The Effect of the Tax Cuts and Jobs Act on the Housing Market[*]

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February 2021

Abstract

The Tax Cuts and Jobs Act of 2017 (TCJA) reduced the incentive for households to claim itemized deductions that subsidize homeownership and simultaneously lowered income tax rates. We use an equilibrium model to quantify the effects of the TCJA on house prices, homeownership, and welfare. The reform removes the tax subsidy to owner-occupied housing for most households, who now choose to claim the standard deduction. However, over-consumption of tax subsidized housing by the remaining wealthy itemizers persists. Our results highlight the critical, yet surprisingly understudied, role of the standard deduction in determining the tax-favored status of owner-occupied housing, and through this channel, its effects on homeownership, consumption, and mortgage debt accumulation across the wealth and income distributions.

1   Introduction

In 2017, the U.S. Congress passed the Tax Cuts and Jobs Act (TCJA). Among other provisions, this law doubled the size of the standard deduction and limited deductions for State and local income taxes (SALT). By reducing the incentive for households to claim itemized deductions for mortgage interest and property taxes, this law represents an unprecedented reduction in the tax-favored status of owner-occupied housing. Of particular importance, the role of the large increase in the standard deduction is not well understood, as the existing quantitative housing literature has not considered large changes in this deduction. Confounding the situation is the fact that the TCJA is also a large tax cut. In particular, the act simultaneously lowered marginal income tax rates across the board and altered tax brackets. In addition, the doubled standard deduction further increased the after-tax income of households who do not itemize on their tax returns. Beyond simply generating opposing shifts in demand for housing of unknown magnitude, these provisions of the TCJA likely interact in complex ways and have differential effects by household income, homeownership status, house value, and level of mortgage debt. As a result, the overall effect of TCJA on the housing market and household welfare is quite uncertain.

In this paper, we use an equilibrium model of the housing market to study the effects of the TCJA on house prices, rents, homeownership, tax revenue, and welfare. Households in the model choose between renting and owning housing. Mortgages are available to finance purchases of housing, subject to a minimum required down payment. Federal income taxes are progressive, and individuals choose between claiming a standard deduction or itemizing deductions for mortgage interest, property taxes, and State income taxes. Tax subsidies of owner-occupied housing are largest for the wealthy because of the progressive nature of income taxation. House prices and rents are determined in equilibrium, so tax benefits that favor housing are capitalized into market prices.

We analyze the TCJA in two stages. In the first stage, we isolate the effect of the TCJA provisions that only alter deductions, holding tax rates and brackets fixed at their pre-reform lev-

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els.[1] We then perform a second experiment that implements the TCJA changes in tax rates (and brackets) jointly with the changes in deductions. The first experiment demonstrates that doubling the standard deduction, coupled with the newly adopted SALT and mortgage interest deduction (MID) caps, is a progressive tax reform that causes a slight reduction in house prices, higher homeownership, and equitably distributed welfare gains. In marked contrast, and highly relevant from a policy perspective, the full reform in the second experiment leaves the progressivity of the baseline tax system approximately unchanged from the pre-reform economy, has nearly no effect on house prices, and generates welfare gains that are heavily skewed toward the wealthy.

The experiments offer a number of insights into the mechanism through which the TCJA affects the housing market and welfare. In the first experiment, changes to the deduction structure embedded in the TCJA sharply reduce the percentage of households who claim itemized deductions. For these newly non-itemizing homeowners, housing consumption is no longer subsidized by the mortgage interest and property tax deductions, so on the intensive margin, these households shift their consumption away from housing services toward non-durable goods. However, equilibrium house prices fall only slightly, as the decline in housing demand by newly non-itemizing (often middle-income) households is largely offset by increased demand for housing by households at the opposite ends of the income spectrum.

On one end of the spectrum, doubling the standard deduction increases the disposable income of low-income (often renter) households who would not itemize at any rate. With their incomes suddenly higher, these households are now able to either rent larger spaces, or even become homeowners. At the other end of the spectrum are the remaining itemizers, who are high-income households living in large homes. These households take advantage of lower equilibrium house prices—and their continued access to mortgage interest and property tax deductions—by increasing consumption of housing. In equilibrium, the combination of lower house prices, the progressively distributed tax windfall, and the re-optimization

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[1]The results allow one to compare and contrast the TCJA's effect on the housing market to a straightforward repeal of the mortgage interest deduction, which is the subject of a rapidly expanding line of research; see references below.

of household consumption decisions act in concert to produce welfare gains that are shared approximately equally across the wage distribution, with all wage quintiles realizing gains of approximately 3 percent, measured in consumption equivalent units.

The second experiment implements the TCJA cuts to tax rates jointly with the changes in deductions. Federal income tax payments now decline even more sharply, boosting demand for housing (as well as other goods) by now wealthier households. This increase in housing demand bids up house prices to nearly their baseline level, even as the fraction of itemizers remains very low. The homeownership rate remains elevated, however, as higher disposable incomes increase housing affordability even at prices that are near their pre-reform price levels. In contrast to the egalitarian first experiment, welfare gains become more unequally distributed under the full reform. The largest beneficiaries are wealthy households who profit from lower marginal tax rates and still enjoy tax subsidies for housing from itemized deductions for mortgage interest and property taxes. The welfare gains accruing to the top wealth quintile are nearly triple the gains accruing to those at the bottom of the wealth distribution.

Overall, our results highlight the crucial, yet vastly understudied, role that the standard deduction plays in determining the tax-favored status of owner-occupied housing. As such, beyond simply understanding how the TCJA operates, a key contribution of our analysis is providing a detailed illustration of the mechanisms by which the standard deduction affects equilibrium outcomes in the housing market. An additional consideration is that there is considerable regional variation in house prices and taxation that interact with the TCJA, including the newly introduced SALT cap. In the interest of model tractability, and consistent with the quantitative macroeconomic housing literature, our model abstracts from this source of heterogeneity.[2] We discuss this issue further in the conclusion.

Given the crucial importance of the housing market for the aggregate U.S. economy, it is not surprising that the study of housing tax policy has a long history (Laidler, 1969; Aaron, 1970; Rosen, 1985). Our paper is related to several strands of the literature. First, an extensive

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[2]For examples of quantitative housing papers that abstract away from regional variation, see Kaplan, Mitman and Violante (2019), Sommer and Sullivan (2018),Chambers, Garriga and Schlagenhauf (2009*b*), and Karlman, Kinnerud and Kragh-Sørensen (2020).

literature studies how taxation affects the user cost of housing; for seminal papers, see Poterba (1984, 1991, 1992). Building on this framework, Rappoport (2019) estimates that the TCJA lowers house prices by about 2 percent on average.[3]

Second, our paper relates to research studying the effects of eliminating the mortgage interest deduction (MID). These papers use approaches ranging from reduced form empirical work to quantitative equilibrium models of the housing market.[4] Among the empirical studies, Davis (2019) shows that the MID increases house prices, while Hilber and Turner (2014) demonstrate that the MID can reduce homeownership.[5] These findings are consistent with theoretical mechanisms produced by the closely related general equilibrium models in Sommer and Sullivan (2018), Floetotto, Kirker and Stroebel (2016), and Karlman, Kinnerud and Kragh-Sørensen (2020), where the MID capitalizes into house prices and crowds marginal homeowners out of the housing market. In addition to this closely related work, our study of the TCJA also builds on prior influential macroeconomic models where the tax favored status of housing plays a central role (Gervais, 2002; Davis and Heathcote, 2005; Díaz and Luengo-Prado, 2008; Chambers, Garriga and Schlagenhauf, 2009*b*; Chatterjee and Eyigungor, 2015; Kaplan, Mitman and Violante, 2019).[6]

Although the research cited above contains insights that are relevant to the TCJA, our results show that it is not possible to evaluate the TCJA by simply extrapolating from existing research on the MID. In particular, we show that by eliminating preferential tax treatment of housing for many households, the TCJA considerably lowers households' incentive to over-consume housing. This result is also generated in studies of the counterfactual elimination of the MID, which find that repealing the MID in its entirety is a progressive tax reform that reallocates housing from high income to low income households (Sommer and Sullivan, 2018).

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[3]Rappoport (2019) focuses on regional house price effects, and does not study the broader effects of the TCJA on welfare, or any other endogenous market outcomes such as homeownership.

[4]See Davis and Van Nieuwerburgh (2015) and Piazzesi and Schneider (2016) for thorough surveys of this research.

[5]Both of these papers use using state-level variation in U.S. taxes to estimate the effects of interest.

[6]A related literature focuses on the role of government policy towards the financial sector that affects the housing market, such as interventions in the mortgage market. For examples, see Jeske, Krueger and Mitman (2013) and Elenev, Landvoigt and Van Nieuwerburgh (2016).

However, the TCJA is a fundamentally different reform, and these differences have major consequences for housing market outcomes and welfare. Of primary importance, the TCJA preserves the tax subsidy of housing for wealthy households who continue to itemize. The continued over-consumption of housing by the wealthy, acting in concert with lower marginal tax rates, means the TCJA is *not* a progressive reform. Having said that, the TCJA is a large tax windfall which, if sustained, can generate large welfare gains across the income distribution.[7]

2 The Model of the Housing Market

The model of the housing market builds on the heterogeneous agent equilibrium framework used to evaluate the effects of the mortgage interest tax deduction in Sommer and Sullivan (2018).[8] Households face uninsurable labor earnings shocks and make decisions about consumption of both a non-durable good and shelter services. Shelter can be obtained through homeownership or by renting. Households also make optimal financial decisions about mortgage debt and savings, and can also earn rental income by becoming a landlord. Quantitatively important frictions such as transactions costs incurred on purchases and sales of homes, maintenance expenses, and a minimum required downpayment for a mortgage affect demand for housing. The income tax code is very detailed, and captures the key features of the tax code that are crucial for evaluating the TCJA. Of particular importance, households minimize their tax burden by choosing between claiming itemized deductions or a standard deduction. Itemized deductions include mortgage interest, property taxes, and State and local income taxes. Federal income taxes are progressive, so the tax subsidies enjoyed by itemizers increase with income. House prices and rents are determined in equilibrium by the clearing of markets for shelter and housing.

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[7]The analysis in this paper assumes the TCJA changes to be permanent. We leave the analysis of possible, but as of this date not implemented, policies where today's reduction in household tax liabilities is paid for by increases in future household tax liabilities (or decreases in government spending) for subsequent research.

[8]To assess the full effect of the TCJA, we enrich this framework by including State and local income taxes, and calibrating the model so that the aggregate local income tax burden matches U.S. data.

2.1 Household Preferences, Demography, and Labor Income

The economy is populated by overlapping generations households who supply labor inelastically and derive utility from consumption of a numeraire good, c, and shelter services, s. The discounted expected value of lifetime utility is

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\mathbb{E}_0\left[\sum_{t=1}^{\infty}\beta^{t-1}\frac{\left(c_t^{\alpha}s_t^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}\right], \tag{1}
$$

where β is the discount factor, and α and σ are parameters. The expectation is taken over labor income shocks described below. Households are born without assets, and bequests are not allowed. Upon death, financial and housing assets are taxed at a 100 percent rate by the government, and the housing is immediately resold. All proceeds from this estate taxation are used to finance government expenditures that do not affect households.

We specify a stochastic aging economy in the tradition of Heathcote (2005). Households transition between discrete labor income levels, $w \in \mathcal{W}$, over time according to a finite-state Markov process where wages change over time due to two mechanisms: (1) aging shocks and (2) productivity shocks.[9] The probability of transiting from a state w due to an aging shock is $\chi = 1/(pL)$, where p is the fraction of the population with productivity w, and L is a constant equal to the expected lifetime. The conditional probability of transiting from a state w to a state w' due to a productivity shock is $P(w'|w)$. The overall transition probability, $\pi(w'|w)$, equals the likelihood of transitioning from w to w' due to an aging shock, plus the likelihood of making this transition due to a productivity shock, conditional on not aging. The overall transition probability matrix is

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[9]Stochastic aging allows expected household income to increase over time, without the need to explicitly incorporate age into the state space of the dynamic program.

$$\Pi = \begin{bmatrix} 0 & \chi_1 & 0 & 0 \\ 0 & 0 & \ddots & 0 \\ 0 & 0 & 0 & \chi_{J-1} \\ \chi_J & 0 & 0 & 0 \end{bmatrix} + \begin{bmatrix} (1-\chi_1) & 0 & 0 & 0 \\ 0 & \ddots & 0 & 0 \\ 0 & 0 & (1-\chi_{J-1}) & 0 \\ 0 & 0 & 0 & (1-\chi_J) \end{bmatrix} P, \qquad (2)$$

with the fractions p being the solutions to the system of equations $p = p\Pi$.[10]

2.2 Assets and Household Decisions

Households enter the period with three assets: houses (h), deposits (d), and mortgages (m). After observing their current period labor earnings, households choose nondurable consumption (c) and shelter consumption (s), and simultaneously select new asset holdings: $h', d',$ and m'. Shelter services can be obtained through renting or homeownership. Houses are available for purchase in discrete sizes from the set $\mathcal{H} = \{0, \underline{h}, ..., \overline{h}\}$ at per-unit price p_h. A linear technology translates housing, h', into shelter services, s. Importantly, this structure allows tax reform to affect housing demand along both the extensive and intensive margins. As described below, households choose between owning and renting, and also select the size of their home or rented unit.

Renters: Households who choose not to purchase a house ($h' = 0$) obtain shelter services, $s \in \{\underline{s}, \underline{h}, ..., \overline{h}\}$, in the rental market, at per-unit price ρ_s. The minimum shelter size satisfies $0 < \underline{s} < \underline{h}$, and represents a small unit of shelter that is available on the rental market, but not for purchase.[11]

Owner-occupiers: Households choosing $h' > 0$ are homeowners, and may be owner-occupiers or landlords. Owner-occupiers consume all the shelter services from their home, setting $s = h'$. Owner-occupiers incur a number of per-period expenses that are proportional to the value

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[10]See the Appendix of Heathcote's paper for a detailed description of this process.

[11]Allowing for a rental unit smaller than the minimum house size is a common assumption. See, for example, Chambers, Garriga and Schlagenhauf (2009*a,b,c*), Sommer, Sullivan and Verbrugge (2013), and Sommer and Sullivan (2018).

of their house, $p_h h'$. Specifically, maintenance expenses of $\delta^h p_h h'$, which fully offset depreciation, and property taxes of $\tau^h p_h h'$. Home-buyers incur proportional transactions costs of $\tau^b p_h h'$, and home-sellers pay transactions costs of $\tau^s p_h h$.

Landlords: Landlords choose to occupy less housing than they own ($s < h'$), and lease ($h'-s$) units of shelter to renters at rental rate ρ_s.[12]   Landlords face the same proportional maintenance expenses, property taxes, and transactions costs as owner-occupiers, and also pay an additional fixed cost, ϕ. The fixed cost captures the burden of managing a rental property. In addition, there are important differences in the tax treatment of landlords and owner-occupiers discussed in detail in Section 2.3. Of particular relevance, landlords pay income taxes on their net rental income.

Savings Deposits and Mortgages: The only avenue for household borrowing is mortgages, which are available to finance housing purchases at interest rate $r^m = r + \kappa$, where r is the interest rate on household savings deposits. This constant markup assumption is standard in models of the housing market with exogenous interest rates. Borrowers must satisfy a minimum down payment requirement,

$$m' \le (1-\theta)p_h h', \tag{3}$$

where $0 < \theta < 1$ represents the minimum equity requirement, and $p_h h'$ is the value of the house. Households who wish to move to a different size house or become renters must repay all outstanding debt, as mortgage default is not allowed. The minimum equity requirement serves as a barrier to reaping the rewards of tax favored homeownership because credit constrained households who are unable to afford a downpayment are forced to rent. Mortgages are modeled in the spirit of home equity lines of credit (HELOCs), so households can borrow against any accumulated housing equity above the down payment requirement.

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[12]Allowing household decisions to determine rental supply was first done by Chambers, Garriga and Schlagenhauf (2009*b*), and has subsequently been used in many quantitative models of the housing market.

2.3 Taxes and Tax Deductions

The model of the U.S. income tax system is intended to capture essential features of the tax treatment of homeownership. Namely, Federal income taxes are progressive, State income taxes exist, and households optimally choose whether to take a standard deduction or to claim itemized deductions. This section presents the baseline tax system, and where appropriate highlights changes made by the TCJA.

Let y represent total income,

$$y = w + rd + TRI, \tag{4}$$

which is the sum of labor income (w), interest income (rd), and rental income net of tax deductible expenses (TRI), which is defined below. Federal taxable income is equal to total income minus allowable deductions,

$$\widetilde{y} = y - \psi(j), \ j \in \{R, O, L\}, \tag{5}$$

where the term $\psi(j)$ represents deductions from total income that differ for renters ($j = R$), owner-occupiers ($j = O$), and landlords ($j = L$). Tax deductions are not refundable, so $\widetilde{y} = 0$ if $y - \psi(j) < 0$. Total taxable income, $\widetilde{y}$, is taxed at a progressive rate according to an income tax function $T(\widetilde{y})$, where the marginal tax rate varies discontinuously over income tax brackets. The model parameterization of the Federal income tax code is shown in Panel II of Table 1, and is discussed in Section 3.

In addition to Federal income taxes, individuals also pay a flat local income tax rate of τ^s on their total income (y), and wages (w) are subject to a payroll tax rate of τ^p. In addition to other admissible deductions, local taxes enter the deductions function $\psi(j)$, as they can be deducted from total income (y) for federal income tax purposes.

Renters (R):   Renters take the personal exemption (e) and choose between claiming the standard deduction (ξ) or the only itemized deduction available to them, State income taxes $(\tau^s y)$, so deductions are

$$\psi(R) = e + \max\big[\xi, \tau^s y\big]. \tag{6}$$

The TCJA repealed the personal exemption and doubled the standard deduction for all households, producing a net tax saving for non-itemizing renters.[13]

Owner-occupiers (O):   Owner-occupiers choose to itemize only if the sum of tax-deductible mortgage interest $\big(m^d(O)\big)$, State income taxes $(\tau^s y)$, and property taxes $(\tau^h p_h h')$ exceed the standard deduction, so deductions are

$$\psi(O) = e + \max\big[\xi, m^d(O) + \tau^s y + \tau^h p_h h'\big], \tag{7}$$

where the MID for an owner-occupier is subject to a cap on the eligible mortgage balance,

$$m^d(O) = \begin{cases} r^m m & \text{if } m < \widetilde{m} \\ r^m \widetilde{m} & \text{if } m \geq \widetilde{m}. \end{cases} \tag{8}$$

Pre-reform, the SALT deduction for homeowners was the unrestricted sum of local income taxes and property taxes, $\tau^s y + \tau^h p_h h'$. The TCJA introduced a cap on this deduction, and also lowered the amount of mortgage debt that qualifies for the MID by reducing $\widetilde{m}$. Notably, doubling the standard deduction limits homeowners' incentive to itemize on their tax returns.

Landlords: The U.S. tax system treats landlords as business entities, who are taxed on net, rather than gross, rental income. For tax purposes, landlords divide their owned housing into two components: (1) property that they personally occupy, and (2) property that they rent out. Landlords are taxed as owner-occupiers on the property that they occupy, and are separately taxed on net rental income from leased property. Letting $h^* \equiv h' - s$ represent the amount of

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[13]Eliminating the personal exemption and doubling the standard deduction increases the after tax income of a non-itemizer because in the tax code, and our model, $\xi > e$. Table 1 shows the values of ξ and e in the model.

housing leased out by a landlord, taxable rental income is

$$TRI = \rho_s h^* - \left[r^m m \left(\frac{h^*}{h'} \right) + \left(\tau^h + \delta^h + \tau^{LL} \right) p_h h^* \right], \tag{9}$$

where $\rho_s h^*$ represents gross rental receipts. Landlords deduct mortgage interest on the fraction of housing that is leased out, $r^m m \left(\frac{h^*}{h'} \right)$, along with property taxes $\left(\tau^h \right)$, maintenance expenses $\left(\delta^h \right)$, and depreciation $\left(\tau^{LL} \right)$, that are each proportional to the value of the leased space $\left(p_h h^* \right)$. Note that the maintenance and depreciation deductions are available to landlords, but are not available to owner-occupiers.

Landlord personal income tax deductions are

$$\psi(L) = e + \max \left[\xi, \tau^s y + m^d(L) + \tau^h p_h s \right], \tag{10}$$

where the landlord's personal mortgage interest deduction $\left(m^d(L) \right)$ is proportional to the share of h' occupied by the landlord, $\left(\frac{s}{h'} \right)$, and is subject to a cap,

$$m^d(L) = \begin{cases} r^m m \left(\frac{s}{h'} \right) & \text{if } m \left(\frac{s}{h'} \right) < \tilde{m} \\ r^m \tilde{m} \left(\frac{s}{h'} \right) & \text{if } m \left(\frac{s}{h'} \right) \geq \tilde{m}, \end{cases} \tag{11}$$

and the property tax deduction applies to the value of the housing occupied by the landlord $\left(p_h s \right)$. Thus, the TCJA changes to the standard deduction, personal exemption, and deductions affect landlords through Equations 10 and 11.

2.4 The Household Dynamic Optimization Problem

Households enter each time period with a stock of housing, $h \geq 0$, deposits, $d \geq 0$, and mortgage debt, $m \geq 0$. Each household observes its wage shock, w, and, given the current prices (p_h, ρ_s), solves the problem:

$$v(w, d, m, h) = \max_{c, s, h', d', m'} U(c, s) + \beta \sum_{w' \in \mathcal{W}} \pi(w'|w) v(w', d', m', h') \tag{12}$$

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subject to

$$c + \rho_s(s - h') + d' - m' + p_h(h' - h) + I^s \tau^T p_h h + I^b \tau^b p_h h' \tag{13}$$

$$\leq (1 - \tau^p)w + (1 + r)d - (1 + r^m)m - T(\tilde{y}) - \tau^s y - \tau^h p_h h' - \delta^h p_h h' - \phi I^{h' > s}$$

$$m' \leq (1 - \theta)p_h h' \tag{14}$$

$$m' \geq 0 \tag{15}$$

$$d' \geq 0 \tag{16}$$

$$h' \geq s \text{ if } h' > 0, \tag{17}$$

by choosing levels of non-durable (c) and shelter (s) consumption. Households also choose current levels of housing, h', deposits, d', and mortgage debt, m', and earn interest income rd on deposits and pay mortgage interest $r^m m$ on mortgage debt held last period. Mortgage borrowing is subject to the collateral constraint in Equation 14. The term $\rho(s - h')$ captures either a rental payment by renters (i.e., households with $h' = 0$), or the rental income received by landlords (i.e., households with $h' > s$). The term $p_h(h' - h)$ represents the gap between the value of the housing owned at the start of the current period (h') and the housing owned last period (h). Households pay transaction costs when housing is sold ($\tau^s p_h h$) or bought ($\tau^b p_h h'$), with the binary indicators I^s and I^b indicating the events of selling and buying. Wages w are subject to the payroll tax rate of τ^p. Households also pay progressive federal taxes $T(\tilde{y})$ on their federal taxable income $\tilde{y}$, and a flat local income tax rate of τ^s on their total income y. Homeowners incur property tax payments $\tau^h p_h h'$ and also incur maintenance expense $\delta^h p_h h'$. Finally, landlords face a fixed cost ϕ, with the indicator $I^{h' > s}$ denoting that a household is a landlord. The model parameters are listed in Table 1.

2.5 Housing Market Equilibrium

The stock of housing in the economy is fixed. The equilibrium price of housing (p_h) and market rent (ρ_s) simultaneously clear the market for housing (h) and shelter (s). Demand for housing, conditional on prices, is determined by the solution to the household optimization problem. In equilibrium, all housing is owned, and all shelter is occupied.

The market clearing rent (ρ_s^*) and house price (p_h^*) are found by finding the pair of prices that simultaneously clear both the housing and shelter markets in a simulated economy. Letting $x_i \equiv (w_i, d_i, m_i, h_i)$ represent the state variables for agent i, and letting $h_i'(p_h^*, \rho_s^* | x_i)$ and $s_i'(p_h^*, \rho_s^* | x_i)$ represent the demand functions for housing and shelter, the market clearing conditions for a simulated cross section of N agents are

$$\sum_{i=1}^{N} h_i'(p_h^*, \rho_s^* | x_i) = H \tag{18}$$

$$\sum_{i=1}^{N} s_i'(p_h^*, \rho_s^* | x_i) = H. \tag{19}$$

These conditions state that at the equilibrium prices, aggregate demand for both housing and shelter must equal the total stock of housing, H. The fixed stock of housing assumption is both simple and tractable, and implies that we obtain an upper bound on the price effects from tax reform.[14]

3 Parameterizing the Model

We calibrate the model in two stages. In the first stage, we set parameters that can be determined directly based on data (such as income tax rates), or are standard values drawn from the related literature (such as the wage process). In the second stage, we set the remaining parameters by matching simulated moments from the model to their empirical counterparts

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[14]The simplifying assumption of a fixed housing stock is also made by Sommer, Sullivan and Verbrugge (2013) and Elenev, Landvoigt and Van Nieuwerburgh (2016). Allowing for a supply response would complicate this paper substantially. For an example of a model that incorporates residential investment, population growth, durable housing, and dynamic fluctuations in the stock of housing, see Sommer and Sullivan (2018).

Table 1: Model Parameters

I. Parameters	Notation	Value
I.A Exogenous		
Risk aversion	σ	2.50
Down payment requirement	θ	0.20
Selling transaction cost	τ^T	0.07
Buying transaction cost	τ^b	0.025
Maintenance cost rate	δ^h	0.015
Property tax rate	τ^h	0.010
Payroll tax rate	τ^p	0.076
Rental property depreciation rate	τ^{LL}	0.023
Risk-free interest rate	r	0.04
Mortgage interest rate spread	κ	0.015
Autocorrelation of wage shocks	ρ_w	0.90
Standard deviation of wage shocks	σ_w	0.20
I.B Calibrated		
Discount factor	β	0.986
Consumption share	α	0.684
Landlord fixed cost	ϕ	0.055
Local income tax rate	τ^s	0.03

II. Baseline Federal Income Tax Code

Marginal Rate & Bracket

10%	$0 − $9,325	Personal exemption (e)	$4,050
15%	$9,325 − $37,950	Standard deduction (ξ)	$6,350
25%	$37,950 − $91,900	Cap on SALT deduction	None
28%	$91,900 − $191,650	Cap on mortgage eligible for MID ($\tilde{m}$)	$1,000,000
33%	$191,650 − $416,700		
35%	$416,700 − $418,400		
39.6%	> $418,400		

III. TCJA Federal Income Tax Code

Marginal Rate & Bracket

10%	$0 − $9,525	Personal exemption (e)	$0
12%	$9,525 − $38,700	Standard deduction (ξ)	$12,000
22%	$38,700 − $82,500	Cap on SALT deduction	$10,000
24%	$82,500 − $157,500	Cap on mortgage eligible for MID ($\tilde{m}$)	$750,000
32%	$157,500 − $200,000		
35%	$200,000 − $500,000		
37%	> $500,000		

Notes: Date sources for each exogenous parameter listed in Panel I.A are provided in Section 3. The baseline tax code in Panel II is in 2017 dollars, and is based on 2017 brackets and rates. The TCJA tax code in Panel III is in 2018 dollars, and is based on the 2018 code. In the model, the baseline and TCJA tax codes are converted to real dollars.

in U.S. data.

3.1 Exogenous Parameters

The exogenous parameters are listed in Panel I.A of Table 1. The risk aversion parameter, $\sigma = 2.5$, and minimum downpayment, $\theta = 0.20$, are standard values in the quantitative housing literature (Sommer and Sullivan, 2018). Following empirical work by Gruber and Martin (2003), the proportional transactions costs for buying and selling a home are set to $\tau^b = 0.025$ and $\tau^T = 0.07$. The housing maintenance cost $\delta^h = 0.15$ is based on estimates from Harding, Rosenthal and Sirmans (2007). We assume a property tax rate of $\tau^h = 0.01$, based on estimates from the 2007 American Community Survey by Díaz and Luengo-Prado (2010). The payroll tax rate is based on the 2009 level, so $\tau^p = 0.076$. The U.S. tax code assumes that a rental structure fully depreciates over a period of 27.5 years, which implies a 3.63 percent annual depreciation rate. However, only structures are depreciable for tax purposes, and in our model, the price of a house includes both land and structure. Davis and Heathcote (2007) find that land accounts for 36 percent of the value of a house, on average. Adopting their estimates, we set the depreciation rate of rental property to $\tau^{LL} = (1 - 0.36) \times 0.0363 = 0.023$.

The model interest rate on deposits is $r = 0.04$, and the mortgage interest rate spread is $\kappa = 0.015$. The interest rate on deposits approximately matches the average real interest rate of 3.8 percent on a 30-year constant maturity Treasury bond from 1977–2008. The mortgage interest rate spread, κ, of 1.5 percent matches the spread between the nominal interest rate on a 30-year fixed-rate mortgage and the nominal yield on a 30-year Treasury over the same time period.[15]

Turning to the labor income process, we assume that households live, on average, 50 periods (i.e., $L = 50$). Follow many papers in the quantitative macroeconomics literature, the stochastic process for household labor market productivity follows an AR(1) process. Consistent with empirical work by Card (1994), Hubbard, Skinner and Zeldes (1995) and Heathcote, Storesletten and Violante (2010), we set ρ_w and σ_w to 0.90 and 0.20, and approximate the la-

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[15]See Federal Reserve Statistical Release, H15, Selected Interest Rates.

bor income process with seven discrete states. Finally, the baseline and TCJA Federal income tax codes are shown in Panels II and III.

3.2   Calibrated Parameters

The remaining four parameters, listed in Panel I.B, are estimated using the simulated method of moments so that the model matches selected cross-sectional features of the U.S. housing market. The targeted moments, with empirical values followed by simulated model values in parentheses, are as follows: homeownership rate, 0.65 (0.65), landlord rate, 0.10 (0.095), fraction of homeowners with mortgage debt, 0.650 (0.655), ratio of imputed rent to wage $\left(\frac{\rho_s s}{w}\right)$, 0.250 (0.247), and the aggregate ratio of State and local income taxes to Federal income taxes, 0.278 (0.279).[16]

Although the calibrated parameters are obtained by simultaneously matching the moments listed above, it is useful to provide an intuitive discussion of identification. The discount factor (β) strongly affects household borrowing in the model. This motivates our use of the fraction of households with mortgage debt as a target. The Cobb-Douglas share parameter (α) affects household spending on shelter, so we attempt to match the empirical expenditure share on housing. The landlord fixed cost (ϕ) directly affects the household decision to become a landlord, and indirectly affects the decision to become a homeowner through equilibrium house prices and rents. As a result, we target the homeownership rate and landlord rate.

The final endogenous parameter is the State income tax rate (τ^s). In the U.S., the details of the local income tax code vary widely across regions, and it is not computationally feasible to incorporate locational choice in our dynamic equilibrium model. With this in mind, we assume a parsimonious flat-tax structure, and estimate (τ^s) by targeting the ratio of State and

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[16]According to Census data, the U.S. homeownership rate was approximately 65 percent between 1970 and 1996. The target fraction of landlords in the population is based on estimates from the American Housing Survey (AHS) by Chambers, Garriga and Schlagenhauf (2009*a*). The fraction of homeowners with mortgage debt is calculated using the 1994-1998 AHS. The housing expenditure share is from Davis and Ortalo-Magné (2011), and is based on data from 1980, 1990, and 2000 Decennial Census of Housing. The ratio of State and local income taxes to Federal income taxes is from the BEA NIPA data, 2009-2012.

Table 2: Moments Not Targeted in Estimation

	Data	Model
	(1)	(2)
Median house value-to-income ratio	2.91[†]	2.99
Median loan-to-income ratio	0.81[†]	0.76
Median loan-to-value ratio	0.32[†]	0.27
House price-to-rent ratio	12[§]	12.3
Average Federal income tax rate	0.10[#]	0.10
Fraction of households itemizing	0.30[‡]	0.28

[†] Averages over the 1998, 2007, and 2010 waves of the Survey of Consumer Finances.
[§] Using the Consumer Expenditure Survey, Garner and Verbrugge (2009) report that the house price to rent ratio ranges from 8 to 15.5 with a mean of approximately 12.
[#] Average Federal income tax rate from 1979-2016 (Tax Policy Center 2019).
[‡] Average fraction of households claiming itemized deductions from 2008-2016 (U.S. Internal Revenue Service, 2019).

local income taxes to Federal income taxes. The advantage of this approach is that it ensures that the relative local income tax tax burden on households, and the corresponding Federal income tax deduction, matches aggregate U.S. data.

3.3 Moments not Targeted in Estimation

To provide additional evidence on the model's fit, Table 2 reports several generated by the model that we did not target in the estimation. Reassuringly, several key housing statistics—median house value-to-income, loan-to-income, and loan-to-value ratios—are all close to estimates constructed from the 1998, 2007 and 2010 waves of the Survey of Consumer Finances (SCF).[17] The relative price of shelter, captured by the house price to rent ratio, is 12.3—consistent with estimates reported in Garner and Verbrugge (2009).[18] The model also gener-

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[17]These ratios vary over time. In these three waves of the SCF, the median house value-to-income ratio ranges from 2.44 to 3.32, the median loan-to-income ratio ranges from 0.58 to 0.93, and the median loan-to-value ratio ranges from 0.28 to 0.37. The corresponding statistics from the model fall within these ranges. The appendix shows how we compute these moments in the SCF data.

[18]There are many additional sources of data on the price to rent ratio. For example, the U.S. Department of Housing and Urban Development and the U.S. Census Bureau report a price to rent ratio of 10 in the 2001 Residential Finance Survey (chapter 4, Table 4-2). Davis, Martin and Lehnert (2008) use Decennial Censuses of Housing surveys between 1960 and 1995 to construct a quarterly time series of the rent-price ratio for the aggregate stock of owner-occupied housing in the United States. They find that the price to rent ratio ranged between 18.8 and 20 between 1960 and 1995.

ates an average Federal income tax rate of 0.10, which matches the U.S. average from 1979-2016 (Tax Policy Center 2019). In addition, the model captures well the progressivity of the tax system compared to the available estimates from Gouveia and Strauss (1994).[19] Finally, the model generates a baseline pre-TCJA itemization rate of 28 percent, compared to 30 percent from 2008-2016 (U.S. Internal Revenue Service, 2019).

4 The Effect of the Tax Cuts and Jobs Act

We perform two experiments to isolate the effect of provisions of the TCJA that alter tax deductions from the effect of provisions that alter marginal tax rates and brackets. In accordance with the TCJA, the first experiment doubles the standard deduction, eliminates the personal exemption, and caps SALT and MID deductions (details are shown in Table 1).[20] In the remainder of the paper, we refer to the first experiment as the "partial TCJA" in the interest of brevity. The second experiment makes all of these changes to tax deductions, and also alters tax brackets and marginal tax rates as in the TCJA. In the remainder of the paper, we refer to the second experiment as the "full TCJA."

4.1 The Effect of the TCJA: Changes in Deductions Only

Column 2 of Table 3 shows how the partial TCJA affects equilibrium outcomes in the housing market. The model predicts a sharp reduction in the number of itemizing households, with the fraction of itemizers falling from 28.3 percent to 1.9 percent (Table 3, Panel B). This shift towards claiming the now higher standard deduction causes Federal income tax revenue to decline by over 3 percent (Panel D). Demand for previously tax-favored owner-occupied housing declines on net, causing equilibrium house prices to drop by 2.6 percent (Panel A). The key to understanding the effect of the partial reform on the housing market is the fact that

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[19]See the appendix.

[20]The cap on the mortgage amount eligible for the MID is only binding for a very small number of households. According to Home Mortgage Disclosure Act (HMDA) data, only 2.5 percent of home purchase mortgages were greater than $750,000 in 2016.

Table 3: The Effect of the Tax Cuts and Jobs Act

		Tax Experiments	
	Baseline	Partial TCJA: Change Deductions[#]	Full TCJA: Change Deductions & Tax Rates & Brackets[†]
	(1)	(2)	(3)
(A) Housing Market			
House price	2.997	2.918	2.984
Rent	0.240	0.242	0.246
Price-rent ratio	12.473	12.074	12.114
Fraction homeowner	0.648	0.687	0.683
Fraction renter	0.352	0.313	0.317
Fraction owner-occupier	0.555	0.601	0.596
Fraction landlord	0.093	0.086	0.087
Fraction homeowners in debt	0.262	0.265	0.269
Mortgage amount[‡]	2.633	2.123	2.104
(B) Tax Deductions			
Fraction itemizing	0.284	0.019	0.017
Itemized deduction amount[‡]	0.313	0.419	0.413
(C) Fraction Itemizing by Wage Quintile			
1st quintile (bottom)	0.070	0.000	0.000
2nd quintile	0.182	0.000	0.000
3rd quintile	0.261	0.000	0.000
4th quintile	0.357	0.000	0.000
5th quintile (top)	0.574	0.116	0.108
(D) Welfare & Tax Revenue			
CEV^{*}	—	0.027	0.031
Federal income tax revenue ($\triangle$%)	—	-3.36%	-15.67%
Distribution of cev_i[∥]	—		
mean	—	0.030	0.051
standard deviation	—	0.041	0.045
fraction $cev_i > 0$	—	0.860	0.960
5th percentile	—	-0.018	0.003
25th percentile	—	0.010	0.024
50th percentile	—	0.024	0.043
75th percentile	—	0.044	0.067
95th percentile	—	0.098	0.123

[#] The "Partial TCJA" doubles the standard deduction, eliminates the personal exemption, caps SALT deductions, and lowers the MID cap.

[†] The "Full TCJA" makes all the changes in column (2), and also changes Federal income tax rates and brackets.

[‡] These means are conditioned on the variable being positive.

[*] CEV is the ex ante consumption equivalent variation. It measures welfare the change for a newborn household.

[∥] cev_i is the ex post consumption equivalent variation, which varies across heterogenous households.

in the baseline economy, tax deductible mortgage interest and property taxes subsidize the over-consumption of owner-occupied housing. The magnitude of this distortion in housing demand increases with income, because of progressive taxation.[21] When the itemization rate drops in response to the higher standard deduction, the preferential tax treatment of housing is eliminated for most households, apart from the few remaining itemizers. We discuss the various mechanisms underlying the effects of the TCJA on homeownership, housing and non-housing consumption, tax liabilities, and welfare in detail next.

The effects of the tax reform vary systematically (and in nuanced way) with household income. Turning first to middle income homeowners, before the reform these households frequently found it optimal to itemize to reduce their tax liabilities (Table 3, Panel C, column 1). However, post-reform, these households find that claiming the (now doubled) standard deduction generates a net tax saving, so the aggregate itemization rate drops (Table 3, Panel C, column 2). Although the change in itemization status in response to the partial reform is optimal for these households, these "former itemizers" find that the switch to non-itemizing status increases their after-tax cost of housing, as their housing related expenses (such as mortgage interest and property taxes) are no longer subsidized by the tax code. The increase in the after-tax cost of housing does not cause the affected households to abandon homeownership, however. Instead, these households respond to the after-tax price increase on the intensive margin by shifting consumption away from housing. Simultaneously, the partial reform also lowers the tax burden falling on these households. For example, Figure 1c shows that the total taxes paid by median wage households drop by 4 percent under the partial TCJA. Middle income households use this tax windfall, and the funds freed up by their reduction in shelter consumption, to considerably increase non-durable consumption (Figure 1b).

The decline in housing demand by middle-income homeowners who no longer itemize on their tax returns is partially offset by increased demand by households of varying income levels who are affected very differently by the reform. At the low end of the income spectrum, we find

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[21]See Poterba (1992) for a detailed explanation of how the user cost of owner occupied housing is related to marginal tax rates.
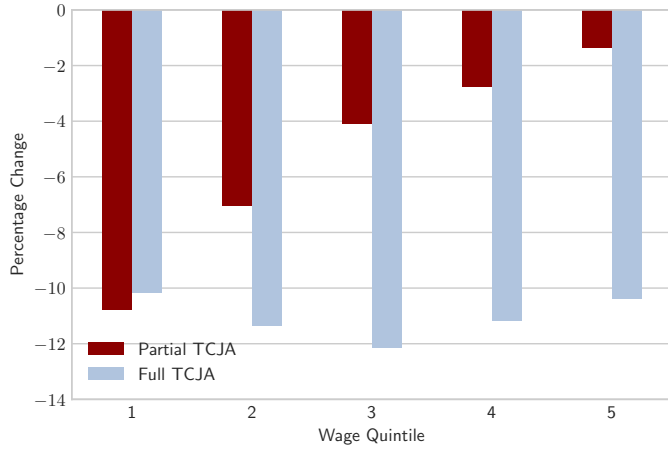
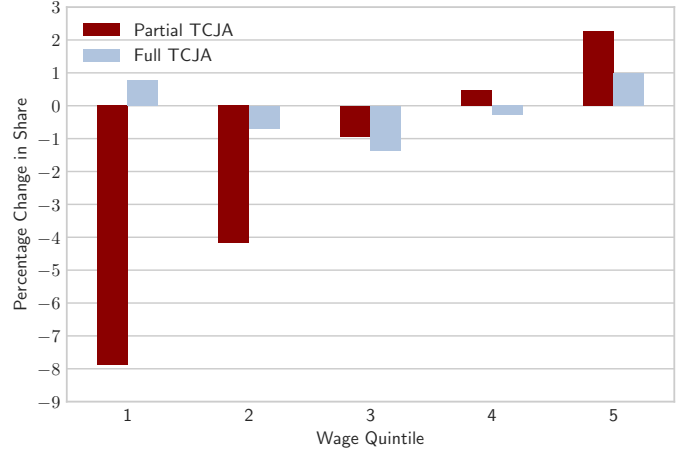Figure 1: The Effects of Tax Reform by Wage Quintiles

(a) Change in Share of Shelter by Wage
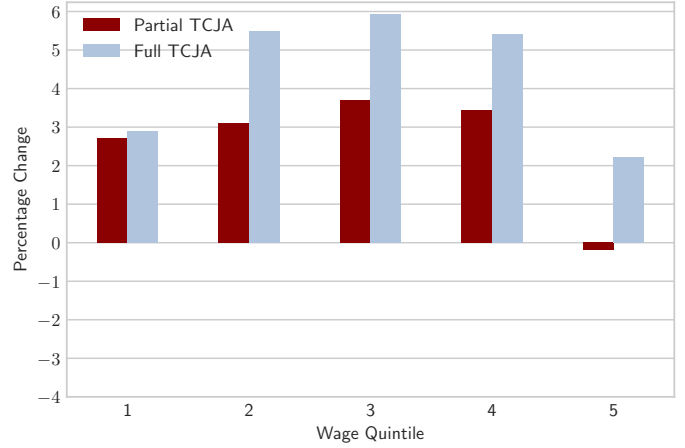
(b) Change in Consumption by Wage

(c) Change in Total Taxes by Wage

(d) Change in Share of Total Taxes by Wage

Notes: The experiment labeled "Partial TCJA" doubles the standard deduction, eliminates the personal exemption, caps SALT deductions, and lowers the MID cap. The experiment labeled "Full TCJA" makes all of these changes, and also changes tax rates and tax brackets as in the TCJA. Figures (c) and (d) show total taxes, the sum of Federal income, State income, and property taxes.

households who are either renters or own small homes with small mortgages and property tax obligations. As a group, these households chose to claim the standard deduction under the baseline tax system, so their after-tax cost of housing is unaffected by the partial TCJA, ceteris paribus. Already non-itemizers, these households benefit directly from the higher standard deduction because it lowers their taxes by approximately 10 percent (Figure 1c). These low

wage earners use their tax windfall to increase both shelter consumption and non-durable consumption (Figures 1a and 1b). Moreover, the equilibrium decline in the house price level, combined with the increase in their disposable income, induces some households who were on the margin of being able to afford a home under the baseline tax system to become home-owners, so the equilibrium homeownership rate rises by 4 percent.

At the other end of the income spectrum, the "remaining itemizers" in the post-reform economy tend to be wealthy households with high marginal tax rates who continue to enjoy tax subsidized housing. These households live in large houses, hold sizable mortgages, and face large property and state income tax liabilities. As a result, these households still choose to itemize despite the doubled standard deduction. Housing is still subsidized by the tax code for this group of wealth itemizers, so in contrast to the rest of the population, their incentive to over-consume housing remains. Furthermore, itemizing high income households are able to take advantage of lower house prices after the tax-reform, and their status as the sole remaining beneficiaries of itemized deductions, by increasing housing consumption. Specifically, Figure 1a shows that the share of housing consumed by the top quintile of the wage distribution increases by 4 percent in response to the partial reform.

4.2   The Effect of the TCJA: Changes in both Deductions and Taxes

The second experiment, summarized in column 3 of Table 3, simultaneously changes marginal tax rates and tax brackets along with deductions. In the interest of brevity, this discussion focuses on how the comprehensive tax reform differs from the partial reform shown in column 2. Of primary importance for understanding the effects of the full reform is the fact that the full TCJA is a large tax cut—Federal income tax payments drop by 15.7 percent relative to the baseline tax system (Panel D of Table 3). The large drop in tax revenue stems from two sources. First, households across the income distribution benefit from lower marginal tax rates. Second, non-itemizing households also benefit from the larger standard deduction. Comparing income tax revenue between the two experiments shows that approximately 80 percent of the tax cut is due to the lower tax rates and new brackets, with the remainder due to the increased

standard deduction.

In addition to the increase in after-tax income, as in the first experiment, the vast majority of households choose not to itemize, and now face a higher after-tax price of housing. Quantitatively, in aggregate the positive demand shock from higher disposable income offsets the negative demand shock from the reduction in the tax subsidy, so house prices remain approximately at their baseline level. However, despite house prices near their baseline levels, the homeownership rate remains elevated because the large increase in disposable income among low wage households increases the affordability of homeownership for this group.

Despite the similarities between many of the aggregate statistics shown in columns 2 and 3 of Table 3, interactions between changes in (1) deductions and (2) tax rates and brackets have important implications for household choices and welfare. These interactions are particularly apparent when the effects of the TCJA are disaggregated by wage quintiles. Figure 1c shows that when the standard deduction is increased, and tax rates are held constant, the tax savings are largest for low income households (the red, or dark, bars). The lowest wage quintile receives a 10 percent tax cut, and the size of the tax decrease declines smoothly with income, with top quintile earners receiving only a 1 percent tax savings. Consistent with this pattern, Figure 1d shows that the partial TCJA increases the progressivity of the tax code: the share of the tax burden falling on the bottom wage quintile falls by 8 percent, while the share paid by the top quintile increases by 2 percent.

Although in isolation, doubling the standard deduction makes the tax code more progressive, this result is completely undone by the TCJA changes in tax rates and brackets that are most valuable for the wealthy. The grey (light) bars in Figure 1c show that the full TCJA reform lowers taxes substantially for households of all wage levels, with mean tax savings falling in a relatively narrow range of 10 to 12 percent. However, the sources of the tax savings vary systematically across the wage distribution. Notably, both the bottom and top wage quintiles receive tax cuts of approximately 10 percent, but low income households benefit primarily from the increased standard deduction, while high income households benefit primarily from lower marginal tax rates. Middle income households receive the largest tax cut by a slight mar-

gin, as they are best positioned to benefit from both the larger standard deduction and lower marginal tax rates. Figure 1d shows that on net, the full TCJA leaves the progressivity of the tax system approximately unchanged from the baseline.

# 5 The Effects of the TCJA on Welfare

We begin assessing the welfare implications of the TCJA by computing an aggregate measure that quantifies the effects of tax reform on a newborn household. The *ex ante* consumption equivalent variation, CEV, is the percentage change in per-period non-housing consumption that equates the discounted expected lifetime utility of a newborn household between the baseline and TCJA economies. This measure provides a quantitative answer to the question: Would you prefer to be born into a world with or without the TCJA?

Panel D of Table 3 shows that welfare increases by 2.7 percent under the partial reform, and increases by 3.1 percent under the full TCJA. These welfare gains are sizable, and stem from the mechanisms identified in Section 4. Perhaps surprisingly, the CEV's reveal that the partial and full TCJA improve *ex ante* welfare by approximately the same amount, even though the full TCJA is a much larger tax cut. The explanation is that house prices are higher under the full TCJA, which partially offsets the welfare gains arising from the tax cut.

5.1 The Distribution of Welfare Gains and Losses

We quantify the distribution of welfare gains and losses using a second measure that captures the differential impact of the TCJA on households who are heterogeneous at the time of the reform. For each household, indexed by i, welfare is measured by the *ex post* consumption equivalent variation, cev_i. The cev_i is the percentage change in per-period non-housing consumption that equates the discounted sum of lifetime utility *realized* under the baseline tax system to that under the TCJA. For each household, cev_i provides a quantitative answer to the question: If you had perfect knowledge of the future, would you prefer to live in a world with or without the TCJA?
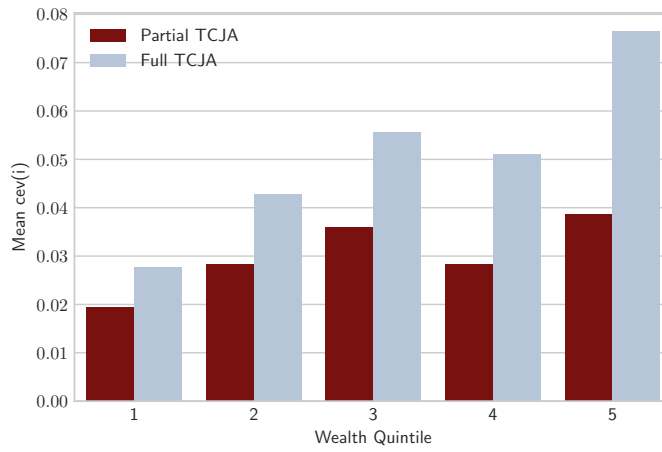
24

Figure 2: The Effects of Tax Reform on Welfare
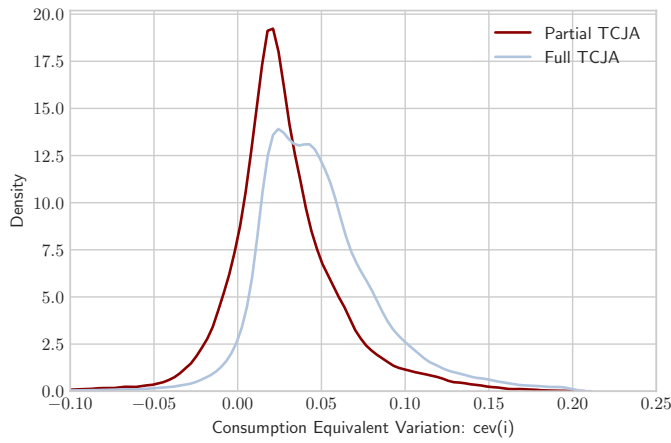
(a) Kernel Density of cev_i
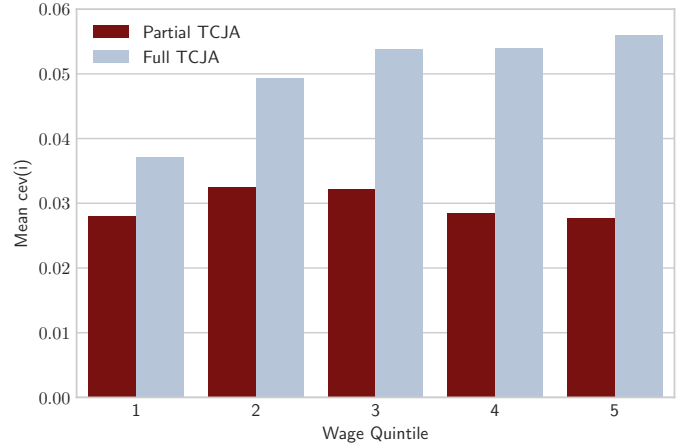
(b) Mean cev_i by Wage Quintle

(c) Mean cev_i by Wealth Quintile

Notes: The experiment labeled "Partial TCJA" doubles the standard deduction, eliminates the personal exemption, caps SALT deductions, and lowers the MID cap. The experiment labeled "Full TCJA" makes all of these changes, and also changes tax rates and tax brackets as in the TCJA.

The densities of cev_i for both tax experiments are shown in Figure 2a, and summary statistics are shown in Panel D of Table 3. The mean welfare gains are 3.0 percent and 5.1 percent for the partial and full TCJA. Although there is substantial heterogeneity across households, 86 percent of the population benefit from the partial reform ($cev_i > 0$), and 96 percent benefit from the full TCJA. If household support for the TCJA were based solely on utility maximization, the TCJA would receive overwhelming support. When interpreting this result, it is

important to keep in mind that our analysis assumes the TCJA is a permanent tax cut that is far from revenue neutral.

Figure 2b shows mean welfare gains by wage quintile for both tax experiments. It is clear from the figure that when income tax rates and brackets are held constant, the TCJA changes to deductions are an egalitarian tax reform—households across the wage distribution realize average welfare gains of approximately 3 percent (red, or dark bars). However, the benefits from the additional tax rate cuts in the full TCJA are shared less equally across the income distribution. Households in the bottom wage quintile realize a 3.5 percent mean welfare increase, while those at the median wage and above experience welfare gains that are nearly 50 percent larger. The regressive nature of the TCJA is particularly evident when welfare gains are summarized by wealth, rather than wages. Figure 2c shows that the bottom wealth quintile realizes a welfare gain of 2.8 percent from the full TCJA, while the top wealth quintile realizes a gain of 7.6 percent.

5.1.1 Who Benefits the Most from the TCJA?

We begin by examining the households who realize the largest welfare gains from the full TCJA—those in the top 1 percent of the distribution of cev_i. This exclusive group consists of households who experience welfare gains in excess of 21 percent. Who are these fortunate households? In the baseline economy, the median member of this group is a high income homeowner who lives in a large house, holds a sizable mortgage, and claims itemized deductions. These wealthy households are well positioned to take advantage of the opportunities presented by the TCJA by altering their behavior in the post-reform economy. The net results are increases in average non-durable consumption and shelter consumption of 17 percent 13 percent for this group. These increased expenditures are directly financed by the tax rate cuts, and are amplified by larger itemized deductions. Notably, households in the top 1 percent of the cev_i distribution increase total itemized deductions by 33 percent, with deductions for mortgage interest growing by nearly 50 percent as these households continue to take advantage of the MID in the post-TCJA economy.

By way of contrast, the experience of the median household, who realizes a welfare gain of approximately 4 percent from the full TCJA, is quite different. The median household in the pre-TCJA economy is a middle income homeowner who finds it optimal to claim the standard deduction rather than itemize. After the TCJA, this is still the case. The larger standard deduction and lower marginal tax rates cause a welfare-improving increase the after-tax income of this group. In turn, these households respond by increasing average non-durable consumption by 4.5 percent, and decreasing average shelter consumption by 2.5 percent.[22]

6 Discussion

The TCJA curtailed the tax favored status of housing to an unprecedented degree. Using an equilibrium model of the housing market, we are able to disentangle the effects of (1) changes in deductions that alter household itemization behavior and after-tax income from the effects of (2) across the board reductions in marginal tax rates. We show that, if implemented in isolation, the TCJA changes in deductions would reduce the overall level of distortions in the housing market by lessening tax subsidies that favor homeowners over renters. Even though this partial reform preserves the tax subsidies for remaining high income itemizers, and the associated distortions in housing demand, the welfare gains are sizable, and shared equally across the income distribution.

However, the situation is quite different under the actual TCJA, which simultaneously changed deductions and lowered tax rates. In the full reform, the preservation of subsides for remaining itemizers, acting in concert with cuts in marginal tax rates, ensures that the wealthy are the primary beneficiaries of the TCJA. At the same time, and highly relevant from the perspective of policy, the provisions of the TCJA analyzed in this paper are predicted to increase the Federal debt by approximately $700 billion over the years 2018-2025 (JCT, 2017). Whether or not this major reduction in revenue is ever balanced by reductions in future spending or increases in taxes, and who bears the burden of these possible changes, is an important consideration

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[22]The small drop in shelter consumption is driven by households who are itemizers in the baseline economy, but reduce shelter consumption under the TCJA because it is no longer optimal for them to itemize.

for future research evaluating the overall effects of the TCJA.

Finally, in the interest of tractability, our model abstracts away from regional variation in housing markets. Incorporating this type of heterogeneity is an interesting, and difficult, potential topic for future research. One topic of particular interest would be to quantify the differential impact of portions of the TCJA, such as the cap on SALT deductions, that disproportionately affect areas where house prices are high.

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A Appendix

A.1 SCF Data

The 1998, 2007, and 2010 waves of the Survey of Consumer Finances (SCF) are used to construct the cross-sectional moments cited in the study. The SCF is a triennial survey of the balance sheet, pension, income, and other demographic characteristics of U.S. families. The total housing wealth is constructed as the total sum of all residential real estate owned by a household, and is taken to represent the housing wealth qh' in the model. Secured debt (i.e., debt secured by primary or other residence) is used as a model analog of the collateralized debt, m'. The model analogue of the total net worth (i.e., $d' + qh' - m'$) is constructed as the sum of household's deposits in the transaction accounts and the housing wealth (as defined above), net of the secured debt. The total household income reported in the SCF is taken to represent the total household income defined in the model as $y = w + rd' + TRI - \tau^{LL} q(h' - s)$. Data and the SAS code are available upon request, but both can be also found at the SCF website.

A.2 Progressivity of Taxation: Model and Empirical Estimates

Table 4: Progressivity of Income Taxation: Model and Data

Income Quintile	Gouveia & Strauss[†] (1)	Model (2)
First	0.08	0.05
Second	0.10	0.08
Third	0.11	0.10
Fourth	0.13	0.13
Fifth	0.15	0.18

[†] Estimated tax rates from Gouveia and Strauss (1994).

This section compares the progressivity of the tax system in the baseline model against available empirical estimates. Quantitative studies of taxation frequently adopt the smooth

parametric tax function estimated by Gouveia and Strauss (1994). Table 4 shows that the simulated income tax rates by income quintile from our model are quite close to the Gouveia and Strauss (1994) estimates.