Macroeconomics of Racial Disparities: Discrimination, Labor Market, and Wealth

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Abstract

This paper examines the impact of racial discrimination in hiring on employment, wages, and wealth disparities between black and white workers. Using a labor search-and-matching model with racially prejudiced and non-prejudiced firms, we show that labor market frictions sustain discriminatory practices as an equilibrium outcome. These practices account for 57% of the racial unemployment gap, 48% of the average wage gap, and 16% of the median wealth gap. Discriminatory hiring also increases unemployment and wage volatility for black workers, increasing their labor market risks over the business cycle. Eliminating prejudiced firms reduces these disparities and improves the welfare of black workers as well as the overall economic welfare.

JEL classification: D14, E21, J15, J64, J65

Keywords: search-and-matching, heterogeneous agents, hiring discrimination, racial inequality, labor market frictions, unemployment, wage gaps, wealth distribution, business cycles

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1 Introduction

Market competition and increased access to information are expected to eliminate discrimination over time. Nonetheless, substantial empirical evidence shows that discriminatory practices persist across markets, perpetuating significant racial disparities.[1] Only recently has macroeconomic research begun exploring racial disparities.[2] Yet, the role of discriminatory practices in shaping these disparities remains underexplored. Developing a general equilibrium framework to explain the persistence of discrimination and its consequences is crucial for understanding the macroeconomic impacts of racial disparities and informing effective policymaking.

This paper constructs a search-and-matching model to examine the macroeconomic effects of persistent racial discrimination in hiring. We find that hiring discrimination explains roughly 57% of the black-white unemployment rate gap, 48% of the average wage gap, and 16% of the median wealth gap in the steady state. Moreover, discriminatory hiring amplifies the volatility of unemployment and wages among black workers over the business cycle. Eliminating hiring discrimination not only improves the welfare of black workers but also enhances overall economic welfare.

The model features two types of firms: prejudiced firms, which hire only white workers, and non-prejudiced firms, which hire all workers equally. As a result, all workers compete for jobs at non-prejudiced firms, but white workers have the additional opportunity to match with prejudiced firms. Matched worker-firm pairs negotiate wages to maximize their joint surplus. Upon calibration, the model endogenously produces a lower job-finding rate, higher

[1]For example, Couch and Fairlie (2010); Biddle and Hamermesh (2013); Kuhn, Schularick, and Steins (2020); Derenoncourt and Montialoux (2021); Lippens, Vermeiren, and Baert (2023); Lang and Spitzer (2020). Resume studies consistently reveal racial discrimination even when controlling for candidate qualifications (e.g., Bertrand and Mullainathan, 2004; Bertrand and Duflo, 2017; Quillian, Pager, Hexel, and Midtbøen, 2017; Kline, Rose, and Walters, 2022). Gaps in labor income and wealth between black and white households have persisted long after the Civil Rights Movement (e.g., Cajner, Radler, Ratner, and Vidangos, 2017; Derenoncourt, Kim, Kuhn, and Schularick, 2023). Small and Pager (2020) argues that discrimination reinforces itself across domains and constitutes a form of market failure.

[2]See, for example, Nakajima (2021), Aliprantis, Carroll, and Young (2023), Boerma and Karabarbounis (2021), Ganong, Jones, Noel, Greig, Farrell, and Wheat (2020), Lee, Macaluso, and Schwartzman (2021).

unemployment rate, and lower bargained wages for black workers. Even without additional financial frictions, the model generates substantial racial disparities in wealth accumulation.

The main message of this paper is that labor market frictions can sustain hiring discrimination as an equilibrium outcome. Our calibration shows that prejudiced firms incur higher vacancy posting costs to discriminate against black workers. Yet, they sustain positive profits by maintaining a lower turnover rate upon hiring white workers. Moreover, hiring discrimination affects the equilibrium economy through firms' vacancy postings. Prejudiced firms compete with non-prejudiced firms for white workers, driving up their wage rates across the economy. This wage pressure reduces the expected profit of non-prejudiced firms, leading them to post fewer vacancies overall. The resulting decline in job openings at non-prejudiced firms directly limits employment opportunities for black workers, contributing to lower wages, higher unemployment, and adverse wealth accumulation. In a counterfactual economy without prejudiced firms, these racial disparities narrow substantially.

Eliminating discriminatory hiring also yields significant welfare gains. Black workers experience a 12.9% increase in welfare as non-prejudiced firms expand their vacancy postings, which in turn improves their job opportunities and wages. Although white workers incur a modest 0.5% welfare decline due to the loss of exclusive job opportunities, the overall welfare of the economy rises by 1.5% because the gains for black workers more than offset the losses for white workers.

We further incorporate aggregate shocks into our benchmark economy to examine how hiring discrimination shapes business cycle dynamics. Our model replicates key empirical patterns: a countercyclical and volatile racial unemployment gap, as well as a more procyclical and volatile wage response among black workers. In a counterfactual model without prejudiced firms, the volatility of unemployment rates and wages for black workers is substantially reduced relative to white workers. Moreover, hiring discrimination amplifies the volatility of racial disparities in consumption and wealth over the business cycle. These findings suggest that firm-side hiring discrimination plays a crucial role in driving the distinct

business cycle dynamics of black and white workers, which cannot be fully explained by demographic factors alone (Cajner et al., 2017; Boulware and Kuttner, 2019, 2024).

This paper contributes to the ongoing discussion on the persistence of racial inequality by focusing on the disparate labor market conditions of black and white workers. Numerous studies have documented racial discrimination in pay and employment opportunities that persist despite policy interventions (e.g., Coate and Loury, 1993; Black, 1995; Rosén, 1997; Bertrand and Mullainathan, 2004; Manduca, 2018). Recent empirical research stresses that racial wage and employment gaps persist across education levels, skill sets, and cohorts. These disparities are not solely attributable to differences in individual qualifications (e.g., Pena, 2018; Cheng, Tamborini, Kim, and Sakamoto, 2019). Building on this insight, our paper develops a model in which discriminatory hiring practices endogenously perpetuate labor market inequalities. Our work adds to the literature by providing a theoretical framework that explains how hiring discrimination can be sustained as an equilibrium outcome in the labor market.

While much of the literature focuses on static disparities, fewer studies document how macroeconomic fluctuations impact black and white workers differently. Notably, Couch and Fairlie (2010) demonstrate that black workers are disproportionately affected during recessions, being the last hired in upturns and the first fired in downturns. Biddle and Hamermesh (2013) find that the discriminatory wage gap is procyclical, widening during economic expansions. Similarly, Cajner et al. (2017) show that black workers experience higher unemployment rate volatility and are more likely to be involuntarily employed part-time. Daly, Hobijn, and Pedtke (2020) suggest that limited employment opportunities for black workers contribute to the growing racial earnings gap. Recent research by Boulware and Kuttner (2019, 2024) further highlights that racial disparities intensify during downturns, driven by increased hiring discrimination and differential sensitivity of black employment to cyclical fluctuations, effects that cannot be fully attributed to black workers' concentration in cyclically sensitive industries. Our paper adds to this body of work by evaluating the

impact of hiring discrimination on the cyclical aspects of racial disparities, examining how discriminatory practices exacerbate the volatility and cyclicality of employment and wages for black workers.

An emerging strand of literature explores racial disparities in wealth accumulation. Studies such as Derenoncourt et al. (2023), Derenoncourt, Kim, Kuhn, and Schularick (2022), Kuhn et al. (2020), Barsky, Bound, Charles, and Lupton (2002), and McIntosh, Moss, Nunn, and Shambaugh (2020) document significant wealth gaps between black and white households. For example, Derenoncourt et al. (2023) provides a historical account of wealth segregation over the past 150 years, showing persistent and substantial disparities. Boerma and Karabarbounis (2021) and Aliprantis et al. (2023) analyze the impact of historical discrimination on earnings, bequests, and capital returns within steady-state models that do not consider aggregate risks. Furthermore, Ganong et al. (2020) demonstrates that income risks affect individuals differently across racial groups due to wealth differences. Building on these findings, Bartscher, Kuhn, Schularick, and Wachtel (2021) and Lee et al. (2021) discuss how monetary policy can have disparate effects on workers of different racial backgrounds. Our paper contributes to this literature by showing that employer discrimination not only affects immediate labor market outcomes but also spills over to long-term wealth accumulation disparities between black and white workers.

Germane to our project, Nakajima (2021) develops a search-and-matching model to examine how monetary policy exacerbates racial differences in the labor market. Our model explicitly distinguishes between prejudiced and non-prejudiced firms in the hiring process and directly examines how hiring discrimination impacts black workers and the broader economy. We analyze the spillover effects of discriminatory hiring practices on both labor and wealth disparities, offering a comprehensive theoretical understanding of these dynamics over the long run and across business cycles.

In a broader context, our paper joins the growing discussion on the distributional impact of economic growth and macroeconomic policies by focusing on the heterogeneous outcomes

for black and white workers. This aligns with studies like Caballero and Hammour (1994), Jaimovich and Siu (2020), and Heathcote, Perri, and Violante (2020), which provide evidence that recessions disproportionately hurt disadvantaged individuals. Borella, De Nardi, and Yang (2018) shows that incorporating gender differences in a life-cycle model improves its empirical fit, emphasizing the importance of accounting for demographic heterogeneity. Krusell and Smith (1998) concludes that heterogeneity in wealth does not alter business cycle fluctuations. Yet, Yum, Jang, and Sunakawa (2023) shows that heterogeneity could generate large aggregate fluctuations when introducing non-convexity in budget constraints through progressive tax. Our paper demonstrates that incorporating racial differences into labor market models enhances their ability to capture business cycle fluctuations. It also provides insights into how racial wedges in labor search processes transmit individual risks and heterogeneity into aggregate economic dynamics.

The rest of the paper proceeds as follows. Section 2 lays out the theoretical framework. Section 3 discusses the calibration strategy. Section 4 examines the steady-state implications of racial discrimination. Section 5 discusses the business cycle implications. Section 6 concludes the paper.

2 Model

This section presents a model of labor market discrimination without aggregate uncertainty. We use this framework to understand the role of hiring discrimination in driving the racial gaps in labor market outcomes and wealth.

2.1 Environment

The model has a unit measure of workers, who are either black or white, $R \in \{bl, wh\}$. Two types of firms post vacancies subject to search and matching frictions. Prejudiced firms (p) discriminate in hiring by effectively excluding black applicants, whereas non-prejudiced

firms (np) hire workers without regard to race. A matched firm-worker pair corresponds to a filled job position, making firms and jobs synonymous within our model. Black workers thus receive offers exclusively from non-prejudiced firms, while white workers can match with both types of firms, increasing their employment opportunities. This assumption closely aligns with extensive empirical evidence on racial disparities in hiring. Audit studies by Bertrand and Mullainathan (2004) find that resumes with white-sounding names receive approximately 50% more callbacks than identical resumes with black-sounding names. Similarly, a meta-analysis by Quillian et al. (2017) confirms that white applicants consistently receive, on average, 36% more callbacks. Although discrimination occurs in other aspects such as wages, promotions, and separations, we specifically focus on hiring discrimination due to its documented significance, allowing us to clearly evaluate its distinct macroeconomic effects.

Workers are either employed (with p or np firm) or unemployed. Those who become unemployed in the current period receive unemployment benefits and continue to receive them in the future with probability P_e. The workers face idiosyncratic productivity shocks s, following an AR(1) process $\log(s') = \rho_s \log(s) + \epsilon_s$, with $\epsilon_s \overset{iid}{\sim} N(0, \sigma_s^2)$.[3] Workers also differ in their asset holdings. They can save using risk-free assets to partially insure themselves against the labor market risks. Following Mukoyama (2013), workers also receive race-specific extreme wealth shocks with probability $\epsilon_R \in \{\epsilon_{bl}, \epsilon_{wh}\}$. Upon realization of the shock, a worker loses all their wealth. Altogether, workers are heterogeneous across race (R), labor market status (e), idiosyncratic productivity (s), and wealth (a). The endogenous distribution of workers is summarized by $\mu(e, R, s, a)$. In the steady state, individual workers may move around the distribution, but the overall distribution remains stationary. Thus, μ is not a state variable in the steady state model but becomes an aggregate state variable in the augmented model with aggregate shocks discussed in Section 5.

[3]To ease exposition, we drop the time subscripts and use a prime symbol (') to denote variables in the next period.

2.2 Labor market search and matching

The total number of unemployed workers denoted as u, is the sum of unemployed black workers (u_{bl}) and unemployed white workers (u_{wh}). There are v_{np} vacancies available in the non-prejudiced market, while the number of vacancies in the prejudiced market is v_p. Non-prejudiced firms search among both black and white unemployed workers, resulting in a non-prejudiced market tightness defined as $\theta_{np} = \frac{v_{np}}{u}$. In contrast, prejudiced firms only hire unemployed white workers, which gives the prejudiced market tightness $\theta_p = \frac{v_p}{u_{wh}}$. Following the works of Den Haan, Ramey, and Watson (2000) and Petrosky-Nadeau, Zhang, and Kuehn (2018), unemployed workers and vacant firms match through a constant returns to scale matching function

$$M(u, v) = \frac{uv}{(u^\iota + v^\iota)^{1/\iota}} \tag{1}$$

with $\iota > 0$. As documented by Den Haan et al. (2000), this functional form ensures that the matching probabilities stay within 0 and 1. The probability for an unemployed worker to match with a vacant np firm is $f(\theta_{np}) = M(u, v_{np})/u = (1 + \theta_{np}^{-\iota})^{-1/\iota}$, while the probability that a white unemployed worker matches with a vacant p firm is $f(\theta_p) = M(u_{wh}, v_p)/u_{wh} = (1 + \theta_p^{-\iota})^{-1/\iota}$. Correspondingly, the probability of filling a vacant np firm is $q(\theta_{np}) = M(u, v_{np})/v_{np} = (1 + \theta_{np}^{\iota})^{-1/\iota}$, while the probability of filling a vacant p firm is $q(\theta_p) = M(u_{wh}, v_p)/v_p = (1 + \theta_p^{\iota})^{-1/\iota}$. In addition, non-prejudiced matches get destructed with probability λ_{np}, while the prejudiced matches separate at the rate λ_p.

2.3 Unemployment Insurance

Unemployment insurance is characterized by the replacement rate h, eligibility probability P_e, and maximum coverage level χ. Following Setty and Yedid-Levi (2021), eligible workers receive unemployment benefits $b(R, s, a) = min\{h\bar{w}(R, s, a), \chi\}$, where $\bar{w}(R, s, a)$ is the counterfactual wage earned by an employed worker with race R, productivity s, and wealth a. We adopt the counterfactual wage to ease the computation burden of tracking wage history.

Similar to Mitman and Rabinovich (2015), newly unemployed workers receive unemployment benefits with certainty and continue to receive benefits next period with probability P_e. If an unemployed worker loses their eligibility to receive benefits, they continue to remain ineligible in the future. Unemployment benefits are funded through a proportional tax τ on the labor income, and the government sets τ to balance its budget.[4]

2.4 Workers

The value function of an employed individual with race R, productivity s, asset a, and working with an np firm is given by $W_{np}(R, s, a)$, while that of a white worker employed with a p firm is given by $W_p(wh, s, a)$. Since the unemployment benefit is indexed to the worker's counterfactual wage, the values of the unemployed workers eligible for benefits depend on whether they worked with a non-prejudiced (with value function $U^I_{np}(R, s, a)$) or a prejudiced (with value function $U^I_p(wh, s, a)$) firm previously. An unemployed worker who is not eligible for unemployment benefits has a value of $U^N(R, s, a)$ over their lifetime. All the workers discount their future utility by β. Similar to Nakajima (2012) and Setty and Yedid-Levi (2021), we assume that workers cannot borrow. This imposes an exogenous constraint of $a' \geq 0$ on all workers.

2.4.1 Employed with *np* firm

Equation (2) describes an employed worker of race R with productivity s and asset holdings a, working in an np firm. The worker chooses consumption c and future savings a' to maximize their discounted lifetime utility. Their income consists of period wage, ω_{np}, net of payroll tax τ, current savings $(1 + r)a$, and dividends d. The expectation of the worker's future value is taken over the idiosyncratic productivity shock s and the race-specific probability of the extreme wealth shock ϵ_R.

[4]We intentionally model a more realistic and complex unemployment insurance structure to capture the racial disparities in the incidence and take-up of unemployment insurance. This helps us generate racial differences in income and wealth distribution, given the asymmetric labor market and wealth risks.

$$W_{np}(R,s,a) = \max_{c,a' \geq 0} \Big\{ u(c) + \beta \sum_{s'} \pi_{ss'} [(1-\epsilon_R)\hat{W}_{np}(R,s',a') + \epsilon_R \hat{W}_{np}(R,s',0)] \Big\}$$

$$\text{s.t.} \tag{2}$$

$$c + a' = (1-\tau)\omega_{np}(R,s,a) + (1+r)a + d$$

The worker receives a job destruction shock specific to np firms and becomes unemployed with probability λ_{np}. Otherwise, they continue to remain employed with probability $1-\lambda_{np}$. If unemployed, the worker receives unemployment benefits and realizes a value of U^I_{np}. Thus, the future value of an employed worker conditional on the realization of wealth shock is given by Equation (3).

$$\hat{W}_{np}(R,s',a') = \lambda_{np} U^I_{np}(R,s',a') + (1-\lambda_{np}) W_{np}(R,s',a') \tag{3}$$

2.4.2 Employed with p firm

Equation (4) describes the case of a worker employed by a p firm. It is analogous to the previous case, but we only consider white workers since prejudiced firms do not hire black workers.

$$W_p(wh,s,a) = \max_{c,a' \geq 0} \Big\{ u(c) + \beta \sum_{s'} \pi_{ss'} [(1-\epsilon_{wh})\hat{W}_p(wh,s',a') + \epsilon_{wh} \hat{W}_p(wh,s',0)] \Big\}$$

$$\text{s.t.} \tag{4}$$

$$c + a' = (1-\tau)\omega_p(wh,s,a) + (1+r)a + d$$

The matched worker receives a job destruction shock specific to p firms, with probability λ_p. A worker losing the job in the current period is eligible for unemployment benefits and earns value U^I_p in the next period. Conditional on realizing the wealth shock, an employed worker's future value expands to Equation (5).

$$\hat{W}_p(wh, s', a') = \lambda_p U_p^I(wh, s', a') + (1 - \lambda_p) W_p(wh, s', a') \tag{5}$$

2.4.3 Unemployed and eligible workers

Since unemployment insurance is proportional to the counterfactual wage, the value obtained by an unemployed and eligible worker depends on whether the past employment was in a p or in an np firm. In addition, unemployed white workers can receive job offers from both p and np firms, while black workers can get matched only with np firms.

Unemployed black worker from np firm

Equation (6) describes the value of an unemployed black worker eligible for benefits. The worker encounters the extreme wealth shock with probability ϵ_{bl}. The worker receives unemployment insurance payout, $b_{np}(bl, s, a)$, net of labor income tax rate τ, previous savings, and lump-sum dividend transfer d.

$$\begin{aligned} U_{np}^I(bl, s, a) = \max_{c, a' \geq 0} & \left\{ u(c) + \beta \sum_{s'} \pi_{ss'} [(1 - \epsilon_{bl}) \hat{U}_{np}^I(bl, s', a') + \epsilon_{bl} \hat{U}_{np}^I(bl, s', 0)] \right\} \\ & \text{s.t.} \\ c + a' &= (1 - \tau) b_{np}(bl, s, a) + (1 + r) a + d \end{aligned} \tag{6}$$

Their future value $\hat{U}_{np}^I(bl, s', a')$ expands to Equation (7).

$$\hat{U}_{np}^I(bl, s', a') = f(\theta_{np}) W_{np}(bl, s', a') + (1 - f(\theta_{np}))[P_e U_{np}^I(bl, s', a') + (1 - P_e) U^N(bl, s', a')] \tag{7}$$

The unemployed black worker finds a job with probability $f(\theta_{np})$, which moves them to a future value of $W_{np}(bl, s', a')$. Otherwise, they remain unemployed and continue to receive unemployment benefits with probability P_e or lose their benefit with probability $(1 - P_e)$. If one loses the benefit, the worker receives a value of $U^N(bl, s', a')$.

Unemployed white worker from np firm

Unemployed white workers are recruited by both p and np firms, and their value function is given by Equation (8). Like a black worker, a white worker encounters an extreme wealth shock with probability ϵ_{wh}. They also have a budget constraint depending on their post-tax unemployment insurance payout, current savings, and a lump-sum dividend transfer.

$$\begin{aligned} U^I_{np}(wh,s,a) = \max_{c,a'\geq 0} \Big\{ u(c) + \beta \sum_{s'} \pi_{ss'} [(1-\epsilon_{wh})\hat{U}^I_{np}(wh,s',a') + \epsilon_{wh}\hat{U}^I_{np}(wh,s',0)] \Big\} \\ \text{s.t.} \\ c + a' = (1-\tau) b_{np}(wh,s,a) + (1+r)a + d. \end{aligned} \tag{8}$$

Equation (9) describes the future value of an unemployed white worker conditional on the wealth shock. With probability $(1-f(\theta_{np}))f(\theta_p)$, the worker receives a job offer only from a p firm, while they receive an offer only from a np firm with probability $f(\theta_{np})(1-f(\theta_p))$. With probability $f(\theta_{np})f(\theta_p)$, they receive offers from both np and p firms simultaneously. If the worker receives both p and np offers, they will choose the job with a higher lifetime value. The white worker will remain unemployed if they don't receive any offer (with probability $(1-f(\theta_p))(1-f(\theta_{np}))$). In this case, the worker continues to receive unemployment benefits with probability P_e, and lose their eligibility with probability $(1-P_e)$.

$$\begin{aligned} \hat{U}^I_{np}(wh,s',a') = (1-f(\theta_{np}))f(\theta_p)W_p(wh,s',a') + f(\theta_{np})(1-f(\theta_p))W_{np}(wh,s',a') \\ + f(\theta_{np})f(\theta_p)\max\{W_p(wh,s',a'), W_{np}(wh,s',a')\} \\ + (1-f(\theta_p))(1-f(\theta_{np}))\Big[P_e U^I_{np}(wh,s',a') + (1-P_e)U^N(wh,s',a')\Big] \end{aligned} \tag{9}$$

Unemployed white worker from p firm

Equation (10) describes the problem faced by a white worker who last worked with a p firm. The problem is identical to the previous case, except that they receive an insurance payout of $b_p(wh, s, a)$.

$$
\begin{aligned}
U_p^I(wh, s, a) = \max_{c, a' \geq 0} \Big\{ u(c) + \beta \sum_{s'} \pi_{ss'} [(1 - \epsilon_{wh}) \hat{U}_p^I(wh, s', a') + \epsilon_{wh} \hat{U}_p^I(wh, s', 0)] \Big\} \\
\text{s.t.} \\
c + a' = (1 - \tau) b_p(wh, s, a) + (1 + r) a + d
\end{aligned} \tag{10}
$$

Analogous to the previous case, the unemployed worker's future value conditional on the wealth shock is given by Equation (11).

$$
\begin{aligned}
\hat{U}_p^I(wh, s', a') = {} & (1 - f(\theta_{np})) f(\theta_p) W_p(wh, s', a') + f(\theta_{np})(1 - f(\theta_p)) W_{np}(wh, s', a') \\
& + f(\theta_{np}) f(\theta_p) \max\{W_p(wh, s', a'), W_{np}(wh, s', a')\} \\
& + (1 - f(\theta_p))(1 - f(\theta_{np})) \Big[P_e U_p^I(wh, s', a') + (1 - P_e) U^N(wh, s', a') \Big]
\end{aligned} \tag{11}
$$

2.4.4 Unemployed and ineligible workers

Ineligible workers are those who have lost their eligibility for receiving unemployment insurance and are still searching for jobs. Once ineligible, they no longer become eligible again. Therefore, their consumption relies solely on their savings and lump sum dividends, regardless of their prior employment status.

Black worker

Equation (12) describes the problem of an unemployed black worker searching for jobs without unemployment insurance.

$$U^N(bl,s,a) = \max_{c,a' \geq 0} \Big\{ u(c) + \beta \sum_{s'} \pi_{ss'} \Big[(1-\epsilon_{bl}) \hat{U}^N(bl,s',a') + \epsilon_{bl} \hat{U}^N(bl,s',0) \Big] \Big\}$$

$$\text{s.t.} \tag{12}$$

$$c + a' = (1+r)a + d$$

Equation (13) expands the conditional future value of the black worker. The worker finds a job with an np firm with probability $f(\theta_{np})$, and remains unemployed and ineligible otherwise.

$$\hat{U}^N(bl,s',a') = f(\theta_{np}) W_{np}(bl,s',a') + (1 - f(\theta_{np})) U^N(bl,s',a') \tag{13}$$

White worker

Similarly, Equation (14) describes the problem of a white worker searching for jobs without unemployment insurance.

$$U^N(wh,s,a) = \max_{c,a' \geq 0} \Big\{ u(c) + \beta \sum_{s'} \pi_{ss'} \Big[(1-\epsilon_{wh}) \hat{U}^N(wh,s',a') + \epsilon_{wh} \hat{U}^N(wh,s',0) \Big] \Big\}$$

$$\text{s.t.} \tag{14}$$

$$c + a' = (1+r)a + d$$

Equation (15) expands the conditional future value of the white worker in this scenario. It is almost identical to Equation (11) except for the fact that, in the event the unemployed worker doesn't find any job (with probability $(1 - f(\theta_p))(1 - f(\theta_{np}))$), the worker continues to remain ineligible for receiving unemployment benefits.

$$\begin{aligned}\hat{U}^N(wh,s',a') &= (1-f(\theta_{np}))f(\theta_p)W_p(wh,s',a') + f(\theta_{np})(1-f(\theta_p))W_{np}(wh,s',a') \\ &+ f(\theta_p)f(\theta_{np})\max\{W_p(wh,s',a'),W_{np}(wh,s',a')\} \\ &+ (1-f(\theta_p))(1-f(\theta_{np}))U^N(wh,s',a')\end{aligned} \tag{15}$$

2.5 Firms

A large number of p and np firms post vacancies after paying the vacancy posting costs. All firms are risk-neutral and discount their future profits using the equilibrium real interest rate.

2.5.1 Vacant *np* firm

Vacant np firms pay a cost of κ_{np} and search among all unemployed workers irrespective of their race. These firms match with an unemployed worker with probability $q(\theta_{np})$. The value of a vacant np firm, V_{np} is given by Equation (16).

$$\begin{aligned}V_{np} = -\kappa_{np} + \frac{q(\theta_{np})}{1+r}\int_a \Bigg\{ &\sum_{s'}\pi_{ss'}\Big[(1-\epsilon_{bl})J_{np}(bl,s',g(bl,s,a)) + \epsilon_{bl}J_{np}(bl,s',0)\Big]\frac{\phi_u(bl,s,a)}{u} \\ &+ \sum_{s'}\pi_{ss'}\Big[(1-\epsilon_{wh})\tilde{V}_{np}(wh,s',g(wh,s,a)) + \epsilon_{wh}\tilde{V}_{np}(wh,s',0)\Big]\frac{\phi_u(wh,s,a)}{u}\Bigg\}da\end{aligned} \tag{16}$$

where

$$\begin{aligned}\tilde{V}_{np}(wh,s',g(wh,s,a)) = &\mathbb{1}_{\{W_{np}(wh,s',g(wh,s,a))\geq W_p(wh,s',g(wh,s,a))\}}\Big(J_{np}(wh,s',g(wh,s,a))\Big) \\ &+ \mathbb{1}_{\{W_{np}(wh,s',g(wh,s,a))< W_p(wh,s',g(wh,s,a))\}}\Big(J_{np}(wh,s',g(wh,s,a))\Big)(1-f(\theta_p))\end{aligned}$$

with $g(R,s,a)$ denoting the worker's optimal choice of asset a' for the next period. The firm's expected value of matching with a worker depends on the probability of matching with a specific worker of type (R,s,a) and the expected value of production. An np firm can

match with either a black or a white worker from the current unemployment pool. $\phi_u(bl, s, a)$ is the mass of unemployed black workers with productivity s and asset a, while $\phi_u(wh, s, a)$ is the corresponding mass of white workers. Thus, $\phi_u(bl, s, a)/u$ and $\phi_u(wh, s, a)/u$ reflect the probabilities that a vacant np firm gets matched with an unemployed worker of type (R, s, a). An unemployed black worker will accept the np job offer once they get matched. On the other hand, since unemployed white workers can potentially receive a competing offer from a p firm, the white worker will accept the np job and begin producing only if the np job provides the worker with a higher value, denoted by $\mathbb{1}_{\{W_{np}(wh,s',g(wh,s,a))\geq W_p(wh,s',g(wh,s,a))\}}$, or if the worker did not receive a p firm offer, described by $\mathbb{1}_{\{W_{np}(wh,s',g(wh,s,a))<W_p(wh,s',g(wh,s,a))\}}(1-f(\theta_p))$.

2.5.2 Vacant p firm

Vacant p firms pay a posting cost of κ_p and restrict their search to unemployed white workers. The probability of matching with an unemployed white worker is $q(\theta_p)$. Equation (17) describes the value of maintaining a p vacancy, V_p.

$$V_p = -\kappa_p + \frac{q(\theta_p)}{1+r}\int_a \left\{ \sum_{s'} \pi_{ss'} \Big[(1-\epsilon_{wh})\tilde{V}_p(wh, s', g(wh, s, a)) + \epsilon_{wh}\tilde{V}_p(wh, s', 0) \Big] \frac{\phi_u(wh, s, a)}{u_{wh}} \right\} da \tag{17}$$

where

$$\begin{aligned}\tilde{V}_p(wh, s', g(wh, s, a)) &= \mathbb{1}_{\{W_p(wh,s',g(wh,s,a))>W_{np}(wh,s',g(wh,s,a))\}}\Big(J_p(wh, s', g(wh, s, a))\Big) \\ &+ \mathbb{1}_{\{W_p(wh,s',g(wh,s,a))\leq W_{np}(wh,s',g(wh,s,a))\}}\Big(J_p(wh, s', g(wh, s, a))\Big)(1-f(\theta_{np}))\end{aligned}$$

Since the vacant p firm searches only among white workers, the probability of matching with an unemployed white worker with productivity s and asset a is given by $\phi_u(wh, s, a)/u_{wh}$. Similar to the case of np firms, a worker will accept the p job only if the offer is more favorable than the other option or if they do not receive a competing offer from an np firm.

We assume that there is free entry of firms, and therefore both p and np firms post

vacancies until $V_p = 0$ and $V_{np} = 0$, respectively.

2.5.3 Producing *np* firm

The problem of a producing np firm is described by Equation (18). The firm chooses capital k to maximize its lifetime value, with the future value discounted using the interest rate and adjusted for the job destruction rate λ_{np}. Since the worker may experience an extreme wealth shock with probability ϵ_R, it changes the wage bargaining position of the worker to the firm. The future value of the firm incorporates this probability.

In the current period, $j(R, s, a)$ represents the profit earned, calculated as the output net of production costs. The matched firm produces $sf(k)$ units of output and incurs costs for renting capital and depreciation, denoted by $(r + \delta)k$, as well as wage costs, $\omega_{np}(R, s, a)$.

$$J_{np}(R, s, a) = \max_k \left\{ j(R, s, a) + \frac{1 - \lambda^{np}}{1 + r} \sum_{s'} \pi_{ss'} [(1 - \epsilon_R) J_{np}(R, s', a') + \epsilon_R J_{np}(R, s', 0)] \right\}$$

where

$$j(R, s, a) = sf(k) - (r + \delta)k - \omega_{np}(R, s, a). \tag{18}$$

2.5.4 Producing *p* firm

Similar to a producing np firm, Equation (19) describes a producing p firm. The firm rents capital and discounts future profit accounting for the job destruction rate λ_p and the worker's extreme wealth shock ϵ_{wh}.

$$J_p(wh,s,a) = \max_k \Big\{ j(wh,s,a) + \Big(\frac{1-\lambda^p}{1+r}\Big) \sum_{s'} \pi_{ss'}[(1-\epsilon_{wh})J_p(wh,s',a') + \epsilon_{wh} J_p(wh,s',0)] \Big\}$$

where

$$j(wh,s,a) = sf(k) - (r+\delta)k - \omega_p(wh,s,a). \tag{19}$$

2.6 Wage bargaining

In each period, matched worker-firm pairs bargain for wages over the match surplus. A worker upon matching earns a surplus of $(W_i(R,s,a) - U_i^I(R,s,a))$ while the firm surplus is given by $J_i(Ra,s,a)$, where i denotes np or p. The bargaining power of the worker ξ_R depends on the individual's race, and the firm's bargaining power is $1-\xi_R$. The resulting wage for workers employed at p and np firms are given by Equation (20) and Equation (21), respectively.

$$\omega_{np}(R,s,a) = \arg\max_{\omega_{np}} \Big(W_{np}(R,s,a) - U_{np}^I(R,s,a)\Big)^{\xi_R} J_{np}(Ra,s,a)^{1-\xi_R} \tag{20}$$

$$\omega_p(wh,s,a) = \arg\max_{\omega_p} (W_p(wh,s,a) - U_p^I(wh,s,a))^{\xi_{wh}} J_p(wh,s,a)^{1-\xi_{wh}} \tag{21}$$

We define the stationary equilibrium in Appendix A.

3 Calibration

Each period in the model represents a quarter. We calibrate the benchmark model to match the relevant US economy moments. We have two sets of parameters. One group of parameters is chosen externally based on the literature and empirical evidence without using model-generated data. The other set of parameters is calibrated internally by simulating our

model to match a set of relevant data moments. Table 1 shows the values of the internal calibrated parameters, their targets, along with the externally chosen parameters and their sources. We set the percentage of black workers in the model at 14.9%, based on the Panel Study of Income Dynamics (PSID) data from 1996 to 2014.[5]

Table 1: Calibration and targeted statistics

Parameter	Value	Description	Target statistics	data	model
Chosen internally					
β	0.9943	discount factor	K/Y	10.26	10.26
ι	1.3452	matching elasticity	job finding rate - black	0.4946	0.4946
κ_p	4.6314	p sector vacancy posting cost	job finding rate - white	0.6599	0.6599
κ_{np}	2.5534	np sector vacancy posting cost	market tightness	1.0	1.0
λ_{np}	0.0644	np sector job destruction rate	job separation rate - black	0.0644	0.0644
λ_p	0.0268	p sector job destruction rate	job separation rate - white	0.0380	0.0380
ξ_{bl}	0.1371	bargaining power - black	mean wage ratio	0.75	0.75
ξ_{wh}	0.1988	bargaining power - white	firm profit share	0.033	0.033
ϵ_{bl}	0.0179	extreme wealth shock - black	zero wealth share - black	0.18	0.18
ϵ_{wh}	0.0088	extreme wealth shock - white	zero wealth share - white	0.07	0.07
χ	0.8403	maximum UI coverage	fraction of median wage	0.48	0.48
Pe	0.5385	prob. of UI eligibility	average weeks of eligibility	26	26
Chosen externally					
α_k	0.2890	capital share of output	Nakajima (2012)		
δ	0.0150	quarterly depreciation rate	Nakajima (2012)		
ρ_s	0.9411	persistence of idiosyncratic shock	PSID		
σ_s	0.1680	standard deviation of idiosyncratic shock	PSID		
h	0.4000	UI replacement rate	Mitman and Rabinovich (2015)		

Notes: This table presents the model parameters, their values, and descriptions. The top panel displays the parameters selected internally by minimizing the distance between the moments generated by the model and the moments derived from the data. The last two columns of the top panel compare the targeted moments in the data with those from the model simulations. The bottom panel provides the parameters chosen externally, their values, their descriptions and sources.

3.1 Preferences

We set the period utility function $u(c)$ to be $\log(c)$. The discount factor, β, is calibrated to match the quarterly capital-output ratio of 10.26, a value used by a number of studies such as Den Haan, Judd, and Juillard (2010) and Carroll, Slacalek, Tokuoka, and White (2017).

[5]Our sample follows Blundell, Pistaferri, and Saporta-Eksten (2018). The share calculation follows Nakajima (2021).

The resulting value of β is 0.9943, and the corresponding quarterly real interest rate is 1.3%.

3.2 Production

The matched worker-firm pairs produce according to a Cobb-Douglas production function, $f(k) = k^{\alpha_k}$. We choose α_k to be 0.289 and set the quarterly capital depreciation rate δ equal to 0.015, following Nakajima (2012).

3.3 Productivity and wealth shocks

We use hourly real wages from the PSID to estimate the persistence, ρ_s, and the standard deviation, σ_s of the productivity process. Our estimation strategy follows Setty and Yedid-Levi (2021). We run a Mincer regression of log wages on demographic controls and year and state fixed effects. The demographic controls include education, labor market experience, race, and marital status. We restrict the sample to men aged 25 and older. We then use the residuals obtained to estimate an AR(1) regression using the panel dimension of the PSID data. The estimated regression operates on a biennial frequency since the PSID data is released every two years. We assign the quarterly adjusted coefficient of the AR(1) regression as the persistence of the idiosyncratic productivity process. The standard deviation of the productivity process corresponds to the standard deviation of the residuals from the AR(1) regression after adjusting for the model frequency. We estimate the quarterly persistence, ρ_s, to be 0.9411 and the corresponding standard deviation, σ_s, to be 0.1680.[6]

Following Mukoyama (2010), our model also features extreme wealth shocks to capture the mass of people with zero wealth. The race-specific probability of losing one's wealth, ϵ_R, is calibrated to be 0.0179 for black workers and 0.0088 for white workers. They capture the empirical moments that around 18% of black workers and 7% of white workers have zero wealth (Nakajima, 2021).

[6]We follow Setty and Yedid-Levi (2021) to have only men in the sample. We also estimate the AR(1) process to include both men and women from PSID. The resulting ρ_s is unchanged (0.9411), and σ_s is slightly lower (0.1671) than the men-only sample.

3.4 Unemployment insurance

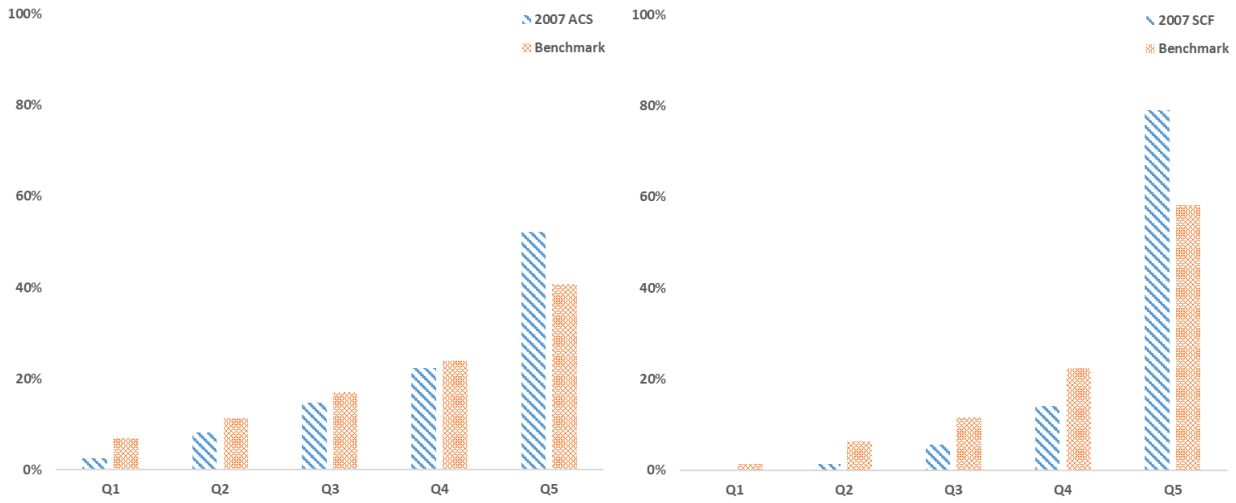
The unemployment insurance system in our model is characterized by the replacement rate, h, the maximum insurance payout, χ, and the probability of maintaining eligibility status, P_e. We choose h to be 0.4 following Shimer (2005) and Mitman and Rabinovich (2015). In accordance with Setty and Yedid-Levi (2021), we calibrate χ to 0.8403, which amounts to 48% of the median wage in the model. The eligibility probability P_e is set to 0.5385 to generate an average duration of unemployment benefits of 26 weeks, as in Mitman and Rabinovich (2015).

3.5 Labor search and wage bargain

The parameters governing the labor search are calibrated to match the labor market turnover statistics obtained from Cajner et al. (2017). The elasticity of the matching function, ι, targets the job-finding rate of black workers. Our calibrated value of 1.3452 is close to 1.25, the value used by Den Haan et al. (2000) and Petrosky-Nadeau et al. (2018). We choose firm-type specific job destruction rates λ_{np} and λ_p to match the job separation rates of black and white workers, respectively. The ensuing values for λ_{np} and λ_p are 0.0644 and 0.0268, respectively.[7] The vacancy posting cost of prejudiced firms, κ_p, is chosen to match the job-finding rate of white workers. The posting cost of non-prejudiced firms, κ_{np}, is chosen to match the aggregate labor market tightness θ, following Wolcott (2021).[8] We find that prejudiced firms pay significantly more than non-prejudiced firms to post their vacancies, with κ_p calibrated at 4.6314, compared to κ_{np} at 2.5534. The bargaining power of black workers, ξ_{bl}, is calibrated to target the average black-white racial wage ratio of 0.75 (Derenoncourt and Montialoux, 2021). The bargaining power of the white worker, ξ_{wh}, is chosen to generate the average firm profit share of 3.3% as in Nakajima (2012). Consistent

[7] All the employed black workers only work with np firms, and hence λ_{np} is exactly equal to the job separation rate of black workers. White workers are employed in both p and np firms. Hence, λ_p (0.0268) is lower than the aggregate separation rate of white workers (0.0380).

[8] Aggregate labor market tightness is defined as $\theta = \frac{v_{np}+v_p}{u_{bl}+u_{wh}}$.



(a) Labor income share

(b) Wealth share

Figure 1: Labor income and wealth distributions

Note: This figure compares the steady-state distributions of wealth and labor income generated by the model with their empirical counterparts. The empirical labor income and wealth distributions are estimated using data from the 2007 American Community Survey (ACS) and the 2007 Consumer Finance Survey (SCF), respectively. The horizontal axes indicate quintiles, from the lowest (Q1) to the highest (Q5), while the vertical axes report the share of total income or wealth accounted for by each quintile. Blue bars represent the data, and red dotted bars show the model-simulated moments.

with our expectations, black workers have a lower bargaining power than white workers, with ξ_{bl} calibrated to be 0.1371 and ξ_{wh} to be 0.1988.

3.6 Assessing the model as a quantitative theory of racial disparity

Our calibration successfully captures the racial gaps across three important dimensions: income, wealth, and employment outcomes. We now discuss the model validity in more detail before proceeding with the quantitative exercises that examine the macroeconomic impact of racial discrimination.

First, the model successfully captures the overall household distribution of wealth and labor earnings as shown in Figure 1, even though we do not explicitly target these distributions. As with most incomplete market models, we also face difficulty in generating the extreme concentration of wealth and labor income in the top quintile of the distribution. On

Table 2: Steady state racial inequality

Moments	Data	Model
Unemp rate (Black)	0.12	0.12
Unemp rate (White)	0.05	0.05
Mean wealth ratio	0.23	0.29
Median wealth ratio	0.17	0.33

Note: This table compares the empirical unemployment and wealth moments with the corresponding steady-state moments generated by the model.

the other hand, we are much closer to the empirical distributions in the lower quintiles since we target the share of zero-wealth workers in our calibration.

Second, the model reproduces the disparities in unemployment, labor income, and wealth between black and white workers. Through calibration, the model replicates the empirical racial labor income gap and the empirical racial difference in the share of people at zero wealth. In addition to the targeted moments in calibration, Table 2 shows that our model successfully generates the untargeted employment and wealth moments close to the data. Specifically, our model produces a 5% unemployment rate among white workers compared to 12% among black workers. Apart from the lower separation rate, white workers have a lower unemployment rate due to their access to prejudiced firms. On the wealth dimension, without targeting, the model generates a mean black-white wealth ratio of 0.29, close to 0.23 in the data (Kaplan, Violante, and Weidner, 2014). However, the model underestimates the median wealth gap between black and white workers. The median black worker holds 33% of the wealth of the median white worker in our model compared to the empirical value of 17% (Kaplan et al., 2014).

In summary, the model reflects the racial disparities present in labor income, wealth, and unemployment outcomes. Next, we investigate how racial discrimination in hiring contributes to these disparities.

4 Steady state results

In this section, we first establish how a search framework sustains hiring discrimination in equilibrium. Then, we examine the steady-state impact of racial discrimination by comparing the benchmark economy with an alternative economy without hiring discrimination. Lastly, we explore the heterogeneous welfare implications associated with eliminating hiring discrimination.

4.1 Sustaining racial discrimination

The presence of search-and-matching frictions allows firms to earn a profit from the surplus generated by search frictions. This feature permits prejudiced and non-prejudiced firms to coexist in the equilibrium. This is in contrast to a canonical frictionless neoclassical model in which prejudiced hiring will be driven out by competition if there is no inherent difference between black and white workers, as discussed in Becker (1957).

Table 3: Firms in the steady state

Moments	Benchmark
p firm profit	0.04
np firm profit	0.02
p firm vacancy	0.02
np firm vacancy	0.05
p firm employment	0.57
np firm employment	0.37

Note: This table presents steady state profit, vacancy postings, and employment levels for p and np firms in the benchmark model.

Table 3 shows the performance of firms in the steady state. Prejudiced firms earn a total profit of 0.04, while the corresponding profit of non-prejudiced firms is 0.02. This difference arises because p firms experience a lower job destruction shock (0.0268) compared to np firms (0.0644). Even though p firms incur higher vacancy posting costs (4.6314) to hire only white workers, they retain their workers for a longer period, reducing the number of vacancy

postings. In contrast, np firms face lower vacancy posting costs (2.5534), but their higher job destruction rate leads to a more frequent need for vacancy postings (0.05). In the steady state, p firms sustain an employment level (0.57) higher than np firms (0.37).

4.2 Impact of hiring discrimination on racial inequality

In this subsection, we analyze the distributional and aggregate effects of discriminatory hiring by comparing the benchmark economy to a counterfactual economy without prejudiced firms. The counterfactual economy contains only non-prejudiced firms, where both black and white workers retain their race-specific job separation rates from the benchmark calibration. By holding these separation rates constant, we isolate how discrimination in hiring - rather than differences in job separation - shapes labor market outcomes.[9] Table 4 presents the comparison.

The first panel shows how racial disparities in household outcomes change when prejudiced firms are removed. While the racial differences in job separation rates remain unchanged at benchmark levels, eliminating discriminatory hiring practices leads to equalized job-finding rates for black and white workers. White workers experience a slight decrease in their job-finding rate, dropping from 0.66 to 0.64, due to losing access to p firms. Meanwhile, black workers' job-finding rate rises significantly, from 0.49 to 0.64, in the counterfactual equilibrium. The removal of p firms leads to endogenous entry of np firms, which increases the number of vacancies and thus raises the job-finding rate for black workers. Overall, this removal in prejudiced firms narrows the racial unemployment gap from 7 percentage points to 3 percentage points, showing that discriminatory hiring explains approximately 57% of the unemployment gap between black and white workers.

Turning to the impact on wages, removing hiring discrimination boosts outcomes for black workers by improving their outside options. This enables black workers to bargain

[9]The benchmark economy calibrates prejudiced and non-prejudiced firms' job destruction shocks (λ_p and λ_{np}) to match observed racial disparities in job separation rates. In the single-firm-type counterfactual, we preserve benchmark separation rates by assigning white workers a λ_{wh} of 0.0380 and black workers a λ_{bl} of 0.0644.

Table 4: Impact of hiring discrimination

Moments	Benchmark	No p firms
Households		
job separation rate - black	0.06	0.06
job separation rate - white	0.04	0.04
job finding rate - black	0.49	0.64
job finding rate - white	0.66	0.64
unemp rate - black	0.12	0.09
unemp rate - white	0.05	0.06
mean wage - black	1.59	1.85
mean wage - white	2.12	2.11
mean wage ratio	0.75	0.87
mean wealth ratio	0.29	0.34
median wealth ratio	0.33	0.44
Firms		
p firm profit	0.04	-
np firm profit	0.02	0.06
p firm vacancy	0.02	-
np firm vacancy	0.05	0.07
p firm employment	0.57	-
np firm employment	0.37	0.94
Labor Market		
p market tightness	0.39	-
np market tightness	0.71	1.17
Aggregate Outcomes		
Y	3.07	3.08
K/Y	10.26	10.27
average wage	2.04	2.07
unemp rate	0.06	0.06

Note: This table compares the benchmark steady state with a counterfactual steady state without p firms. In the counterfactual model, all firms provide equal hiring opportunities to black and white workers. All other parameters stay the same as benchmark calibration.

for higher wages upon a successful match. However, white workers no longer have access to jobs from the exclusive p firms. This lowers their outside option during bargaining, slightly reducing their wage rates. As a result, the average wage ratio between black and white workers increases from 0.75 to 0.87. We can conclude that hiring discrimination accounts for roughly 48% of the wage gap.

The change in hiring practices also narrows the wealth gap: the mean wealth ratio rises from 0.29 to 0.33, and the median wealth ratio increases from 0.34 to 0.44. These shifts imply that discriminatory hiring explains about 7% of the mean wealth gap and 16% of the median wealth gap. The remaining differences in wages and wealth can be accounted for by differences in bargaining power and extreme wealth shocks between black and white workers.[10]

The second panel examines firm dynamics when discriminatory firms are removed.[11] Without prejudiced firms, np firms see their profits triple, which encourages additional np firms to enter the market and post vacancies. Consequently, np firms fully replace p firms in the counterfactual equilibrium. As shown in Table 4, the total number of vacancies and overall employment remain unchanged compared to the benchmark. Still, eliminating prejudiced firms helps narrow the racial gap in labor market outcomes, as described earlier.

The third panel of Table 4 shows how labor market conditions adjust when p firms exit. As these firms leave, additional np firms enter endogenously, raising the labor market tightness in the np market from 0.71 in the benchmark to 1.17 in the counterfactual equilibrium. Consequently, the overall market tightness exceeds the benchmark aggregate level of 1.

The last panel of Table 4 presents the aggregate outcomes. Despite the increased entry of np firms, aggregate output rises only marginally from 3.07 to 3.08. The capital-output ratio increases from 10.26 to 10.27, and the aggregate wage grows from 2.04 to 2.07, while the aggregate unemployment rate remains steady at 6%.

[10] Although not the primary focus of this paper, additional results that remove racial differences in bargaining power and extreme wealth shocks are presented in Appendix B.

[11] We refer to the one-sector economy without discriminatory hiring as np firms, although their job destruction rate λ differs from that of the benchmark np firms.

Our results suggest that prejudiced firms account for a substantial share of employment, income, and wealth inequality. Eliminating p firms improves employment and wage outcomes for black workers, while white workers experience a slight decline in their job-finding rate and an increase in unemployment. This reduction in job prospects weakens white workers' bargaining power and adversely affects their income and wealth. In the next section, we quantify these differential effects by calculating the welfare changes experienced by black and white workers.

4.3 Welfare analysis

We follow Krusell, Mukoyama, and Şahin (2010) in measuring the welfare effects of discriminatory hiring on black and white workers. To do so, we compute the change in average consumption equivalence after removing p firms.[12] Table 5 presents the overall welfare change, as well as the breakdown by productivity type and wealth quintile for both groups.

Eliminating hiring discrimination raises aggregate welfare by 1.5%. Black workers experience a 12.9% increase in their average welfare, mainly due to improved job opportunities and higher wage rates. White workers, on the other hand, experience a modest 0.48% decline, driven by a slight drop in wages and a higher unemployment rate after losing access to the exclusive p firms. Although white workers make up about 85% of the population, the substantial gains for black workers more than offset the small loss among white workers, resulting in a net rise in overall welfare.

The middle panel in Table 5 displays the heterogeneous welfare changes for black and white workers by productivity. For white workers, the welfare decline from eliminating prejudiced firms is similar across productivity levels, with a slightly larger loss for those in the middle productivity group. In contrast, among black workers, the highest productivity group experiences the greatest gain (13.57%), followed by the middle and low productivity groups. The bottom panel in Table 5 breaks down the welfare changes by wealth quintile.

[12] See Appendix C for details on the welfare calculation.

Table 5: Heterogeneous welfare change

Average welfare gain (%)	No p firms	
Aggregate	1.51	
	Black	White
Overall	12.89	-0.48
by productivity		
Low	12.11	-0.47
Mid	12.94	-0.48
High	13.57	-0.47
by wealth		
Low 20%	12.91	-0.45
40-60%	12.92	-0.49
Top 20%	12.65	-0.48

Note: This table compares the average consumption equivalence change from the benchmark steady state to an equilibrium with no p firms. Low, mid, and high productivity corresponds to the lowest, middle, and highest value of idiosyncratic productivity s. The wealth quintiles are based on benchmark steady-state wealth distribution.

Removing prejudiced firms benefits black workers most in the middle quintile, where welfare rises by 12.92%, while the largest welfare decline for white workers also occurs in the middle quintile.

5 Business cycle dynamics

In this section, we first document the racial disparities over the business cycle. We then introduce aggregate uncertainty into our benchmark model to assess how hiring discrimination shapes racially disparate dynamics during economic fluctuations.

5.1 Racial disparities over the business cycles

Table 6 displays the labor market outcome disparities between black and white workers over the business cycle. The top panel presents the dynamics of unemployment rates for both groups, while the bottom panel shows the evolution of average wages after adjusting for composition bias. In this table, volatility is defined as the standard deviation of a variable relative to that of real GDP, and cyclicality is measured as the correlation between the variable and real GDP.

Unemployment rate: We use quarterly data from the Current Population Survey (CPS) from 1996 to 2014 to calculate the business cycle dynamics of unemployment rates. The statistics are computed using log deviations from an HP-filtered trend with a smoothing parameter of 1600. We find that both black and white unemployment rates are countercyclical, although the black unemployment rate is slightly less cyclical and less volatile than the white rate. These findings align with Nakajima (2021). In addition, the black-white unemployment rate gap is itself countercyclical: it widens during recessions and narrows during expansions, indicating that black workers see a larger unemployment increase in recessions but a faster decrease in expansions. This result is consistent with the countercyclical gap documented by Cajner et al. (2017).

Table 6: Business cycle statistics, US data, 1996-2014

	Volatility	Cyclicality
Unemployment rate		
Black	9.51	-0.85
White	11.02	-0.92
Black-White gap	9.46	-0.63
Average wage		
Black	2.54	2.60
White	2.08	1.27

Note: This table provides business cycle statistics for the US. The unemployment rate is obtained from the Current Population Survey (CPS) for 1996 to 2014. Average wage statistics are constructed from the Panel Study of Income Dynamics (PSID) for the same period. Unemployment rate statistics are calculated using HP filtered series with a smoothing parameter of 1600, while wage statistics are obtained using wage growth rates after controlling for demographics.

Wages: We use individual-level data from the PSID (1996–2014) to estimate the cyclical properties of black and white wages. Previous research (Stockman, 1983; Bils, 1985; Solon, Barsky, and Parker, 1994) shows that using aggregate data can be problematic due to changes in worker composition over the business cycle. Specifically, aggregate data tends to weight lower-skilled (and lower-wage) workers more heavily during expansions than recessions, causing countercyclical bias. To address this issue, we rely on the longitudinal structure of the PSID data to keep the composition of workers fixed over time. Following Bils (1985), Solon et al. (1994), and Devereux (2001), we estimate wage cyclicality by regressing wage growth on real GDP growth, controlling for observable characteristics. We measure wage volatility as the standard deviation of wage growth after controlling for demographics.[13] Our findings indicate that both black and white wages are procyclical, with black workers' wages being twice as cyclical as those of white workers. Black workers' wages also exhibit greater volatility than white workers' wages.

[13]Appendix D provides details on measuring the cyclicality and volatility of real wages.

5.2 Augmented model with aggregate shocks

We introduce shocks to aggregate total factor productivity (TFP) z in our benchmark steady-state model described in Section 2. The TFP shocks follow an AR(1) process, $\log(z') = \rho_z \log(z) + \epsilon_z$, with $\epsilon_z \overset{iid}{\sim} N(0, \sigma_z^2)$. The output of the matched worker-firm pairs depends on the realizations of both aggregate and idiosyncratic productivity shocks and is given by $zsf(k)$.

With the introduction of aggregate shocks, the state space expands to include aggregate states (z, μ), where μ is the distribution of workers over their employment status (e), race (R), idiosyncratic productivity (s), and asset (a). The aggregate distribution for the next period μ' is determined by (z, μ), and the endogenous law of motion given by $\mu' = \Gamma(z, \mu)$ is determined in the equilibrium.

We follow Cooley, Prescott, et al. (1995) and Boppart, Krusell, and Mitman (2018) in choosing the persistence parameter ρ_z to be 0.95, while the standard deviation σ_z is set to 0.015. All other parameters remain the same as our benchmark calibration given in Table 1. We obtain the stochastic equilibrium of our model using the sequence space method proposed by Boppart et al. (2018). We first solve non-linearly for the perfect foresight transitions to a single small MIT shock, i.e., an unexpected shock to the aggregate TFP. We then use the solved impulse responses as the numerical derivatives with respect to the initial TFP shock. Using these derivatives, we simulate the stochastic equilibrium by generating the TFP realizations and calculating the corresponding model moments over the business cycles as a linear combination of the impulse response and the TFP realizations.[14]

Table 7 compares business cycle statistics for unemployment and wages between the data and our model. Overall, the model replicates the key patterns observed in the data. It generates countercyclical unemployment rates, with white unemployment being slightly more cyclical than black unemployment, and it accurately reproduces the countercyclical

[14]This method hinges on the assumption that the business cycle dynamics can be well approximated as a linear system. In Appendix E, we demonstrate the validity of this assumption by establishing the symmetry of the impulse responses to 1% positive and negative TFP shocks.

Table 7: Business cycle model vs data

	Volatility		Cyclicality	
	Data	Model	Data	Model
	Unemployment rate			
Black	9.51	0.26	-0.85	-0.69
White	11.02	0.22	-0.92	-0.71
Black-White gap	9.46	0.30	-0.63	-0.68
	Average wage			
Black	2.54	1.08	2.60	1.08
White	2.08	1.00	1.27	1.00

Note: This table compares the data moments with the moments generated by the benchmark model on unemployment and wages.

gap between the two groups. In terms of wages, the model produces procyclical patterns, with black wages showing higher cyclicality and volatility than white wages. However, as is common with standard search models, our model falls short in generating realistic volatility levels for both black and white unemployment rates - a limitation discussed in Shimer (2005).

5.3 Impact of hiring discrimination over business cycle

We compare the benchmark dynamics with a counterfactual model that excludes prejudiced firms to examine how discriminatory hiring impacts the economy under aggregate fluctuations. In this one-sector counterfactual, only non-prejudiced firms operate, and workers face race-specific job separation rates as with Table 4.

5.3.1 Impulse responses

Figure 2 shows how labor market outcomes, wealth, and consumption for both black and white workers respond to an unexpected 1% expansionary TFP shock. We compare the benchmark model's reaction with that of a counterfactual model that excludes p firms. In both models, unemployment rates move countercyclically while wages, wealth, and consump-

tion follow procyclical patterns. However, the responses in the counterfactual economy are generally less pronounced.

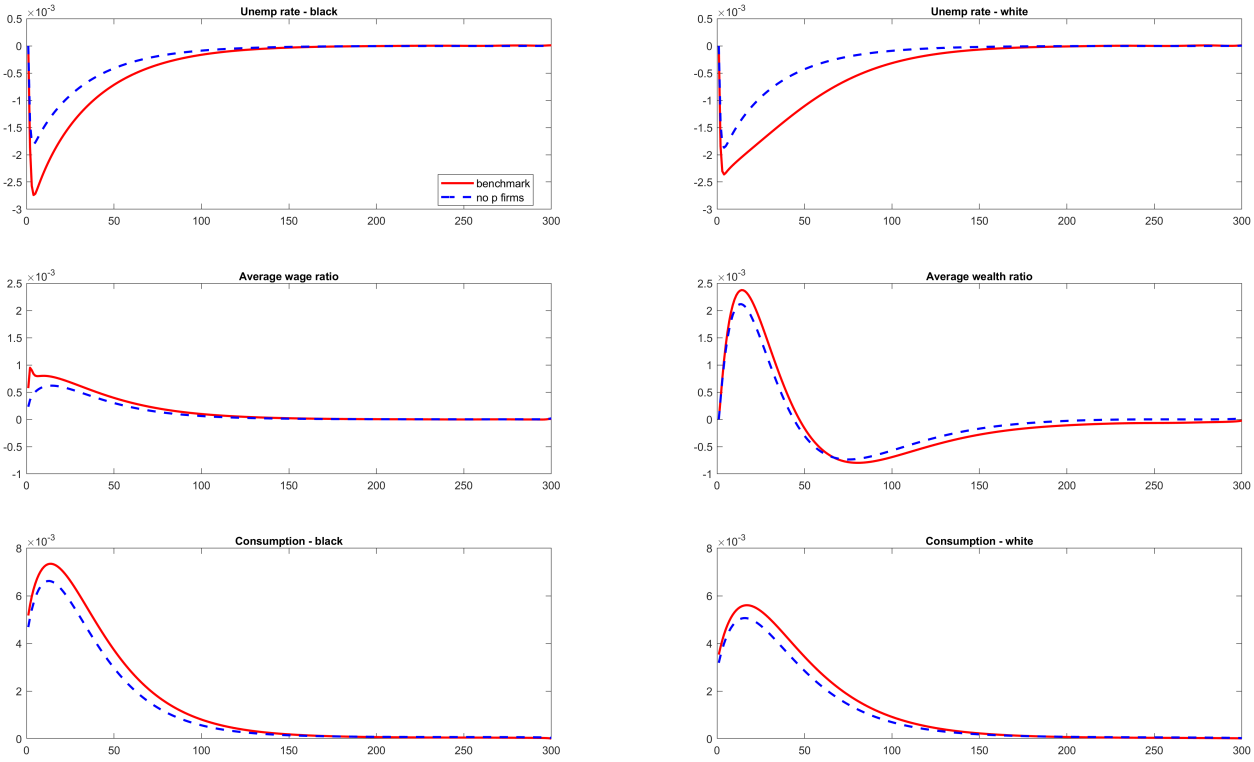


Figure 2: Impulse responses

Note: This figure plots the impulse response functions of unemployment rates, black-white average wage and wealth ratios, and aggregate consumption of black and white workers to a one percent increase in aggregate TFP at date zero. The red solid line denotes the responses from the benchmark model, and the blue dashed line denotes the responses from the counterfactual model without p firms.

In the model without p firms, the unemployment rate for black workers falls less after an expansionary shock than in the benchmark, indicating that black unemployment is less volatile when discriminatory hiring is removed. In the benchmark economy, np firms compete with p firms for hires, which leads them to post more vacancies and create additional opportunities for workers. Although white workers follow a similar pattern, the difference between the benchmark and counterfactual responses is much smaller for them. Notably, the counterfactual model shows a much faster recovery of unemployment rates than the benchmark model.[15]

[15]This is a common feature in dual labor market models, where a single-market setup typically reverts to its steady state faster than a dual-market framework (e.g., Horvath and Yang, 2022).

The average black-white wage and wealth ratios increase more after the expansionary shock in the benchmark model than the model without prejudiced firms. This suggests more volatile procyclical wage and wealth responses for black workers than for white workers in the presence of p firms. Moreover, consumption among both black and white workers responds more strongly in the benchmark model, leading to a more volatile consumption reaction following the expansionary TFP shock.

5.3.2 Stochastic simulation

We simulate the stochastic equilibrium of the economy over 10,000 periods under aggregate TFP shocks, and compare the outcomes with and without p firms. While impulse responses capture the transition path following a one-time shock, stochastic equilibrium focuses on the economy's short-term responses to a series of aggregate shocks. The results are summarized in Table 8.

The stochastic simulation results further support the insights from the impulse response analysis. We find that the presence of p firms increases unemployment rate volatility for both black and white workers, but the effect is more pronounced for black workers. In the counterfactual economy without p firms, both groups have an unemployment rate relative volatility of 0.18. With p firms in the benchmark economy, the volatility for black workers rises to 0.26, compared to 0.22 for white workers. Similarly, the volatility of the black-white unemployment rate gap increases from 0.17 to 0.30, reflecting the disproportionate impact on black workers.

The wages of both black and white workers have dynamics similar to their unemployment rates. In particular, the presence of p firms in the benchmark increases both the cyclicality and volatility of wages compared to the counterfactual without p firms. However, this effect is more pronounced for black workers than for white workers. In our comparison of the benchmark and counterfactual economies, the inclusion of p firms raises the cyclicality and volatility of black wages from 1.01 to 1.08, while white wages increase from 0.98 to 1. Overall,

hiring discrimination not only heightens wage fluctuations but also widens the gap between black and white workers. These results support the findings of Cajner et al. (2017), Boulware and Kuttner (2019, 2024), Ganong et al. (2020), and Ragusett (2022), who argue that demographic differences alone cannot account for the racial disparities observed over the business cycle.

Table 8: Impact of hiring discrimination over business cycle

	Volatility		Cyclicality	
	Benchmark	No p firms	Benchmark	No p firms
		Unemployment rate		
Black	0.26	0.18	-0.69	-0.70
White	0.22	0.18	-0.69	-0.70
Black-White gap	0.30	0.17	-0.67	-0.71
		Average wage		
Black	1.08	1.01	1.08	1.01
White	1.00	0.98	1.00	0.98
		Average wealth		
Black	0.39	0.38	0.12	0.12
White	0.24	0.24	0.07	0.07
Wealth ratio	0.16	0.14	0.21	0.22
		Average consumption		
Black	0.57	0.52	0.95	0.94
White	0.39	0.36	0.93	0.92
Consumption ratio	0.18	0.17	0.97	0.97

Note: This table compares the responses of black-white unemployment rates, wages, consumption, and wealth gaps over the business cycle between the benchmark model and the model without p firms.

We further examine the cyclical properties of wealth and consumption for black and white workers. Consistent with our earlier findings on labor market outcomes, the presence of p firms increases the volatility of both the wealth and consumption ratios. Specifically, with p firms, the volatility of the wealth ratio rises from 0.14 to 0.16, and that of the consumption

ratio increases from 0.17 to 0.18. These results indicate that, beyond labor market variables, the volatility of racial gaps in other dimensions is also notably reduced when discriminatory hiring is eliminated.

In summary, our analysis shows that hiring discrimination amplifies racial disparities over the business cycle. The presence of p firms increases the volatility of outcomes for black workers relative to white workers across multiple dimensions, including labor market variables, wealth, and consumption. These findings suggest that discriminatory hiring plays a key role in driving the cyclical differences in economic outcomes between racial groups.

6 Conclusion

This study examines the effects of discrimination in the hiring of black workers on employment, wage disparities, and wealth accumulation in the US. We develop a search-and-matching model featuring firms with and without racial prejudices. Our findings reveal that racial discrimination in hiring significantly exacerbates wage, unemployment, and wealth gaps in the steady state and business cycles. In addition, discriminatory hiring places black workers disproportionately at the lower end of the wealth spectrum. Contrary to conventional discrimination theories, our analysis suggests that discriminatory hiring persists as an equilibrium outcome in frictional labor markets. Further, eliminating discriminatory hiring results in an increase in overall economic welfare. Our findings shed light on the enduring nature of black-white racial disparities in the US, offering insights into the interplay between discrimination, labor market dynamics, and wealth accumulation.

Appendix A Stationary equilibrium

A stationary equilibrium consists of

1. Value functions of workers $\Big\{W_{np}(R,s,a), W_p(wh,s,a), U^I_{np}(R,s,a), U^I_p(wh,s,a), U^N(R,s,a)\Big\}$, and firms $\Big\{V_{np},\, V_p,\, J_{np}(R,s,a),\, J_p(wh,s,a)\Big\}$

2. Corresponding asset policy functions of workers $\Big\{g_{np}(R,s,a),\, g_p(wh,s,a),\, g^I_{np}(R,s,a),\, g^I_p(wh,s,a),\, g^N(R,s,a)\Big\}$, along with the capital choice of producing firms $\Big\{k_{np}(R,s,a),\, k_p(wh,s,a)\Big\}$ and vacancy choice of vacant firms $\Big\{v_{np},\, v_p\Big\}$

3. Wages $\Big\{\omega_{np}(R,s,a),\, \omega_p(wh,s,a)\Big\}$

4. Aggregate interest rate and labor market tightness $\Big\{r,\, \theta_{np},\, \theta_p\Big\}$

5. Labor income tax rate τ and unemployment insurance payout $\Big\{b_{np}(R,s,a),\, b_p(wh,s,a)\Big\}$

6. Dividends d

7. Distribution over employment status (e), race (R), idiosyncratic productivity (s), and wealth (a), given by $\mu(e,R,s,a)$

such that:

1. $\Big\{W_{np}(R,s,a),\, W_p(wh,s,a),\, U^I_{np}(R,s,a),\, U^I_p(wh,s,a),\, U^N(R,s,a)\Big\}$ are the solutions to the worker's optimization problems (equations 2, 4, 6, 8, 10, 12, and 14), and $\Big\{g_{np}(R,s,a),\, g_p(wh,s,a),\, g^I_{np}(R,s,a),\, g^I_p(wh,s,a),\, g^N(R,s,a)\Big\}$ are the associated optimal decision rules for asset choice.

2. $\Big\{J_{np}(R,s,a),\, J_p(wh,s,a)\Big\}$ are the solutions to the producing firm's problems (equations 18 and 19), and the corresponding capital choice is given by $\Big\{k_{np}(R,s,a),\, k_p(wh,s,a)\Big\}$.

3. Free entry of vacant firms, i.e., $V_{np}=0$ and $V_p=0$ determines the number of vacancies $\Big\{v_{np},\, v_p\Big\}$, and hence labor market tightness $\Big\{\theta_{np},\, \theta_p\Big\}$.

4. Aggregate demand for capital equals aggregate supply, which in turn determines the interest rate r.

5. Wages $\left\{\omega_{np}(R,s,a),\ \omega_p(wh,s,a)\right\}$ are determined by Nash bargaining between the worker and the firm.

6. Labor income tax rate τ solves to balance the government budget of the total unemployment insurance payout.

7. Dividend d is the total flow profits of producing firms, net of total posting costs of vacant firms.

$$d = -\kappa_p v_p - \kappa_{np} v_{np} + \int 1_{e=1,np}\ j_{np}(R,s,a)d\mu + \int 1_{e=1,p}\ j_p(wh,s,a)d\mu \tag{A.1}$$

where j_{np} and j_p refer to the flow profits of np and p firms respectively.

$$\begin{aligned} j_{np}(R,s,a) &= sf(k_{np}) - (r+\delta)k_{np} - \omega_{np} \\ j_p(wh,s,a) &= sf(k_p) - (r+\delta)k_p - \omega_p \end{aligned} \tag{A.2}$$

8. The distribution $\mu(e,R,s,a)$ is invariant and is consistent with the optimal decision rules of capital choice, the law of motion of idiosyncratic productivity, and the labor market flows.

Appendix B Comparing the impact of bargaining power and extreme wealth shock

Our model separately calibrates racial differences in bargaining power and the likelihood of extreme wealth destruction - features we refer to as non-market racial disparities. We conduct additional counterfactual analyses to assess the impact of these non-market factors relative to hiring discrimination. Table B.1 compares the benchmark model to versions that

eliminate non-market disparities by equalizing bargaining power and extreme wealth shocks across racial groups. When we set the bargaining power of black workers equal to that of white workers (Column 2, $\xi_{bl} = \xi_{wh}$), their bargained wages rise directly. However, the job-finding rate for black workers falls. This outcome occurs because non-prejudiced firms retain lower profits and, therefore, post fewer vacancies, which also reduces the job-finding rate and average wage for white workers. Consequently, the average wage gap shrinks to 20% (a wage ratio of 80%), accounting for roughly 20% of the observed racial wage gap.

In Column 3 ($\epsilon_{bl} = \epsilon_{wh}$), we assign black workers the same extreme wealth shock as white workers, an external condition governing the accumulating wealth. The effect resembles assigning higher bargaining power to black workers. This is due to the importance of personal wealth in helping workers self-insurance against uncertain adverse outcomes (Nakajima, 2012). With a lower probability of losing their wealth, black workers can accumulate more personal wealth. Higher personal wealth gives black workers a higher reservation value when bargaining with firms. Effectively, black workers can negotiate for better wage outcomes (1.65 compared to 1.59 in the benchmark model). Similar to having higher bargaining power, the resulting job-finding rates decrease, though to a smaller extent. The lower extreme wealth destruction rate also translates to higher aggregate capital accumulation and increased aggregate output. It spills over to an increase in the average wage rate for all, raising the average black-white wage ratio to 77%, thus explaining around 8% of the racial wage gap. Since it directly raises the wealth position of black workers, the mean and median black-white wealth ratios increase drastically (77% and 88% from the benchmark levels of 29% and 33%).

Appendix C Welfare calculation

We follow Krusell et al. (2010) in measuring the welfare effects of discriminatory hiring on black and white workers. We calculate the consumption equivalence in a counterfactual

Table B.1: Aggregate impact of racial disparities from non-market factors

Moments	Benchmark	$\xi_{bl} = \xi_{wh}$	$\epsilon_{bl} = \epsilon_{wh}$
	Households		
job separation rate - black	0.06	0.06	0.06
job separation rate - white	0.04	0.04	0.04
job finding rate - black	0.49	0.44	0.48
job finding rate - white	0.66	0.64	0.66
unemp rate - black	0.12	0.13	0.12
unemp rate - white	0.05	0.05	0.05
mean wage - black	1.59	1.70	1.65
mean wage - white	2.12	2.11	2.13
mean wage ratio	0.75	0.80	0.77
mean wealth ratio	0.29	0.30	0.77
median wealth ratio	0.33	0.33	0.88
	Firms		
p firm profit	0.04	0.05	0.04
np firm profit	0.02	0.02	0.02
p firm vacancy	0.02	0.02	0.02
np firm vacancy	0.05	0.04	0.04
p firm employment	0.57	0.61	0.58
np firm employment	0.37	0.33	0.35
	Labor Market		
p market tightness	0.39	0.44	0.42
np market tightness	0.71	0.60	0.67
	Aggregate Outcomes		
Y	3.07	3.06	3.08
K/Y	10.26	10.25	10.40
average wage	2.05	2.05	2.06
unemp rate	0.06	0.06	0.06

Note: This table compares the benchmark steady state to a model with equal bargaining power $\xi_{bl} = \xi_{wh}$ and a model with equal extreme wealth shock $\epsilon_{bl} = \epsilon_{wh}$.

scenario without p firms. Under the benchmark model, let $V(e, R, s, a) = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t log(c_t)$ be the maximal value of the individual with employment status e, race R, productivity s, and asset a. In an alternative economy, let $\tilde{V}(e, R, s, a) = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t log(\tilde{c}_t)$ be the maximal value of individuals with each corresponding state. We examine the welfare change between the two economies through consumption equivalence Ω, following the equation: $\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t log((1 + \Omega)c_t) = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t log(\tilde{c}_t)$.

Under log utility, we derive $\Omega = \exp((\tilde{V} - V)(1 - \beta)) - 1$. We aggregate the individual-level consumption equivalence, Ωs, using the distribution of the counterfactual economy to calculate the average welfare change. We aggregate over the counterfactual distribution rather than the benchmark distribution because eliminating p firms in the model removes the distribution of white workers from the states associated with p firms. Aggregating using the benchmark distribution overstates the welfare change for white workers without accounting for this distribution shift.

Appendix D Measuring the business cycle properties for wage

Aggregate data can be misleading when estimating wage cyclicality because shifts in worker composition over the business cycle tend to overweight lower-skilled (and lower-wage) workers during expansions, resulting in countercyclical bias. To overcome this issue, we use individual-level PSID data (1996-2014), which allows us to hold the composition of workers fixed over time.

Following the methodology of Bils (1985), Solon et al. (1994), and Devereux (2001), we estimate wage cyclicality by regressing the change in individual log wages on the change in log GDP while controlling for key demographic characteristics. Our specification is as follows:

$$\Delta \log w_{it} = \alpha + \beta \Delta \log Y_t + \gamma x_{it} + \nu_t + \upsilon_s + \epsilon_{it}, \tag{D.1}$$

where Y_t is real GDP. The demographic variables x_{it} include gender, education, labor market experience, and marital status. We also include year fixed effects, ν_t, and state fixed effects, υ_s.

In this regression, the coefficient β captures the cyclicality of wages. We then compute wage volatility as the standard deviation of wage growth after controlling for the demographics. The year fixed effects from the regression reflect aggregate wage growth and provide a measure of this volatility. This approach ensures that our estimates of wage cyclicality and volatility reflect true economic fluctuations rather than changes in workforce composition.

Appendix E Impulse responses

We follow Boppart et al. (2018) to simulate the business cycle moments of the model from the derivatives of the impulse response functions. For the impulse response functions to represent the numerical derivative, the magnitude of the MIT shock should be small. This method also requires the business cycle dynamics to be well approximated as a linear system. Figure E.1 presents the impulse response functions for the benchmark model to a 1% positive and a 1% negative TFP shock at date 0. The shock gradually returns to a steady state with a persistence of 0.95. Our model produces symmetric impulse responses for positive and negative TFP shocks for all variables.

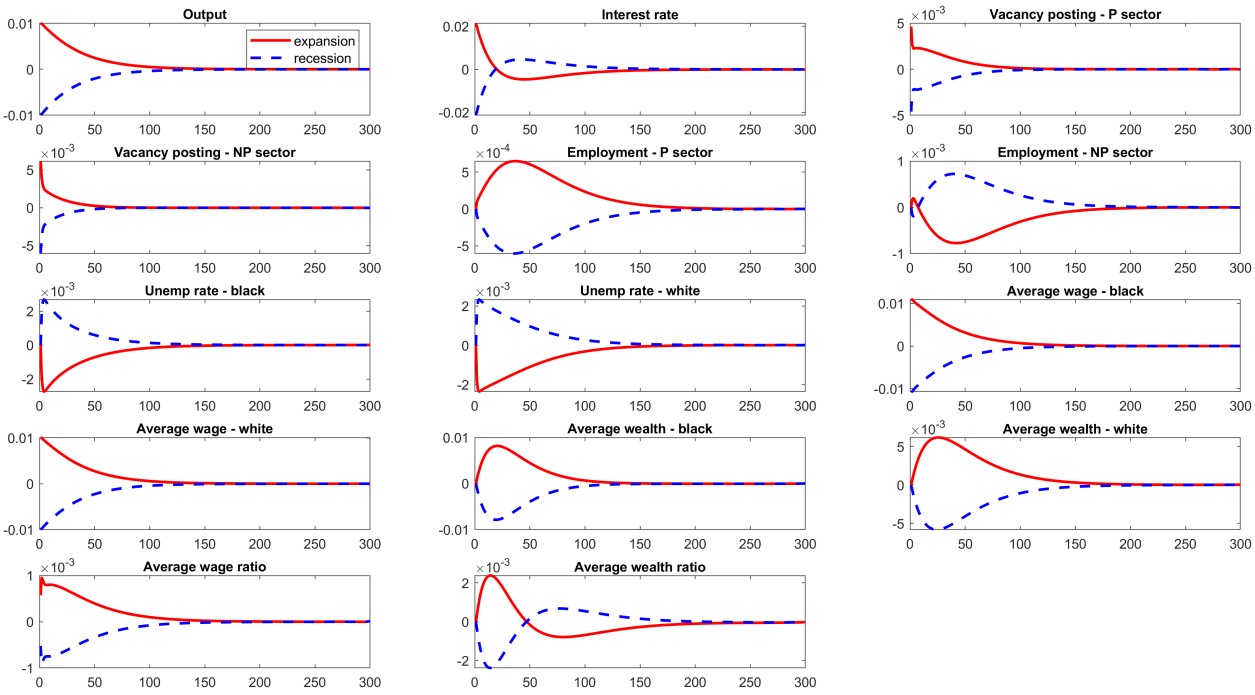


Figure E.1: Comparing impulse responses

Note: This figure plots the impulse response functions of the benchmark economy to a one percent increase and a one percent decrease in aggregate TFP at date zero. The red solid line denotes the responses to the expansionary shock, and the blue dashed line denotes the responses to the recessionary shock.

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