borrowers tend to purchase homes in neighborhoods with lower incomes. In particular, bowers with loan-to-value ratios above 80% tend to purchase homes in lower-income neighborhoods. This reflects both the wealth of borrowers who require high leverage, and the structure of the FHA program.

Overall, our findings highlight previously overlooked leverage differences across racial groups. Because of differences in wealth early in life—which is in part the consequence of differences in bequests—white borrowers are able to afford larger down payments, on average. The presence of leverage constraints at origination therefore restricts Black home-buyers to smaller sized loans for cheaper homes that are further from job opportunities. Because this financial constraint limits Black borrowers ability to access location-based income prospects, it may limit the growth of income and wealth over the life-cycle. By allowing high leverage in relatively low cost areas, the FHA is able to relax the constraint to some degree. However,

[18] In Appendix Figure A.VII, we show that the same is true for the *individual* income of borrowers with large loan amounts. Similarly, we find that individual borrowers that choose high leverage mortgages tend to have lower incomes. We also show, in Appendix Table A.II that higher loan sizes are broadly associated with improved access to opportunity on several measures: including local job access, school quality, and causal measures of upward mobility.

*Panel A: Income Against Loan Amount*




*Panel B: Income Against LTV*

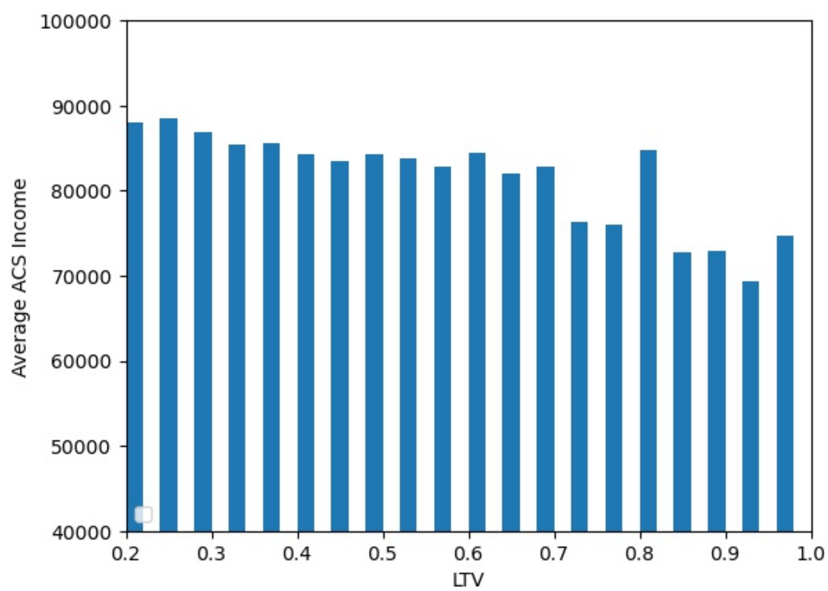



**FIGURE 4: LEVERAGE AND INCOME**

*Notes:* In this figure we show the relationship between neighborhood income, measured using tract-level income in the ACS, and loan size (Panel A) or LTV (Panel B).

the heavy reliance of Black borrowers on these loans shines a light on how tightly the leverage constraint binds—and how distortionary the existence of conventional leverage constraints are for access to higher-cost housing stocks and neighborhoods.

A caveat to these results, so far, is that we are limited in our ability to causally determine the consequences of financial constraints on outcomes for Black borrowers. Instead, our objective in this section is to demonstrate the sorting of borrowers along the dimensions of leverage, loan product, and neighborhood income. We next explore the implications of this sorting in the context of our structural model.

# 3 Two-by-Two Model of Housing Markets

Motivated by the stylized facts in the previous section, this section describes a $2 \times 2$ life-cycle model of U.S. housing markets. Households exogenously belong to two demographic groups, which correspond to Black and white populations, with different initial wealth and income conditions. Across their life-cycles, they endogenously sort across two types of housing stocks, which correspond to FHA-eligible and non-eligible housing, and are respectively located in low- and high-opportunity areas. The degree to which households accumulate wealth depends jointly on their choices of housing stock, home ownership, leverage, and savings. These choices, in turn, depend on their initial demographic groups and locations, and within those, on households' age, income, wealth, and home ownership.

The goal of our spatial life-cycle model is to capture the consequences of financial constraints for long-run outcomes, including wealth, income, location, and consumption. The central friction is that, in the presence of leverage constraints, demographic groups with low levels of initial wealth will find it difficult to access more expensive housing stocks, especially when these housing stocks also have tighter leverage requirements as in the data. 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 helps determine 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 also offer higher labor market returns, which allow households to save more every period and accumulate wealth faster.

## 3.1 Environment

The $2 \times 2$ endowment economy is populated by overlapping generations of heterogeneous risk-averse households with a life-cycle. Households belong to two demographic groups and purchase housing from two different stocks. Markets are incomplete, and prices are exogenously set to match their values in the data. Population size is stationary, and there is a continuum of measure 1 of households who have 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, while retirees earn pension income, which is lower on average.

**Preferences** Households have constant relative risk aversion (CRRA) utility preferences, over a constant elasticity of substitution (CES) aggregator of nondurable consumption $c_t$ and housing services $h_t$. 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 $h_t \in \left(0, \overline{h}\right]$. Households are subject to taste shocks which capture, all else equal, all unmodeled costs and benefits of home ownership (including any discriminatory barriers), and differ between demographic groups and housing stocks. They are also subject to moving cost shocks which affect their propensity to switch between housing stocks, and differ between them. These two shocks are modeled as additive utility shifters with respective averages given by the $2 \times 2$ and the $2 \times 1$ matrices $\Xi$ and $m$. These parameters help with the quantitative fit of the model, but they are not necessary for our main mechanism.[19] A household's instantaneous utility function is given by:

$$\frac{u\left(c_t, h_t\right)^{1-\gamma}}{1-\gamma} + \Xi - m \equiv \frac{\left[\left((1-\alpha)c_t^{\epsilon} + \alpha h_t^{\epsilon}\right)^{\frac{1}{\epsilon}}\right]^{1-\gamma}}{1-\gamma} + \Xi - m. \tag{1}$$

**Endowments and risk** Households face idiosyncratic income risk and mortality risk. Their survival probabilities $\{p_a\}$ vary over the life-cycle. Bequests accidentally arise when households die, and they are redistributed to young workers within the same demographic group. Homeowners must fully repay their mortgage before dying.

For workers, the logarithm of income for household $i$ at date $t$, when they are at age $a$, belong to demographic group $g$, and live in area (or, equivalently, housing stock) $j$ is given by:

$$\begin{aligned}
y_{i,a,j,g,t} &= g_a + \mu_g + \mu^j + e_{i,t}, \\
e_{i,t} &= \rho_e e_{i,t-1} + \varepsilon_{i,t}, \\
\varepsilon &\overset{iid}{\sim} \mathcal{N}\left(0, \sigma_\varepsilon^2\right).
\end{aligned} \tag{2}$$

Households receive income depending on their age, idiosyncratic shocks, demographic group, and housing

[19] Our first robustness test in Section 6 eliminates the home ownership shocks and the moving frictions. In the baseline model, these parameters are calibrated to match the home ownership rates for each demographic group and the moving rates between the two housing stocks, which both affect households' wealth.

stock. $g_a$ is the log of the deterministic life-cycle income profile. $e_{i,t}$ is the log of the persistent idiosyncratic component of income for household $i$. $\varepsilon_{i,t}$ is the log of the i.i.d. idiosyncratic component of income for household $i$, which is drawn from a Normal distribution with mean zero and standard deviation $\sigma_\varepsilon$. $\mu_g$ is a racial income shifter which differs between Black and white households, and $\mu^j$ is a spatial income shifter which differs between low- and high-opportunity areas. Different areas, as a consequence, boost individual income (e.g., Bilal & Rossi-Hansberg (2021)). We interpret these location specific shifters as representative of real productivity throughout. Retirement income is modeled to replicate the main features of the U.S. pension system (Guvenen & Smith, 2014).

**Household balance sheets** Households can invest in a financial asset with a risk-free rate of return $r > 0$ and in real estate to accumulate wealth. Investments in the risk-free asset face a no-borrowing constraint, such that households cannot borrow against their future income unless they buy a house. Renters who buy can use long-term amortizing mortgages to borrow, subject to LTV constraints which only apply at origination. They face an exogenous mortgage rate $r^b > r$, which implies that mortgage borrowers first pay back their debt before holding risk-free assets.[20] We denote $\tilde{r} = r$ if net savings $b_{t+1}$ are positive, and $\tilde{r} = r^b$ if households borrow. The amortization schedule of mortgages is exogenous, and they must be fully repaid when old households die. Mortgages are non-recourse; if borrowers default, they face a utility cost and subsequently become renters in the same area.

**Home ownership** Home ownership comes with three benefits. First, the owner-occupied and the rental stocks are segmented (e.g. Greenwald & Guren, 2021). Owning allows buyers to access larger homes producing more valuable housing services. 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.[21] Third, owning gives households exogenous utility benefits captured by $\Xi$. These motives are consistent with the empirical literature on home ownership (e.g., Goodman & Mayer, 2018; Sodini *et al.*, 2021).

**Two-by-two housing markets** Households have an exogenous probability of belonging to either of the two demographic groups $g$, which correspond to Black and white households. The two groups differ in the probability a household begins the model in either the high- or low-opportunity areas, in their initial

[20] The assumption that mortgage borrowers cannot save accounts for the large fraction of "wealthy hand-to-mouth" households with little liquid assets in the data (Kaplan & Violante (2014)).

[21] When the owner-occupied and rental markets are fully 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. Since owners can better smooth their housing expenditures compared to renting, this motive stands for owner-occupied housing being a hedge against rent risk (Sinai & Souleles (2005)).

wealth, in their average income (due to the racial income shifter), and in their average home ownership shocks, which capture unmodeled costs and benefits associated with home ownership.

Households from the two groups may choose to live in either of the two areas (housing stocks) which differ in house prices and rents, opportunity (as measured by average income, due to the spatial income shifter), and moving costs between areas. The two housing stocks are associated with two types of long-term, fully amortizing mortgages with different LTV limits, which correspond to FHA-eligible and non-eligible loans.

**Household choices** Households make decisions each period on whether to move between housing stocks, to buy or own within each housing stock, and to default on their mortgage if they have one. Owner-occupied units come in a single size $\overline{h}$ (normalized to 1) at price $P_j$ in housing stock $j$. Rental size can be chosen continuously in $\left(0,\overline{h}\right]$ at rent $R_j$. They also choose nondurable consumption $c_t$, and save in a risk-free liquid asset $b_t > 0$ or borrow with a long-term mortgage $b_t < 0$. Combined with the fixed costs of moving and of housing transactions, the discrete choices of home ownership and housing stock lead to inaction regions (e.g., Arrow *et al.* (1951)), whereby households with a given combination of state variables keep their current discrete choices, while others switch between housing stocks and home ownership statuses.

**Timing** A household located in a given housing stock makes discrete choices for their next housing stock and home ownership, earns labor and financial income in their area of origin, and then makes consumption and housing size choices, as well as debt or savings choices.

## 3.2 Household Problem

This subsection describes the household problem laid out above in recursive form. The individual state variables are their demographic group $g$, home ownership status $\mathcal{H} = r, o$ (renter or owner), housing stock $j = L, H$ (low- or high-opportunity area), age $a$, net asset position $b$, and endowment $y$. We describe the problem for the low-opportunity area $L$ (FHA housing) and a given investor group $g$. The problem is similar for the high-opportunity area $H$ (non-eligible housing).

### 3.2.1 Renter

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

$$V_g^{rL}(a, b_t, y_t) = \max \left\{ V_g^{rL,rL}, V_g^{rL,rH}, V_g^{rL,oL}, V_g^{rL,oH}. \right\} \tag{3}$$

Denote $d_g^{rL} \in \{rL, rH, oL, oH\}$ the resulting policy function for the discrete choice problem. Then, renters choose nondurable 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

$$V_g^{rL,rL}(a, b_t, y_t) = \max_{c_t, h_t, b_{t+1}} \frac{u\left(c_t, h_t\right)^{1-\gamma}}{1-\gamma} + \beta p_a \mathbb{E}_t \left[ V_g^{rL}(a+1, b_{t+1}, y_{t+1}) \right], \tag{4}$$

subject to the constraint that expenses on nondurable consumption, rented housing services, and savings, must be no lower, and at the optimum equal to, resources from labor income and financial income from risk-free assets

$$c_t + R_L h_t + b_{t+1} = y_t + (1+r) b_t, \tag{5}$$

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

$$b_{t+1} \geq 0, \quad h_t \in \left(0, \bar{h}\right]. \tag{6}$$

Expectations are taken with respect to the conditional distribution of idiosyncratic income shocks at date $t$. Since the household does not own a house, bequests left with probability $1 - p_a$ only include financial wealth $b_{t+1}$.

*Renter moving between housing stocks.* When moving to housing stock $H$ and staying a renter, a renter incurs a moving cost $m_H$ in utility terms and faces the continuation value function in housing stock $H$:

$$\begin{aligned} & V_g^{rL,rH}(a, b_t, y_t) = \max_{c_t, h_t, b_{t+1}} \tfrac{u(c_t, h_t)^{1-\gamma}}{1-\gamma} - m_H + \beta p_a \mathbb{E}_t \left[ V_g^{rH}(a+1, b_{t+1}, y_{t+1}) \right], \\ & \text{s.t. } \; c_t + R_L h_t + b_{t+1} = y_t + (1+r) b_t, \\ & b_{t+1} \geq 0, \quad h_t \in \left(0, \bar{h}\right]. \end{aligned} \tag{7}$$

*Home buyer.* When buying a house in the same housing stock, the renter's value function is

$$V_g^{rL,oL}(a, h_t, b_t, y_t) = \max_{c_t, h_t, b_{t+1}} \frac{u\left(c_t, h_t\right)^{1-\gamma}}{1-\gamma} + \beta p_a \mathbb{E}_t \left[ V_g^{oL}(a+1, b_{t+1}, y_{t+1}) \right]. \tag{8}$$

In addition to rental services purchased at rate $R_L$, the household buys owner-occupied housing at price $P_L$,

$$c_t + R_L h_t + F_m + P_L \overline{h}(1 + f_m) + b_{t+1} = y_t + (1 + r^f) b_t, \quad h_t \in \left(0, \overline{h}\right], \tag{9}$$

using a mix of savings accumulated over the life-cycle, and of long-term mortgage debt $b_{t+1}$ borrowed at rate $r^b$, subject to fixed and proportional origination fees $F_m$ and $f_m$, and the LTV constraint in FHA housing $\theta^L_{LTV}$ (low-opportunity area),

$$b_{t+1} \geq -\theta^L_{LTV} P_L \overline{h}. \tag{10}$$

$\theta_{LTV}$ is the maximum fraction of the house price in area $L$ which the household can borrow, so $1 - \theta_{LTV}$ is the down payment requirement. The constraint only applies at origination, and may be violated in subsequent periods in response to income shocks and house price movements. Every period, homeowners with a mortgage pay interests and roll over their current debt subject to the requirement that they repay at least a fraction $1 - \theta_{am}$ of the principal,

$$b_{t+1} \geq \min\left[\theta_{am} b_t, 0\right]. \tag{11}$$

The lowest payment that households can make in a period therefore equals $\left(1 + r^b - \theta_{am}\right) b_t$. Bequests left with probability $1 - p_a$ include financial and housing wealth $(1 + \tilde{r}) b_{t+1} + P_L \overline{h}$.

*Home buyer moving between housing stocks.* The value of moving to housing stock $H$ and buying a house is similar, with the addition of the moving cost $m_H$:

$$V^{rL,oH}_g(a, b_t, y_t) = \max_{c_t, h_t, b_{t+1}} \frac{u\left(c_t, h_t\right)^{1-\gamma}}{1-\gamma} - m_H + \beta p_a \mathbb{E}_t \left[V^{oH}_g(a+1, b_{t+1}, y_{t+1})\right], \tag{12}$$

subject to the budget constraint, and the LTV constraint in the non-eligible housing stock $\theta^H_{LTV}$ (high-opportunity area):

$$\begin{aligned} &c_t + R_L h_t + F_m + P_H \overline{h}(1 + f_m) + b_{t+1} = y_t + (1 + r^f) b_t, \quad h_t \in \left(0, \overline{h}\right], \\ &b_{t+1} \geq -\theta^H_{LTV} P_H \overline{h}. \end{aligned} \tag{13}$$

### 3.2.2 Homeowner

The problem for existing home owners has a similar structure. Denote the value function of an owner starting the period in stock $L$, as $V^{oL}_g(a, b_t, y_t)$. They choose to either default, remain an owner, or sell the house and become a renter. If they leave their residence, they choose the housing stock to which they move over the period:

$$V_g^{oL}(a, b_t, y_t) = \max\left\{V_g^{oL,oL}, V_g^{oL,oH}, V_g^{oL,rL}, V_g^{oL,rH}, V_g^{oL,d}\right\}. \tag{14}$$

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 home owner in housing stock $L$ is given by the Bellman equation with fixed housing services $\overline{h}$,

$$V_g^{oL,oL}(a, b_t, y_t) = \max_{c_t, b_{t+1}} \frac{u\left(c_t, \overline{h}\right)^{1-\gamma}}{1-\gamma} + \Xi_g^L + \beta p_a \mathbb{E}_t\left[V_g^{oL}(a+1, b_{t+1}, y_{t+1})\right], \tag{15}$$

subject to the budget constraint

$$c_t + b_{t+1} = y_t + (1+\tilde{r})b_t, \tag{16}$$

and the loan amortization constraint

$$b_{t+1} \geq \min\left[\theta_{am} b_t, 0\right]. \tag{17}$$

Bequests left with probability $1 - p_a$ include financial and housing wealth, $(1+\tilde{r})b_{t+1} + P_L\overline{h}$.

*Owner moving between housing stocks.* When selling their house and purchasing a house in the other housing stock $H$, an owner incurs the moving cost $m_H$:

$$V_g^{oL,oH}(a, b_t, y_t) = \max_{c_t, b_{t+1}} \frac{u\left(c_t, \overline{h}\right)^{1-\gamma}}{1-\gamma} + \Xi_g^L - m_H + \beta p_a \mathbb{E}_t\left[V_g^{oH}(a+1, b_{t+1}, y_{t+1})\right]. \tag{18}$$

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 borrowing constraint in non-eligible housing (high-opportunity area) as a renter, In addition, there are sales transaction costs $f_s$ on the house sold in area $L$,

$$\begin{aligned} &c_t + F_m + P_H\overline{h}(1+f_m) + b_{t+1} = y_t + (1+\tilde{r})b_t + (1-f_s)\, P_L\overline{h}, \\ &b_{t+1} \geq -\theta_{LTV}^H P_H\overline{h}. \end{aligned} \tag{19}$$

*Home seller.* An owner selling its house and becoming a renter in the same housing stock incurs the proportional selling transaction cost $f_s$:

$$V_g^{oL,rL}(a, b_t, y_t) = \max_{c_t, b_{t+1}} \frac{u\left(c_t, \overline{h}\right)^{1-\gamma}}{1-\gamma} + \Xi_g^L + \beta p_a \mathbb{E}_t\left[V_g^{rL}(a+1, b_{t+1}, y_{t+1})\right], \tag{20}$$

subject to the budget and no-borrowing constraints

$$\begin{aligned}
& c_t + b_{t+1} = y_t + (1+\tilde{r})b_t + (1-f_s)\, P_t\overline{h}, \\
& b_{t+1} \geq 0.
\end{aligned} \tag{21}$$

Because the owners sell their houses during the period, bequests left with probability $1 - p_a$ only include financial wealth $(1 + r^f)b_{t+1}$.

*Home seller moving between housing stocks.* The value of selling their house to move and become a renter in the other housing stock $H$ is similar to the previous one, with the subtraction of the moving cost $m_H$.

*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 becomes renters in the same housing stock in the next period.

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

subject to the budget and no-borrowing constraints

$$\begin{aligned}
& c_t + b_{t+1} = y_t, \\
& b_{t+1} \geq 0
\end{aligned} \tag{23}$$

Because they their houses during the period, bequests left with probability $1 - p_a$ only include financial wealth $(1 + r^f)b_{t+1}$.

### 3.3 Spatial Steady State

This subsection defines a stationary steady state for the $2 \times 2$ economy taking house prices, rents, and interest rates as given.

**Definition** A recursive stationary spatial steady state consists of the following objects, which are defined for demographic group $g$, housing stocks $j = L, H$, and home ownership $\mathcal{H} = r, o$:

(i) value functions $\left\{ V_g^{\mathcal{H}j}, V_g^{\mathcal{H}'j'} \right\}$,

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

(iii) a law of motion for the cross-sectional distribution of households $\lambda\left(\mathcal{H}, g, j, a, b, y\right)$ between housing stocks, home ownership statuses, and idiosyncratic states (demographic groups are fixed), such that households optimize given prices, and the law of motion for the distribution of households is consistent with their choices and prices.

Appendix B describes the numerical solution of the model. We use idiosyncratic taste shocks, as in the dynamic demand literature, to smooth the computation of the law of motion for the cross-sectional distribution implied by households' policy functions.

# 4 Calibration and Model Fit

In this section, we describe the calibration and the fit of the model outlined in Section 3 above.

## 4.1 Calibration

All moments are jointly determined, but some parameters have a larger effect on specific moments (e.g., Andrews *et al.*, 2017). We exploit this feature for the internal calibration of the model. We proceed in three steps: first, fix the externally calibrated parameters from the data; second, choose the internally calibrated parameters to match empirical targets; and third, evaluate the out-of-sample fit of the model using additional moments. Tables 1 and 2 describe the results.

**External parameters** We calibrate certain parameters for utility, housing, and geography based on external sources. Among utility parameters, we set the risk aversion parameter $\gamma$ to 2, a standard value in finance. The CES aggregator has an elasticity of substitution between nondurable consumption and housing of 1.25 (Piazzesi *et al.*, 2007).

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).

For mortgage values, we set the maximum LTV ratios for FHA-eligible properties as $\theta^L_{LTV} = 0.95$, and $\theta^H_{LTV} = 0.80$ as the $90^{th}$ percentiles of the two distributions of LTV in the data (HMDA). This replicates the thresholds of 96.5 for FHA mortgages and 80 for conforming loans without private mortgage insurance. The amortization rate $\theta_{am}$ is set to 0.93, such that the fraction of the principal to be repaid each period, $1 - \theta_{am}$, is 7%, the four-year equivalent of the value reported by Greenwald *et al.* (forthcoming).

The interest rate $r^b$ at which households borrow is 5%, the average of 30-year U.S. mortgage rates since 1975 (Freddie Mac Primary Mortgage Market Survey). It is 75 basis points higher than the risk-free rate $r$ of 4.25% at which households can save, which 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). 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 the value in the Freddie Mac Primary Mortgage Market Survey after 2000.

For housing characteristics, we compare outcomes both above FHA limits, which are non-eligible for FHA loans, compared to below. We measure the average house prices using 2018–2020 HMDA data for individual properties either above or below their county-specific FHA limit. We calculate data on rent using ACS data from 2014–2019 for areas eligible and non-eligible for FHA loans. To measure starting shares, we look at the racial composition of individuals in HMDA data starting housing choice in FHA-eligible or ineligible housing. The income shifter between FHA and non-FHA is taken as the difference in average income for households eligible and non-eligible for FHA housing using their reported income in 2014–2019 HMDA. We measure initial wealth for Black and white households, under the age of 35, using 2019 SCF data (Bhutta *et al.*, 2020).

**Internal parameters** Another set of parameters are calibrated internally in order to match a predefined set of moments. Some parameters are chosen to match race- and housing segment-specific moments which are unique to our $2 \times 2$ model. We choose the racial income shifter $\mu_W$ for white households to match the ratio of average incomes between white and Black households of 2.07 (ACS).

Across regions, we set the spatial income shifter $\mu^H$ in the non-eligible stock to deliver an average income boost of 44.02% relative to the eligible stock as in the data (Infutor and HMDA).[22] The $1 \times 2$ vector of moving shocks $m$ in utility terms is chosen to match average annual moving rates of 2% from the eligible to the non-eligible housing stock, and of 10% for the opposite direction (Infutor and HMDA).

The $2 \times 2$ vector $\Xi$ of utility benefits from owning by race and housing stock is chosen to match average home ownership rates by race of respectively 72% for white and 44% for Black households across housing stocks (SCF).

A further set of parameters are intended to match broad distributional patterns. We calibrate the discount factor $\beta$ to match the average wealth to income ratio of 4.5 for the bottom 90% of households in the economy (SCF).[23] We choose the preference parameter for housing $\alpha$ to match the average rent to income ratio of 0.20 (decennial Census data, Davis & Ortalo-Magne, 2011). Finally, the utility cost of default $d$ is chosen to match the average default rate of 1% on U.S. mortgages in a recent sample of foreclosures which includes the Great Recession (RealtyTrac).

[22]In 2019, the average income is \$79,010 in the non-eligible housing stock and \$54,860 in the eligible stock.

[23]There is no mechanism in the model to generate high wealth inequality at the top. For all households, the wealth/income ratio is 5.6.

**TABLE 1: CALIBRATION**

| Parameter | Explanation | Value | Source/Target |
|---|---|---|---|
| | **External:** *Preferences and income* | | |
| $\gamma$ | Risk aversion | 2.000 | See text |
| $\epsilon$ | CES parameter housing/consumption | 0.200 | Elasticity of substitution 1.25 |
| $\rho_e$ | Autocorrelation income | 0.700 | Floden & Lindé (2001) |
| $\sigma_\varepsilon$ | Std. dev. income | 0.387 | Floden & Lindé (2001) |
| | *Mortgages* | | |
| $r$ | Risk-free rate | 4.250% | Avg 30-year Treasury rate |
| $r^b$ | Mortgage rate | 5.000% | Avg 30-year mortgage rate |
| $F_b$ | Selling transaction cost | 0.060 | Proportional 6% of purchase price |
| $F_s$ | Proportional buying transaction cost | 0.006 | Proportional 0.6% of loan |
| $f_s$ | Fixed buying transaction cost | 0.003 | Fixed $1,200 |
| $\theta^H_{LTV}$ | LTV limit non-eligible housing | 0.800 | P90 LTV distribution=80% |
| $\theta^L_{LTV}$ | LTV limit FHA housing | 0.950 | P90 LTV distribution=95% |
| $\theta_{am}$ | 1-amortization rate | 0.930 | Amortization 1.75% |
| | *Housing stocks* | | |
| $P_H$ | House price non-eligible housing | 1.500 | Avg price non-eligible $600,000 |
| $P_L$ | House price FHA housing | 0.500 | Avg price FHA $200,000 |
| $R_H$ | Rent non-eligible housing | 0.145 | Avg rent non-eligible $1,241 monthly |
| $R_L$ | Rent FHA housing | 0.132 | Avg rent FHA $1,104 monthly |
| $\pi^H_W$ | Prob white start in non-eligible | 0.780 | Share white hhs in non-eligible housing |
| $\pi^H_B$ | Prob Black start in non-eligible | 0.580 | Share Black hhs in non-eligible housing |
| | *Demographic groups* | | |
| $\pi_B$ | Share Black households | 0.180 | Share Black buyers |
| $b_{0,W}$ | Initial wealth white | 0.064 | Avg wealth white under 35 y.o. $25,400 |
| $b_{0,B}$ | Initial wealth Black | 0.002 | Avg wealth Black under 35 y.o. $600 |
| | **Internal:** *Preferences* | | |
| $\beta$ | Discount factor | 0.765 | Wealth/income 4.5 |
| $\alpha$ | Cobb-Douglas pref for housing | 0.615 | Avg rent/avg income 0.20 |
| $d$ | Utility cost of default | 1.092 | Avg default rate 1% |
| $\Xi^H_W$ | Avg home ownership shock non-eligible housing white | 3.549 | Avg home ownership white 72% |
| $\Xi^L_W$ | Avg home ownership shock FHA housing white | 1.520 | Avg home ownership white 72% |
| $\Xi^H_B$ | Avg home ownership shock non-eligible housing Black | 2.275 | Avg home ownership Black 44% |
| $\Xi^L_B$ | Avg home ownership shock FHA housing Black | -0.338 | Avg home ownership Black 44% |
| | *Housing stocks and demographic groups* | | |
| $m_H$ | Moving cost to non-eligible housing | 5.914 | Moving rate 2% |
| $m_L$ | Moving cost to FHA housing | -3.780 | Moving rate 10% |
| $\mu^H$ | Income shifter non-eligible housing | 0.365 | Avg income boost 44% non-eligible housing |
| $\mu_W$ | Income shifter white | 0.211 | Avg income white/Black 2.07 |

*Notes:* One model period corresponds to four years. Targets are annualized.

## 4.2 Model Fit

Table 2 shows how the model fits the data. The three upper panels report targeted moments, and the fourth panel non-targeted moments. The first panel focuses on aggregate housing market moments, and the second and third panels on moments for housing stocks and demographic groups which are specific to our $2 \times 2$ model. The fourth panel focuses on wealth and leverage gaps between Black and white households.

*Targeted Moments:* The model successfully replicates housing wealth accumulation patterns in the data. It exactly matches the ratio of average wealth to income (4.49), and differences in home ownership rates between Black (0.44) and white households (0.72). It successfully matches differences in initial conditions between Black and white households which ultimately lead to differences in wealth accumulation, such as the gap in income (2.07× higher for white households) and in average bequests (3.03× higher). It also matches moving patterns between the housing market segments into which borrowers sort endogenously at various stages of their life-cycles. On average, the moving rate from the less desirable FHA to more desirable non-eligible housing is much lower (2.8%) than the opposite (9.4%), as in the data. Moving frictions add to the difficulty of accessing the more valuable housing stock, especially for Black households who need to overcome the relatively higher moving costs $m_H$ compared to their utility. In addition, the model captures household behavior outside of home ownership, by matching the share of rental expenditures in households' income (0.17) and the average default rate on mortgages (1.2%). Without targeting them, the model generates higher default rates for Black borrowers (2.6%) relative to white borrowers (1%), as in the data (e.g., Kermani & Wong, 2021).

*Non-Targeted Moments:* The model generates substantial racial inequality in households' balance sheets and comes close to matching key non-targeted moments. Crucially, it explains a large fraction of racial leverage gaps, which are not targeted in the callibration. Across the two housing stocks, Black borrowers have a higher average LTV (just under 1.10× higher than white households), median LTV (1.04× higher), and $90^{th}$ percentile LTV (1.02× higher). As in the data, there is considerable bunching in the leverage distributions of Black buyers at the two LTV limits $\theta^L_{LTV} = 0.95$ and $\theta^H_{LTV} = 0.80$.

For Black borrowers in the low-opportunity area, the $25^{th}$ percentile of the LTV distribution and above is equal to the $\theta^L_{LTV} = 0.95$ limit. The $10^{th}$ percentile is equal to 0.61. Overall, a large fraction of Black households lever up in order to access home ownership in the relatively affordable housing stock, leading to a greater ownership rate (relative to the high-opportunity area). In the high-opportunity area, the $75^{th}$ percentile and above of the LTV distribution for Black borrowers is equal to the $\theta^H_{LTV} = 0.80$ limit, the $50^{th}$ percentile is equal to 0.74, the $25^{th}$ to 0.55, and the $10^{th}$ to 0.42. Accessing home ownership in the high-opportunity area also 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, a small fraction of buyers borrow as much as the LTV limit allows. An even larger fraction is rationed out of the high-opportunity area altogether. The LTV constraint forces them to exit of the owner-occupied market. Since house prices are on average 3× higher in the non-eligible housing stock ($600,000) than in the FHA-eligible stock ($200,000), those that do purchase in the non-eligible stock tend to be relatively richer due to endogenous selection.

The core of the racial leverage gap reflects two sources. First, while both white and black homeowners in the low-opportunity area tend to be highly leveraged, a larger portion of black homeowners choose to live in this area. Second, within the high-opportunity area, there is much less bunching at the $\theta^{H}_{LTV} = 0.80$ limit for white borrowers. In stark contrast with Black buyers, the $90^{th}$ percentile of their LTV distribution is only equal to 0.79, the $75^{th}$ to 0.67, the $50^{th}$ and the $25^{th}$ to 0.65, and the $10^{th}$ to 0.55.

**TABLE 2: MODEL FIT**

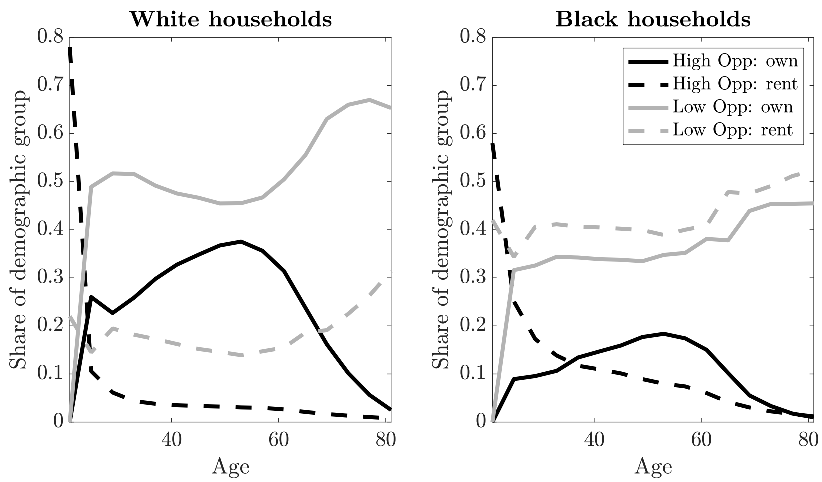
| Variable | Data | Model |
|---|---|---|
| Avg wealth/avg income | 4.50 | 4.49 |
| Avg rent/avg income | 0.20 | 0.17 |
| Avg default rate | 1% | 1.2% |
| Avg moving rate to non-eligible housing | 2% | 2.8% |
| Avg moving rate to FHA housing | 10% | 9.4% |
| Home ownership white | 0.72 | 0.72 |
| Home ownership Black | 0.44 | 0.44 |
| Avg income white/Black | 2.07 | 2.07 |
| Avg bequest white/Black | 3.03 | 3.14 |
| Avg LTV white/Black | 0.83 | 0.92 |
| Median LTV white/Black | 0.93 | 0.97 |
| P90 LTV white/Black | 0.98 | 0.99 |
| Avg wealth white/Black | 6.25 | 3.25 |

*Notes:* The three upper panels report targeted moments, the fourth panel reports non-targeted moments. Moments are annualized. Sources: SCF Plus (2016), HMDA (2018). In 2016, average wealth is $138,000 for Black households and $890,000 for white households.

The model also generates a substantial racial wealth gap between Black and white households, whose wealth is on average 3.25× higher. This represents more than 50% of the gap in the data, without including explicit sources of discrimination or other types of investments. Additional 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), differences 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. Importantly, however, the simple $2 \times 2$ structure we propose is sufficient to capture a large fraction of the racial wealth gap.

Finally, the model provides estimates of ownership and renting across demographic groups and age, as shown in Figure 5. It generates a hump-shaped pattern for ownership in the high-opportunity area, as agents accumulate wealth to make down payments in that area, before moving to the low-opportunity area 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 the high opportunity area (white households purchase at age 30, Black households purchase at age 39). 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 the high opportunity area where prices and down payments are high. These statistics broadly match the empirical distributions of these outcomes for individuals who initially appear in the Infutor data across high- and low-minority share neighborhoods in Appendix Figure A.VIII. In particular, we match the fact that individuals from high minority share neighborhoods take longer to purchase homes in high-opportunity areas, and are less likely to ever do so.

**FIGURE 5: LIFE-CYCLE PROFILE OF 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.

# 5 Baseline Model Results and Policies

This section outlines our main results, which consist of three sets of counterfactual experiments. First, we demonstrate the severe consequences of financial constraints for racial inequality—the central contribution of our paper—by analyzing counterfactual economies with alternative LTV constraints. Second, we examine the heterogeneous consequences on wealth accumulation across racial groups of one of the largest recent trends in housing markets: house price growth. Third, and finally, we study the effectiveness of several policies aimed at alleviating Black-white disparities. Because the spatial allocation of households is at the core of our model, we focus particularly on policies that ease the cost of moving to opportunities to build wealth. We also explore more conventional policy tools, including interest rate subsidies, place based policies, and direct race-targeted reparations.

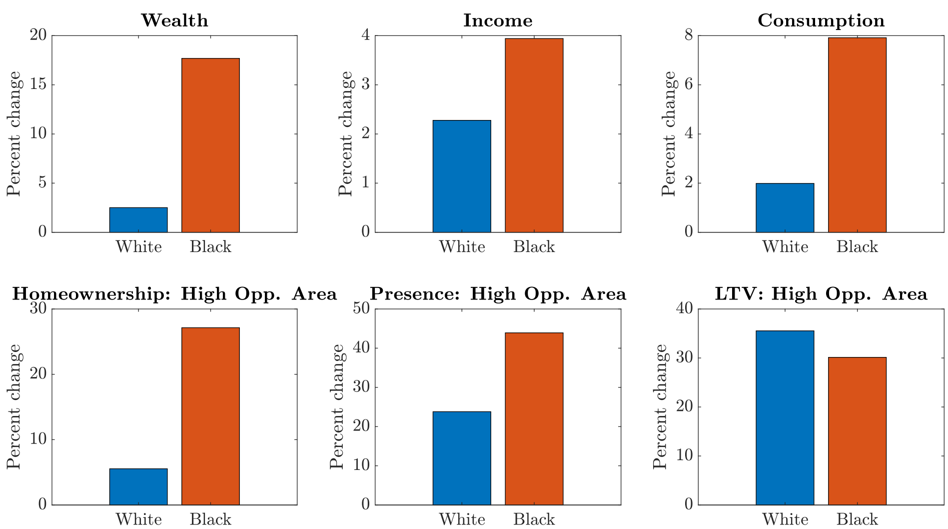
## 5.1 Impact of Leverage Constraints

To demonstrate the importance of financial constraints for Black-white disparities, our first set of experiments analyzes the steady states of counterfactual economies where the key financial constraint in our model, the leverage cap, is looser or tighter than in the baseline. Given the central role this constraint, we use the results of this experiment as our main point of comparison when evaluating the robustness of our model in Section 6.

**High leverage limits** We begin by comparing outcomes for Black and white borrowers under relaxed financial constraints in the high-opportunity area. Specifically, we study the steady state of a counterfactual economy where the LTV limit in the high-opportunity region is relaxed from 0.80 to 0.95. This can be interpreted as an experiment that removes the loan cap for FHA loans, a simple counterfactual that provides the clearest way to understand the distortions created by financial constraints.

A slacker leverage constraint leads to substantial improvements in outcomes for both groups, but the improvements are far more significant for Black households. The constraint differentially distorts choices across demographic groups. Figure 6 shows a basic set of results, with a more comprehensive accounting in Appendix Figure C.I. Each sub-panel shows the change in outcomes for Black and white households after relaxing the constraint, relative to the baseline. As first step, we confirm that leverage ratios increase substantially in response to relaxing the LTV constraint, indicating that the constraint does in fact bind.

**FIGURE 6: HIGH LEVERAGE LIMITS**




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure plots the result for a counterfactual economy in which the LTV limit in the high-opportunity housing stock is higher than in the baseline ($\theta^H_{LTV} = 0.95$, instead of $\theta^H_{LTV} = 0.80$ at baseline). We plot outcomes including: wealth, income, and consumption across both housing zones 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. Appendix Figure C.I shows a fuller set of results for this counterfactual.

Black wealth increases substantially in response to the relaxation, leading to a reduction in the wealth gap. Average wealth for Black households across both housing stocks rises by 18% in response to the policy. Average wealth for white households also rises, but by a much smaller amount (roughly 2%). This confirms an important role for financial constraints in perpetuating disparities in wealth.

Wealth gains are driven primarily by an increase in Black homeownership in the high-opportunity area, and the resulting gains in life-cycle wealth accumulation (despite the lower wealth necessary to acquire a mortgage). This demonstrates the core spatial misallocation generated by leverage constraints. In an unconstrained world, a larger fraction would live, earn, and own in the high-opportunity area. Specifically, in our experiment, average homeownership for all households goes up by 2.5% in response to loosening this financial constraint, but homeownership of Black households in the high-opportunity area jumps by more than 25% (and the share of Black households in the area jumps significantly). This provides access to higher incomes—which rise by 3.9% for Black households—and equity in more valuable homes.

Perhaps most strikingly, relaxing the leverage constraint delivers all these benefits, in home ownership, wealth and income, while also substantially increasing the consumption of Black household (by around 8%). There is no tradeoff between homeownership, wealth, and consumption in this experiment. Because consumption increases and housing is valuable, the welfare gap decreases.[24] While we would generically expect relaxing the constraint to improve households' outcomes (absent externalities), the key finding is that these benefits disproportionately accrue to Black households.

The objective of this experiment is to quantify the importance of leverage constraints for racial gaps, and not directly model or consider broader macroeconomic consequences. In particular, relaxing mortgage leverage constraints may have macro-prudential implications for asset prices and default behavior, both of which have been explored in prior literature (Greenwald, 2018; Defusco *et al.*, 2019; Adelino *et al.*, 2012; Johnson, 2020; Gupta & Hansman, 2022). Given this limitation, the aggregate consequences from relaxing LTV constraints may be different from those implied by the increase in consumption and homeownership accruing to Black households, which limits the direct policy implications of this experiment. Importantly, however, it shows that leverage constraints play a fundamental role in housing and wealth gaps. As such, policies that relax down payment requirements while minimizing macro-prudential risk—for example, financial assistance to first-time buyers (Berger *et al.*, 2020; Mabille, forthcoming), equity assistance to top up down payments (Benetton *et al.*, 2018), or constraints that are based on lifetime wealth rather than current wealth—may provide promising channels for addressing racial disparities.

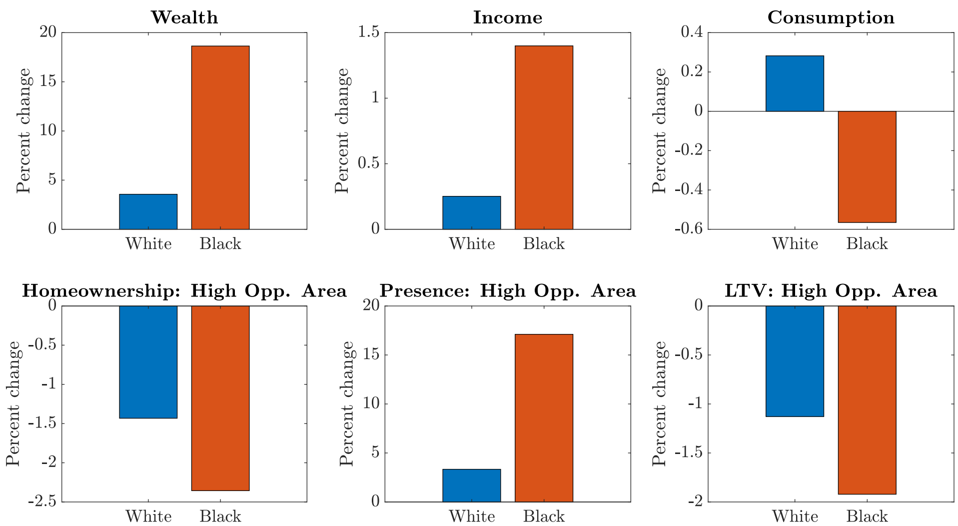
**Low leverage limits: phasing out FHA mortgages** We next consider a counterfactual economy where leverage ratios are lower. Specifically, we explore the consequences of tightening the leverage constraint in the low-opportunity area from 95% to the same 80% level as in the high opportunity area. This counterfactual replicates removing the FHA program entirely. We show basic results in Figure 7 and more detailed

[24] In the value functions described in Section 3, utility depends on both non-durable consumption and housing services provided by rental and owner-occupied units. We provide detailed results for those in Appendix Figure C.I.

results in Appendix Figure C.II.

The impacts of this experiment are slightly more complex compared to the impacts of a looser constraint. Tightening leverage requirements appears to disproportionally impact Black households, once again highlighting the importance of financial constraints for racial disparities. Two of the key contributors to utility, consumption and homeownership, drop more sharply for Black households (in fact, consumption rises for white households). Overall, homeownership drops by about 12% for Black households and by less than 3% for white households, who have higher initial wealth and whose constraints are less binding.

**FIGURE 7: LOW LEVERAGE LIMITS: PHASING OUT FHA MORTGAGES**




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure plots the results for a counterfactual economy in which the LTV limit is tighter in the low opportunity housing stock than in the baseline ($\theta^L_{LTV} = 0.80$, instead of $\theta^H_{LTV} = 0.95$ at baseline). We plot outcomes including: wealth, income, and consumption across both housing zones 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. Appendix Figure C.II shows a fuller set of results for this policy counterfactual.

Interestingly, this policy actually leads to an increase in average wealth for all households, and a reduction in the wealth gap. While initially surprising, this comes largely because mortgages acts as a forced savings mechanism. The tightened leverage constraint forces home buyers, and particularly Black buyers, to contribute substantially more home equity in the counterfactual economy. While many buyers exit homeownership, those that stay have significantly more home equity, and this shifts the mean of the wealth distribution.[25] Of course, this increase in wealth is not costless. Households are faced with the option of forgoing consumption to remain homeowners or forgoing the benefits of homeownership altogether.

This mismatch in outcomes between wealth and homeownership is a recurring theme across our results, and points to important limitations in the use of either wealth or homeownership to measure inequality, or

[25]There is also an increase in incomes, as households that formerly chose to own in the low-opportunity area move and become renters in the high-opportunity area.

as a proxy for welfare. Homeownership comes with tradeoffs for households who must also decide where to live, where to work, what to consume, and how much equity to put down.

## 5.2 Impact of House Price Changes

We next explore the impact of exogenous changes in housing prices, which are a key determinant of how binding leverage constraints are, on Black-white disparities. The consequences of price changes depend crucially on the features of the $2 \times 2$ housing markets. First, because demographic groups have different characteristics, price changes have quantitatively and even sometimes *qualitatively* different effects on Black and white households. Second, because investors endogenously sort across housing stocks, price changes in a single housing stock have spillover effects to the entire housing market as they modify households' moving rates. These results, like Berger *et al.* (2017) and Bailey *et al.* (2019), assume exogenous house prices and rents, whose increases can be interpreted as a gentrification shock.[26]

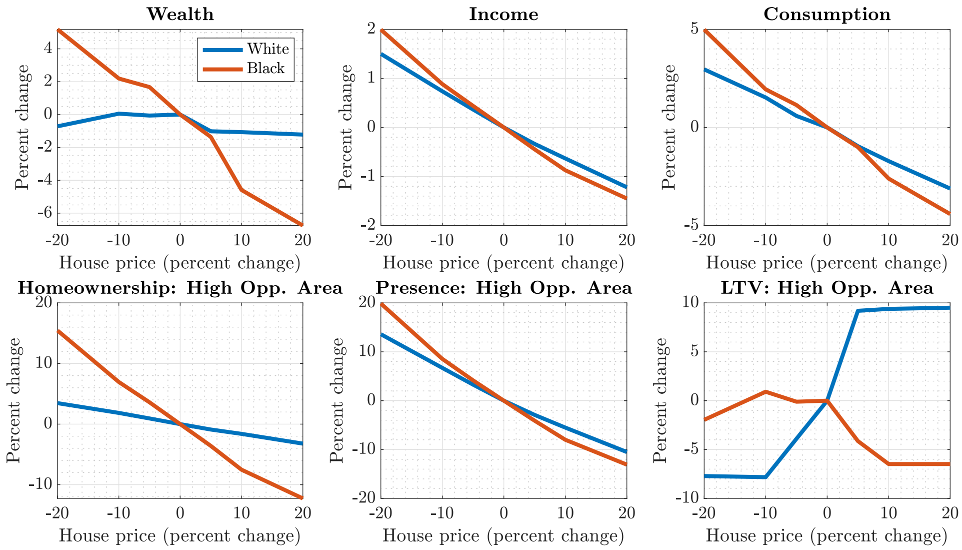
Figure 8 plots the percentage changes in the main components of households' balance sheets in the steady state of the model, compared to the baseline, in response to a percentage change in prices in the high-opportunity (Panel A) and low opportunity (Panel B) housing stocks. More comprehensive figures are provided in Appendix Figures C.III and C.IV.

Our results have several implications for the racial housing gap. First, higher house prices in high-opportunity areas have particularly adverse consequences for Black borrowers in steady state but have little effect on wealth accumulation for white households. Black wealth and income decline sharply in response to price increases in the high-opportunity area, as Black households drop out of homeownership in the high-opportunity area, move to the low opportunity area, and receive lower incomes. By contrast, white household wealth is relatively unaffected by higher house prices in either region, because a large fraction are able to adjust leverage without substantially changing consumption or exiting homeownership. We therefore provide a framework for understanding the phenomenon of "displacement" by which gentrification and price increases in already desirable neighborhoods can push low-income and minority individuals to lower cost areas (Couture *et al.*, 2019; Guerrieri *et al.*, 2013).

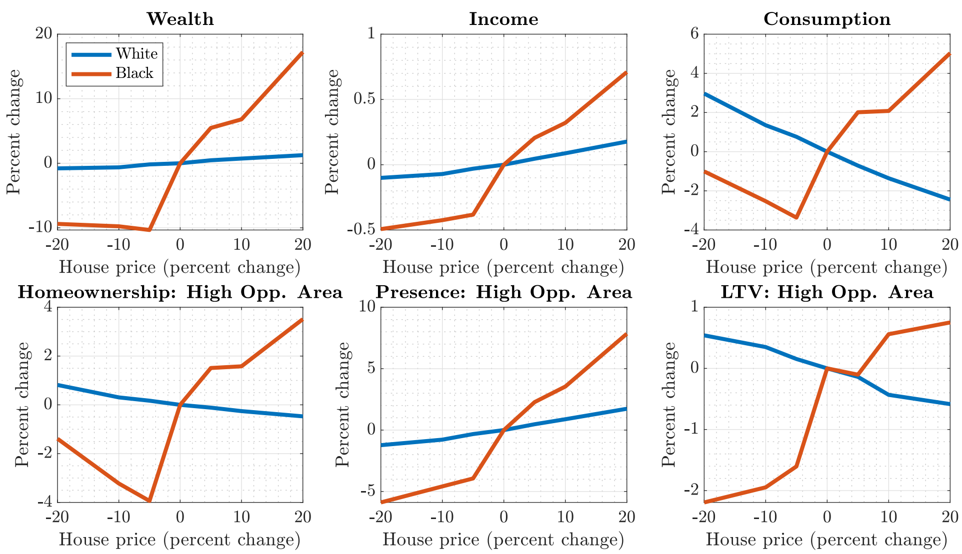
Second, a price increase in either of the two housing stocks also leads to an improvement in home ownership for Black households in the *other* housing stock, due to the endogenous relocation of Black buyers. However, overall homeownership declines in general. Third, increases in home prices in the low-opportunity area actually lead to increases in income, as many households transition into the rental market in the higher opportunity area, and earn higher incomes. On the other hand, increases in prices in the

[26] They complement Lustig & Van Nieuwerburgh (2005) and Lustig & Van Nieuwerburgh (2010), who show that house price decreases lead to less borrowing. They also complement Adelino *et al.* (2016) and Adelino *et al.* (2018), who show that expectations of future price increases led to an increase in leverage for a wide range of households.

**FIGURE 8: HOUSE PRICE SHOCKS**




**PANEL A: PRICE SHOCKS IN HIGH-OPPORTUNITY AREA**




**PANEL B: PRICE SHOCKS IN LOW-OPPORTUNITY AREA**

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure corresponds to a counterfactual experiment in which we vary the price of homes in the non-FHA eligible, high-opportunity zone (Panel A), as well as the FHA-eligible low-opportunity zone (Panel B). Red lines depict the variable of interest for Black households, and blue lines for white households. We plot changes in wealth, income, home ownership in the high-opportunity zone, and the presence of households in the high-opportunity zones, all for various changes in house prices.

high-opportunity area unequivocally reduce incomes, particularly for black households. These results are in line with a large literature arguing that housing costs play a role in driving internal migration within the United States (Ganong & Shoag, 2017; Zabel, 2012; Plantinga *et al.*, 2013), especially the migration of individuals away from high-income but high-cost metropolitan areas to other parts of the country that have lower housing costs and lower incomes.

We find less striking results in the case of rent changes, shown in Appendix Figures C.V and C.VI, for which households can choose to consume continuously lower housing services to reduce their expenses and do not get higher utility benefits. Interestingly, an increase in rents slightly raises average Black wealth due to a positive effect on home ownership, which becomes relatively more attractive. This suggests that housing affordability issues in ownership and rental markets may have substantially different consequences for household wealth accumulation.

## 5.3 Policies

Our last set of experiments considers the effectiveness of several policies that target Black-white disparities in homeownership or wealth. Given the importance of spatial allocations in our model, we focus particularly on the impacts of policies that remove moving frictions, allowing households to move to wealth building opportunities.

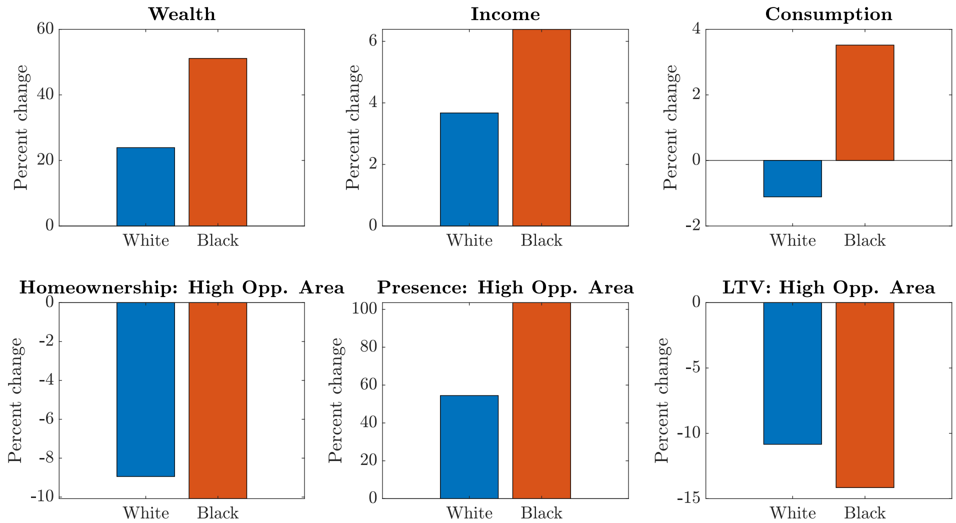
#### Moving to Wealth Opportunities

The first policy that we analyze lowers the costs of "moving to opportunity," by setting moving costs from the low-opportunity (FHA-eligible) housing stock to the non-eligible stock equal to zero. 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 closely to the examination of outcomes following the Great Migration in Derenoncourt (2022).

Overall, this policy succeeds in inducing more households to move to the high opportunity area, resulting in an increased presence in that housing stock, particularly for Black households. We show main results in Figure 9 and more detailed results in Appendix Figure C.VII. By lowering moving frictions, this policy reduces spatial misallocation, and significantly increases income and wealth for both Black and white households. Crucially, this disproportionately benefits Black borrowers, reducing income and wealth gaps.

Importantly, the policy actually *decreases* home ownership substantially for both white and Black households. Because spatial frictions are lower, some households choose to give up homeownership to move to the high-opportunity area and rent. In doing so, they accumulate greater income and wealth. Because these households end up saving more, those who do reach homeownership are richer and have lower leverage than previously. This result mirrors our findings in subsection 5.1, in which phasing out the FHA increased wealth but decreased homeownership. Removing migration frictions has similar outcomes in

**FIGURE 9: MOVING TO WEALTH OPPORTUNITIES**




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. The figures shows the consequences of setting moving costs from the FHA-eligible housing stock to the non-eligible stock equal to zero. We plot outcomes including: wealth, income, and consumption across both housing zones 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. Appendix Figure C.VII shows a fuller set of results for this policy counterfactual.

terms of wealth and homeownership; but increases welfare because households find it easier to transition between housing stocks across the lifecycle. Black households also see substantial increases in consumption.

We characterize this policy as one that enables "moving to *wealth* opportunities" because the improved sorting of Black households across housing stocks improves wealth building. Households have better access to opportunity—-as characterized by productivity and income—in ways that accumulate across the lifecycle to generate higher wealth.

**Reparation Policies**

We next consider a series of alternative policies. To conserve space, we report the detailed results of these experiments in the Appendix. We begin by analyzing reparations-style policies that specifically target Black households and seek to equate initial conditions across demographic groups.[27] Appendix Figure D.I shows detailed results for increases in initial wealth. Perhaps unsurprisingly, raising initial wealth increases Black wealth over the life-cycle. It also increases income and homeownership, particularly in high-opportunity areas. Given the targeted nature of reparations, these changes lead to reduced disparities. Interestingly, there are non-monotonic impacts in the low-opportunity area, as some households may choose to move to the high-opportunity zone as wealth increases, while others transition from renting to buying in the low-opportunity area.

[27] Reparation policies have also been adopted in the case of Jewish victims of the Holocaust (Pross, 1998).

We also examine a policy that gives Black households the same income shifter as white households, which corresponds to a 207% increase in average income (Appendix Figure D.II). 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 lower-opportunity FHA-eligible housing stock, and higher home ownership in the more expensive non-eligible stock.[28]

The next two experiments are targeted housing policies which modify specific features of our $2 \times 2$ model of housing markets. Such policies are at the center of lively public discussions and have been increasingly studied (e.g., Kopczuk & Munroe, 2015; Han *et al.*, 2021). The first policy targets mortgage borrowers. The second policy targets areas themselves.

**Mortgage Rate Subsidy**

We consider a policy intended to lower mortgage costs by decreasing the mortgage rate faced by all borrowers by 50 basis points from 5% to 4.5% (Appendix Figure D.III). It is similar to first-time buyers programs which allow borrowers to benefit from lower rates. Black homeownership increases across the board, although much more so in the high-opportunity area. The policy also has a complex impact on leverage, which increases in the high-opportunity area, and decreases in the low-opportunity area. The net effect is a reduction in overall leverage. Given the lower interest rate, and the ability of borrowers to move to the high-opportunity zone, income and wealth are both increased by this subsidy.

**Place-Based Labor Market Policy**

Our last policy experiment equalizes the spatial income shifter in the high and low opportunity areas. It corresponds to a 20% increase in average local income in the FHA-eligible stock, and can be interpreted as an improvement in local labor market conditions due, e.g., to place-based policies. Appendix Figure D.IV describes the results. This policy has positive impacts on income, wealth and overall homeownership for Black households. However, because the place-based policy also benefits white households, the net impact actually accentuates the wealth gap.

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

## 6 Robustness

Our main results are robust to modifications of the baseline model which either simplify it or further add to its realism. In this section, we explore six variants of our model, recreating the first experiment shown in subsection 5.1 for each. First, we analyze the impact of leverage constraints in a stylized model without moving frictions and home ownership shocks. Second, we turn to an extended version of our baseline model with payment-to-income (PTI) constraints. Third, we consider the possible role of mortgage market discrimination, which increases borrowing costs for Black buyers. Fourth, we show the robustness of our baseline results with a lower spatial income shifter, which reduces the causal impact of migration on income. Fifth, we allow for differential interest rates for high leverage mortgages, which reflect the insurance premium for FHA loans. Finally, we incorporate risky housing returns into our model. In each case, the model is fully recalibrated to match the targets described in Section 4.

### 6.1 Removing Homeownership Shocks and Moving Frictions

In order to simplify our baseline model, we consider a stylized model which has no moving frictions or taste shocks for home ownership. Crucially, this removes any preference differences across demographic groups, to confirm that these differences are not driving our results. We show our findings in Panel A of Figure 10.

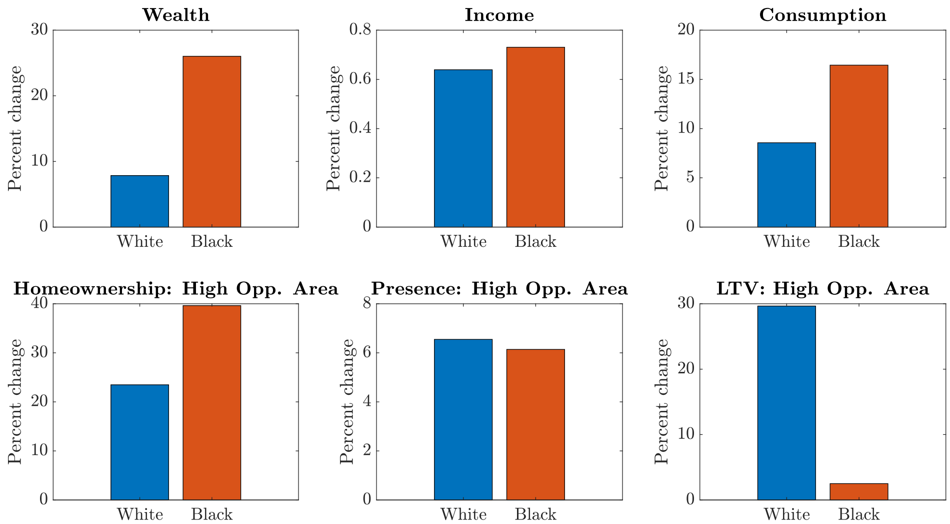
Results are similar to the baseline model: wealth, income, ownership in the high-opportunity area, and presence of agents in the high-opportunity areas improve substantially in an economy with a higher leverage cap, and particularly so for Black households. This leads to a reduction in disparities across outcomes. This suggests that financial constraints play an important role in limiting access to high-opportunity areas even in this simplified model, and that the assumption of cross-group differences in preferences, while important to match aggregate moments, are not responsible for the underlying mechanism we highlight.

### 6.2 PTI Limit

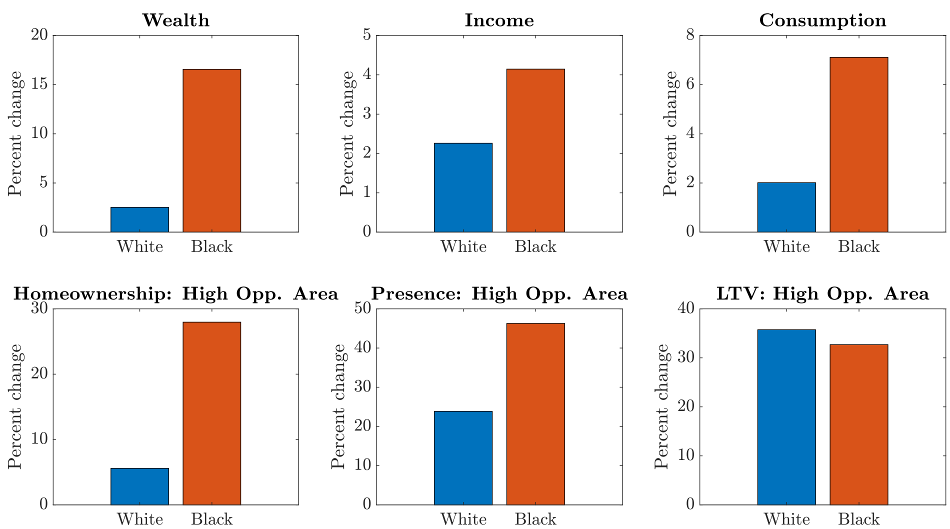
Our baseline model incorporates two key financial frictions: LTV limits at the time of origination and an implicit assumption that agents cannot borrow against future labor income. However, in practice, mortgage borrowers also face another financial constraint: a payment-to-income (PTI) limit, which caps the total mortgage payments made by borrowers as a fraction of income.

We consider whether our model is robust to the inclusion of a PTI limit $\theta_{PTI}$, which only applies at mortgage origination and constrains mortgage payments such that $-(r^b + 1 - \theta_{am})b_{t+1} \leq \theta_{PTI} y_t$. $\theta_{PTI}$ is chosen to match the average PTI level of 36% in the data. We obtain an average PTI of 35.8% and plot the main moments for an economy with a higher leverage limit in Panel B of Figure 10. We confirm, as before,

**FIGURE 10: ROBUSTNESS TO REMOVING PREFERENCE DIFFERENCES OR ADDING PTI CONSTRAINTS**




**PANEL A: HIGH LEVERAGE LIMITS WITHOUT HOMEOWNERSHIP SHOCKS OR MOVING FRICTIONS**




**PANEL B: HIGH LEVERAGE LIMITS WITH A PTI CONSTRAINT**

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the alternative model. Panel A shows a stylized version of the model without moving frictions ($m$) or taste shocks for home ownership ($\Xi$). Panel B shows the result of an alternate calibration which also includes a constraint for the fraction of income devoted to mortgage payments. We plot outcomes including: wealth, income, and consumption across both housing zones 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.

that the key insight of the model—the differential impact of leverage constraints—persists even when we account for borrowers also facing a PTI constraint.

### 6.3 Mortgage Rate Discrimination

We next extend our baseline model to account for the possibility that Black borrowers face discrimination in mortgage lending. There remains considerable debate on whether racial discrimination persists in mortgage markets—Bartlett *et al.* (2021) argues for some role for racial discrimination in mortgage pricing, while Bhutta & Hizmo (2021) argues these results can be explained by mortgage points, which are upfront costs paid by borrowers in exchange for lower contract borrowing rates. Just as minority borrowers have higher LTV ratios and lower down payments, they are also less likely to purchase mortgage points.

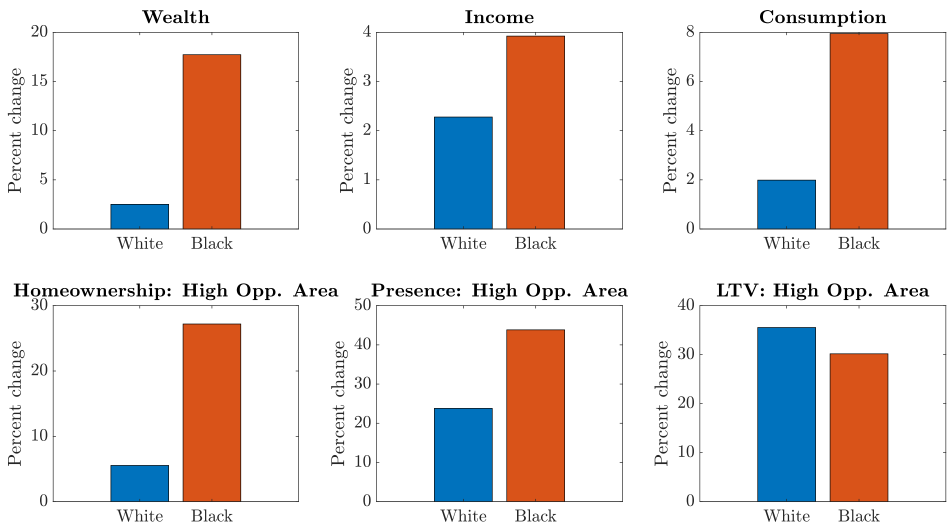
Following Bartlett *et al.* (2021), we assume that the interest rate paid by Black borrowers is 10 bp higher than for white borrowers, i.e., $r_B^b = r_W^b + 10bp$. We show results for an economy with a higher leverage constraint under this assumption in Panel A of Figure 11. Outcomes are quantitatively similar after accounting for mortgage rate discrimination. This result suggests that the range of mortgage rate estimates in the literature does not seem to be large enough to account for the bulk of the observable variation in Black-white wealth and housing gaps. By contrast, our mechanism, which is driven by the interaction of initial wealth and leverage constraints, appears to explain a significant fraction of these gaps even without mortgage rate discrimination.

### 6.4 Spatial Income Shifter

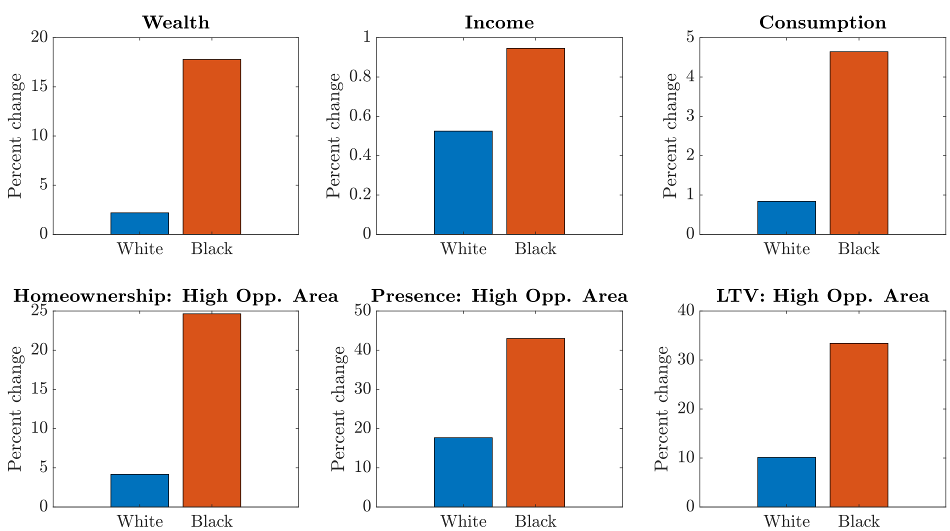
A key assumption in our baseline model is that all agents receive higher income upon moving to the high-opportunity area, while keeping their persistent idiosyncratic income component from previous periods. However, in recent work, Card *et al.* (2021) argue that two thirds of the variation in observed wage premiums for working in different commuting zones is attributable to skill-based sorting. To test the extend to which our results are driven by this pattern, we lower the spatial income shifter $\mu^H = 0.365$ in the high-opportunity area by two thirds of its value to $\widetilde{\mu}^H = 0.122$. Panel B in Figure 11 plots our main results in this alternative model.

Our main result holds under this alternate calibration. Higher LTV constraints in the high-opportunity area increase income, and therefore consumption, quantitatively by less than in the baseline model. However, wealth, and home ownership and the presence of Black households in the high-opportunity area all increase almost as much as in the baseline. For Black buyers, this is achieved with higher LTVs since living in the high-opportunity area brings reduced income benefits in this alternative model.

**FIGURE 11: ROBUSTNESS TO MORTGAGE RATE DISCRIMINATION OR LOWER SPATIAL INCOME SHIFTERS**




**PANEL A: HIGH LEVERAGE LIMITS WITH MORTGAGE RATE DISCRIMINATION**




**PANEL B: HIGH LEVERAGE LIMITS WITH REDUCED SPATIAL INCOME SHIFTERS**

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the alternative model. Panel A shows the result of an alternate calibration in which Black borrowers pay 10 basis point more for mortgages relative to white borrowers, $r_B^b = r_W^b + 10bp$, motivated by the evidence in Bartlett *et al.* (2021). Panel B shows the result of an alternate calibration in which income differences are smaller in the high-opportunity area; $\mu^H = 0.365$ instead of $\widetilde{\mu}^H = 0.122$, motivated by the evidence in Card *et al.* (2021). We plot outcomes including: wealth, income, and consumption across both housing zones 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.

## 6.5 Leverage-Dependent Mortgage Rate

Our analysis so far has assumed that borrowers only face one interest rate with respect to mortgage borrowing. In practice, borrowers typically face higher interest rates when they take on higher leverage. This is the result of both up front and ongoing fees in the FHA mortgage system, in order to pay for mortgage insurance against the chance of default. Similarly, borrowers taking high leverage conventional loans will pay an additional premium for private mortgage insurance if they take on a conforming mortgage which is mandatory for borrowers with less a down payment of less than twenty percent.

We accommodate this realistic feature of mortgage markets by assuming that borrowers who take on high leverage (an LTV greater than 80) pay an additional 100 bp for borrowing. This additional premium captures, in reduced form, an 85 basis point ongoing mortgage insurance premium for FHA borrowing above 80 LTV, as well as an additional 1.75% up front fee. We present our results in Panel A of Figure 12. Compared to the baseline, the differential effects of relaxed constraints in the model with the two part interest rate schedule corresponding to FHA are still large, suggesting that our core intuition also goes through even when accommodating interest rate differences for high leverage borrowing.

The higher interest rate makes high leverage borrowing slightly less attractive when it is extended to the high-opportunity zone. This leads the increase in wealth for Black households resulting from relaxed financial constraints to be lower for two reasons. First, the increase in Black households' presence in the high-opportunity area is slightly lower, so the income boost is slightly lower. Second, households who pay a higher interest rate accumulate wealth more slowly because of higher interest payments. The change in consumption is smaller as well.

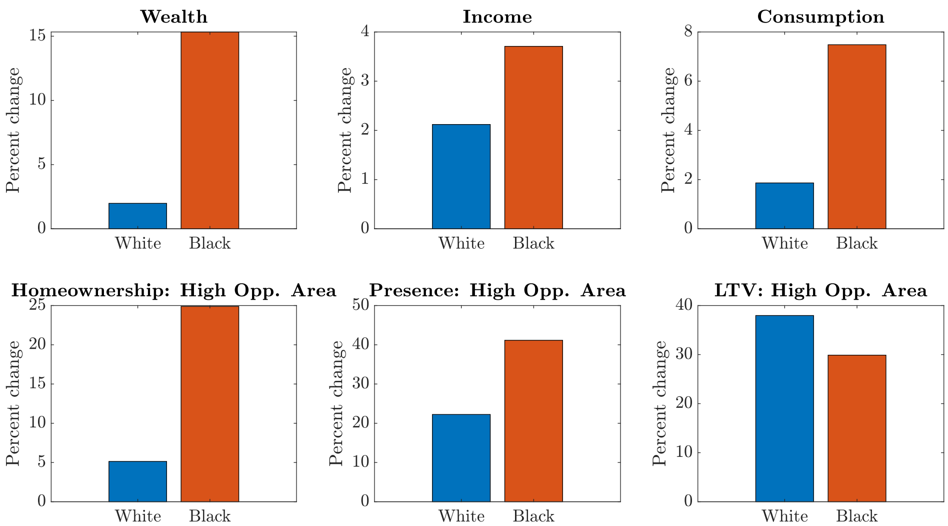
## 6.6 Idiosyncratic Housing Returns

We also relax the assumption that homeowners only build equity deterministically through mortgage payments by allowing for risky idiosyncratic housing returns. Incorporating these returns fully in the context of a stationary model and calculating the appropriate balanced growth trajectory for housing prices is challenging, as the historic data on house prices may reflect unusually positive house price realizations that are unlikely to be realized in the future.

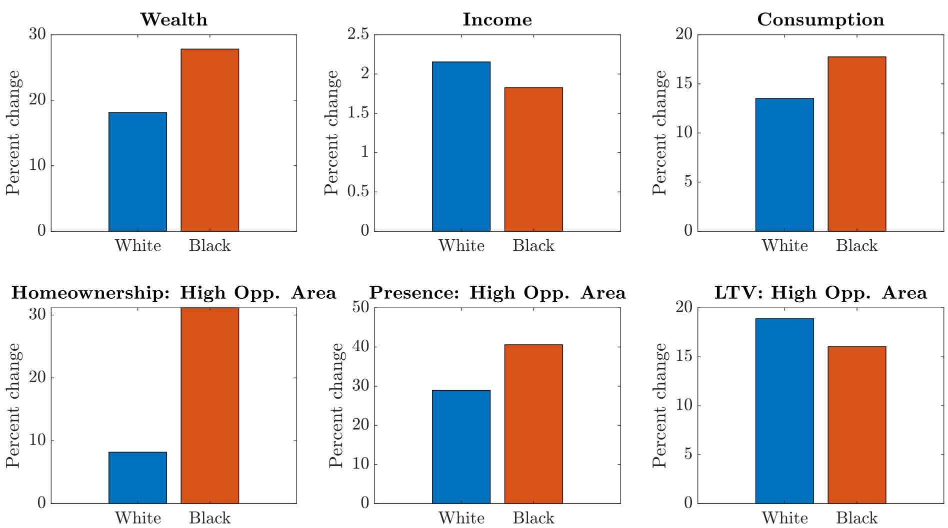
We accommodate idiosyncratic housing returns by following Campbell & Cocco (2003) and specifying an annual average return of 1.6%, with a standard deviation of 11.5% per year. To ensure that housing prices remain bounded, we assume that homeowners realize these returns as cash in each period (as opposed to seeing an increase in the asset value of the house, to be realized only upon sale).[29] Our approach therefore

[29] One interpretation of this assumption is that it corresponds to households either continuously buying or selling a fraction of the house (or the housing equity) in each period to realize this housing return.

**FIGURE 12: ROBUSTNESS TO LEVERAGE DEPENDENT MORTGAGE RATES OR IDIOSYNCRATIC HOUSING RETURNS**




**PANEL A: HIGH LEVERAGE LIMITS WITH LTV-DEPENDENT MORTGAGE RATES**




**PANEL B: HIGH LEVERAGE LIMITS WITH IDIOSYNCRATIC HOUSING RETURNS**

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the alternative model. Panel A shows the result of an alternate calibration in which the mortgage rate increases with LTV such that $r^b = 4.5\%$ when $LTV \leq 0.80$ and $r^b = 5.5\%$ otherwise. Panel B shows the result of an alternate calibration in which homeowners earn idiosyncratic housing returns with an average of 1.6% and a standard deviation of 11.5% (annualized). We plot outcomes including: wealth, income, and consumption across both housing zones 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.

provides an upper bound on the liquidity benefit of home price growth, abstracting away from the process by which capital gains are actually realized.

We find that average wealth for Black households is again higher in an economy with relaxed leverage constraints under this approach, and quantitatively almost twice as much as in the baseline (Panel B in Figure 12). This improvement comes from a large increase in homeownership in the high opportunity area from existing Black renters, and also to an increase in Black households' presence in that area which slightly improves their average income. The primary difference with our main results is that relaxed financial constraints also increases average wealth for white households, though to a much lower extent than for Black households, such that the racial wealth gap substantially decreases.

# 7 Conclusion

Our paper highlights the role of financial constraints, and specifically limits on mortgage leverage at origination, as a driver of disparities across racial groups. We contribute to an emerging literature which has emphasized the importance of housing as a component of broad racial differences in wealth. We add to this literature by documenting a novel racial leverage gap, with Black borrowers purchasing homes with substantially higher LTV ratios than white borrowers, and exploring the implications of this gap in a spatial life-cycle model. Racial leverage differences reflect the disproportionate use of high-leverage FHA mortgages by minority borrowers, which restrict them to smaller, less valuable homes in areas with worse income generating potential.

Our novel $2 \times 2$ model accounts for the fact that access to housing is a necessary condition to access both valuable real estate assets and high-quality job opportunities, and matches several important Black-white differences in wealth, income, and housing. We use it to study the implications of financial constraints for income, consumption, location, and, ultimately, wealth accumulation. Leverage constraints adversely distort the choices of Black borrowers, leading them to purchase homes and live in areas with reduced labor market opportunities. This, in turn, perpetuates initial differences in wealth. House price growth reinforces this mechanism and tends to worsen, rather than improve, racial gaps in wealth and income, a potential cause for concern in the face of skyrocketing house prices in the U.S. since Covid-19.

We find, however, that policies which ease moving to areas that enable wealth accumulation can help close these gaps, suggesting that helping minorities "move to *wealth* opportunity" is a useful complement to policies that traditionally focus on income (e.g., Chetty & Hendren (2018), Bergman *et al.* (2019)). Interestingly, such policies improve wealth even without increasing homeownership, suggesting that legislators' focus on the latter as part of the "American Dream" and throughout the world may not reflect an optimal way to accumulate wealth for most households. More generally, our findings highlight the tensions that arise when jointly modeling location, home purchase, and leverage choices over the life-cycle for different demographic groups, and the pitfalls of regulation that narrowly focuses on inequality in homeownership, without considering how location affects wealth accumulation.

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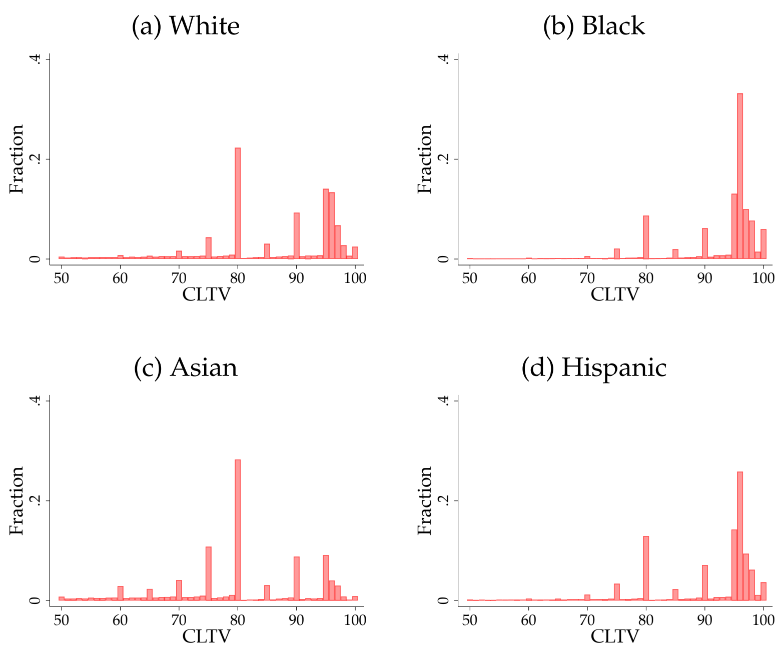
# Internet Appendix

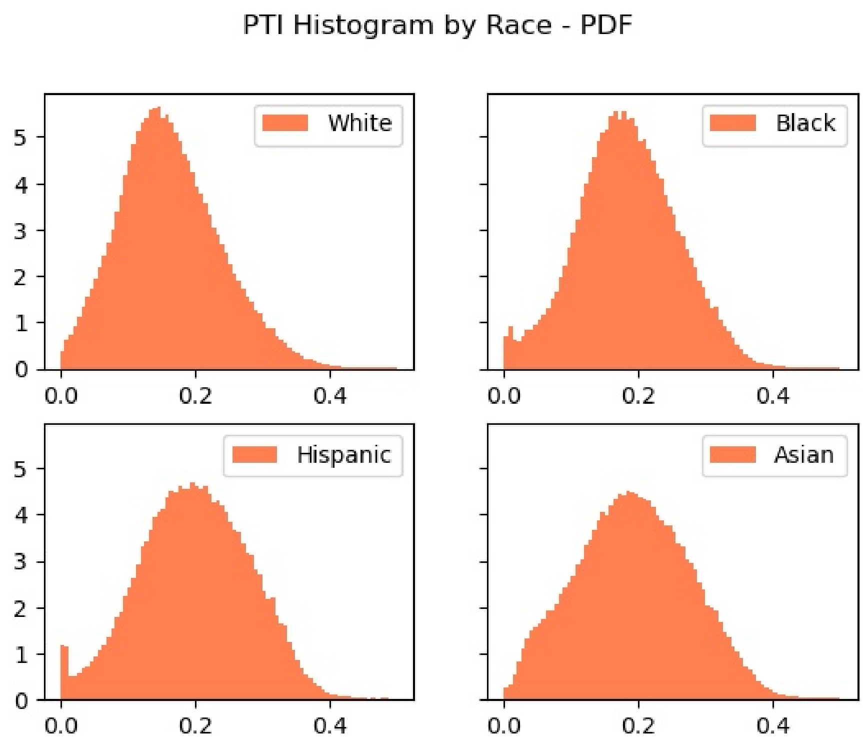
# A Stylized Facts

**FIGURE A.I: COMBINED LTV AT ORIGINATION BY RACE AND ETHNICITY**



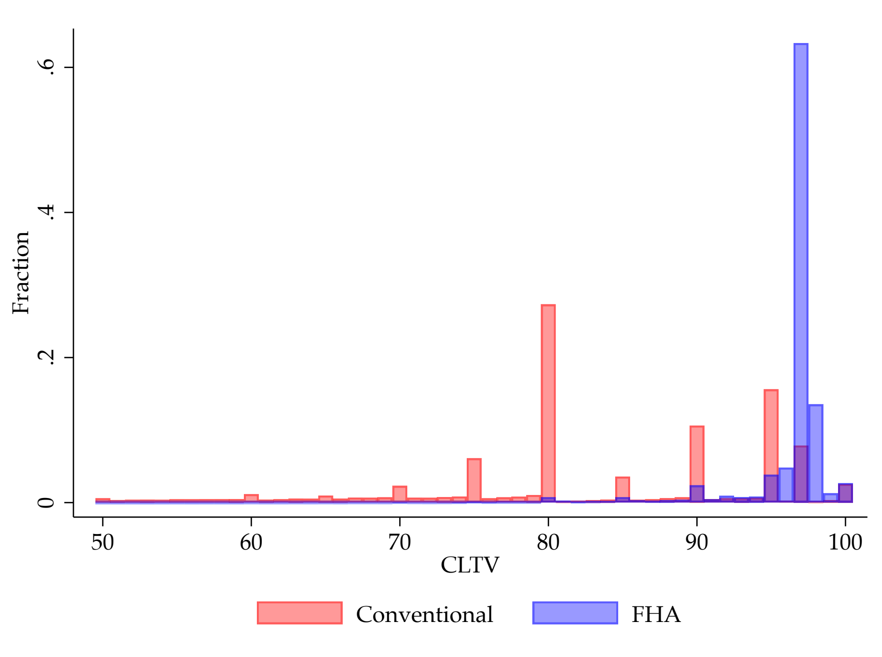

*Notes:* This figure plots the distribution of leverage at origination for new purchase mortgages in 2018. Sample excludes VA, FSA, and RHS loans. White, Black, and Asian are inclusive of both Hispanic and non-Hispanic borrowers.

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

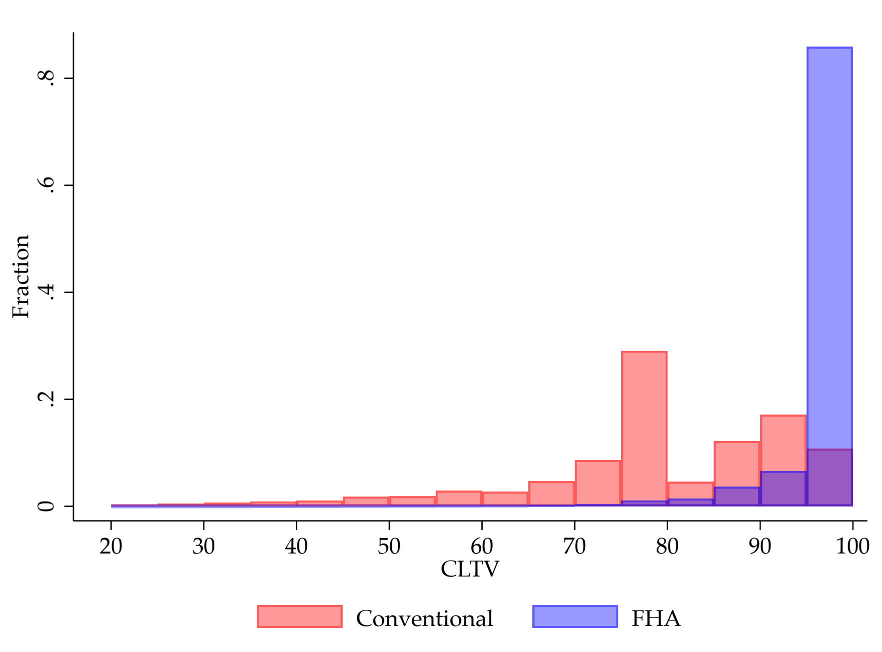



*Notes:* This graph shows the Payment-to-Income ratio (PTI) across racial groups in the HMDA data. We focus on purchase-only loans in 2018, and measure the front-end payment based on a fully-amortizing mortgage payment. Specifically, we show total payments relative to borrower income reported in HMDA.

FIGURE A.III: INITIAL LEVERAGE BY LOAN CHANNEL



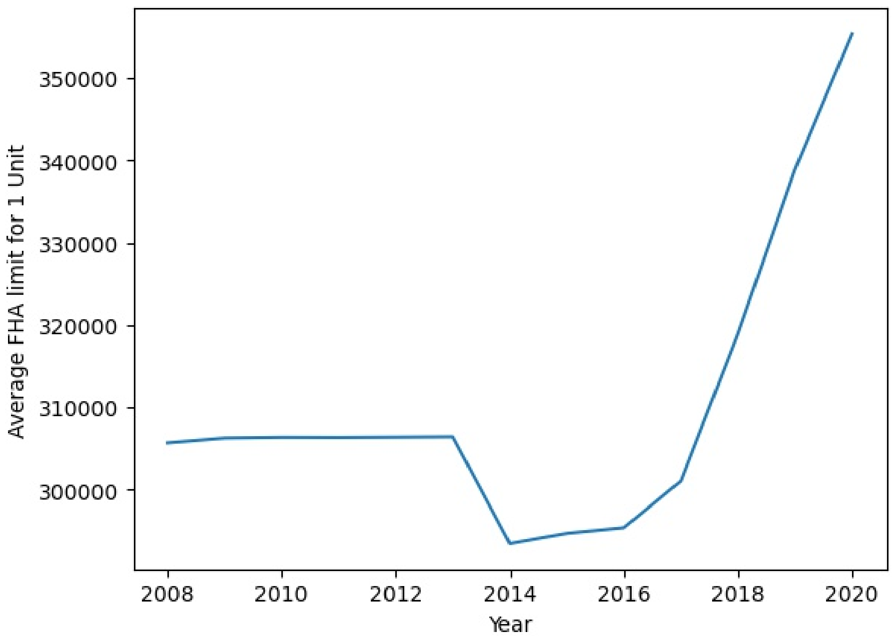

PANEL A: 1 LTV POINT BINS




PANEL B: 5 LTV POINT BINS

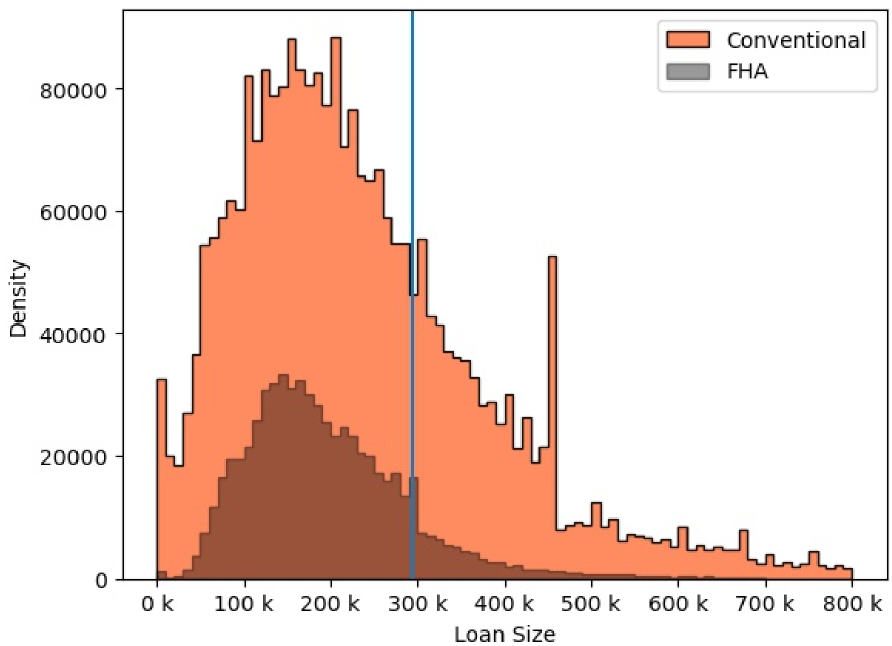
*Notes:* This figure plots the distribution of leverage at origination for new purchase mortgages by loan channel in 2018. Sample excludes VA, FSA, and RHS loans.

**FIGURE A.IV: FHA LOAN CUTOFF OVER TIME**



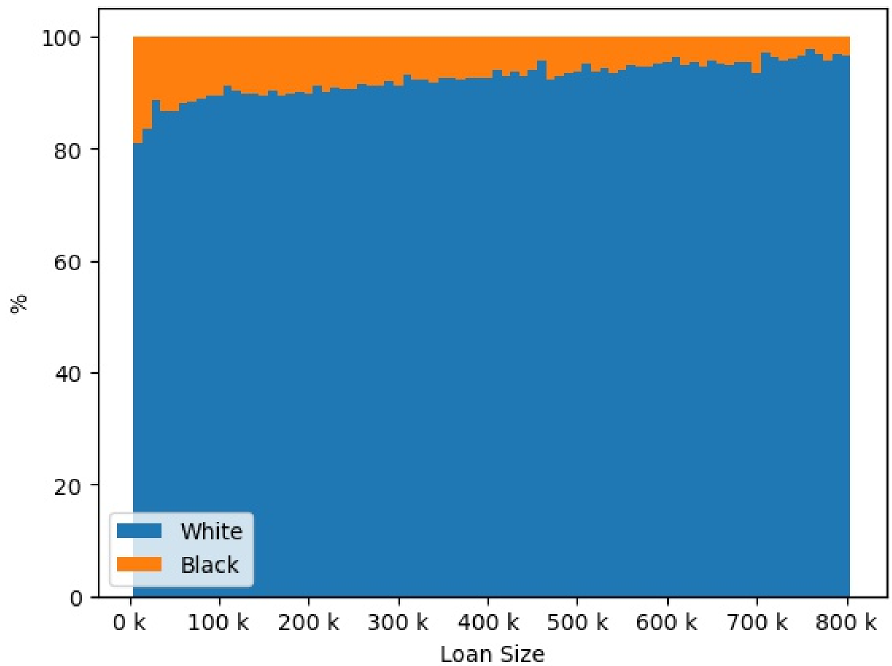

*Notes:* This graph shows the change in the nationwide FHA loan cutoff over time. This cutoff determines the maximum size of FHA loans. The nationwide limit determines the national base for the FHA cutoff; high-housing cost counties have location-specific FHA cutoffs that apply to specific areas.

**FIGURE A.V: LOAN COUNTS BY LOAN SIZE**



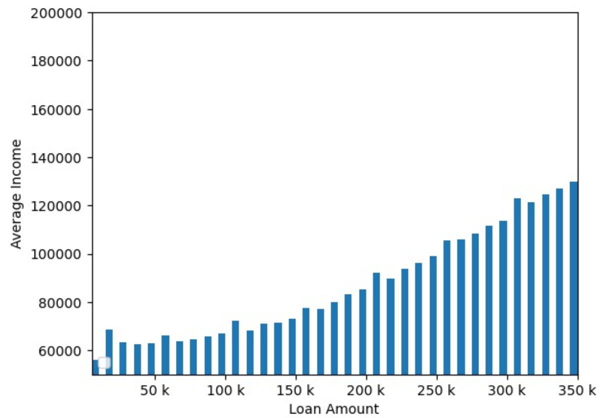

*Notes:* This figure shows loan counts for borrowers across the conventional and FHA loan product categories using 2018 HMDA data. We restrict to purchase loans, and plot the density of borrowers around the national FHA loan size limit (plotted as the vertical line). Sample excludes VA, FSA, and RHS loans.

**FIGURE A.VI: BORROWER RACE BY LOAN SIZE**

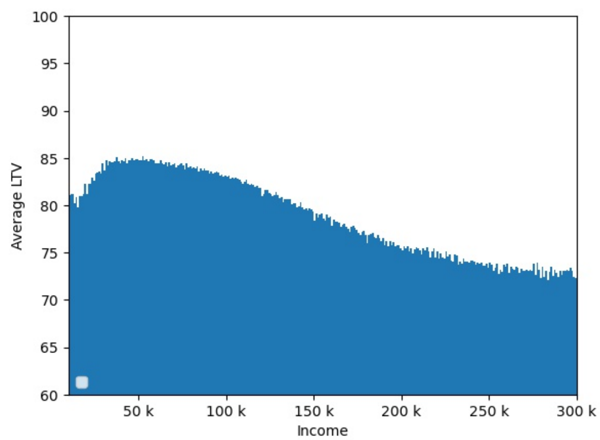



*Notes:* This Figure shows the racial composition of borrowers across different parts of the loan size distribution, focusing on white and Black borrowers. We measure race and loan size using purchase-only loans from the 2018 HMDA dataset. Sample excludes VA, FSA, and RHS loans.

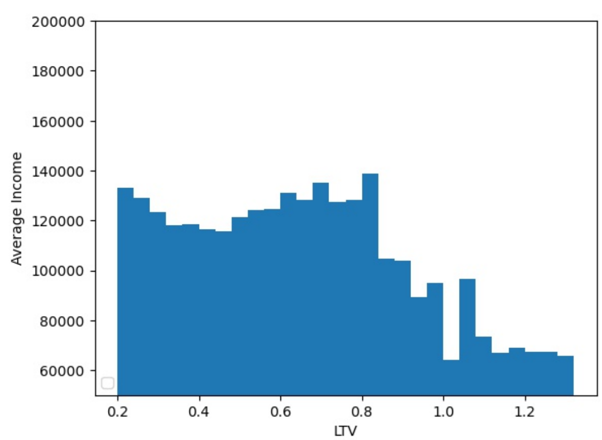
**FIGURE A.VII: LEVERAGE, INCOME AND LOAN SIZE AT THE BORROWER LEVEL**




**PANEL A: BORROWER INCOME BY MORTGAGE SIZE**




**PANEL B: LTV BY BORROWER INCOME**

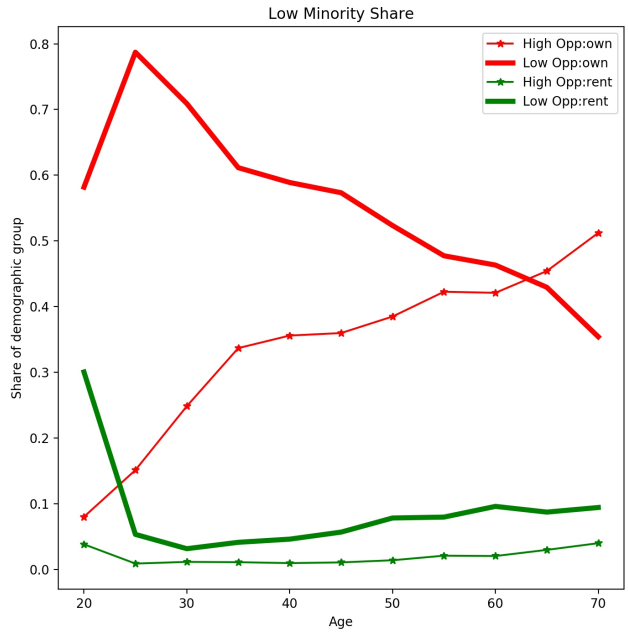



**PANEL C: BORROWER INCOME BY LTV**

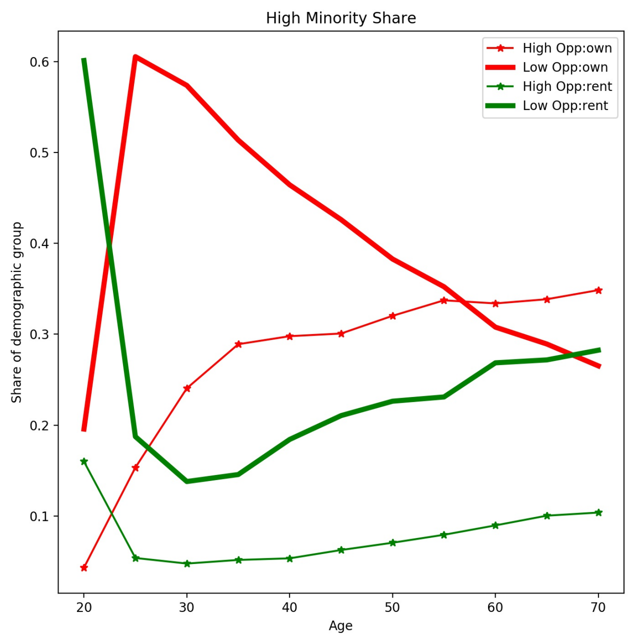
*Notes:* This figure shows the relationship between individual income, as reported in the HMDA mortgage application and loan size (Panel A) or LTV (Panels B and C). We measure all variables using purchase-only loans from the 2018 HMDA dataset.

## Figure A.VIII: Ownership and Renting Spells Across Lifecycle

### Panel A: Agents from Low Minority Share Neighborhoods




### Panel B: Agents from High Minority Share Neighborhoods




*Notes:* This figure shows the rates of home ownership and renting in Infutor data, across the two housing stocks (low- and high-opportunity), for the two demographic groups (Black and white households, proxied by initial presence in low minority share neighborhoods defined as the lowest quartile for minorities in Panel A, and initial presence high minority share neighborhoods in Panel B as defined by the highest quartile). Low-opportunity areas are defined as those in which 115% of the average sales price is above or below the FHA limit. Because the FHA limit is set in the previous year, and will be reset to 115% of the median house price in the current year, our definition of high opportunity captures areas that are FHA ineligible, as well as areas experiencing high house price growth which will likely become FHA ineligible the next year.

**TABLE A.I: LEVERAGE AND BORROWER RACE AND ETHNICITY**

| Dependent Variable: | log(LTV) | | | | I(LTV≥95) | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Black | 0.1162 | 0.0728 | 0.0651 | 0.0325 | 0.2952 | 0.1684 | 0.1550 | 0.1239 |
| | (.001) | (.001) | (.001) | (.001) | (.001) | (.002) | (.001) | (.002) |
| Hispanic | 0.0674 | 0.0231 | 0.0372 | 0.0173 | 0.1279 | 0.0472 | 0.0587 | 0.0393 |
| | (.001) | (.001) | (.001) | (.001) | (.002) | (.002) | (.002) | (.003) |
| Asian | -0.0489 | -0.0467 | -0.0252 | -0.0312 | -0.1824 | -0.1087 | -0.0794 | -0.0812 |
| | (.001) | (.000) | (.001) | (.001) | (.001) | (.001) | (.001) | (.002) |
| Controls | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Geographic Control | No | No | Yes | Yes | No | No | Yes | Yes |
| First Home Control | No | No | No | Yes | No | No | No | Yes |
| Observations | 4,092,570 | 4,092,570 | 4,092,570 | 1,317,103 | 4,228,202 | 4,228,202 | 4,228,202 | 1,358,401 |
| $R^2$ | 0.014 | 0.213 | 0.137 | 0.251 | 0.029 | 0.304 | 0.282 | 0.307 |

*Notes:* This table shows regressions of borrower leverage against race and ethnicity using 2018 and 2019 HMDA data for purchase loans. Leverage is measured as the log of LTV at the time of origination (columns 1–4) and with an indicator for whether initial leverage is in excess of 95 (columns 1–8). Controls include year, income decile, sex, purchaser type, loan type, occupancy type, and the debt to income ratio. Geographic controls are for the census tract, and a control for first time home buyer controls for whether the buyer is between 24–35 in age. Standard errors are shown in parentheses.

**TABLE A.II: LOAN AMOUNTS AND LOCAL CHARACTERISTICS**

| | log(LTV) | Black | log(Income) | log(Tract Income) | Math Test | Job Access | Causal Place |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| log(Loan Amount) | 0.209*** | -0.0041*** | 0.619*** | 0.349*** | 0.200*** | 1130.8*** | 0.0510* |
| | (.001) | (.001) | (.002) | (.000) | (.006) | (83.47) | (.02) |
| Observations | 3,676,749 | 3,676,749 | 3,676,749 | 2,250,625 | 3,676,714 | 3,676,714 | 3,655,094 |
| $R^2$ | 0.0496 | 0.0396 | 0.687 | 0.246 | 0.0361 | 0.00562 | 0.0160 |

*Notes:* This table shows regressions of borrower leverage against a variety of personal and local outcomes using 2018 and 2019 HMDA data for purchase loans. Columns 1–3 focus on individual outcomes: individual LTV (in logs), an indicator for Black borrowers, and income of the borrower (in logs). Column 4 measures income of the Census tract (in logs). Column 5 shows math test scores, column 6 measures the prevalence of local job opportunities, and column 7 measures causal place based estimates of local country presence. Estimates for columns 5–7 are drawn from Chetty & Hendren (2018). Standard errors are shown in parentheses.

# B Model Appendix

## B.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 retirement to define pension benefits allows to save a state variable in the dynamic programming problem. Retirement income is equal to:

$$Y_{i,R} = \overline{Y} \times \begin{cases} 0.9\tilde{Y}_{i,R} & \text{if } \tilde{Y}_{i,R} \leq 0.3 \\ 0.27 + 0.32(\tilde{Y}_{i,R} - 0.3)\tilde{Y}_{i,R} & \text{if } 0.3 < \tilde{Y}_{i,R} \leq 2 \\ 0.81 + 0.15(\tilde{Y}_{i,R} - 2)\tilde{Y}_{i,R} & \text{if } 2 < \tilde{Y}_{i,R} \leq 4.1 \\ 1.13 & \text{if } 4.1 \leq \tilde{Y}_{i,R} \end{cases} \tag{24}$$

## B.2 Numerical Solution

Households' value functions are subject to i.i.d. idiosyncratic taste shocks, which cancel out in the aggregate. This is a classical assumption in the dynamic demand literature, used in Mabille (forthcoming). Given value functions, it allows 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 $2 \times 2$ model with discrete choices, and computing counterfactual experiments without generating jumps in targeted moments upon parameter changes.

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

$$\tilde{V}_g^{rL}(a, b_t, y_t) = V_g^{rL}(a, b_t, y_t) + \tilde{\varepsilon}_g^{rL}(a, b_t, y_t) \tag{25}$$

where $\tilde{\varepsilon}$ follows a type I Extreme Value distribution with location parameter 0 and scale 1.

(i) 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 to reduce the size of the state space and makes the problem tractable. Without it, a very 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 $g$:

$$\mathbb{E}_g^{rL}\left[V^r\right] = \mathbb{E}_g^{rL}\left[\int \tilde{V}^r \mathbf{dF}\left(\tilde{\varepsilon}\right)\right] = \mathbb{E}_g^{rL}\left[\log\left(\sum_j e^{\tilde{V}^{r,j}}\right)\right] \tag{26}$$

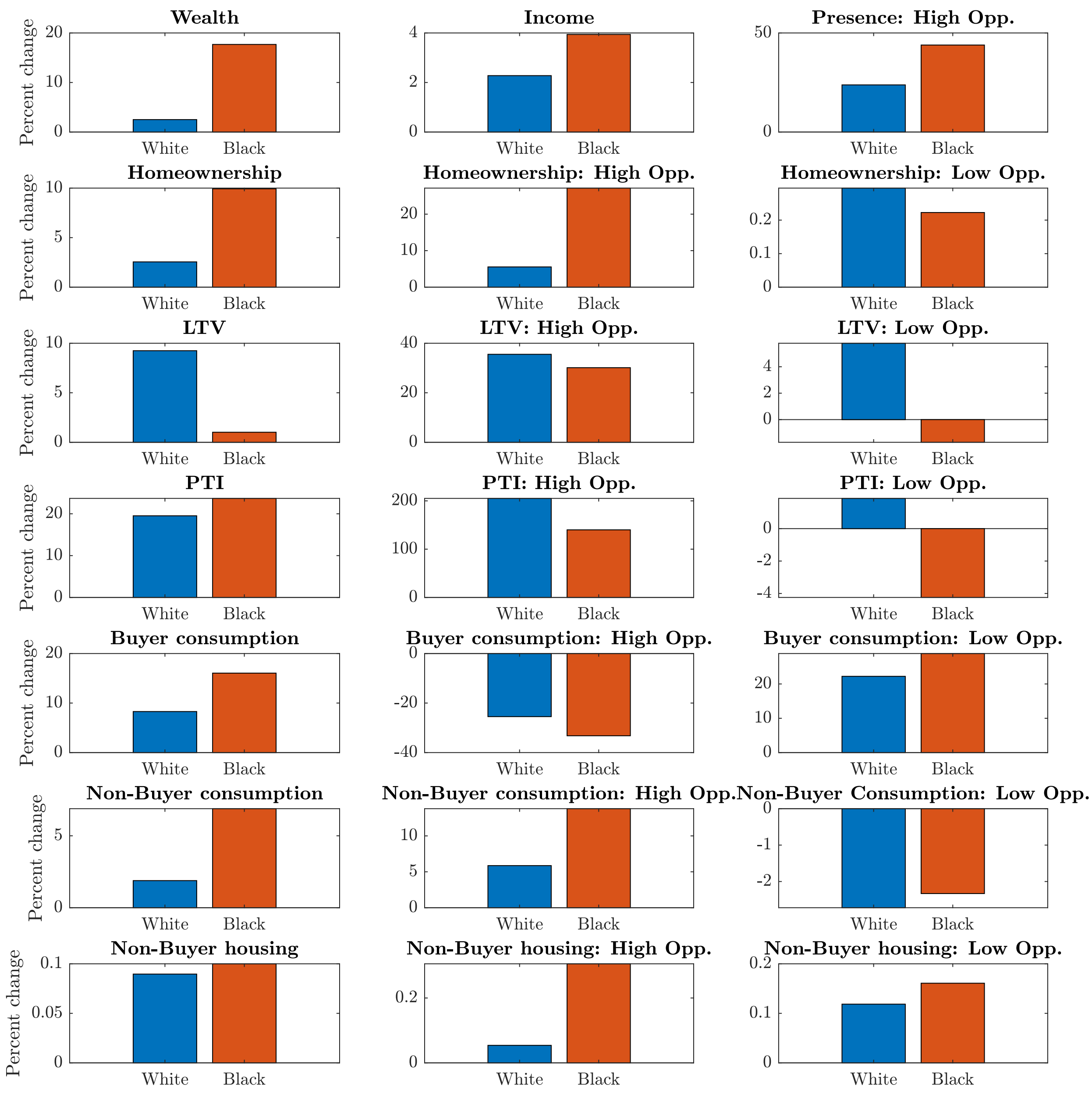
where $\tilde{V}^r \equiv \max\left\{\tilde{V}^{r,j}\right\}_j$. The outside expectation $\mathbb{E}_{L,t}\left[.\right]$ is taken over the distribution of idiosyncratic income shocks (identical across areas in the baseline). $V^r$ denotes the ex-ante value function, after integrating over the vector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

(ii) We 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:

$$\Pr\left(\tilde{V}_g^r = \tilde{V}_g^{r,j}\right) = \frac{e^{\tilde{V}_g^{r,j}}}{\sum_{j'} e^{\tilde{V}_g^{r,j'}}} \tag{27}$$

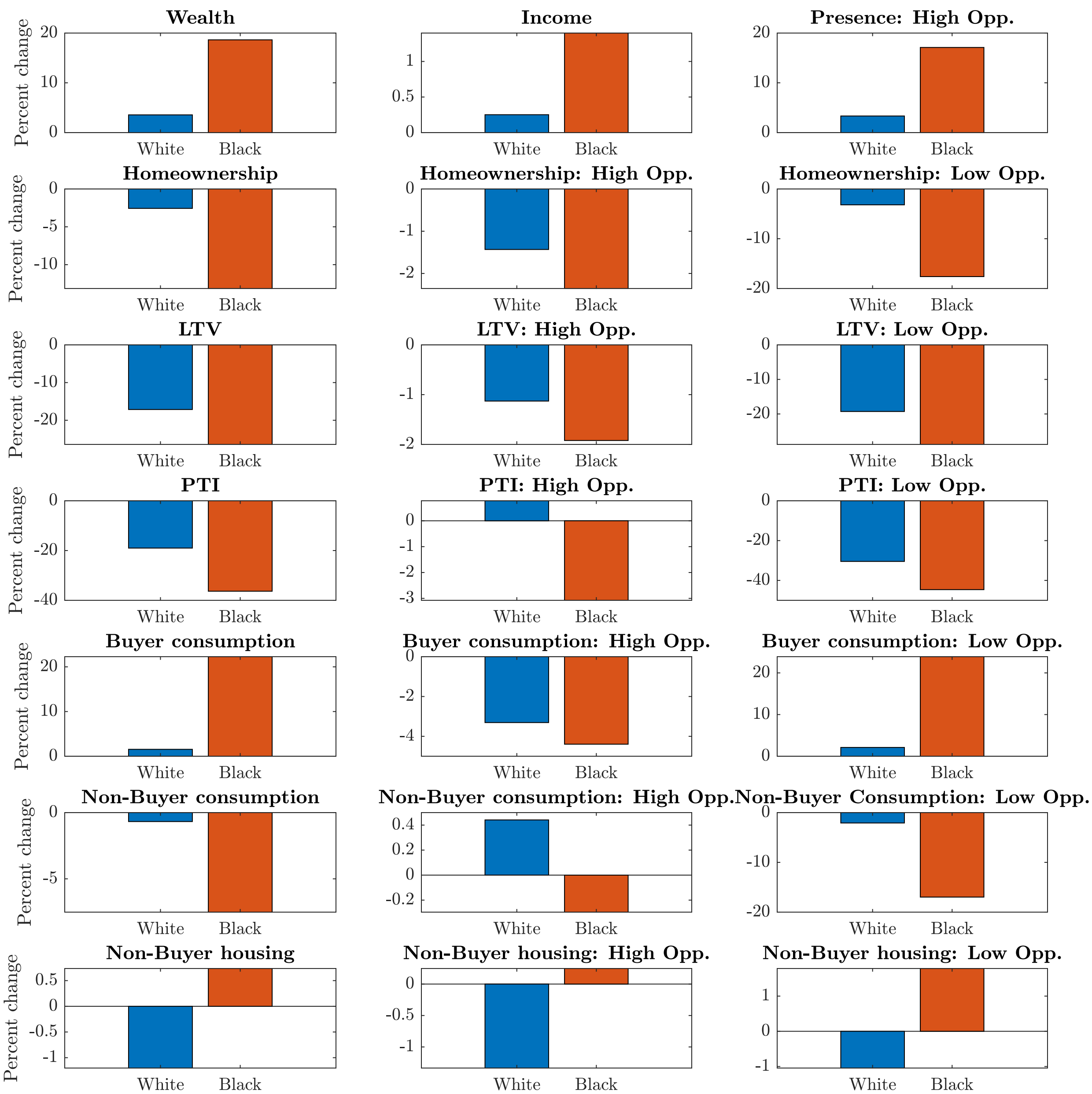
# C Detailed Model Results

**Figure C.I: Relaxing leverage constraints: detailed results**



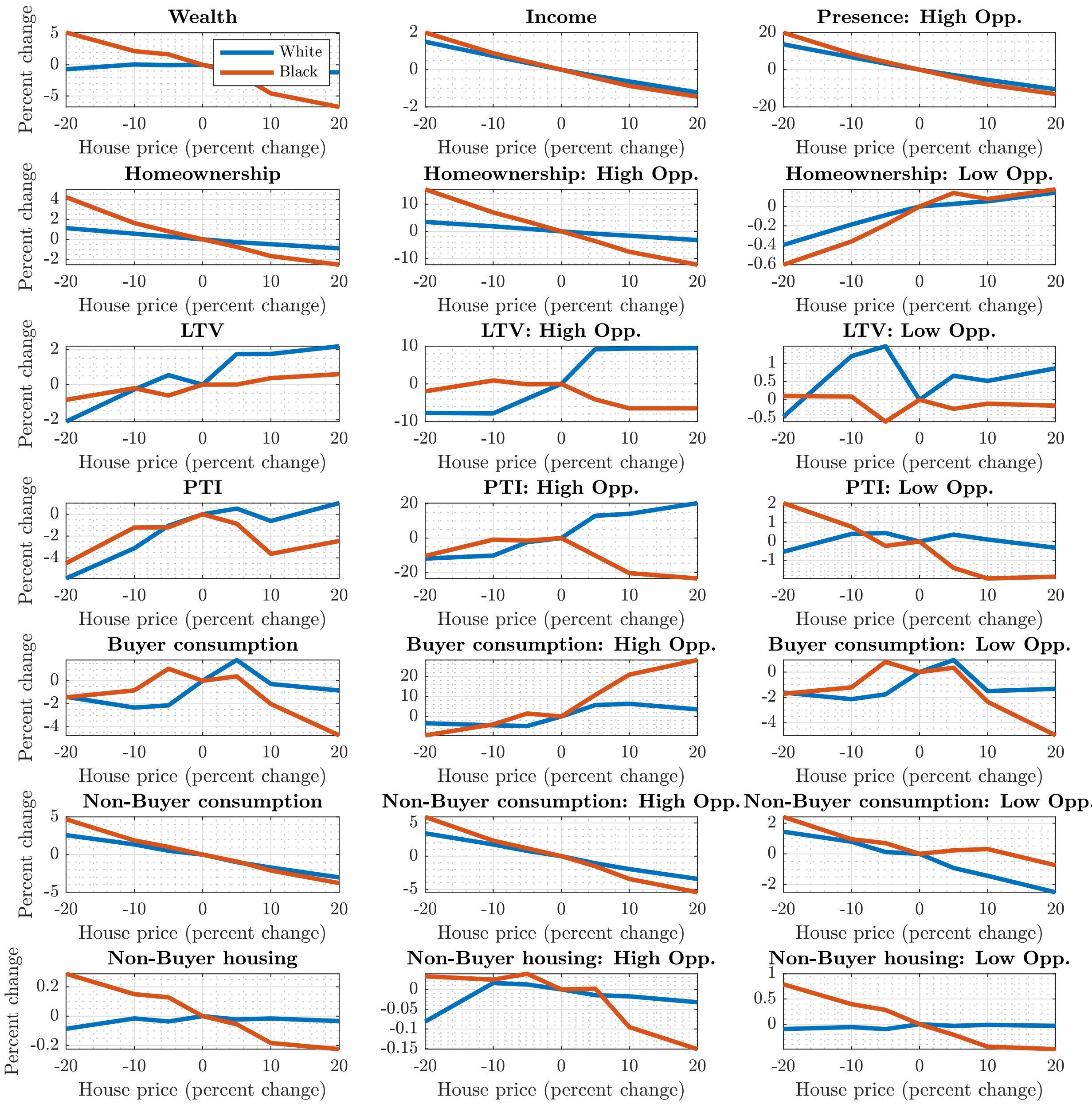

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure plots the result of a counterfactual experiment in which we relax LTV constraints in the high-opportunity housing stock ($\theta^H_{LTV} = 0.95$, instead of $\theta^H_{LTV} = 0.80$ at baseline).

**FIGURE C.II: TIGHTENING LEVERAGE CONSTRAINTS (PHASING OUT FHA MORTGAGES)**



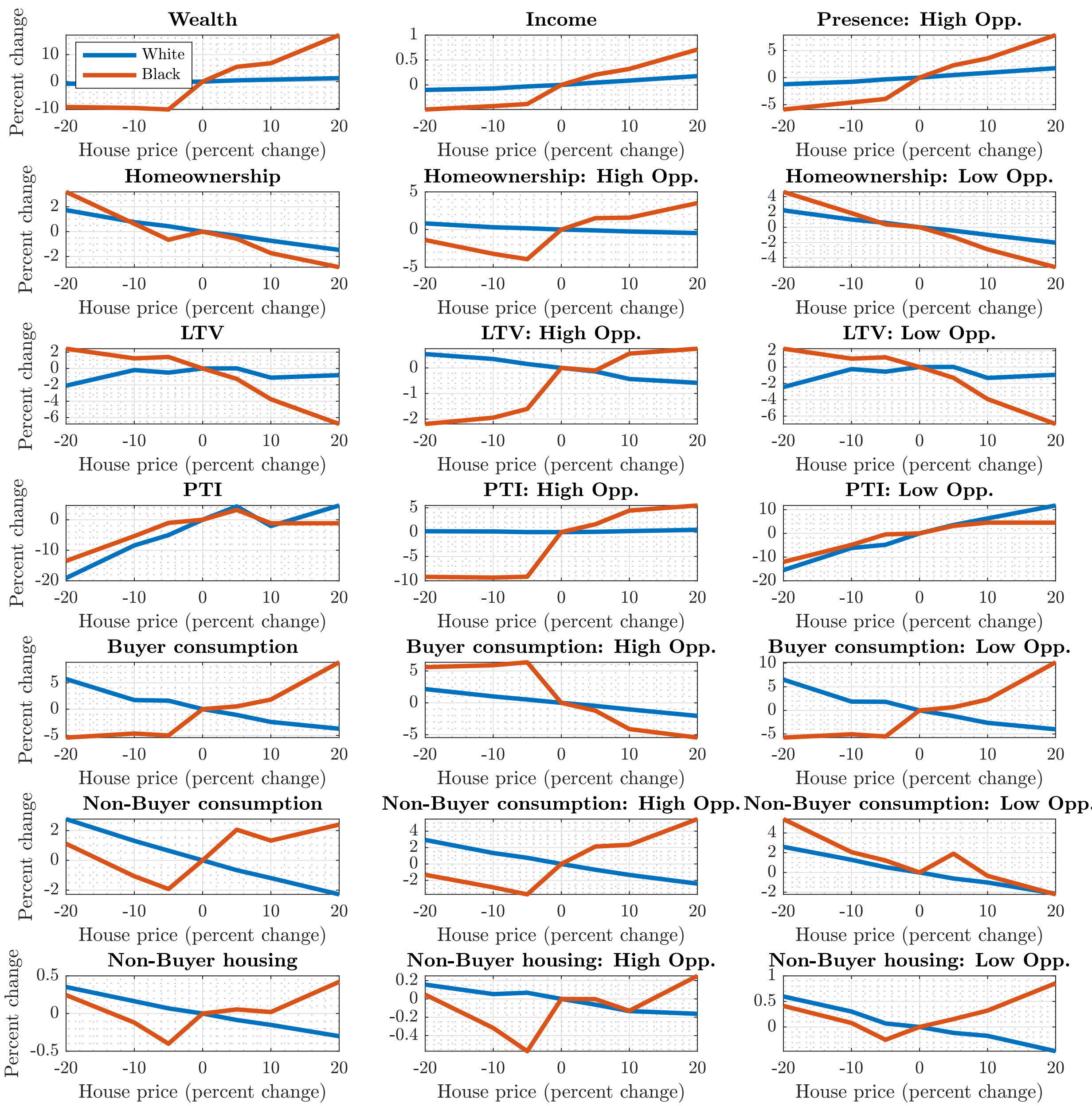

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure plots the result of a counterfactual experiment in which we tighten LTV constraints in the low opportunity housing stock ($\theta^L_{LTV} = 0.80$, instead of $\theta^H_{LTV} = 0.95$ at baseline).

**FIGURE C.III: HOUSE PRICE SHOCKS IN HIGH OPPORTUNITY AREA: DETAILED RESULTS**



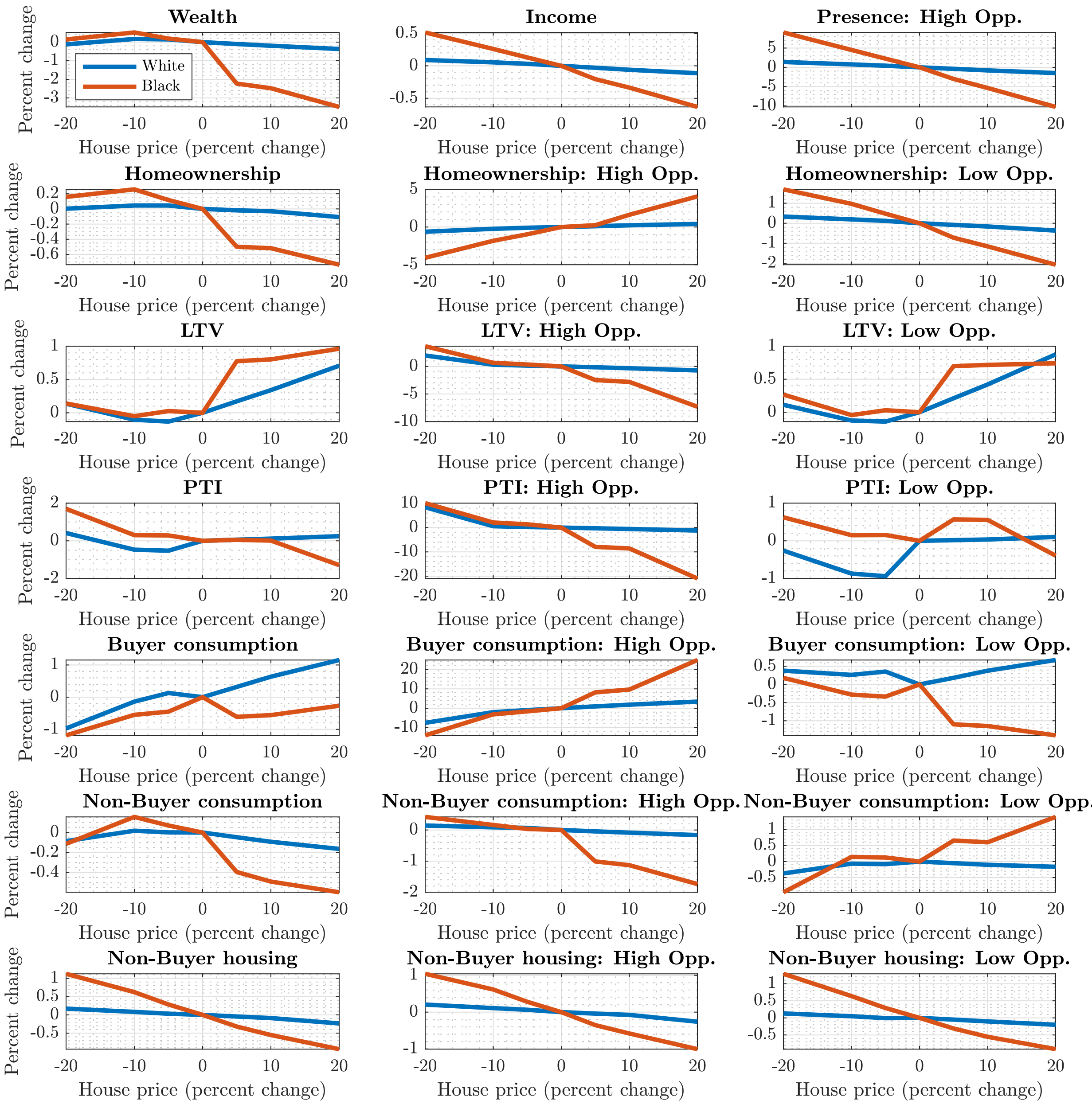

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure corresponds to a counterfactual experiment in which we vary the price of homes in the non-FHA eligible, high-opportunity zone.

## FIGURE C.IV: HOUSE PRICE SHOCKS IN LOW OPPORTUNITY AREA: DETAILED RESULTS



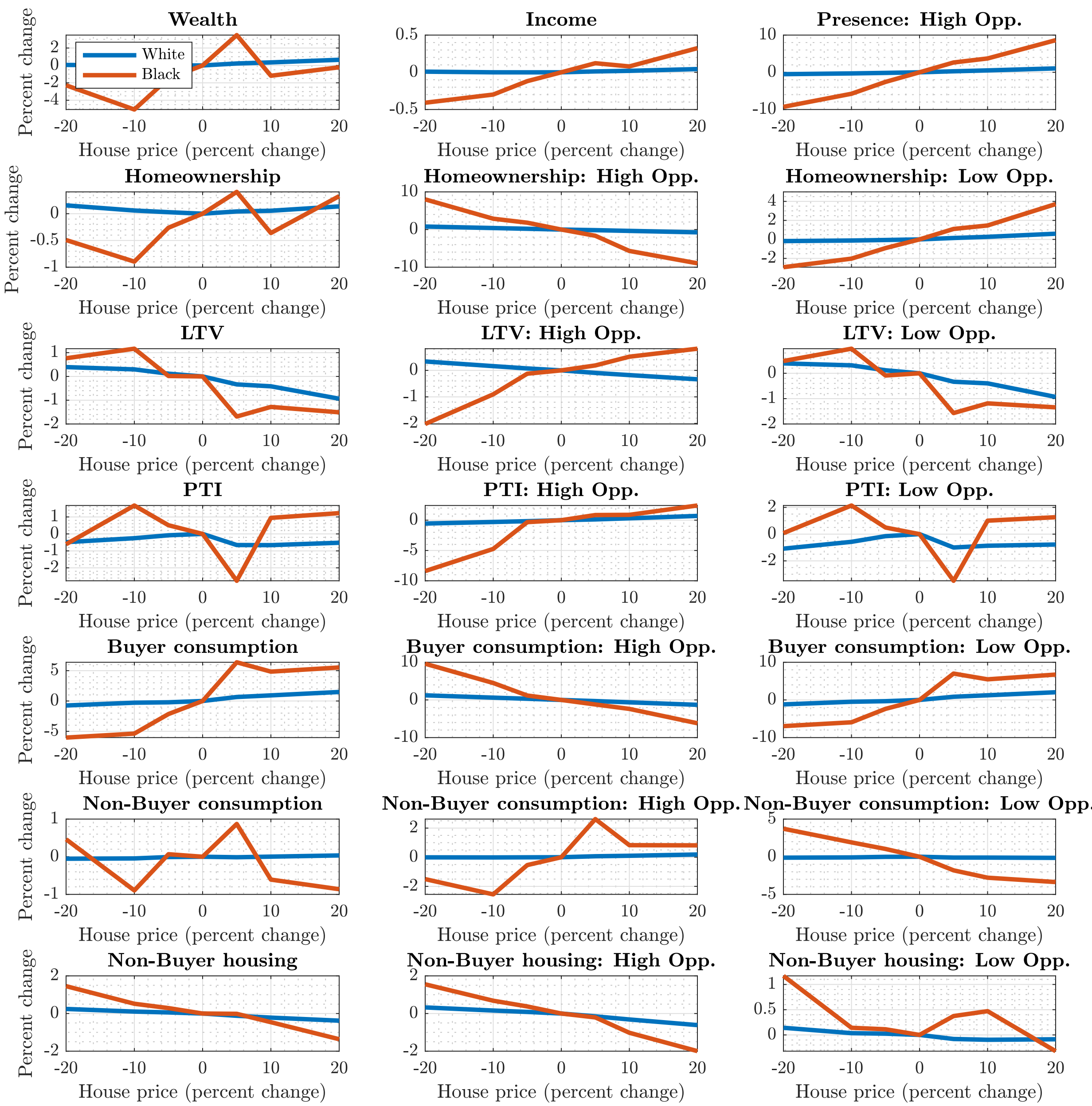

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure corresponds to a counterfactual experiment in which we vary the price of homes in the FHA eligible, low-opportunity zone.

**FIGURE C.V: RENT SHOCKS IN HIGH-OPPORTUNITY AREA: DETAILED RESULTS**



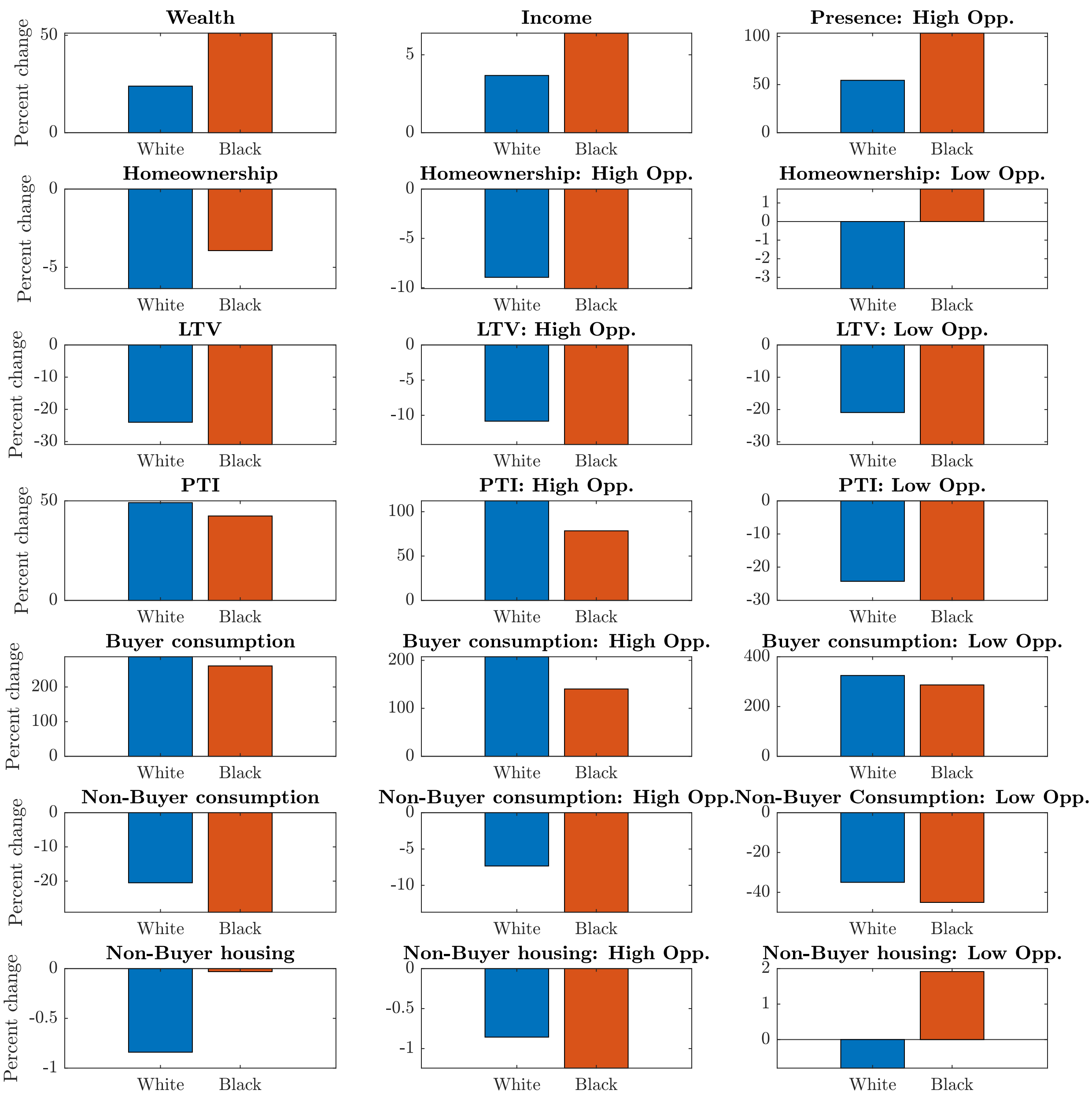

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure corresponds to a counterfactual experiment in which we vary rental prices in the non-FHA eligible, high-opportunity zone.

## Figure C.VI: Rent shocks in low-opportunity area: detailed results




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure corresponds to a counterfactual experiment in which we vary rental prices in the non-FHA eligible, high-opportunity zone.

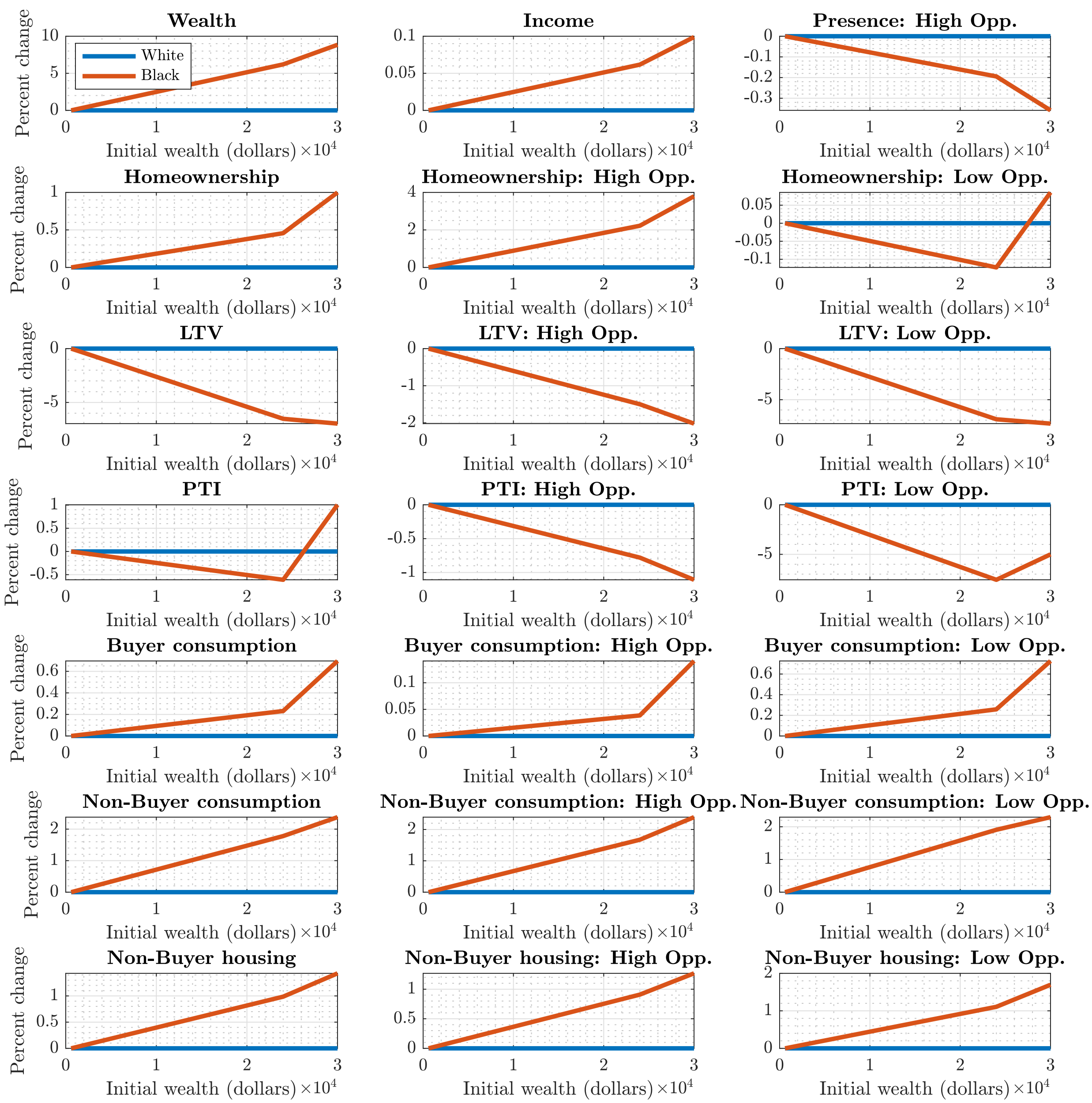
FIGURE C.VII: MOVING TO WEALTH OPPORTUNITIES: DETAILED RESULTS




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. The figures show the consequences of setting moving costs from the FHA-eligible housing stock to the non-eligible stock equal to zero.

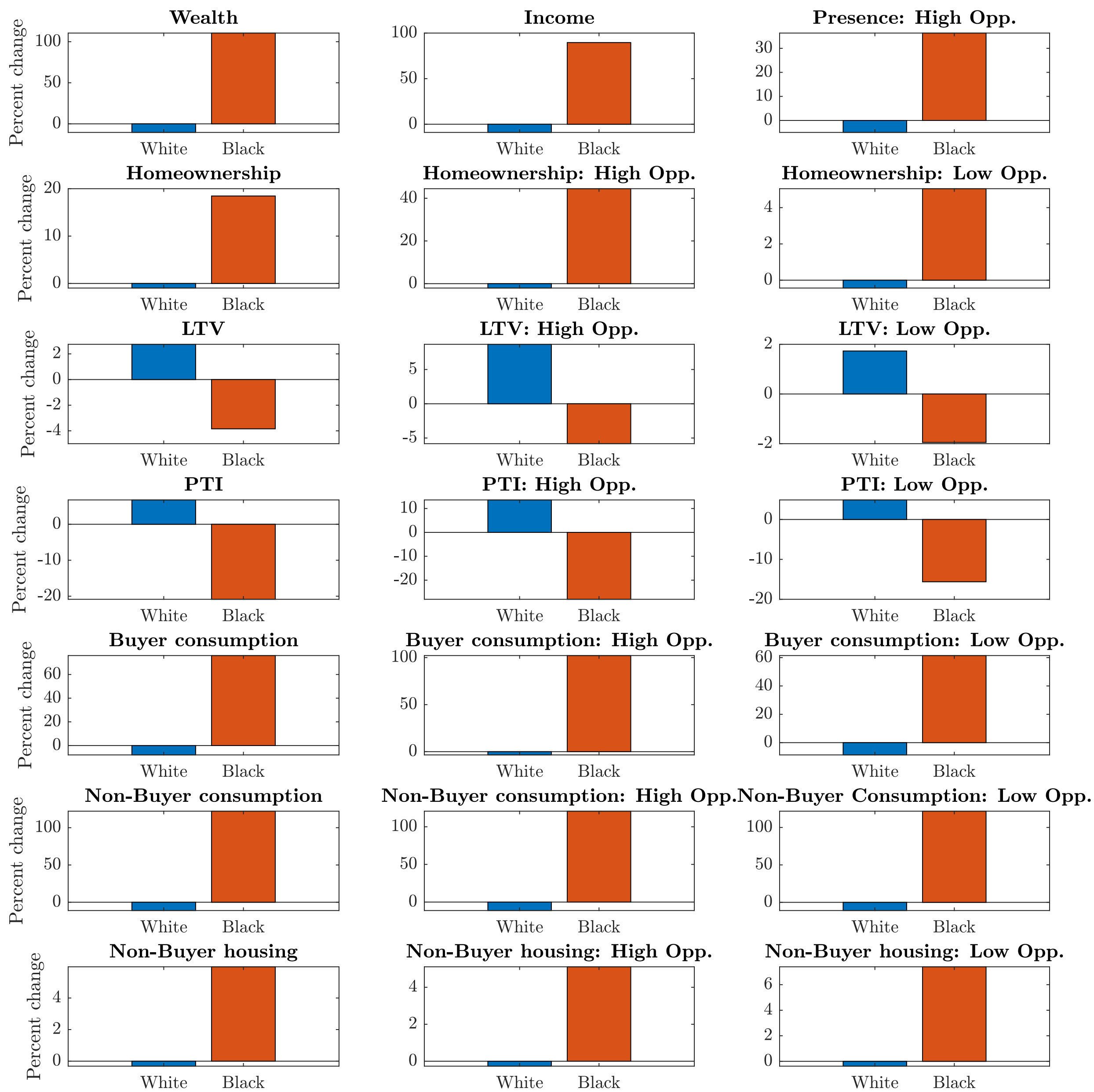
# D Additional Policy Results

**FIGURE D.I: REPARATIONS TO INCREASE INITIAL WEALTH OF BLACK HOUSEHOLDS**



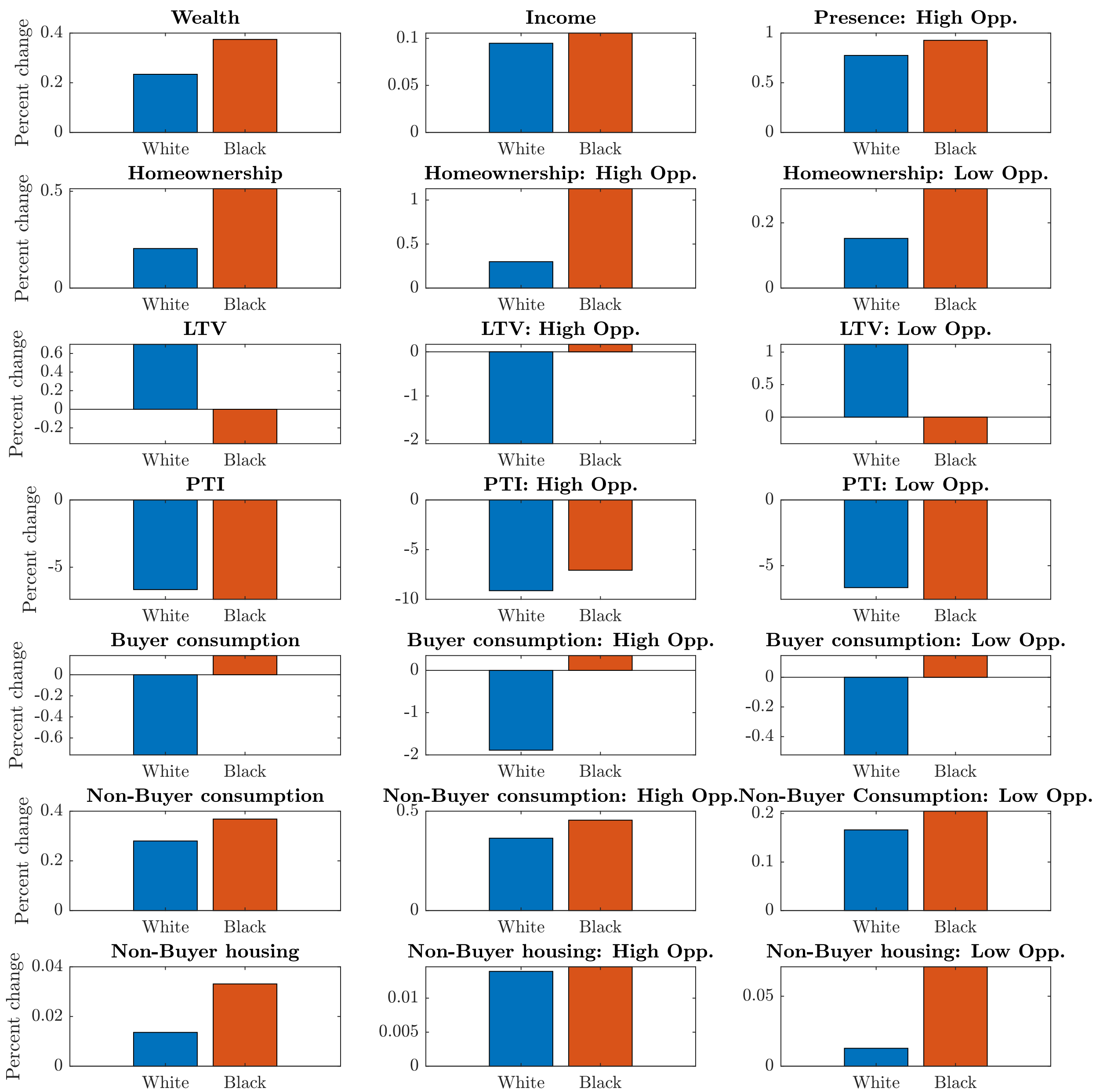

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. These figures show the consequences of reparations-style policies that increase baseline wealth for Black households.

**FIGURE D.II: REPARATIONS TO EQUATE INCOME DIFFERENCES ACROSS GROUPS**



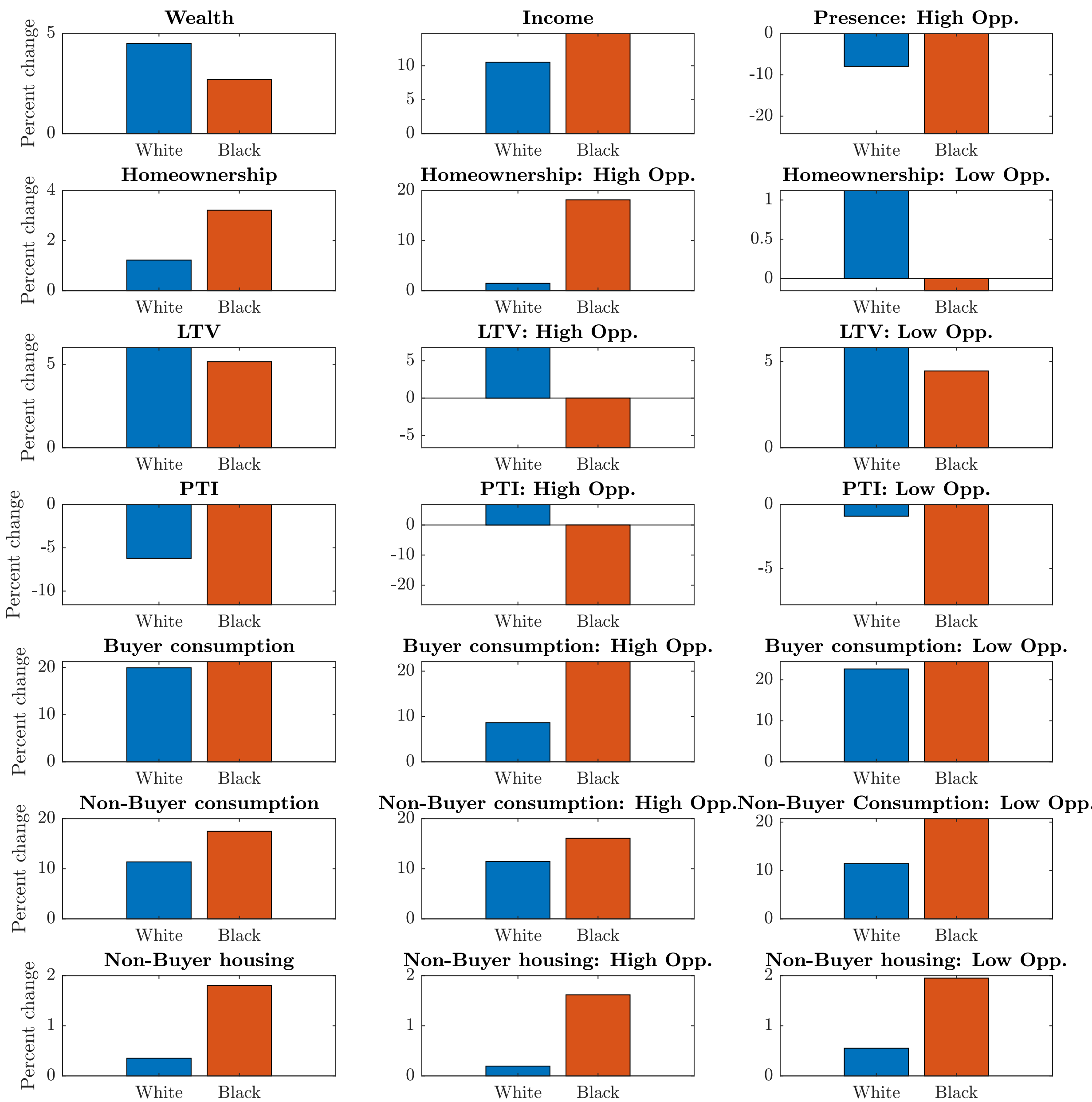

*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. These figures show the consequences of reparations-style policies that equate income shifters for Black and white households.

## FIGURE D.III: MORTGAGE RATE SUBSIDY: DETAILED RESULTS




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. These figures show the consequences of a mortgage rate subsidy of 50 basis points.

**FIGURE D.IV: PLACE-BASED LABOR MARKET POLICY: DETAILED RESULTS**




*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. These figures show the consequences of removing spatial income shifters between the high and low opportunity zones.