

# Financial Constraints and the Racial Housing Gap\*

Arpit Gupta<sup>†</sup>

NYU Stern

Christopher Hansman<sup>‡</sup>

Imperial College London

Pierre Mabille<sup>§</sup>

INSEAD

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## Abstract

We highlight the role of financial constraints in contributing 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 worse initial conditions on the home purchase decisions, spatial allocation, and long-term wealth accumulation of minority borrowers. Wealth and income outcomes for Black borrowers are substantially improved by relaxing LTV constraints and reducing moving frictions.

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<sup>†</sup>Email: [arpit.gupta@stern.nyu.edu](mailto:arpit.gupta@stern.nyu.edu). Website: <http://arpitgupta.info>.

<sup>‡</sup>Email: [c.hansman@imperial.ac.uk](mailto:c.hansman@imperial.ac.uk). Website: <https://chansman.github.io>.

<sup>§</sup>Email: [pierre.mabille@insead.edu](mailto:pierre.mabille@insead.edu). Website: <https://www.pierremabille.com>.

# 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 remains unclear. Considerable empirical and theoretical work has in fact 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 their impact on wealth accumulation across groups. In the presence of more stringent leverage requirements in areas with more expensive housing, households with limited wealth find it difficult to access homeownership in these high-opportunity areas. This limits labor market and wealth building opportunities for groups with lower initial wealth and income conditions. First, more expensive housing markets typically offer higher labor market returns, which allow households to save more and accumulate wealth more quickly. Second, the ability to purchase valuable homes determines the size of wealth accumulation over the life-cycle and future bequests within the same group. As a result, low-wealth households facing binding leverage constraints are spatially misallocated in that they are limited in their ability to access neighborhoods which enable them to build wealth.

We evaluate this mechanism in the context of the Black-white wealth gap, which we focus on for two reasons. First, racial disparities in wealth are particularly striking in the United States, and represent 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.<sup>1</sup> Our model demonstrates that leverage constraints perpetuate initial disparities between Black and white households. Because of initial differences in wealth, Black households have more difficulty in overcoming leverage constraints and reaching high-opportunity areas. This limits the ability of Black households to access valuable real estate

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<sup>1</sup>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/](https://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/).

assets, job opportunities, and as a result build wealth over time. Our calibration suggests that relaxing leverage constraints in high-opportunity areas would increase Black wealth substantially, by 18%.

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 homeowners put at least 10 percent down for new purchase mortgage originations, compared to less than 20 percent of Black households.<sup>2</sup> 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 also come with loan caps which constrain the ability of high leverage and minority borrowers to access more expensive homes, which generally correspond to high-opportunity areas with higher incomes.<sup>3</sup>

We then develop a structural model that accounts for these facts, to understand 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 from two different stocks, which correspond to FHA-eligible and FHA-ineligible housing and are respectively located in high- and low-opportunity areas.<sup>4</sup> The degree to which households accumulate wealth depends jointly on their choices of housing stock, home ownership, and leverage. These choices 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.

To calibrate the model, we base demographic groups on observed levels of 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 differ-

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

<sup>3</sup>The FHA loan cutoff is 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](https://www.hud.gov/program_offices/housing/sfh/lender/origination/mortgage_limits).

<sup>4</sup>High-opportunity and low-opportunity refer to labor income prospects within the model.

ences 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 the racial differences in leverage, and 52% of the racial wealth gap. While there are a number of other unmodeled factors that play a role in determining aggregate Black-white disparities, these results suggest that accounting for financial constraints is important in understanding racial differences in housing and wealth. Our results therefore complement existing analyses of racial wealth gaps based on macroeconomic accounting (e.g. [Derenoncourt \*et al.\*, 2022](#)). With the calibrated model in hand, we next turn to examining the role of financial constraints as a driver of observed differences by race and evaluating the efficacy of various policy proposals.

Our first counterfactual exercise demonstrates the importance of financial constraints in determining observed Black-white disparities. We relax the leverage requirement in the high-opportunity areas, allowing borrowers to purchase homes in this region with relatively low down payments. This change has unambiguously beneficial impacts on lifetime income, wealth, and homeownership—especially for Black borrowers. Because Black households have lower wealth, on average, relaxed leverage constraints enable access to home-ownership and higher incomes in the high-opportunity zone. In this counterfactual raising possible LTV ratios to 95 percent in the high-opportunity zone, we find that average Black income grows by nearly 5% and Black wealth by 18%. Meanwhile, both homeownership and presence in the high-opportunity area increase for these households. This exercise underscores the main result of our paper, that the presence of leverage constraints differentially impacts Black households, and leads to persistent spatial misallocation in ways that impair income prospects and wealth building.

We then turn to analyzing the impact of one of the most important recent trends in housing markets—house price growth—on wealth accumulation and Black-white gaps. Increases in house prices in high opportunity areas can be loosely thought of as a “gentrification” shock ([Guerrieri \*et al.\*, 2013a](#)), to the extent that they ultimately stem from increased demand for areas with strong labor markets, and have potential displacement consequences. We find that they have heterogeneous impacts across demographic groups, and a much larger negative impact on Black households because they tend to be closer to the leverage constraint. An exogenous increase in house prices in the high-opportunity zone decreases average wealth, homeownership, and income in the steady state, as households transition out of homeownership and into the lower-opportunity area. The impact is substantially larger for Black borrowers, who are less able to adjust to slightly higher leverage and remain homeowners. By contrast, the wealth of white borrowers remains relatively unchanged.

Finally, since the core mechanism in our model is the spatial mismatch of Black borrowers into the low-opportunity housing stock, we consider policies aimed at reducing moving frictions between areas. We view

such policies as improving household's ability to move to wealth building opportunities. Our results show that these policies are also effective at reducing Black-white wealth gaps, but interestingly do so by lowering Black homeownership. 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 end up saving more, such that those who reach homeownership are richer and have lower leverage than previously. In that sense, these policies lower spatial misallocation by putting the right home buyers in the right place. They also highlight a set of tensions that arise across several counterfactual experiments, which reflect the fact that wealth, homeownership, income, and welfare are not synonymous. It is possible for housing policies to increase both wealth and homeownership while reducing overall welfare, because households are forced to save instead of consume. Other policies may increase welfare while reducing both wealth and income, as borrowers are able to enjoy the benefits of homeownership in a lower-opportunity area. These tensions highlight the pitfalls of a narrow focus on improving wealth or homeownership gaps at the expense of underlying gaps in consumption or welfare. We supplement our main three experiments by further analyzing them for more conventional policy tools such as mortgage rate subsidies and place-based labor market policies, as well as reparation-style transfers to Black buyers.

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. Our results similarly persist when removing income differences between Black and white households, demonstrating that initial wealth differences alone are sufficient to generate long-run impacts in the presence of financial constraints. Second, our model focuses on the central role of LTV constraints, and so does not include payment-to-income (PTI) limits; we show that our results are also 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. We also weaken this assumption using recent evidence drawn from mover designs.

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 face 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), 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—Giacolotti *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 contribute to this literature by providing a sufficiently rich structural framework in which to evaluate explicit counterfactual policies aimed at addressing the racial wealth gap via the housing channel. Furthermore, we bring the role of the leverage gap 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-Boninfant (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 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), and Favilukis *et al.* (forthcoming). Our contribution to this literature comes from the  $2 \times 2$  structure of our 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 affects wealth accumulation between 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 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 a central stylized fact of our analysis: minority borrowers have substantially higher leverage at the time of mortgage origination compared to white borrowers. 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 and high-opportunity neighborhoods.

## 2.1 Data Description

In order to establish some key housing facts on as comprehensive of a sample as possible, 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 to 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 role of 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 use this historical information in order to connect household movements 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).<sup>5</sup> Finally, in order to establish racial differences over time, we use 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.\* \(2021\)](#)).

## 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

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<sup>5</sup>See: [www.Zillow.com/data](http://www.Zillow.com/data).

borrowers—nearly 60 percent—have initial combined loan-to-value-ratios (CLTV) above 95 (percent). By contrast, less than 30 percent of white borrowers have this level of high leverage. Indeed, the median CLTV for Black borrowers is 96.5 (vs. 90 for white borrowers).<sup>6</sup> 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 percent of the total borrower pool across the distribution below 90 LTV, but only 64 percent of the borrower pool among those with CLTV over 95.

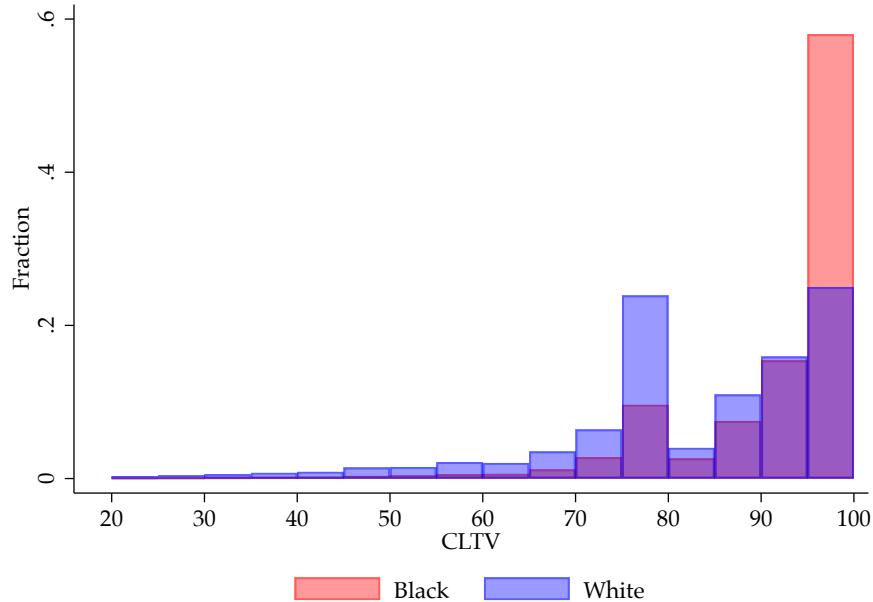
Origination leverage is one of the two main margins on which borrowers may face constraints in the mortgage application process. LTV reflects the extent to which borrowers have pre-existing savings to make down payments. The other constraint is typically in terms of payment-to-income (PTI), which captures the loan burden relative to current flow income. [Greenwald \(2018\)](#) shows that both constraints, the LTV and the PTI, 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). This motivates our focus on an LTV constraint in our structural model. In Section 6 we extend our results to also 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 compared with 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 had received an inheritance in the survey, compared to 10% of Black families and just 7% of Hispanic families. [Charles & Hurst \(2002\)](#) emphasize the role parental income transfers in down payment assistance as drivers of racial differences in housing behavior (see also [Benetton et al., 2022](#)). Expected inheritances, as well, are much higher for white households in the SCF. In addition to formal bequests, the receipt of which tend to occur later in the life-cycle, white families also report 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 in 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.

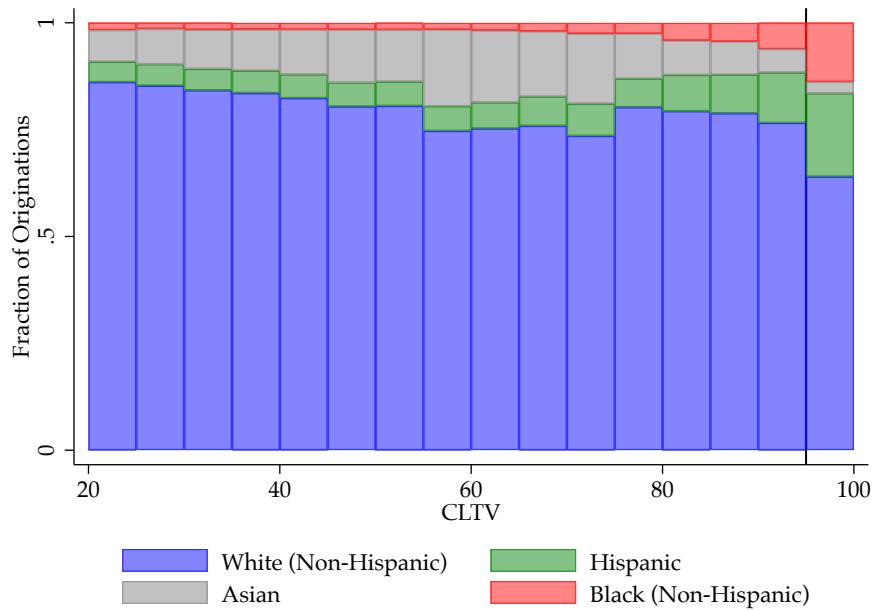
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<sup>6</sup>High leverage mortgages are also common among Hispanic borrowers, although to a lesser extent. See Appendix figure A.I. These statistics, and all others in this section, except where otherwise indicated, are drawn from the 2018 HMDA sample 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 in 2018. 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.

## 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.<sup>7</sup> The FHA system was created in the wake of the Great Depression, when private lenders typically required much higher down payments for private mortgages for shorter terms. The popularity of the FHA mortgage system has varied over 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.<sup>8</sup>

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 the Housing Stock 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 the 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

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<sup>7</sup>Borrowers with credit scores as low as 500 can also qualify for FHA mortgages, but must have down payments of at least 10 percent.

<sup>8</sup>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).

year 2021), a nationwide ceiling (\$822,375 in 2021), and thresholds set at 115 percent of the median home price for counties between the floor and ceiling.<sup>9</sup>

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.<sup>10</sup>

This loan cap constraint also limits the housing stock accessible by Black homeowners. Panel B of Figure 2 shows evidence of substantial bunching for Black borrowers at the FHA loan limit, with a substantial 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.<sup>11</sup>

## 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.<sup>12</sup> The fact that minority borrower sort along leverage implies that they haveS access to worse quality geographical areas. The idea that minority borrowers face spatial segregation with consequences on 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 as well as borrower sorting. This racial allocation, in turn, disadvantages minority borrowers with respect to accessing high-quality jobs and other opportunities within and across metropolitan areas.

Our contribution to this literature is to highlight that this sorting is amplified by leverage constraints

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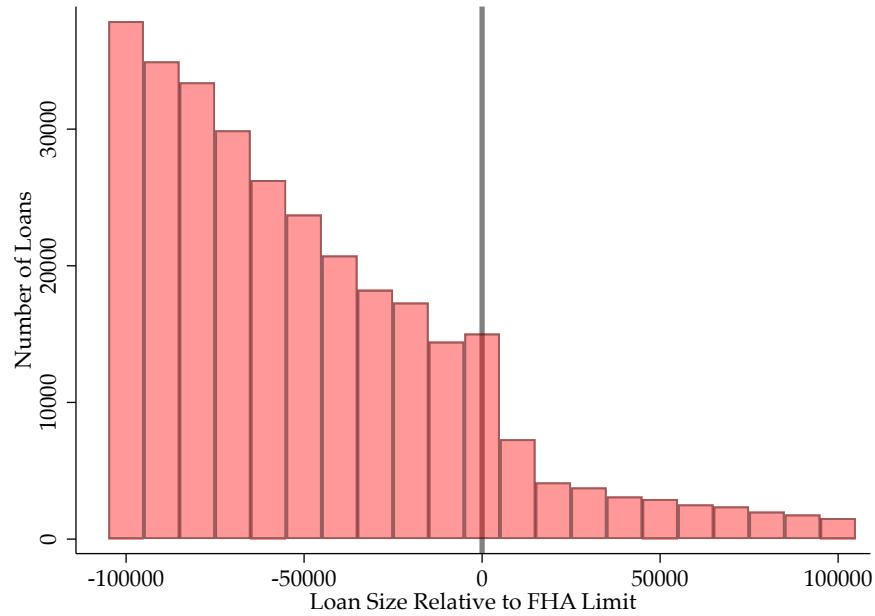
<sup>9</sup>See: [https://www.hud.gov/press/press\\_releases\\_media\\_advisories/HUD\\_No\\_20\\_201](https://www.hud.gov/press/press_releases_media_advisories/HUD_No_20_201). Appendix Figure A.IV shows changes in the nationwide limit over time.

<sup>10</sup>A similar bunching pattern is also evident in raw loan sizes around the nationwide floor, as shown in Appendix Figure A.V.

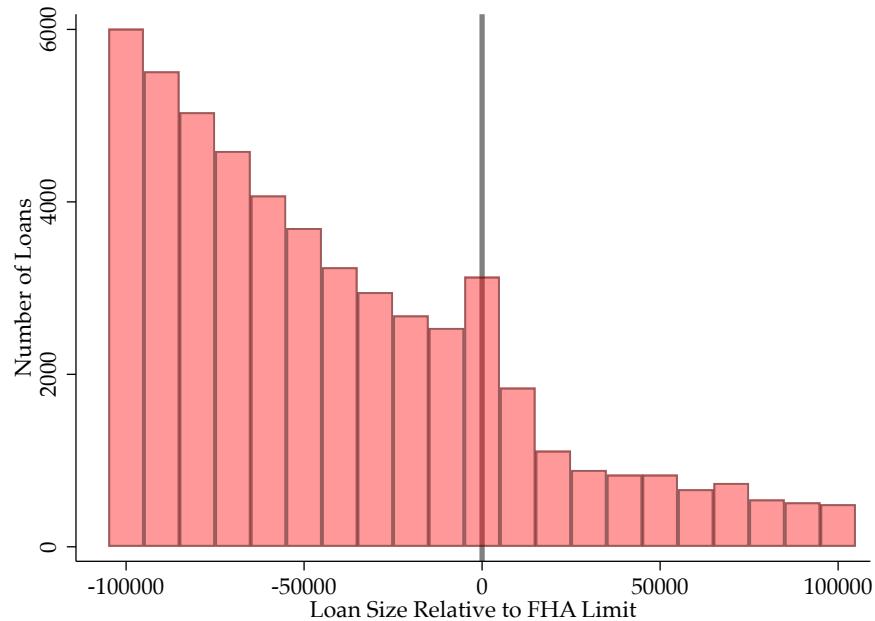
<sup>11</sup>These estimates suggest that borrowers are not neutral across all loan origination channels; but that the FHA plays a unique role in facilitating high-leverage borrowing by individuals who, as a consequence, are clustered at lower loan and house sizes. We see further evidence of this sorting 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.

<sup>12</sup>Of course, sorting across housing stocks even within metro-areas can have important consequences for inequality. See, e.g., Fogli & Guerrieri (2019).

**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**

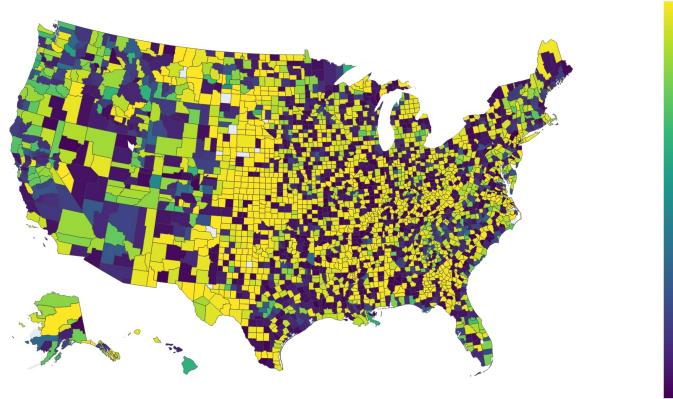


**PANEL B: BLACK BORROWERS – LOAN SIZE RELATIVE TO THE FHA LIMIT**

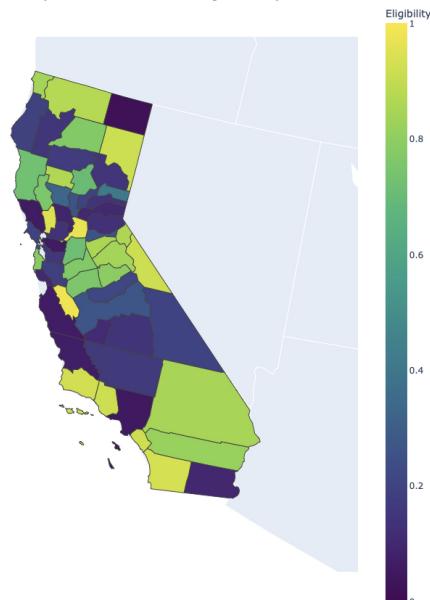
*Notes:* Panel A plots the distribution of loan size at origination relative to the local county FHA limit for loans with initial combined LTV at or above 95%. Panel B plots the distribution of loan size at origination relative to the local county FHA limit for Black borrowers. In both figures, the sample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

(and by the variation in leverage constraints generated by the FHA). Because of the structure of FHA limits, a significant fraction of homes in higher priced areas may be ineligible for purchase with a high leverage

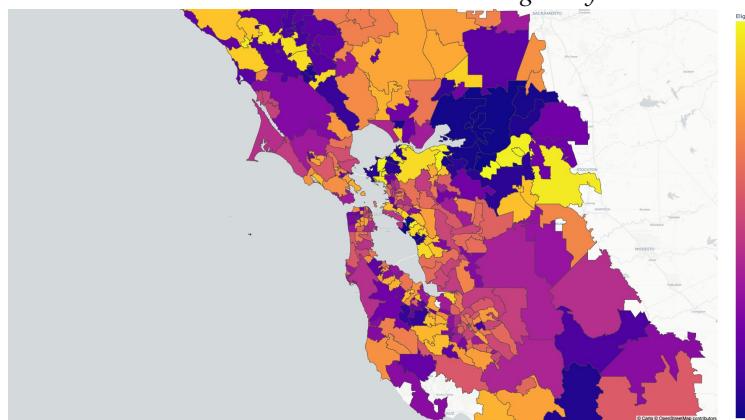
*Panel A: National FHA Eligibility*



*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 HMDA data which can be purchased by fully-levered borrowers using FHA loans. To determine eligibility, we compare the house purchase price against the county-specific FHA loan limit.

FHA loan. This is typically because either (i) most house prices in these areas are above the nationwide ceiling, or (ii) prices 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 mortgaged financed properties across the United States (zooming in on California and San Francisco, as an example) which can be accessed 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 substantially more binding in many urban areas which feature access to 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 much smaller fraction of transacting properties which are accessible through the FHA program.

A consequence of the distortions generated by leverage is the ability to access better labor market opportunities. Unlike other assets, residential real estate is unique because it combines a financial return as well as a fixed residence. Because individuals are limited in their commute times, access to centrally located housing stock is an essential prerequisite to access these job opportunities. We show, in Figure 4, that more constrained borrowers—as measured by higher LTVs and lower loan sizes—are typically purchasing homes in neighborhoods with lower incomes.<sup>13</sup> While it is unlikely that the entirety of income differences is place-based, recent research (Card *et al.*, 2021) suggests that a non-trivial portion is causally driven by location.

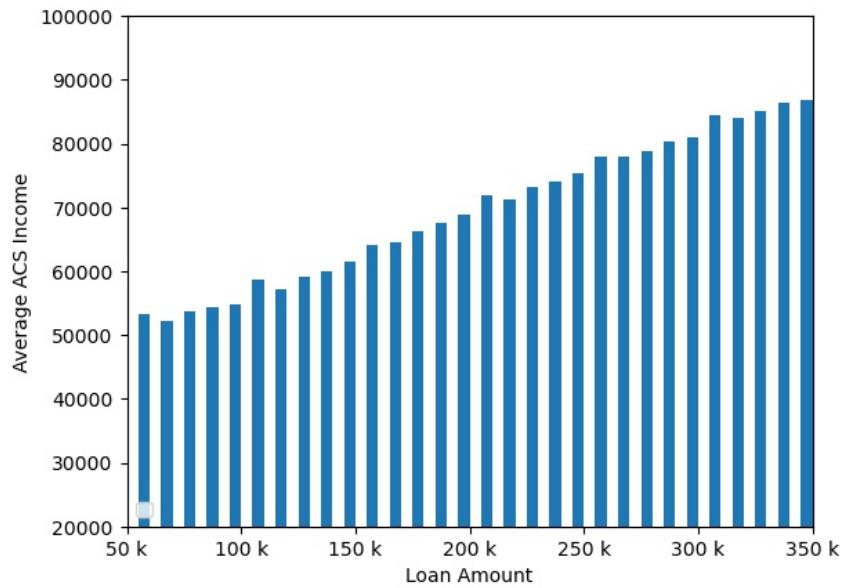
Overall, our results highlight previously overlooked leverage differences across racial groups. Because of differences in wealth early in life—which in part is the consequence of differences in bequests—Black borrowers on average are able to make lower down payments. The presence of leverage constraints at origination therefore restricts Black home-buyers to smaller sized loans in cheaper homes that are further from job opportunities. Because this financial constraint limits Black borrowers ability to access neighborhood-based income prospects, they 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, the heavy reliance of Black borrowers on these loans shines a light on how tightly their 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 first demonstrate the sorting of borrowers along the dimensions of leverage, loan product, and neighbor-

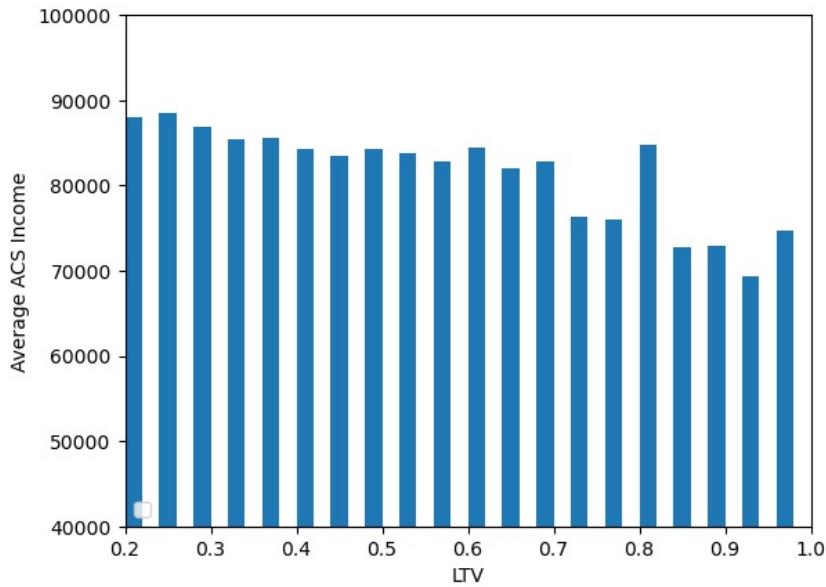
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<sup>13</sup>We also show, in Appendix Figure A.VII, that the same is true for the *individual* income of borrowers accessing high leverage mortgages.

*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 the ACS, against loan size (Panel A) and LTV (Panel B). For each property, we measure the ZIP-level household income, and report the average neighborhood income for each part of the loan size and LTV distributions.

hood income. We then 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 with incomplete markets and overlapping generations of heterogeneous households. 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 mostly located in low- and high-opportunity areas. The degree to which households accumulate wealth depends jointly on their choices of housing stock, home ownership, and leverage. These choices, in turn, depend on their initial demographic groups and housing stocks, 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 on long-run outcomes, including wealth, income, location choice, 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, which also deliver higher utility flows. Because households have a finite lifespan, the value of the house that they are able to buy mainly determines how much 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 typically offer higher labor market returns, which allow households to save more every period and accumulate wealth more quickly.

#### 3.1 Environment

The model is a  $2 \times 2$  endowment economy 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. Our main contribution is to analyze the interaction of financial (leverage) constraints and moving frictions, and how it affects wealth accumulation between these groups. 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  $\bar{h}$ . Renters consume continuous quantities of housing services  $h_t \in (0, \bar{h}]$ . 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  $2 \times 1$  vectors  $\Xi$  and  $m$ . These parameters help with the quantitative fit of the model, but they are not necessary for our main mechanism.<sup>14</sup> A household's instantaneous utility function is given by:

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

**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 have age  $a$ , belong to demographic group  $g$ , and live in housing stock  $j$  is given by:

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

Households receive income depending on their age, idiosyncratic shocks, demographic group, and housing 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 FHA and non-eligible housing, which correspond to low- and high-opportunity areas. Dif-

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<sup>14</sup>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.

ferent areas, as a consequence, boost individual income as in [Bilal & Rossi-Hansberg \(2021\)](#). 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 liquid asset with a risk-free rate of return  $r > 0$  and in real estate. 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.<sup>15</sup> 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 motives. 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.<sup>16</sup> 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 to belong to either of the two demographic groups  $g$  corresponding to Black and white households. The two groups differ in households' probabilities to first enter either housing stock, in their initial wealth, average income (racial income shifter), and average home ownership shocks, which capture unmodeled costs and benefits associated with home ownership.

Households from the two groups have access to two housing stocks which differ in house prices and rents, average income (spatial income shifter), 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 and non-eligible loans.

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<sup>15</sup>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 \(2014\)](#)).

<sup>16</sup>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 \(2005\)](#)).

**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  $\bar{h}$  (normalized to 1) at price  $P_j$  in housing stock  $j$ . Rental size can be chosen continuously in  $(0, \bar{h}]$  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, as well as debt or savings choices.

## 3.2 Household Problem

This section 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:

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

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

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

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

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

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

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

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  $H$ :

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

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

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

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

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

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  $\theta_{LTV}^L$  (low-opportunity area),

$$b_{t+1} \geq -\theta_{LTV}^L P_L \bar{h}. \quad (10)$$

$\theta_{LTV}$  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,

$$b_{t+1} \geq \min [\theta_{am} b_t, 0]. \quad (11)$$

The lowest payment that households can make in a period therefore equals  $(1 + r^b - \theta_{am}) b_t$ .

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

*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  $m_H$ :

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

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

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

### 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  $V_g^{oL}(a, b_t, y_t)$ . They choose to either default, remain an owner, or sell the house and become a renter. If they leave their residence, they choose the housing stock to which they move over the period:

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

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  $\bar{h}$ ,

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

subject to the budget constraint

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

and the loan amortization constraint

$$b_{t+1} \geq \min [\theta_{amb_t}, 0]. \quad (17)$$

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

*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  $m_H$ :

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

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  $L$ ,

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

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

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

subject to the budget and no-borrowing constraints

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

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.

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

subject to the budget and no-borrowing constraints

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

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 section 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  $\{V_g^{\mathcal{H}j}, V_g^{\mathcal{H}'j'}\}$ ,
- (ii) policy functions  $\{d_g^{\mathcal{H}j}, c_g^{\mathcal{H}j}, h_g^{\mathcal{H}j}, b_{g,t+1}^{\mathcal{H}j}\}$ ,
- (iii) a law of motion for the cross-sectional distribution of households  $\lambda(\mathcal{H}, g, j, a, b, y)$  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.

## 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. \(2007\)](#)).

Across regions, we set the spatial income shifter  $\mu^H$  in the non-eligible stock exogenously to deliver an average income boost of 44.02% relative to the eligible stock as in the data (Infutor and HMDA).<sup>17</sup>

For mortgage values, we set the maximum LTV ratios for FHA-eligible properties as  $\theta_{LTV}^L = 0.95$ , and  $\theta_{LTV}^H = 0.80$  as the 90<sup>th</sup> percentiles of the two distributions of LTV in the data (HMDA). 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  $r^f$  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.

**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  $2 \times 2$  framework. 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). 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). 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).

Another 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

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<sup>17</sup>In 2019, the average income is \$79,010 in the non-eligible housing stock and \$54,860 in the eligible stock.

TABLE 1: CALIBRATION

Parameter	Explanation	Value	Source/Target
<b>External:</b>			
<i>Preferences and income</i>			
$\gamma$	Risk aversion	2.000	See text
$\epsilon$	CES parameter housing/consumption	0.200	Elasticity of substitution 1.25
$\rho_e$	Autocorrelation income	0.700	Floeden & Lindé (2001)
$\sigma_e$	Std. dev. income	0.387	Floeden & Lindé (2001)
<i>Mortgages</i>			
$r^f$	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
$\theta_{LTV}^H$	LTV limit non-eligible housing	0.800	P90 LTV distribution=80%
$\theta_{LTV}^L$	LTV limit FHA housing	0.950	P90 LTV distribution=95%
$\theta_{am}$	1-amortization rate	0.930	Amortization 1.75%
<i>Housing stocks</i>			
$P_H$	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
$\pi_W^H$	Prob white start in non-eligible	0.780	Share white hhs in non-eligible housing
$\pi_W^B$	Prob Black start in non-eligible	0.580	Share Black hhs in non-eligible housing
$\mu^H$	Income shifter non-eligible housing	0.365	Avg income boost 44% non-eligible housing
<i>Demographic groups</i>			
$\pi_B$	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
<b>Internal:</b>			
<i>Preferences</i>			
$\beta$	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%
$\Xi_W^H$	Avg home ownership shock non-eligible housing white	3.549	Avg home ownership white 72%
$\Xi_W^L$	Avg home ownership shock FHA housing white	1.520	Avg home ownership white 72%
$\Xi_B^H$	Avg home ownership shock non-eligible housing Black	2.275	Avg home ownership Black 44%
$\Xi_B^L$	Avg home ownership shock FHA housing Black	-0.338	Avg home ownership Black 44%
<i>Housing stocks and demographic groups</i>			
$m_H$	Moving cost to non-eligible housing	5.914	Moving rate 2%
$m_L$	Moving cost to FHA housing	-3.780	Moving rate 10%
$\mu_W$	Income shifter white	0.211	Avg income white/Black 2.07

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

(SCF).<sup>18</sup> 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).

<sup>18</sup>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.

## 4.2 Model Fit

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

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 matches well differences in initial conditions between Black and white households which ultimately lead to differences in wealth accumulation, such as the gap in income ( $2.07 \times$  higher for white households) and in average bequests ( $3.03 \times$  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. They substantially amplify the adverse effects on Black wealth accumulation of the spatial sorting which arise from the financial constraints. 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 \(2021\)](#)).

The model generates substantial racial inequality in households' balance sheets and comes close to matching key non-targeted moments. It explains a large fraction of the racial leverage gaps. Across the two housing stocks, Black buyers have higher average LTV ( $1.10 \times$  higher than white households), median LTV ( $1.04 \times$  higher), and 90<sup>th</sup> percentile of LTV ( $1.02 \times$  higher). As in the data, there is considerable bunching in the leverage distributions of Black buyers at the two LTV limits  $\theta_{LTV}^L = 0.95$  and  $\theta_{LTV}^H = 0.80$ . In the low-opportunity area, the 25<sup>th</sup> to the highest percentile of their LTV distribution are equal to the  $\theta_{LTV}^L = 0.95$  limit, and the 10<sup>th</sup> percentile is equal to 0.61. A large fraction of Black households lever up to access home ownership in the housing stock which is more affordable for them and in which their home ownership rate is higher. In the high-opportunity area, the 75<sup>th</sup> to the highest percentile of their LTV distribution are equal to the  $\theta_{LTV}^H = 0.80$  limit, the 50<sup>th</sup> percentile is equal to 0.74, the 25<sup>th</sup> to 0.55, and the 10<sup>th</sup> to 0.42. Accessing home ownership in the high-opportunity area requires Black buyers to considerably lever up. Since they

have lower savings due to worse initial wealth and income conditions, a small fraction of buyers borrows as much as the LTV limit allows, and a large fraction of potential buyers is rationed out altogether by the binding LTV constraint, which forces them to drop out of the owner-occupied market in this area. Since house prices are on average  $3 \times$  higher in the non-eligible housing stock (\$600,000) than in FHA housing (\$200,000), a much lower fraction of Black buyers is able to access home ownership, and they tend to be relatively richer due to endogenous selection. At the source of the racial leverage gap is the fact that the LTV distribution of white buyers has much less bunching at the  $\theta_{LTV}^H = 0.80$  limit in the high-opportunity area than Black buyers, even though it is similar in the low-opportunity area. In stark contrast with Black buyers, the 90<sup>th</sup> percentile of their LTV distribution is only equal to 0.79, the 75<sup>th</sup> to 0.67, the 50<sup>th</sup> and the 25<sup>th</sup> to 0.65, and the 10<sup>th</sup> to 0.55.

These results highlight that the  $2 \times 2$  structure of U.S. housing markets is largely responsible for inequality in housing wealth accumulation between demographic groups. The model generates a substantial racial wealth gap between Black and white households, whose wealth is on average  $3.25 \times$  higher. It replicates more than 50% of the gap in the data even despite the absence of explicit sources of discrimination, which have been a focus of prior literature, and of other types of investments such as equity. Additional forces which are 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), in property taxes (Avenancio-Leon & Howard, 2022), in rents (Early *et al.*, 2018) and in housing market expectations (Adelino *et al.*, 2018), as well as other unmodeled labor market factors. Importantly, however, the  $2 \times 2$  structure of U.S. housing markets is sufficient to generate a large racial wealth gap.

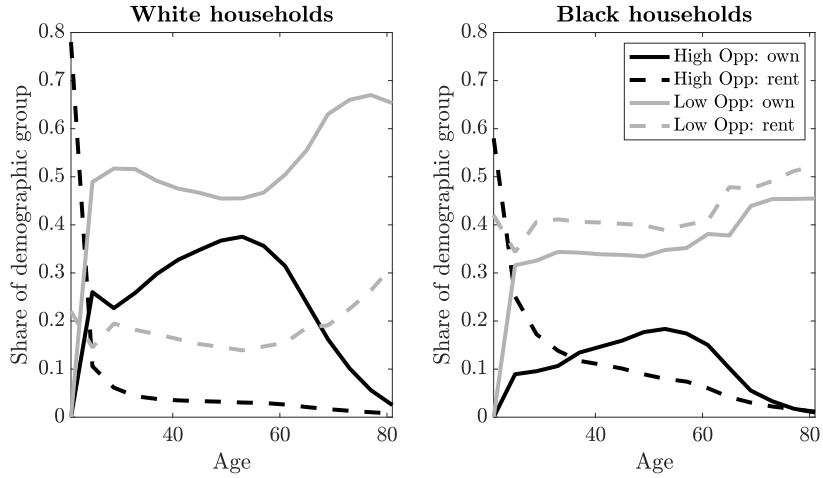
**TABLE 2: MODEL FIT**

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 bottom 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.

Finally, the model provides estimates of ownership and renting across demographic groups and age, shown in Figure 5. It generates a hump-shaped pattern for ownership in the high-opportunity area, as agents accumulate wealth to purchase 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; particularly in the high opportunity area where the 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 on the role of financial constraints in amplifying disparities, as well as the effectiveness of policies intended to alleviate racial wealth gaps. We first demonstrate the severe consequences of financial constraints for racial inequality—the central mechanism of our paper—by examining policies which directly alter LTV constraints. We then examine the heterogeneous consequences across racial groups of one of the most salient

recent trends in housing markets: house price growth. Finally, because the spatial allocation of racial groups is at the core of the disparities in our model, we consider policies that ease Black household’s ability to move to opportunities to build wealth. We compare these experiments with more classical policy tools, including interest rate subsidies and place based policies, and also with reparations.

## 5.1 Altering Leverage Constraints

**Relaxing leverage constraints** In order to demonstrate the role for financial constraints, our first result compares the outcomes for Black and white borrowers after relaxing the financial constraint in the high-opportunity area. Our experiment shows this by relaxing the LTV constraint in the high-opportunity region from 0.80 to 0.95. This is roughly analogous to a policy of removing the loan cap for FHA loans, a simple counterfactual that provides perhaps the clearest way to understand the distortions created by financial constraints in high-opportunity areas.

Slackening leverage constraints leads to substantial improvements in outcomes for both groups, but the improvements are far more dramatic for Black households, for whom the financial constraints bind more sharply. Figure 6 shows a basic set of results, with a more comprehensive accounting in Appendix Figure A.IX. We first confirm that leverage ratios do increase substantially in response to lowering these constraints, indicating that they do in fact bind. Our next key takeaway is that average Black wealth (across both housing stocks) increases by 18% in response to the policy. This confirms an important role for financial constraints in perpetuating wealth disparities: we observe wealth for Black households increase sharply when the constraint is lifted and they are able to access housing in high-opportunity areas more easily.

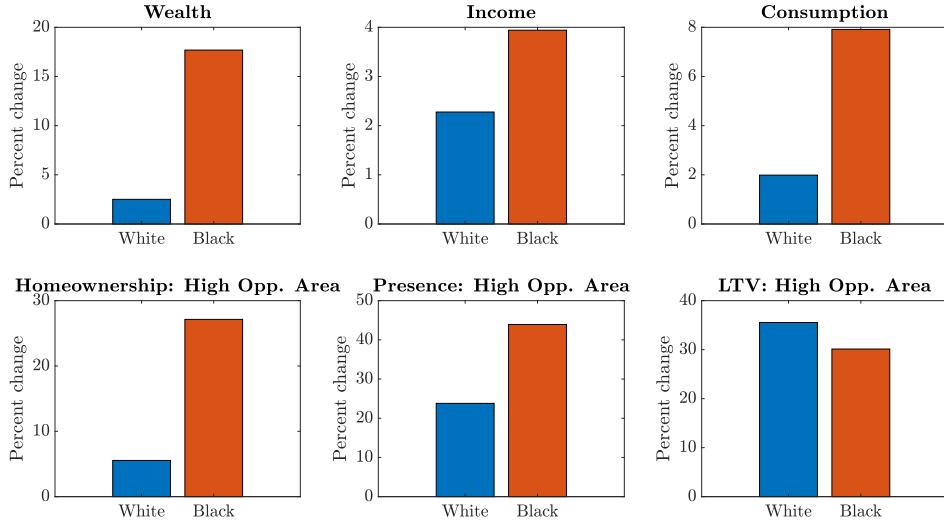
Wealth gains are driven primarily by an increase in Black ownership in the high-opportunity area, and the resulting gains in life-cycle wealth accumulation (despite the lower wealth necessary to acquire a mortgage). Average ownership for all groups goes up by 2.5% in response to loosening this financial 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, this policy delivers all these benefits, in home ownership, wealth and income, while also substantially increasing the consumption of black households by around 8%. There is no tradeoff between homeownership and wealth in this experiment. Because consumption increases and housing is valuable, relaxing leverage constraints significantly decreases the welfare gap.<sup>19</sup>

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<sup>19</sup>We measure welfare directly using our utility function outlined in the model Section 3, and show this result in Appendix Figure Appendix A.IX.

**FIGURE 6: RELAXING LEVERAGE CONSTRAINTS**



*Notes:* Variables are conditional averages in percentage deviation from the steady state of the baseline model. This figure plots the result of a policy experiment in which we relax LTV constraints in the high-opportunity housing stock ( $\theta_{LTV}^H = 0.95$ , instead of  $\theta_{LTV}^H = 0.80$  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 A.IX shows a fuller set of results for this policy counterfactual.

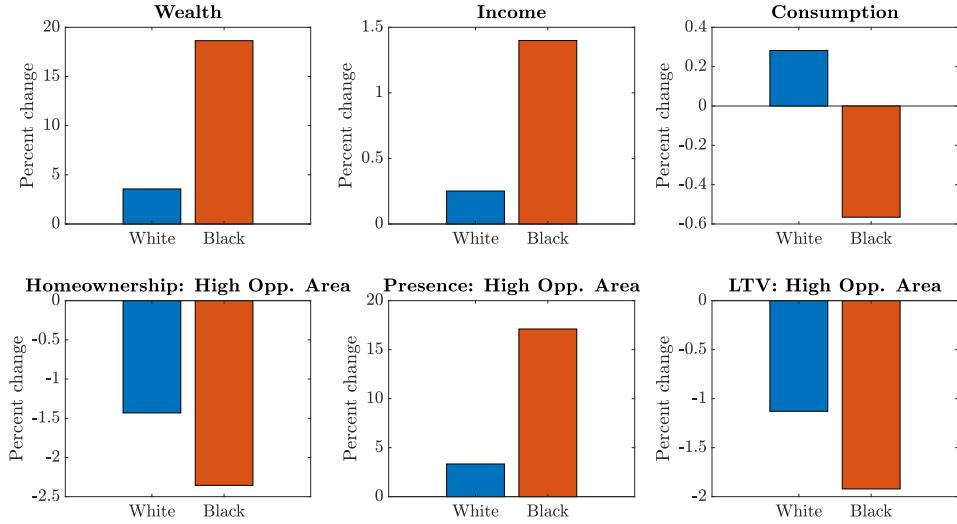
**Phasing out FHA mortgages** We also consider a policy which moves leverage ratios in the opposite direction: a counterfactual policy which phases out FHA mortgages by reducing the maximum LTV ratio in the FHA-eligible housing stock from 95% to the same 80% level as in the non-eligible stock. We show basic results in Figure 7 and more detailed results in Figure A.X from this policy experiment. Tightening leverage constraints leads to a slight decrease in home ownership overall, especially for Black households, who rely heavily on FHA mortgages. However, it also acts like forced savings for these buyers and improves their leverage distribution at the cost of consumption. Consequently, the net impact on wealth accumulation is actually *positive* for Black buyers (despite lower overall welfare).

This mismatch in outcomes between wealth and homeownership is a recurring theme in our results, and points to important tradeoffs in the consideration of mortgage policies, and limitations in the use of either wealth or homeownership as a sufficient statistic for welfare. The central intuition is that homeownership comes with tradeoffs when considering households who also decide in which area to live, and how much equity to put down.

## 5.2 Impact of House Price Shocks

Having established a central role for financial constraints—specifically leverage constraints—we next turn to experiments which shift aspects of the environment to understand their effects on the Black-white hous-

**FIGURE 7: 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 policy experiment in which we tighten LTV constraints in the low opportunity housing stock ( $\theta_{LTV}^L = 0.80$ , instead of  $\theta_{LTV}^H = 0.95$  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 A.X shows a fuller set of results for this policy counterfactual.

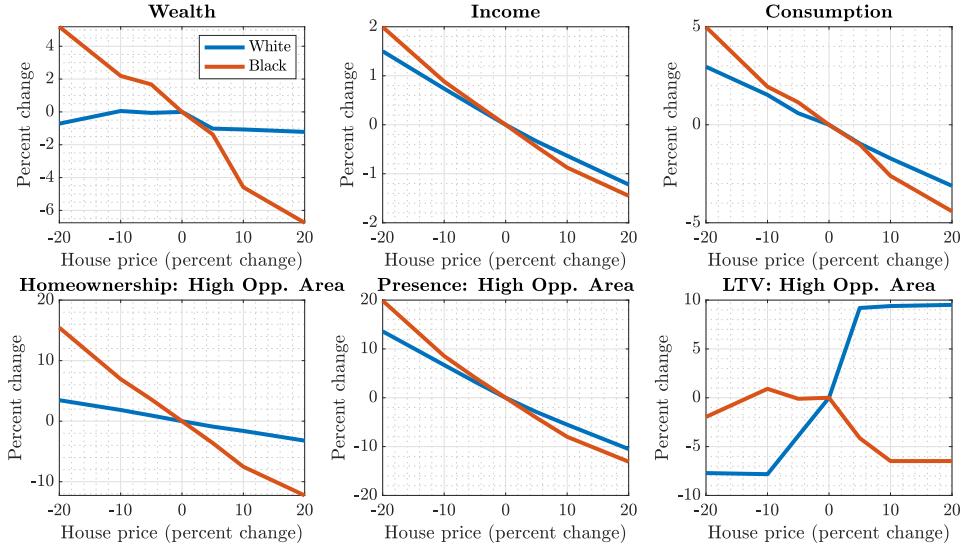
ing gap. We start with changes in house price changes, which have been a salient feature of real estate markets over the past thirty years. These price effects depend crucially on the features of the  $2 \times 2$  housing markets. First, because investor groups have different characteristics, price 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. 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.

Figures 8 plot the percentage changes in the main components of households' balance sheets' compared to the baseline calibration, in response to a percentage change in prices in the non-FHA-eligible (Panel A) and eligible housing stock (Panel B). More comprehensive figures are provided in Appendix Figures A.XI and A.XII.

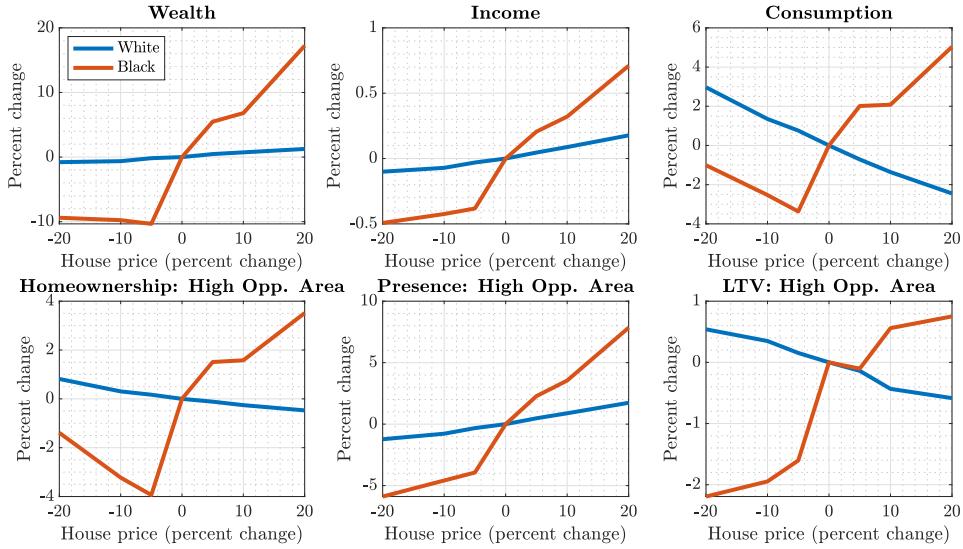
Our results have several implications for the racial housing gap. First, higher house prices in high-opportunity areas have particularly adverse consequences for Black borrowers in steady state. Black wealth and income decline sharply in response to price increases in the high-opportunity area, as Black

**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 policy 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.

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 price shocks in either region—white households appear to be relatively hedged in wealth against house price shock risk, likely 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., 2013a](#)).

A price increase in one of the two housing stocks also leads to an improvement in home ownership for Black households in the *other* housing stock, as endogenous relocation of Black buyers to the relatively cheaper stock lead to spillover effects. However, overall homeownership declines in general. Furthermore, 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. These results also relate to 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 incomes but also lower housing costs. We obtain this result in our model as well, and show why minority borrowers are particularly sensitive to this force, which has particularly negative consequences on both income and wealth accumulation.

These effects are smaller in the case of rent changes (Appendix Figures [A.XIII](#) and [A.XIV](#)), for which households can choose to consume continuously lower housing services to reduce their expenses, further illustrating the previous point. Interestingly, an increase in rents slightly increases average Black wealth due to a positive effect on home ownership, which becomes relatively more attractive. This suggests that housing affordability crises centering on prices and on rents may have different effect on households’ wealth accumulation.

### 5.3 Moving to Wealth Opportunities

Next, we consider a policy which lowers the costs of “moving to opportunity,” by setting moving costs from the FHA-eligible housing stock to the non-eligible stock equal to zero. The experiment is intended to simulate policy shocks which induce migration resulting from natural shocks ([Nakamura et al., 2021](#); [McIntosh, 2008](#)) or explicit policy-induced incentives for migration ([Bergman et al., 2019](#); [Bryan et al., 2014](#)). [Derenoncourt \(2022\)](#) also examines outcomes during the Great Migration period of Black moves to Northern cities.

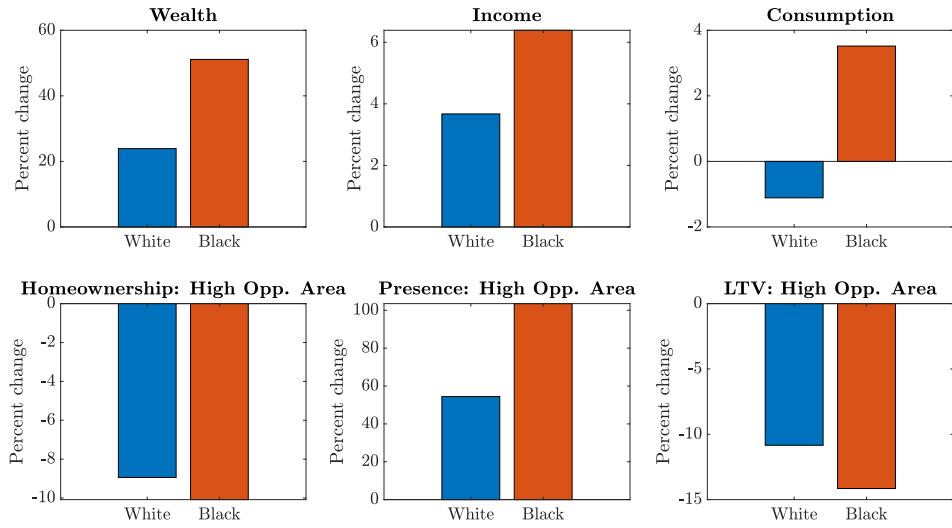
Overall, this policy—main results shown in Figure [9](#), and more detailed results in Appendix Figure [A.XV](#)—succeeds in inducing more moving to the housing stock with better income prospects, and higher presence in that more valuable stock. By lowering frictions to moving, the policy reduces spatial misallocation, and allows to significantly increase the average wealth of Black households. It also increases the average wealth of white households, through an increase in income, but outcomes generally increase more

for Black agents.

However, the policy actually *decreases* home ownership substantially for both white and Black agents. Because spatial frictions are not as binding, agents are more likely to live in the high-opportunity area as renters, and they accumulate greater income and wealth in that process. Because these households end up saving more, those who reach homeownership are richer and have lower leverage than previously. In that sense, the policy lowers spatial misallocation by putting the right home buyers (those with more savings) in the right place (the high-opportunity area). 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 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 out of this housing wealth.

We characterize this policy as one that enables “moving to wealth opportunities” because the improved sorting of minority households across housing stocks appears to be effective in wealth building. Households have improved access to opportunity as characterized by income, in ways that accumulate across the lifecycle to generate higher wealth.

**FIGURE 9: MOVING TO WEALTH OPPORTUNITIES**



*Notes:* variables are conditional averages in percentage deviation from the steady state of the baseline model. The Figure shows the outcome of changing moving costs in the model 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 A.XV shows a fuller set of results for this policy counterfactual.

## 5.4 Additional Policies

In addition to our main experiments, we also analyze reparations-style policies, and more conventional policy tools such as mortgage rate subsidies and place-based labor market policies, for which there are no counterfactuals in the data. The results for these policies are reported in Appendix.

**Reparation Policies** The reparation-style policies that we analyze specifically target Black households and seek to equate initial conditions with white households.<sup>20</sup> These experiments help to diagnose the sources of Black-white differences in outcomes. Appendix Figure A.XVI shows detailed results for increases in initial wealth. Perhaps unsurprisingly, raising initial wealth increases Black wealth over the lifecycle, income, and homeownership, particularly in high-opportunity areas. 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.

We also examine a policy that gives Black households the same income shifter as white households, which corresponds to a large 207% increase in average income (Appendix Figure A.XVIII). It corresponds to, for instance, targeted human capital development policies coupled with a reduction in labor market discrimination. The policy significantly improves Black wealth and reduces the racial housing gap, through a combination of lower Black leverage in the cheaper FHA-eligible housing stock and higher homeownership in the more expensive non-eligible stock.

The next two experiments are targeted housing policies which modify the two features of our  $2 \times 2$  model of housing markets. Such policies have been at the center of lively public discussions and are 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 also 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%. It is similar to first-time buyers programs which allow borrowers to benefit from lower rates (Appendix Figure A.XIX). Black homeownership increases across the board, although much more so in the high-opportunity area. There is also 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.

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<sup>20</sup>Reparation policies have also been adopted in the case of Jewish victims of the Holocaust (Pross, 1998).

**Place-Based Labor Market Policy** This 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 A.XX describes the results. This policy has positive impacts on income, wealth and overall homeownership of black households. However, because the place based policy also benefits white households, the net impact actually accentuates the wealth gap.

## 6 Robustness

Our main results are robust to modifications of the baseline model which either simplify it or further add to its realism. 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) limits. 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, hence smaller causal effects for migration. In each case, the model is fully recalibrated to match the same targets as above in Section 4.

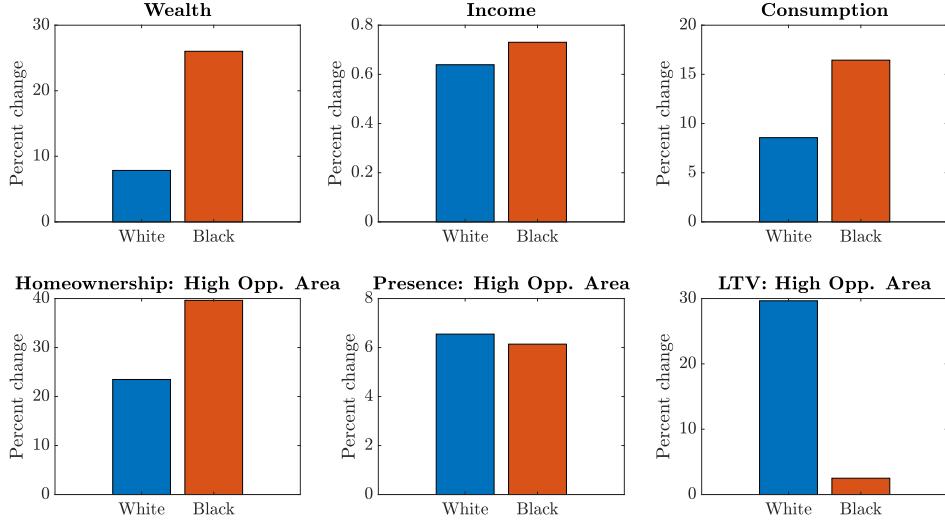
### 6.1 Frictionless Model Without Homeownership Shocks

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 households, to confirm that these differences are not driving our results. We show results in Figure 10 for this model, in which we change LTV ratios in the high-opportunity area as in our main experiment in subsection 5.1.

We see very similar effects as in the baseline model: wealth, income, ownership in the high-opportunity area, and presence of agents in the high-opportunity areas improve substantially after leverage ratio relaxation, suggesting that financial constraints play an important role in limiting access to high-opportunity areas even in this simplified model.

While this stylized model relaxes some of the central frictions in our model, it leaves in place baseline income differences between Black and white borrowers. These are an important feature of the data, and hence important moments for our baseline model to fit. However, a natural question is whether our key mechanism could hold in a world with only initial wealth differences, but no income differences between groups. To consider this possibility, we also examine a stylized model with no moving frictions and no taste shocks for home ownership in which Black and white households have the same income shifter  $\mu_B = \mu_W$  (Figure A.XXI).

**FIGURE 10: RELAXING LEVERAGE CONSTRAINTS: FRICTIONLESS MODEL WITHOUT HOMEOWNERSHIP SHOCKS OR MOVING FRICTIONS**



*Notes:* variables are conditional averages in percentage deviation from the steady state of the alternative model. This Figure plots a stylized version of the model without moving frictions ( $m$ ) or taste shocks for home ownership ( $\Xi$ ). 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.

Perhaps surprisingly, we again see the central role for relaxing leverage constraints in the high-opportunity area on a range of outcomes indicating that agents, particularly Black agents, are constrained by the combination of initial conditions and financial frictions which ensure that these conditions continue to bind. They suggest, as a consequence, that the key mechanism in our model is an important one which may continue to operate even if income differences between groups are ameliorated.

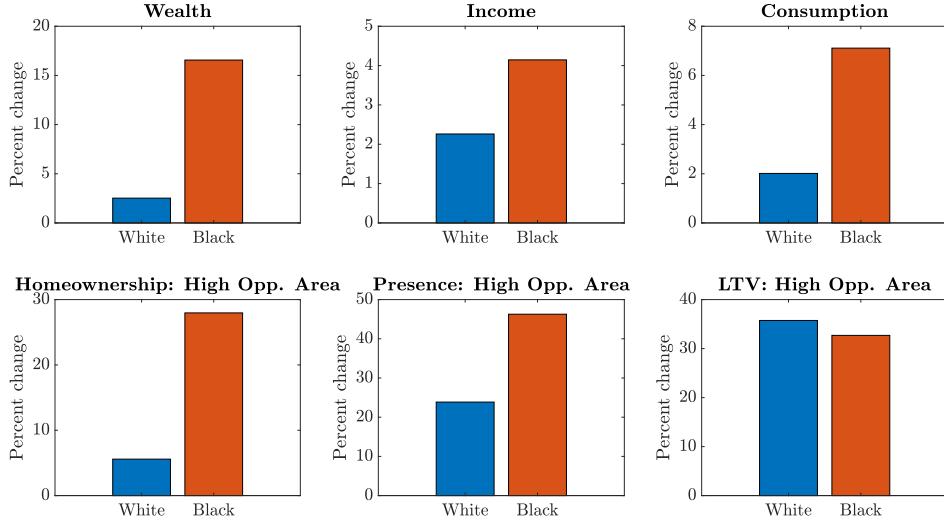
## 6.2 PTI Limit

Our baseline model incorporates two key financial frictions: the LTV limits at the time of origination, as well as an implicit assumption that agents cannot borrow against future labor income. However, in practice, mortgage borrowers also face another financial constraint: the payment-to-income (PTI) constraint, which limits 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%—households endogenously choose low PTIs to smooth consumption, so the PTI limit does not bind often—and plot the results of a similar relaxation of the leverage constraint in Figure 11. We confirm, as before, that the key insight of the model—the persistent impact of initial leverage ratios—persists even when we account for

borrowers also facing a PTI constraint.

**FIGURE 11: RELAXING LEVERAGE CONSTRAINTS: BASELINE MODEL WITH PTI LIMIT**



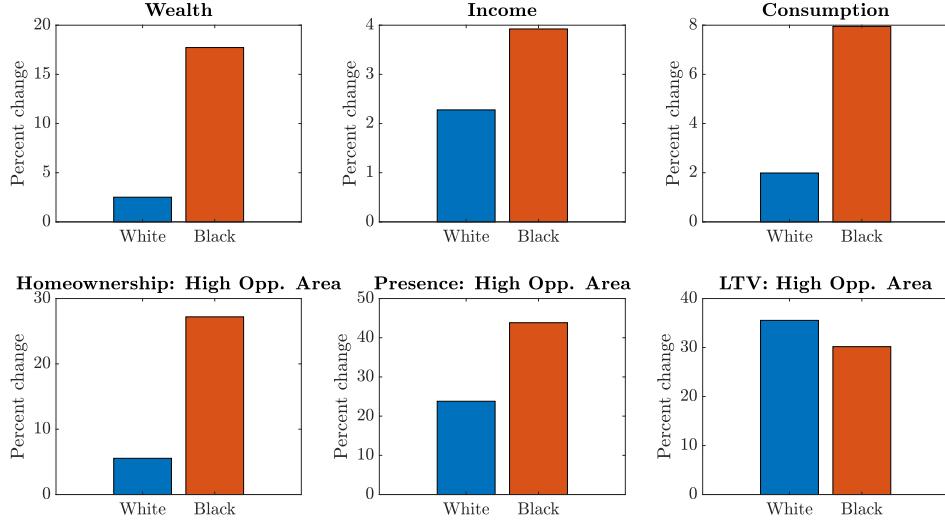
*Notes:* variables are conditional averages in percentage deviation from the steady state of the alternative model. This figure shows the result of an alternate calibration which also includes a constraint for the fraction of income devoted to mortgage payments,  $\theta_{PTI} = 5$ . We plot outcomes 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.

### 6.3 Mortgage Rate Discrimination

We also extend our baseline model to account for possible discrimination faced by Black borrowers for mortgages. 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.

We adopt estimates similar to [Bartlett et al. \(2021\)](#) and 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 the results in Figure 12 of relaxing financial constraints in a world with financial discrimination, which again do not change our results. In general, outcomes are relatively similar quantitatively accounting for higher mortgage rates. These results indicate that while the literature has focused on disparate outcomes faced by otherwise similar borrowers of different races trying to obtain mortgage credit; the range of estimates available in the literature do not seem to account for the bulk of the observable variation in Black-white wealth and housing gaps. By contrast, our proposed mechanism, in which initial wealth conditions remain binding due to leverage gaps, appears to explain a larger component of these overall gaps.

**FIGURE 12: RELAXING LEVERAGE CONSTRAINTS: BASELINE MODEL WITH MORTGAGE RATE DISCRIMINATION**



*Notes:* variables are conditional averages in percentage deviation from the steady state of the alternative model. This figure 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). 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.

## 6.4 Spatial Income Shifter

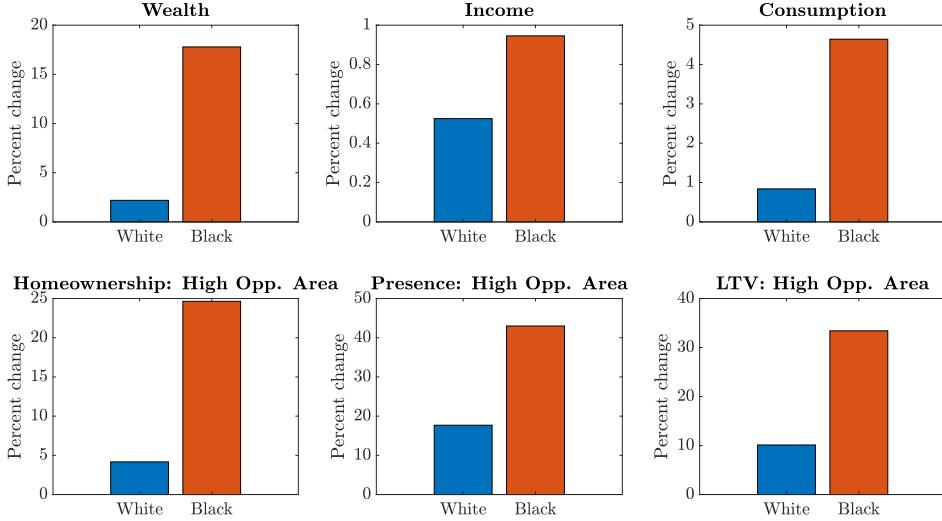
A key assumption in our baseline model is that all agents receive higher income upon moving to the high-opportunity zone. However, in recent work, Card *et al.* (2021) argue that two thirds of the variation in observed wage premiums for working in different commuting zones is attributable to skill-based 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  $\tilde{\mu}^H = 0.122$ . Figure 13 plots our main results in this alternative model.

Our main result holds under this alternate calibration. Relaxing LTV constraints in the high-opportunity area increases income, and therefore consumption, 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 in a similar way as in the baseline. For Black buyers, this is achieved with higher LTVs since living in the high-opportunity area brings less income benefits in this alternative model.

## 7 Conclusion

Our paper highlights the role of financial constraints, and mortgage leverage at origination specifically, in helping to explain important differences in wealth accumulation across racial groups. Our work exists in

**FIGURE 13: RELAXING LEVERAGE CONSTRAINTS: BASELINE MODEL WITH LOWER SPATIAL INCOME SHIFTER**



*Notes:* variables are conditional averages in percentage deviation from the steady state of the alternative model. This figure shows the result of an alternate calibration in which income differences are smaller in the high-opportunity area;  $\mu^H = 0.365$  instead of  $\bar{\mu}^H = 0.122$ , 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.

the context of a large literature which has emphasized the importance of racial housing gaps as a part of racial wealth gaps broadly. We contribute 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 its implications in a spatial life-cycle model. Our novel  $2 \times 2$  framework accounts for the fact that access to housing is a necessary condition to access both valuable real estate assets as well as high-quality job opportunities, and matches many important Black-white differences in wealth and income.

We also document that racial leverage differences are associated with minority borrowers disproportionately using high-leverage FHA mortgages, which restrict them to smaller, less valuable homes in areas with worse income generating potential. Our model fits these facts, and we use it to study the implications of leverage constraints on wealth accumulation. We find that financial constraints induce initial differences in wealth to remain persistent over time, suggesting that there has been unequal access across racial groups to the so-called “housing ladder,” an important route for wealth accumulation and upward mobility. We also find that house price growth tends to adversely impact Black households, and that policies which ease moving to areas that enable wealth accumulation appear to be valuable, even without increasing homeownership.

A central insight from our findings lies in the joint consideration of housing and leverage gaps. While many traditional housing policies are intended to address gaps in Black homeownership, we show that such

policies often have adverse consequences when failing to consider racial differences in leverage. In particular, policies which promote homeownership can amplify leverage, leaving Black borrowers more overextended in their overall financial position. These results point to an important tension in considering the role of home ownership: while our results confirm that access to housing is indeed crucial for wealth accumulation, we find that incremental home ownership policies do not have unambiguously positive consequences for minority borrowers, and typically fail to address problems faced by poorer borrowers in particular.

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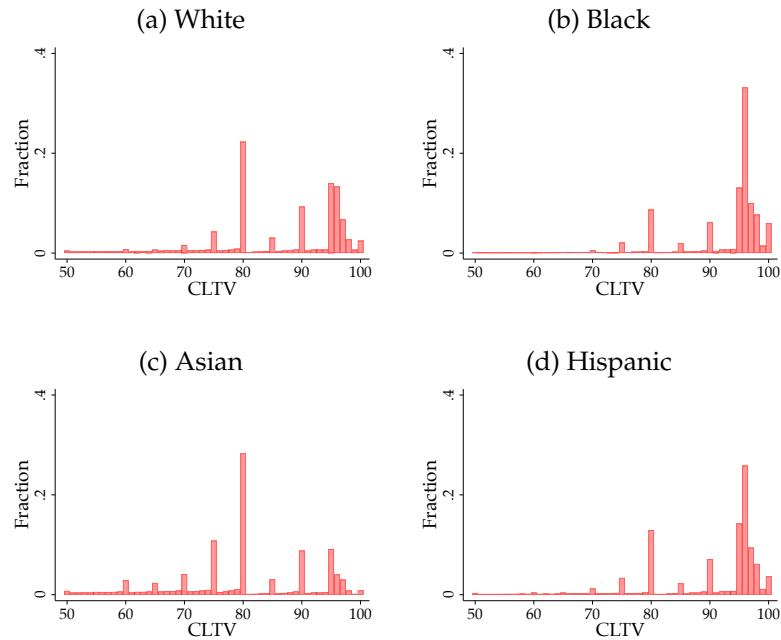
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# Appendix

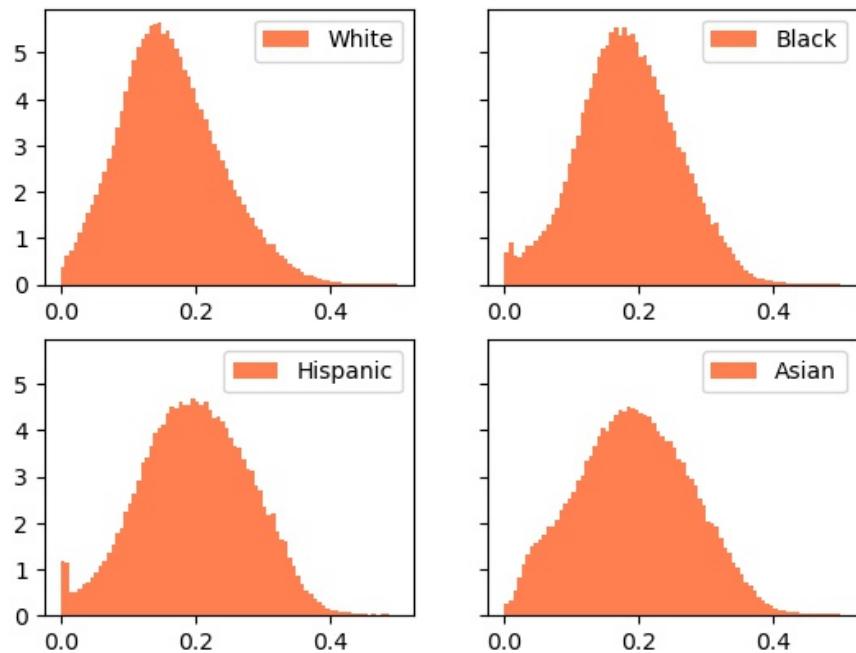
## A Stylized Facts



**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.

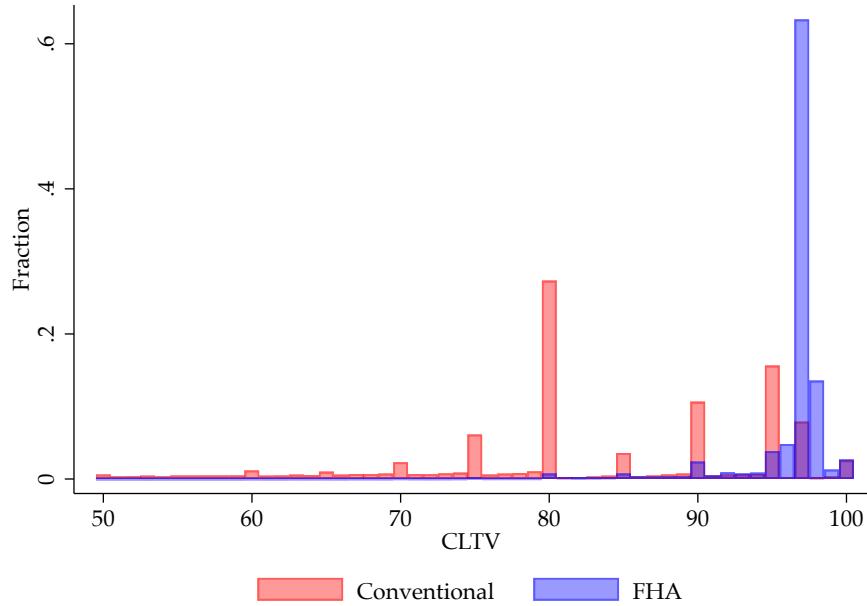
PTI Histogram by Race - PDF



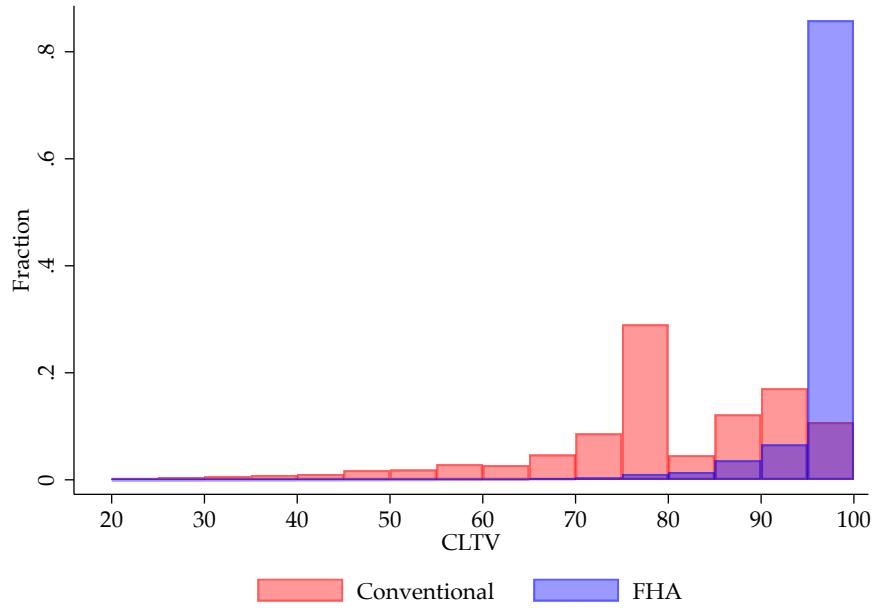
**FIGURE A.II: PAYMENT-TO-INCOME BY RACE**

*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. We measure total payments relative to borrower income reported in HMDA.

**FIGURE A.III: INITIAL LEVERAGE BY LOAN CHANNEL**

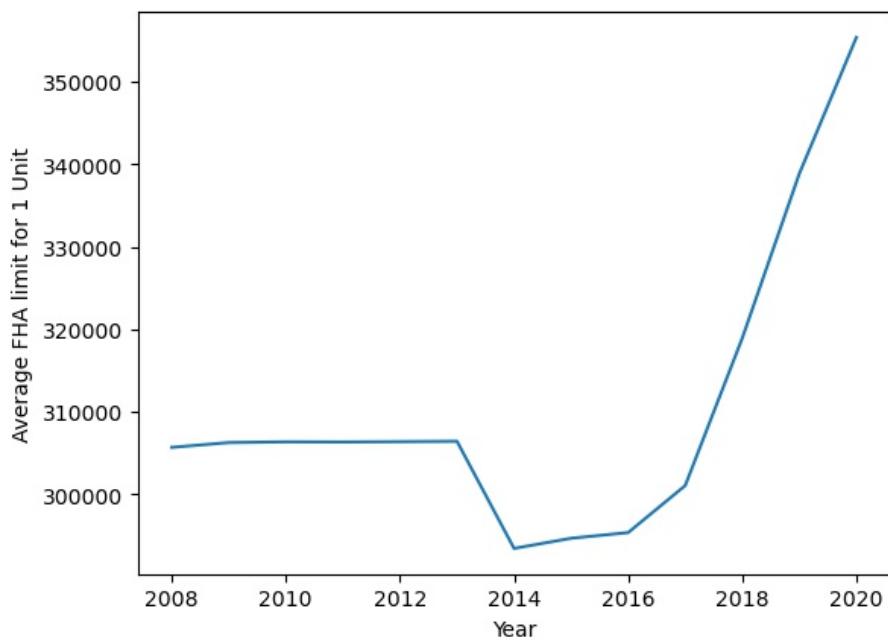


**PANEL A: 1 LTV POINT BINS**



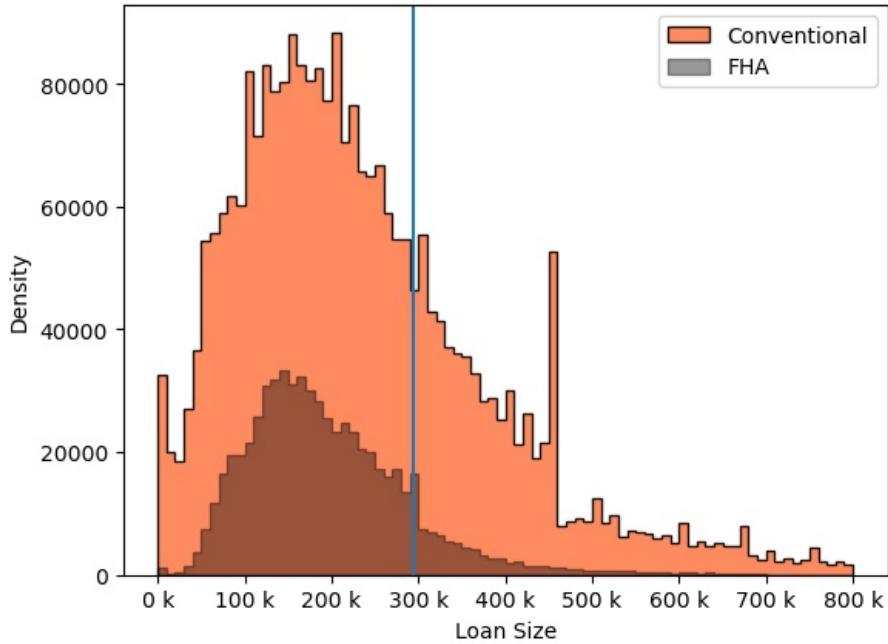
**PANEL B: 5 LTV POINT BINS**

*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.



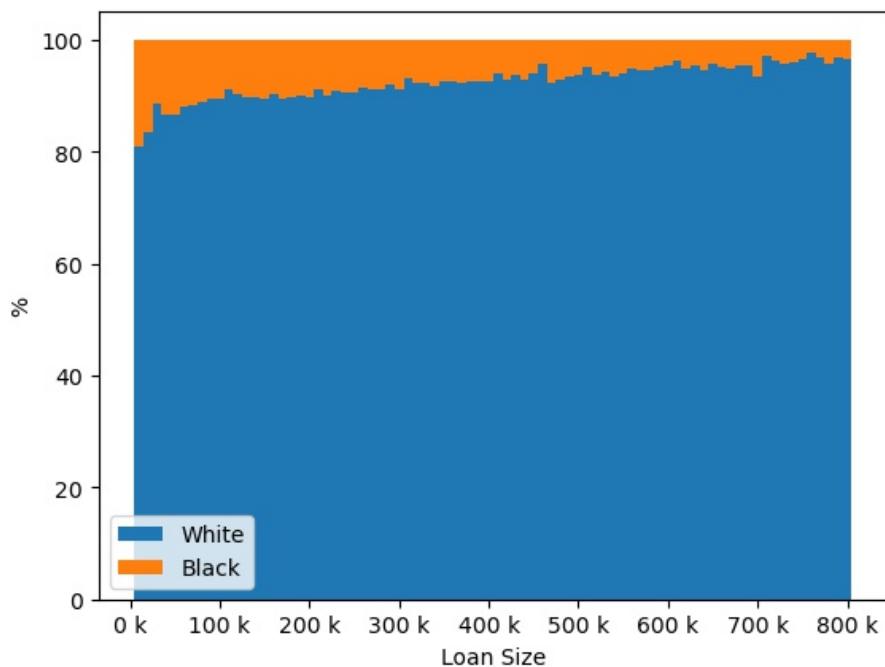
**FIGURE A.IV: FHA LOAN CUTOFF OVER TIME**

*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**

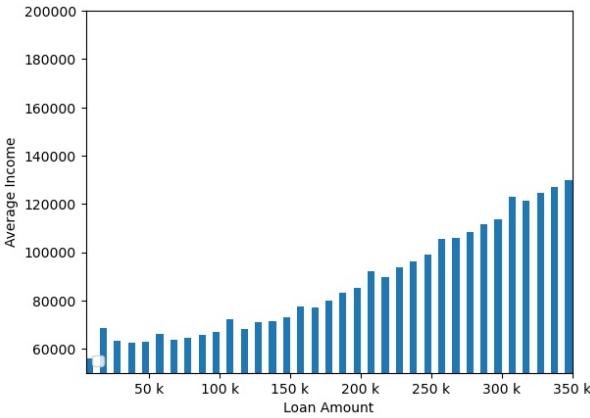
*Notes:* This Figure shows loan counts for borrowers across the conventional and FHA loan product categories using 2018 HMDA data. We restrict to purchase loans, and plot the density of borrowers around the national FHA loan size limit (plotted as the vertical line). Sample excludes VA, FSA, and RHS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



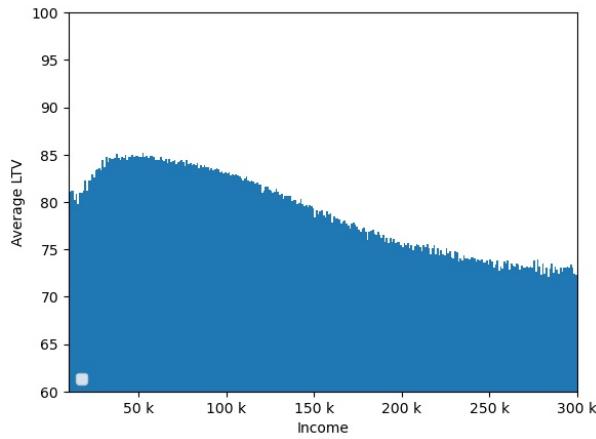
**FIGURE A.VI: BORROWER RACE BY LOAN SIZE**

*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.

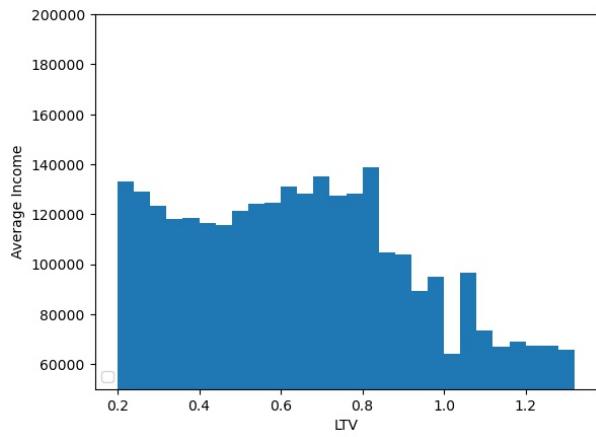
*Panel A: Personal Income Against Loan Amount*



*Panel B: Loan Amount Against Personal Income*



*Panel C: LTV Against Personal Income*

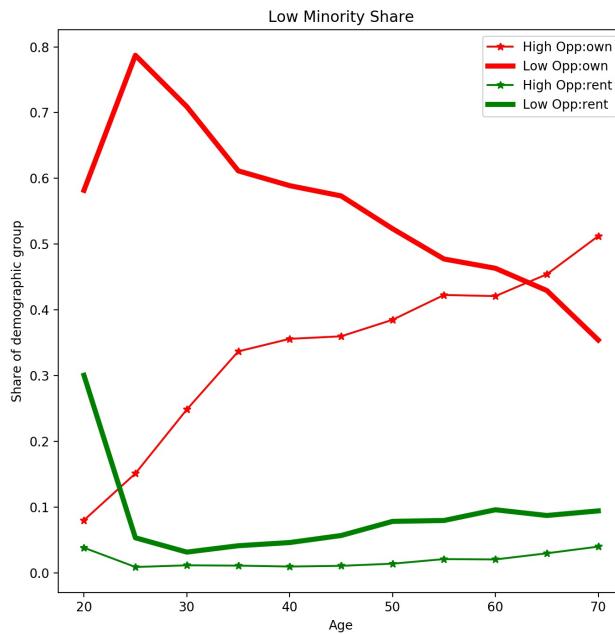


**FIGURE A.VII: LEVERAGE AND INCOME**

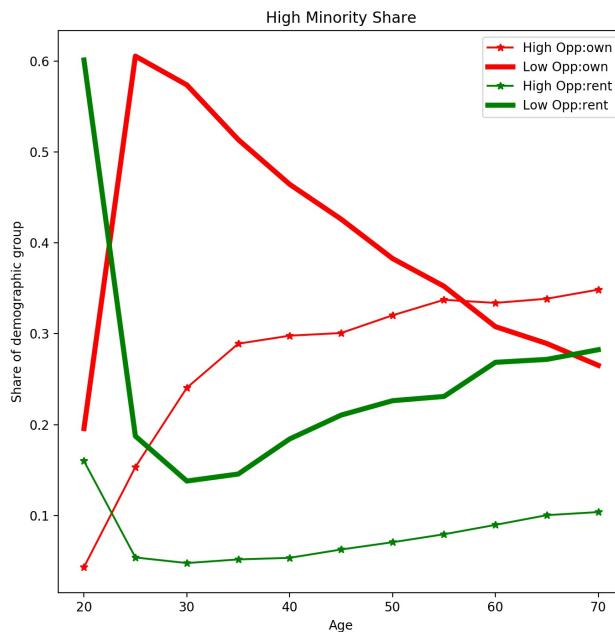
*Notes:* This Figure shows the relationship between individual income, as reported in the HMDA mortgage application against loan size (Panel A), and LTV (Panel C). Panel B shows the average income across different levels of the loan size distribution. We measure all variables using purchase-only loans from the 2018 HMDA dataset.

**FIGURE A.VIII: OWNERSHIP AND RENTING SPELLS ACROSS LIFECYCLE**

**PANEL A: AGENTS FROM LOW MINORITY SHARE NEIGHBORHOODS**



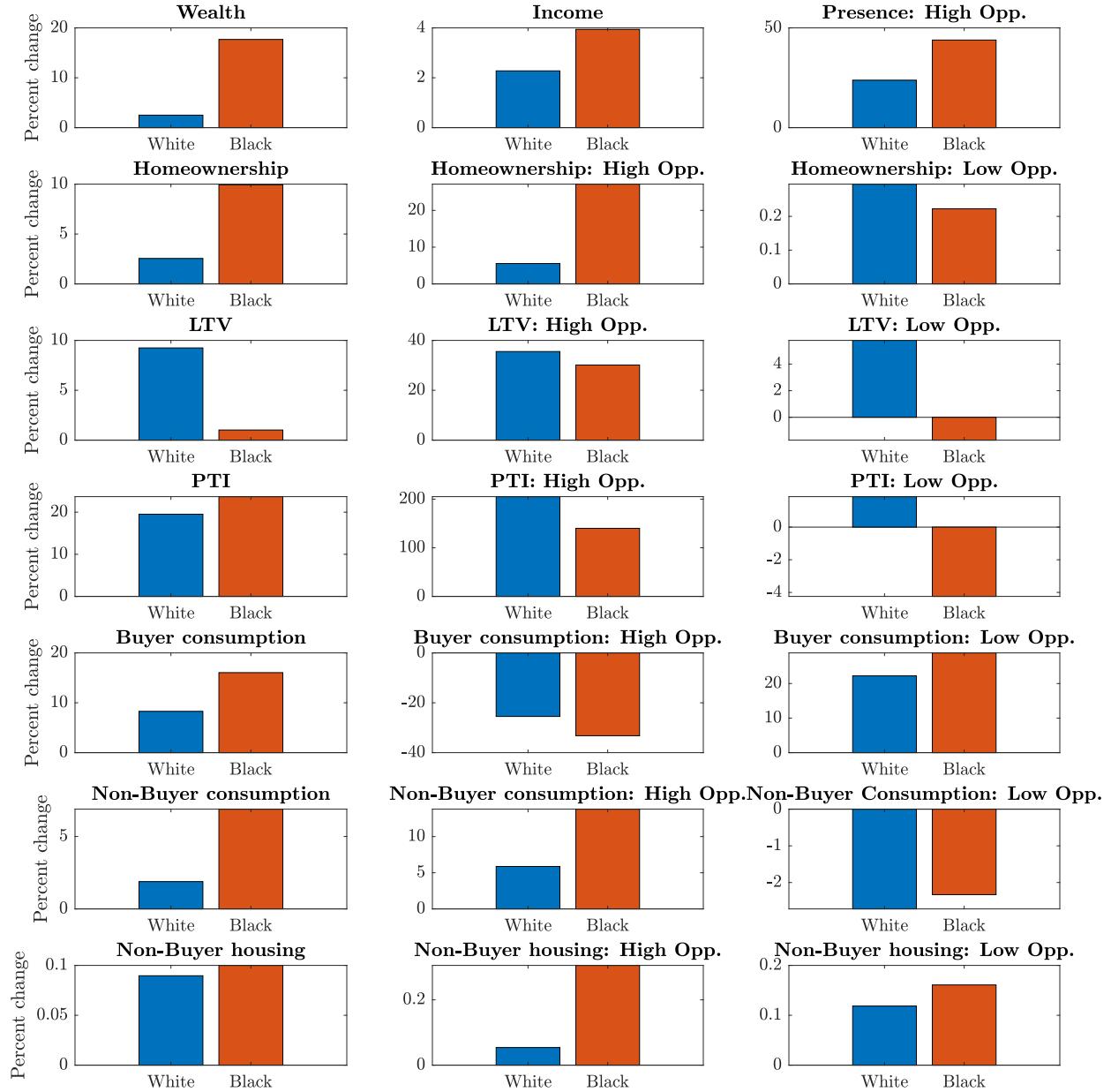
**PANEL B: AGENTS FROM HIGH MINORITY SHARE NEIGHBORHOODS**



*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 for by initial presence in low minority share neighborhoods defined as the lowest quartile for minority in Panel A, and high minority share neighborhoods in Panel B as defined by the highest quartile).

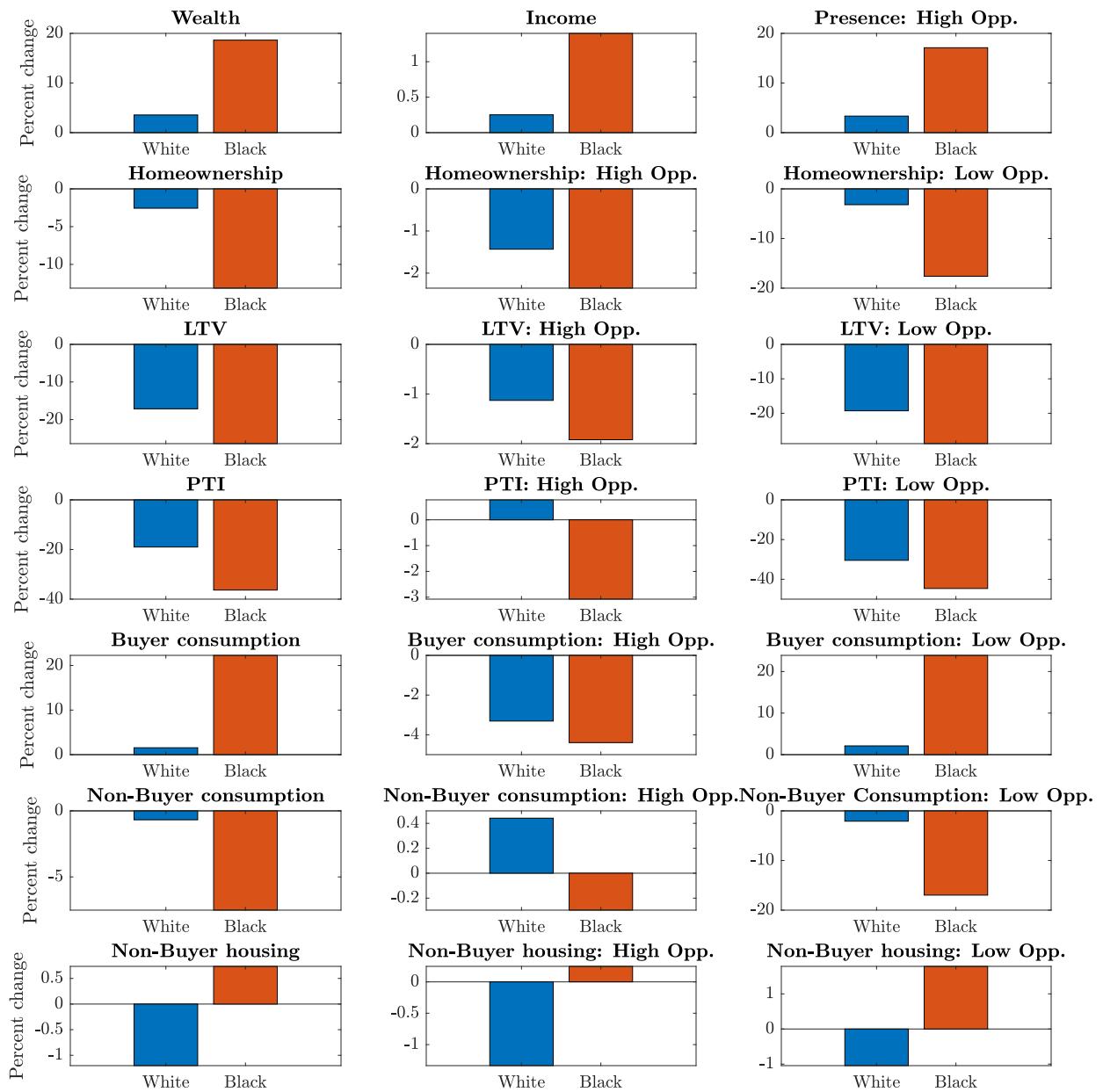
## B Detailed Model Results

**FIGURE A.IX: RELAXING LEVERAGE CONSTRAINTS: DETAILED RESULTS**



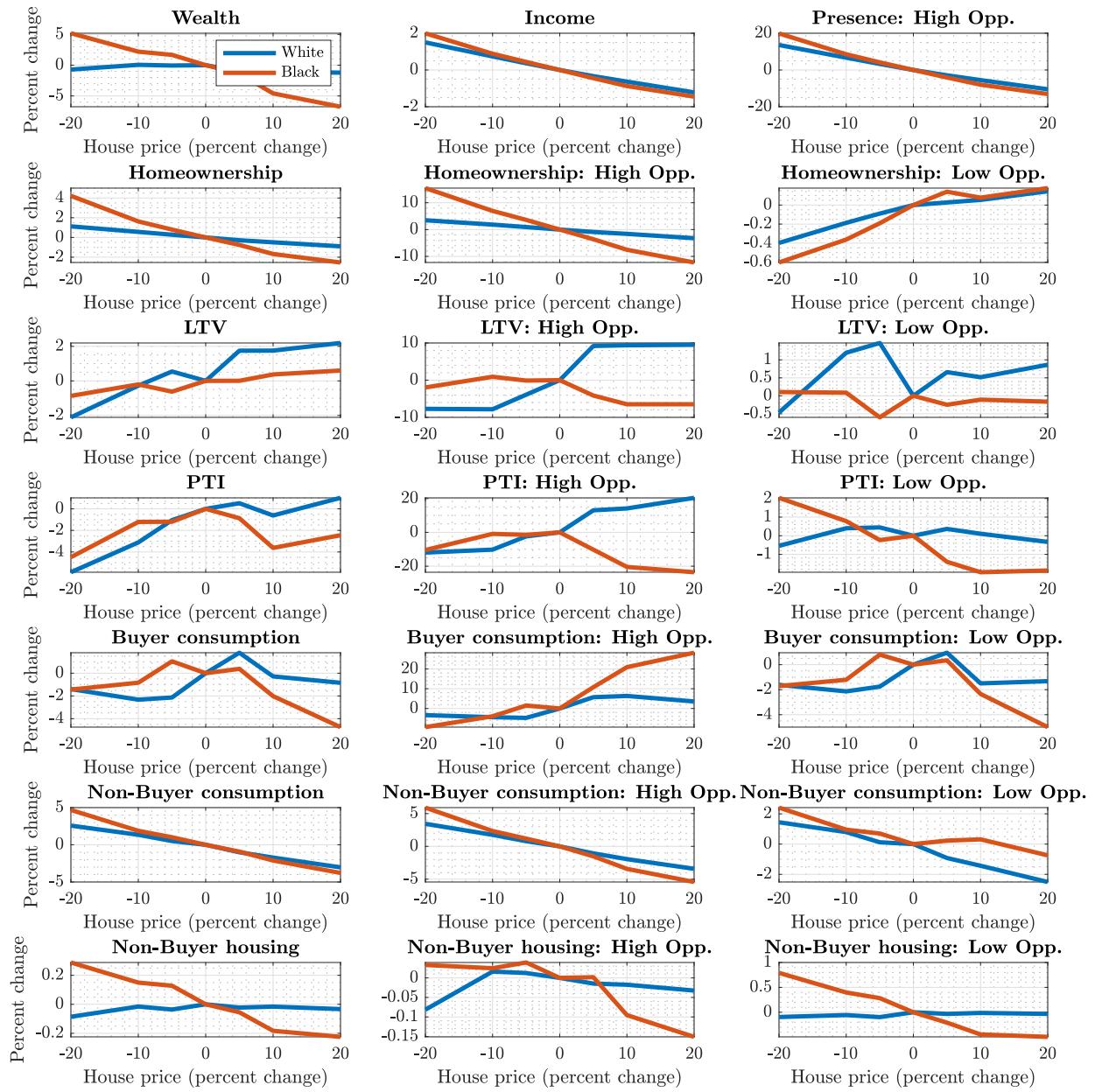
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.X: PHASING OUT FHA MORTGAGES: DETAILED RESULTS**



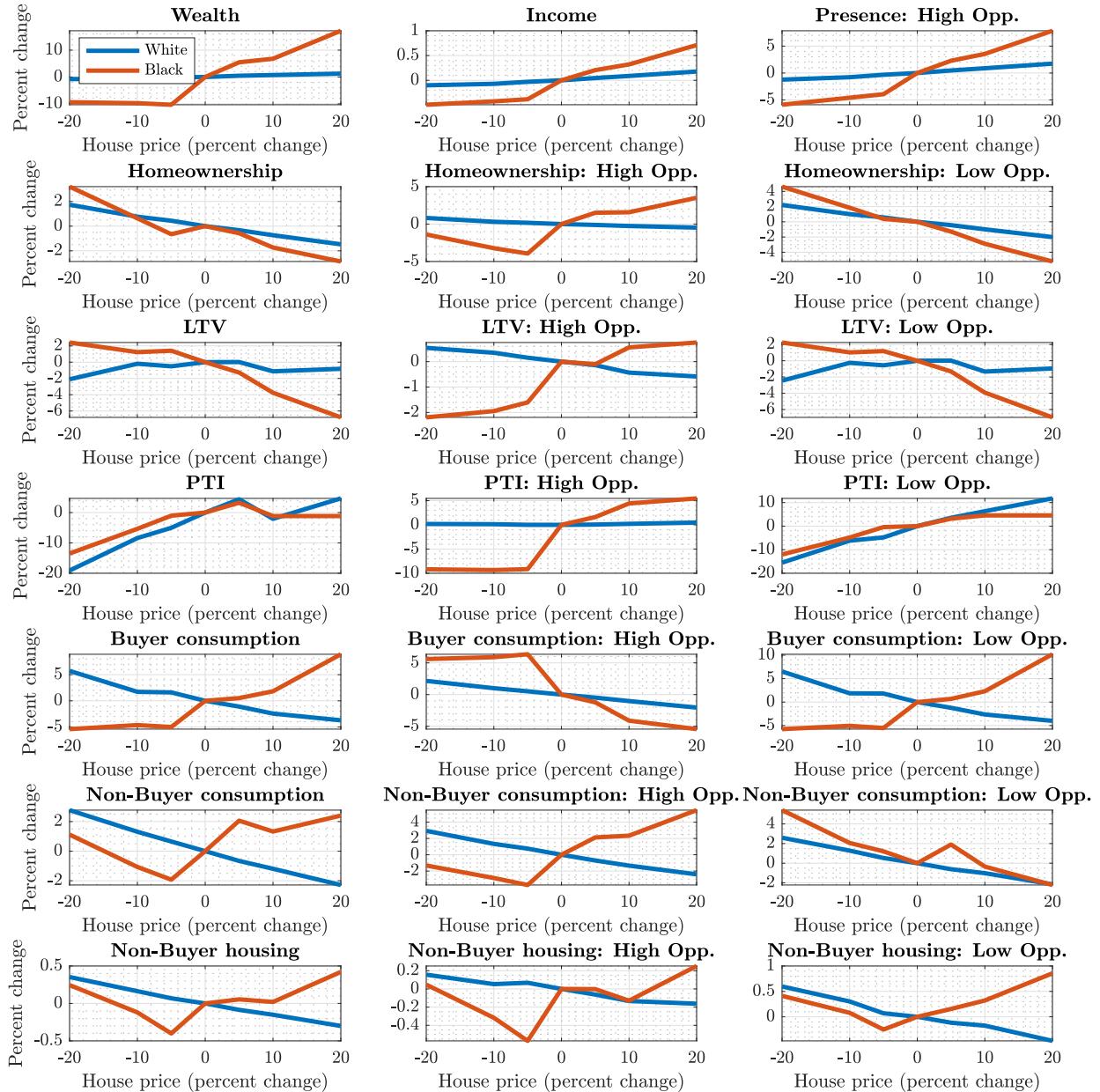
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XI: HOUSE PRICE SHOCKS IN HIGH OPPORTUNITY AREA: DETAILED RESULTS**



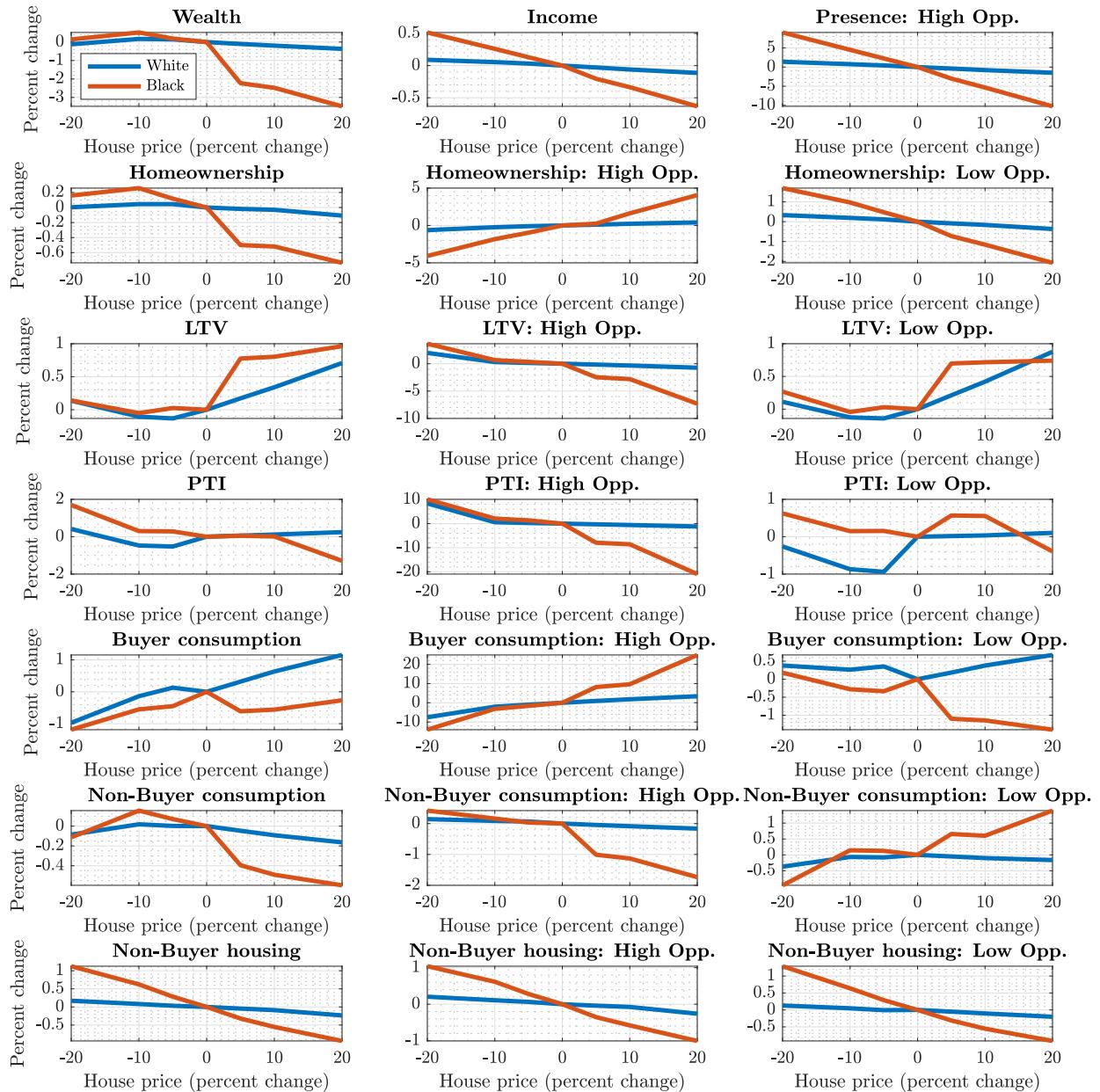
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XII: HOUSE PRICE SHOCKS IN LOW OPPORTUNITY AREA: DETAILED RESULTS**



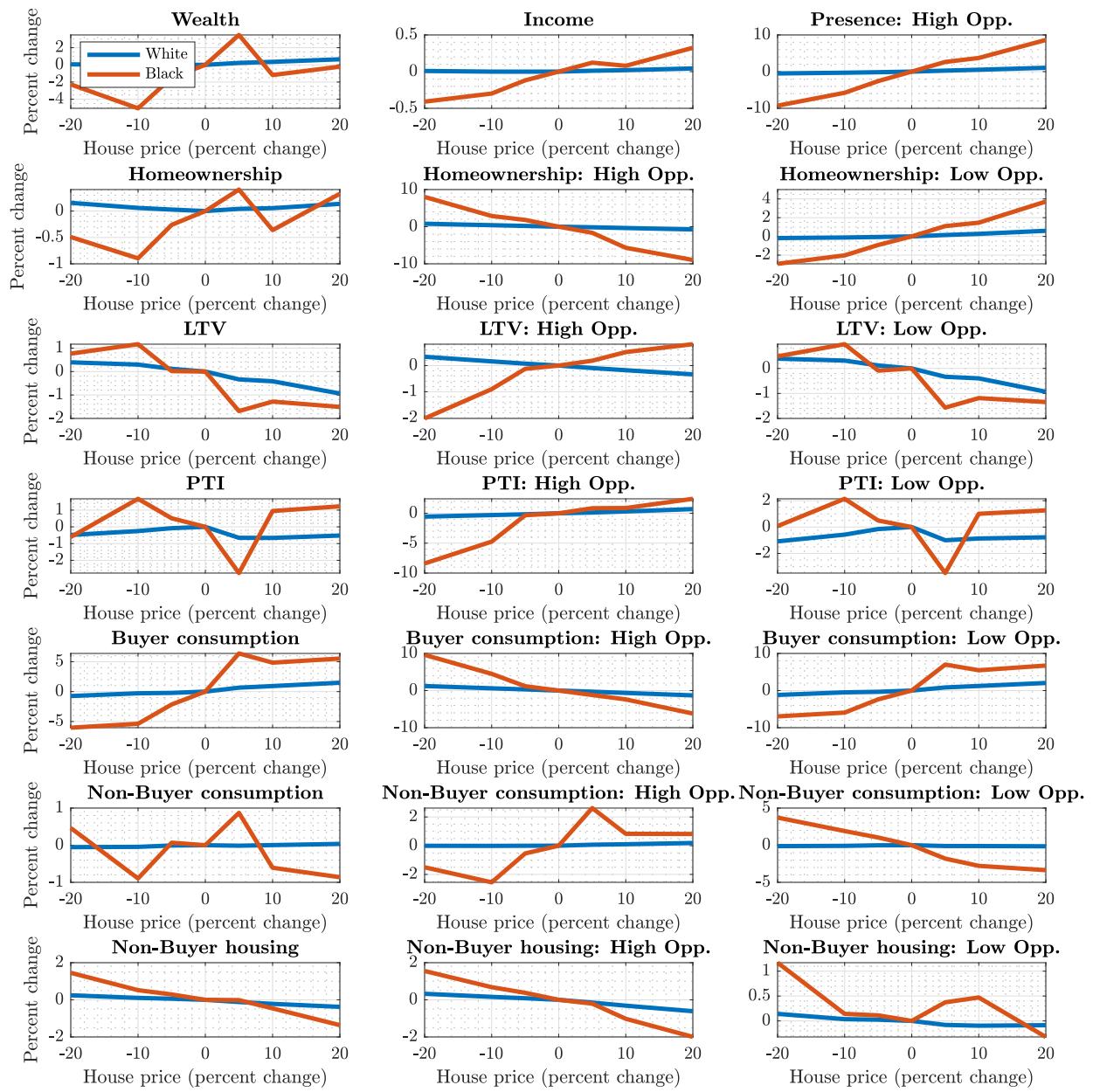
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XIII: RENT SHOCKS IN HIGH-OPPORTUNITY AREA: DETAILED RESULTS**



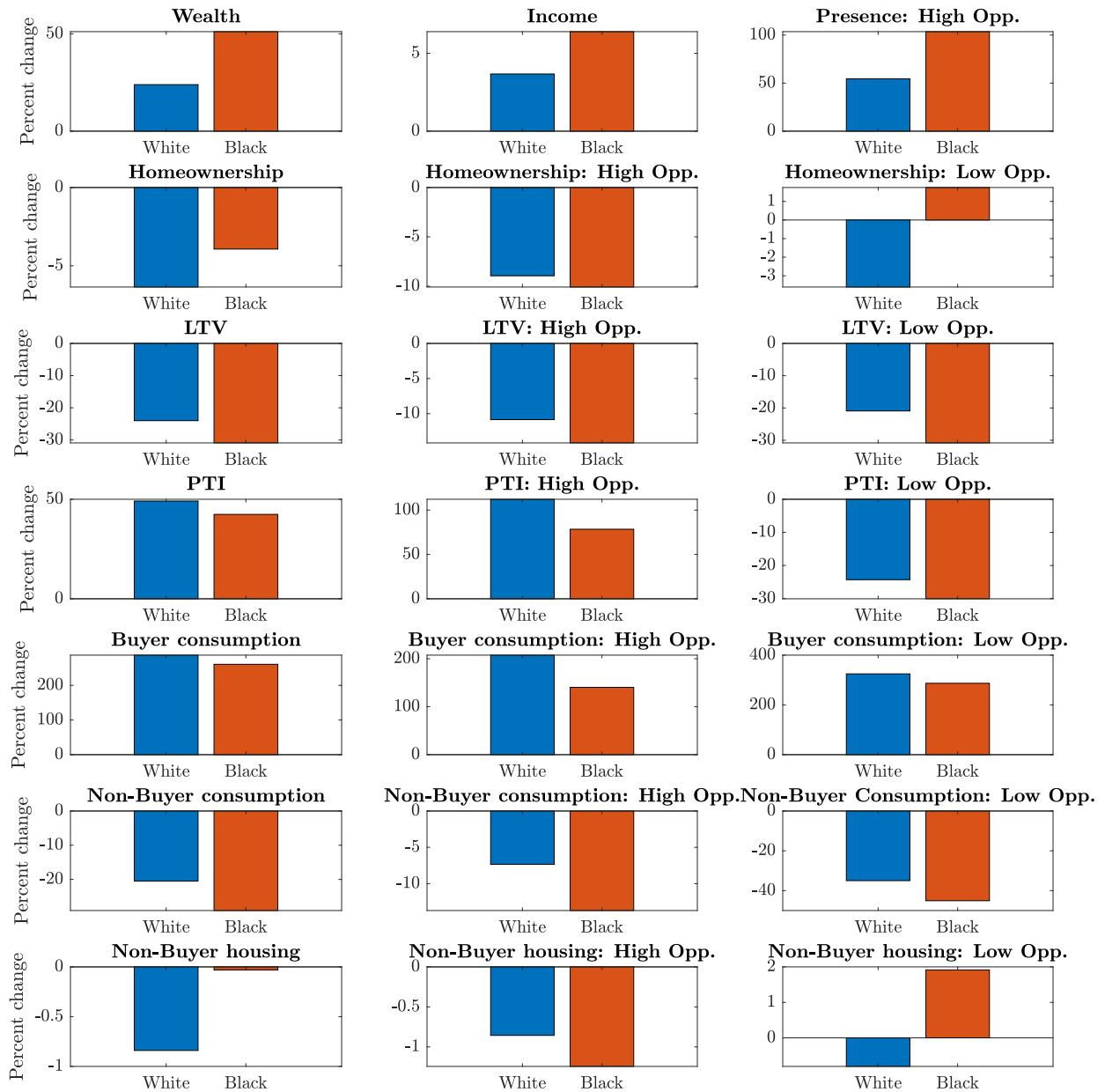
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XIV: RENT SHOCKS IN HIGH-OPPORTUNITY AREA: DETAILED RESULTS**



Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

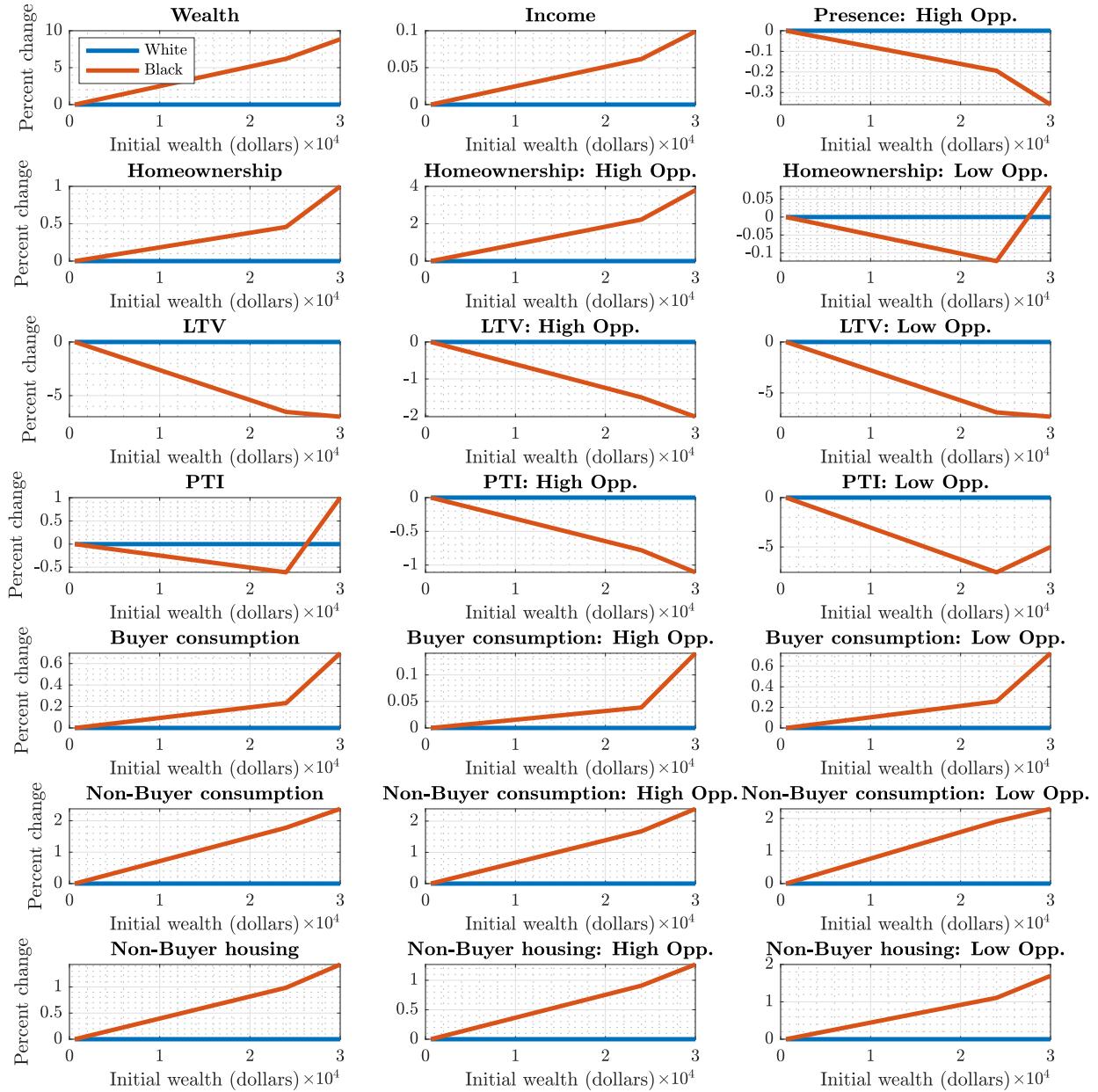
**FIGURE A.XV: MOVING TO WEALTH OPPORTUNITIES: DETAILED RESULTS**



*Notes:* variables are conditional averages in percentage deviation from the steady state of the baseline model. Household moving costs are set to zero.

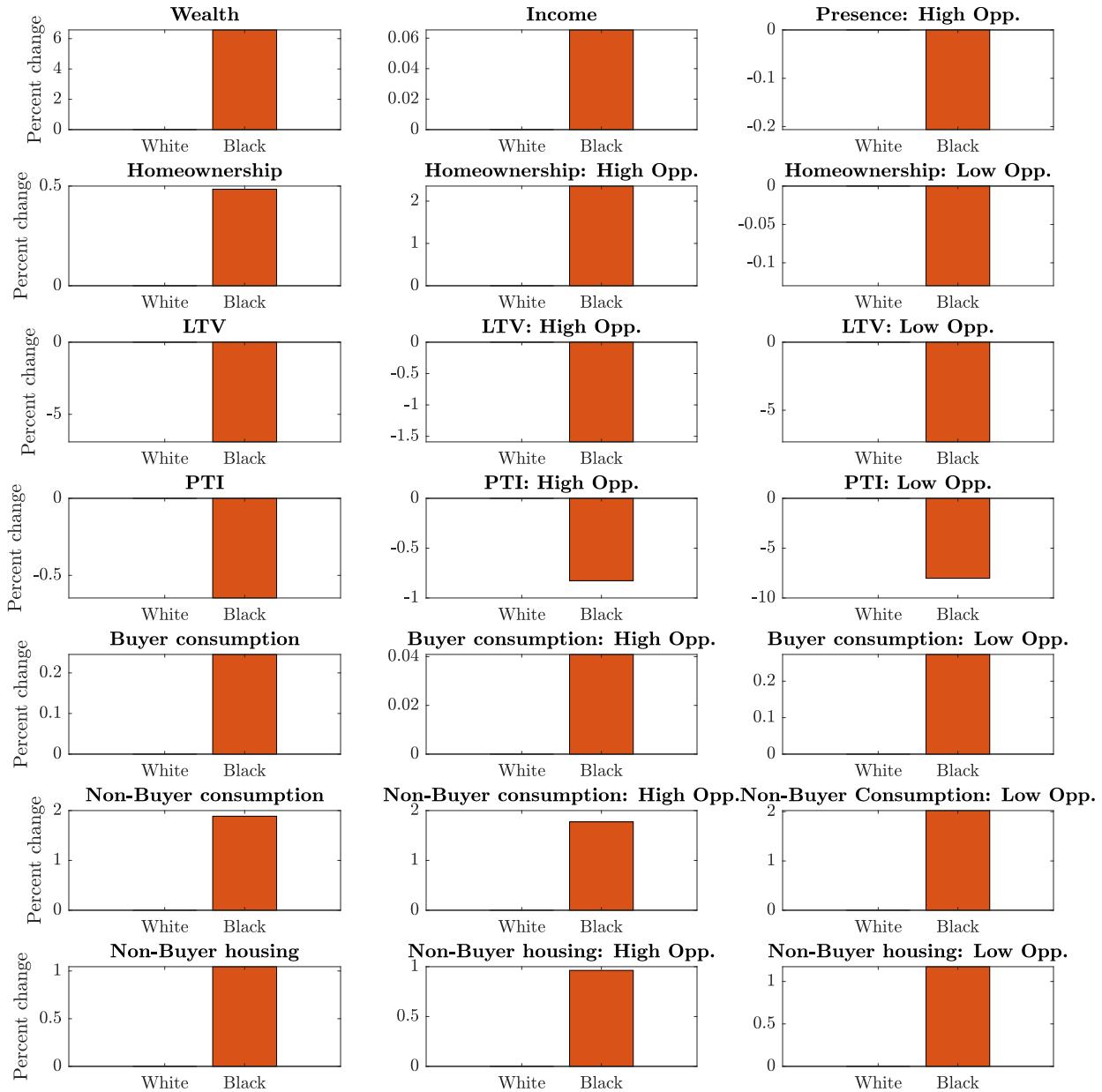
## C Additional Policy Results

**FIGURE A.XVI: INITIAL WEALTH OF BLACK HOUSEHOLDS: DETAILED RESULTS**



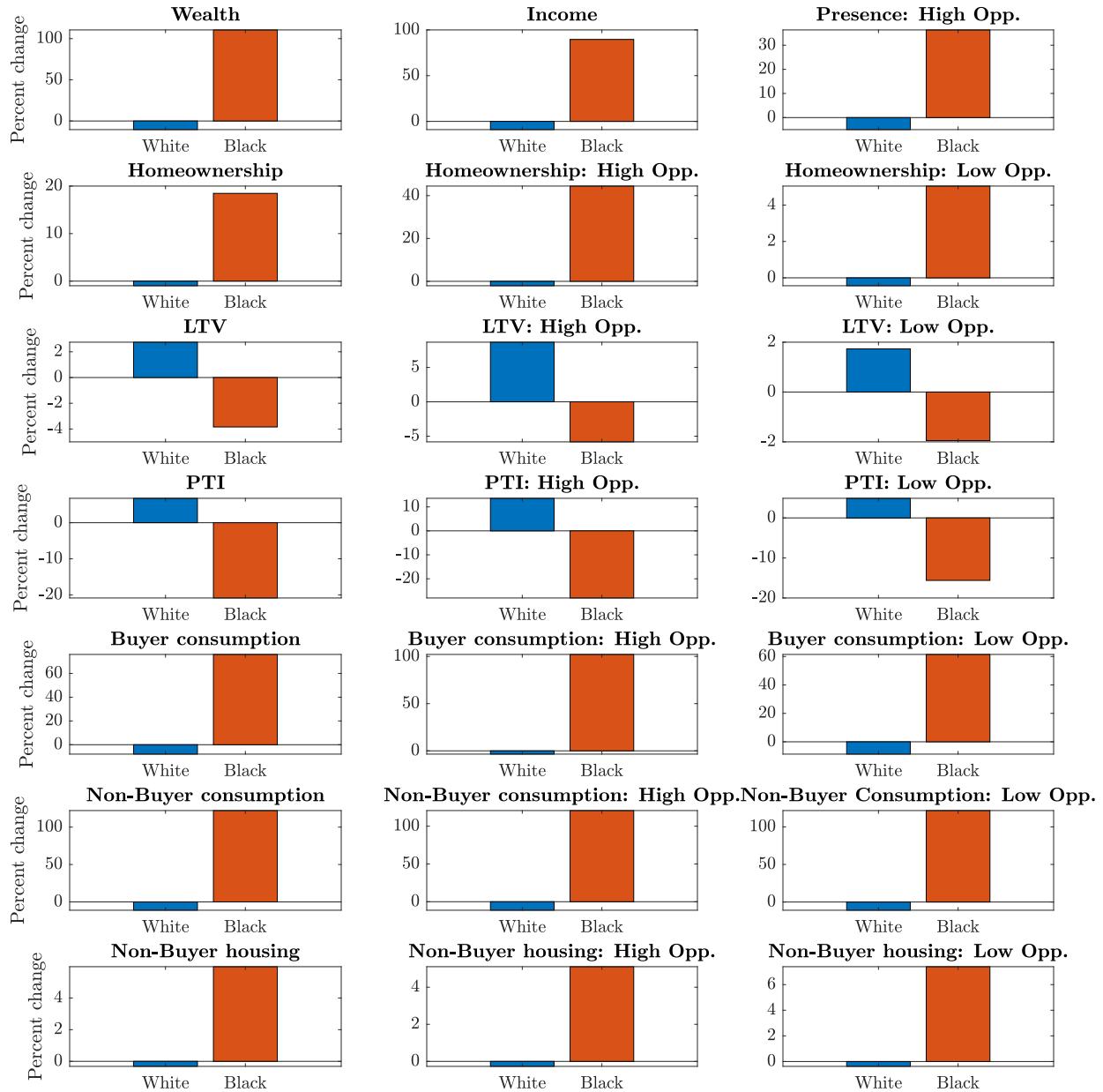
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XVII: REPARATION: INITIAL WEALTH, DETAILED RESULTS**



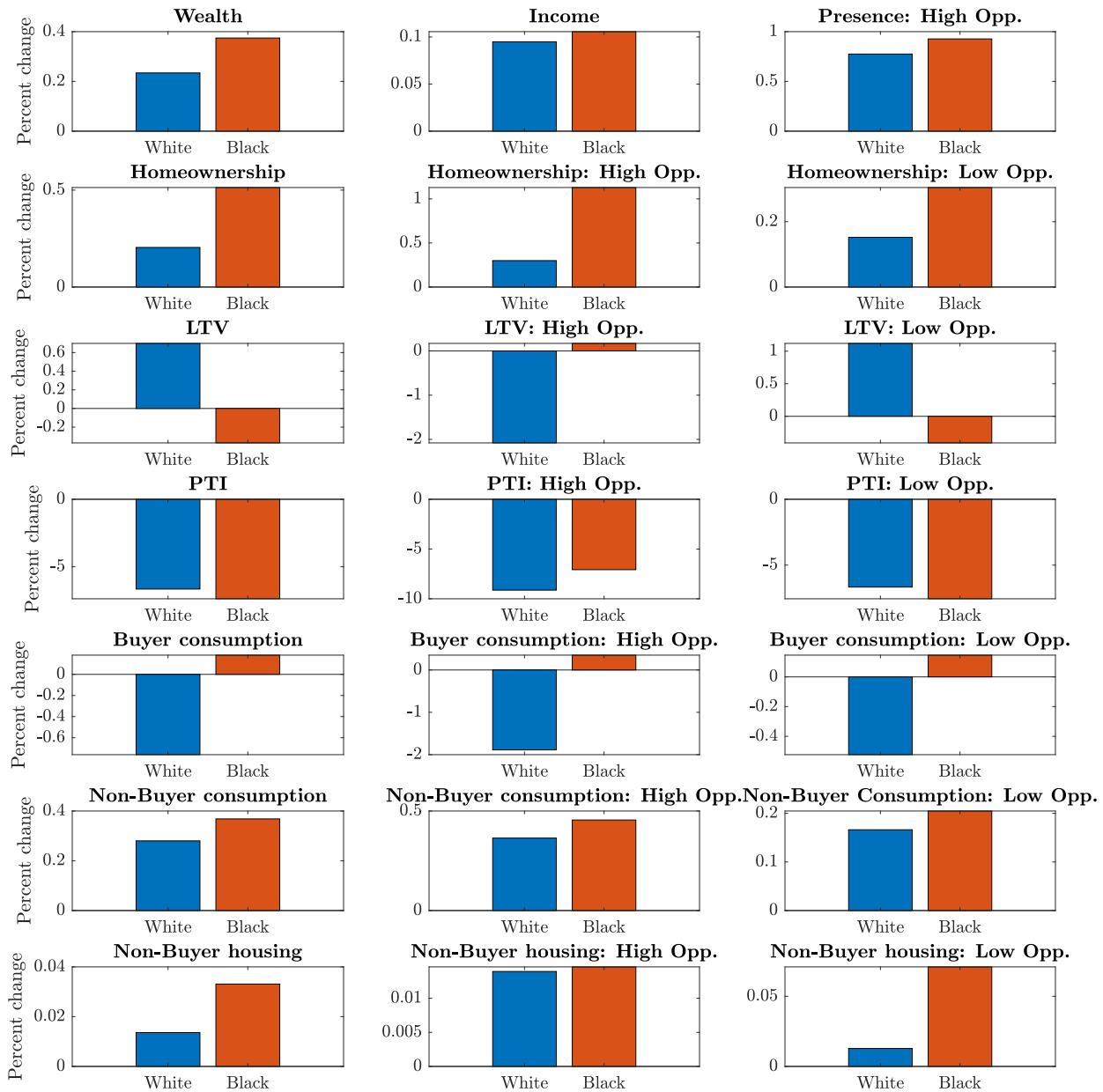
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XVIII: REPARATION: INCOME, DETAILED RESULTS**



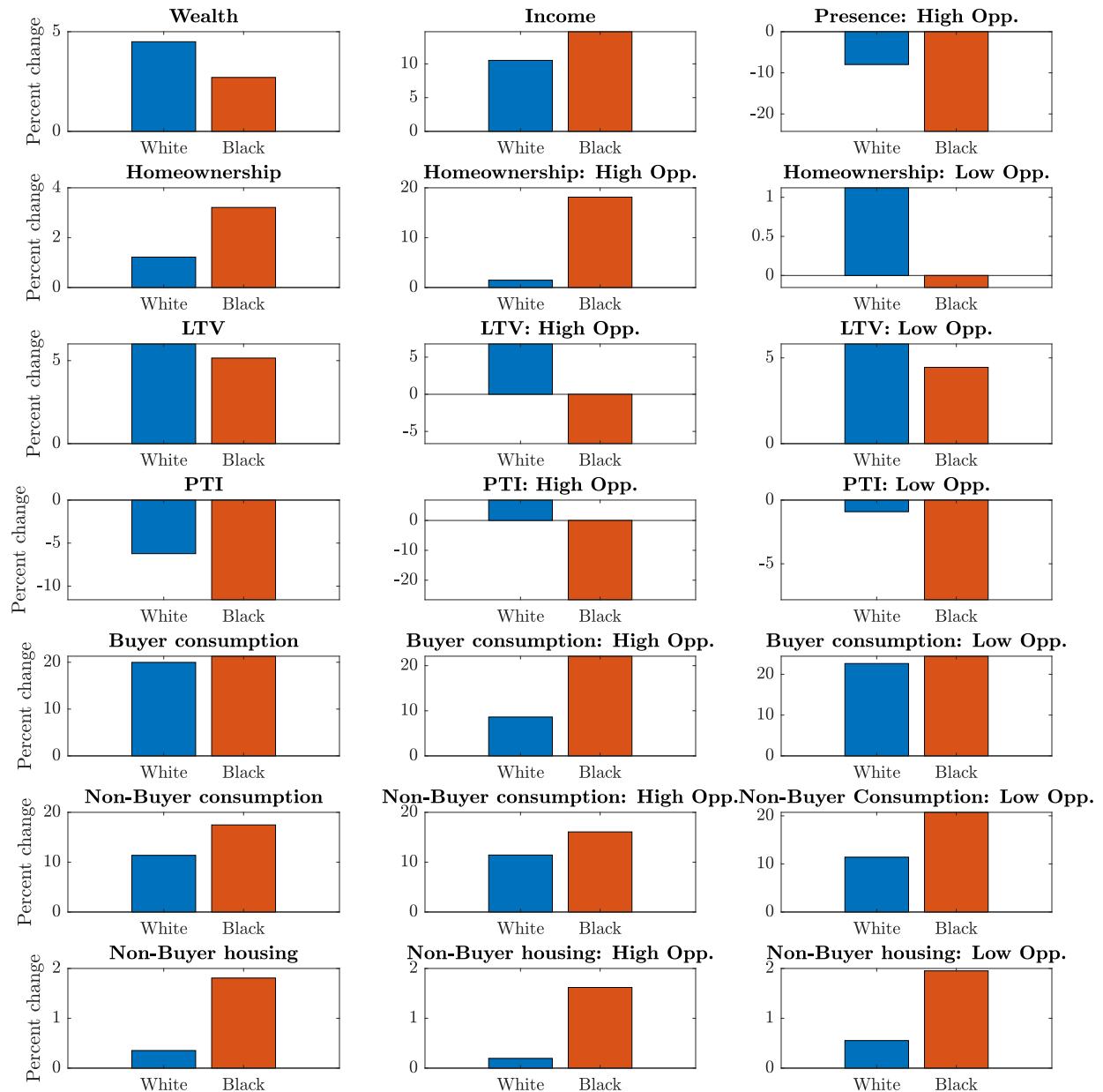
Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

**FIGURE A.XIX: MORTGAGE RATE SUBSIDY: DETAILED RESULTS**



Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

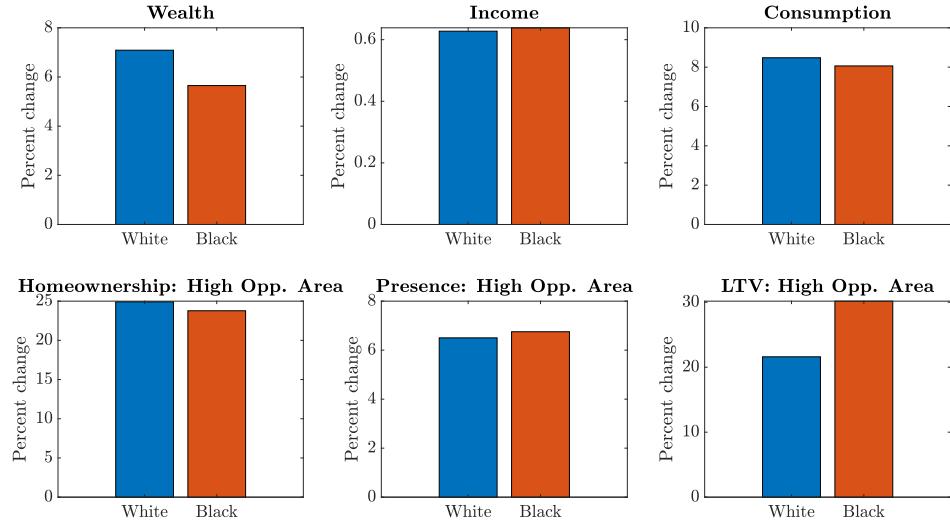
**FIGURE A.XX: PLACE-BASED LABOR MARKET POLICY: DETAILED RESULTS**



Notes: variables are conditional averages in percentage deviation from the steady state of the baseline model.

## D Detailed Robustness Results

**FIGURE A.XXI: RELAXING LEVERAGE CONSTRAINTS: FRICTIONLESS MODEL WITHOUT HOMEOWNERSHIP SHOCKS, MOVING FRICTIONS, OR RACIAL INCOME DIFFERENCES**



*Notes:* variables are conditional averages in percentage deviation from the steady state of the alternative model.