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The Impact of the Tax Cuts and Jobs Act on Local Home Values

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This paper simulates changes to neighborhood home prices resulting from reforms to tax preferences in the recently passed Tax Cuts and Jobs Act (TCJA). The simulation uses federal tax data summarized at a fine geography to impute homeowner rents at the zip code level across six income classes. Employing a user cost framework, I model rents as a function of prices under the old tax law and under the TCJA. While the average price impact of the TCJA is found to be -5.7 percent, local effects range from 0 to -23 percent across zip codes. Variation across income class is also large. Simulations by income class suggest that the most severe declines in price occur for upper middle-income households ($100,000 - $200,000). The paper also simulates partial versions of the TCJA that omit different features of the law that affect housing preference. I find that the higher standard deductions in the new law are the largest driver of price declines.

JEL Codes: H24, H31, R21.

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1. Introduction

The mortgage interest and property tax deductions are among the largest policy interventions in the housing market. They account for approximately $66 billion and $34 billion, respectively, in forgone tax revenues in 2017 (Office of Tax Analysis 2017), yet this expenditure does not fall evenly among taxpayers. The benefits of tax preference for housing accrue disproportionately to those with higher incomes (Glaeser and Shapiro 2003; Hanson and Martin 2014). They also fall unevenly across space (Gyourko and Sinai 2003; Sinai and Gyourko 2004; Hanson, Brannon, and Hawley 2013). High standard deductions have caused the mortgage interest deduction and the property tax deduction to benefit only about one in four tax filers in recent years.

In December 2017, a significant revamping of both the corporate and personal income tax code, the Tax Cuts and Jobs Act (TCJA), was passed into law. While the TCJA ostensibly leaves intact both the mortgage interest and the property tax deductions, these tax subsidies to housing have been effectively scaled back owing to other changes in the tax code. The TCJA substantially raises the standard deduction and removes many deductions from income. Both of these changes put the tax subsidy to housing further out of reach for most taxpayers. Marginal tax rates are also lower for most (but not all) taxpayers, which modestly reduces the marginal value of the subsidies when they are claimed.

In this study I simulate the effect of enacting the TCJA on local home prices, further segmented by income class. The tax subsidy is spatially correlated, largely because households tend to sort by income across space, and high-income households receive a larger per dollar subsidy (because of their higher marginal tax rates as well as the fact that they purchase sufficiently expensive housing) that their property tax and mortgage interest merit itemizing tax deductions. Consequently, the TCJA yields diverse price effects across housing markets. The simulation implies that neighborhoods with a high concentration of itemizers under the 2017 tax law are likely to see more dramatic changes to home values under the new law, raising the marginal cost of homeownership and shifting the after-tax demand curves of affected homebuyers. I find that while the overall impact of the tax reform on home values is a modest decline in prices of 5.7 percent, simulated price changes vary substantially at the neighborhood level and across income classes. I also simulate the TCJA as though it were implemented without each of several major features that impact home prices. This reveals how much price movement is driven by each part of the law. I find the largest differences occur because of the higher standard deduction, without which the TCJA would have approximately half the impact on home prices.

The paper proceeds as follows: in section 2, I discuss prior related work; section 3 presents the simulation model and discusses its implementation; section 4 describes sources of the data; and in section 5, I present the results. The final section provides discussion and conclusions.

2. Related literature

While there is a large literature on the effects of the mortgage interest deduction (and, to a lesser extent, the local property tax deduction),[1] relatively little attention is paid to the potential consequences of reform for the housing market. This study is conducted in the spirit of Martin and Hanson (2016), who simulate price changes resulting from previous proposals for reforming the mortgage interest deduction (MID) in a similar framework at the metropolitan level for a

[1] Studies on the MID's effects on efficiency and consumer choice in various dimensions such as tenure, home size, debt portfolio, etc. include Dunsky and Follain (1997, 2000), Green and Vandell (1999), Anderson et al. (2007), Poterba and Sinai (2008, 2011), Hanson (2012), Hilber and Turner (2014), Hanson and Martin (2014) and Albouy and Hanson (2014), among others.

selection of metropolitan areas. I adopt several features from that study into this examination of neighborhood price effects, but with an emphasis on neighborhoods rather than on the city as a whole, and with a more sophisticated approach to modeling prices that is suitable to capturing the features of the TCJA.

Several studies have noted that the tax preference for housing does not fall evenly across space. Hanson et al. (2013) use zip-code-level data to describe the local variation in MID claims. Brady et al. (2003) use a sample of IRS tax returns from 1995 and discuss differences by US census region in itemization and MID claim rates. Gyourko and Sinai (2003) explore differences in MID utilization at the state and metropolitan area levels, finding that variation increases when moving from state- to metropolitan-level analysis.

A few studies consider the price effects of reforming the MID. Bruce and Holtz-Eakin (1997) perform a dynamic simulation that predicts minor price consequences for eliminating the MID. Harris (2013) generates metropolitan-area price estimates for several reforms in a framework similar to that of Capozza et al. (1996), but with the addition of real estate transaction costs to the user cost model. Also, Martin and Hanson (2016) model the price effects of MID reform at the metropolitan level. More recently, Sommer and Sullivan (2018) construct a dynamic model of the housing and labor sectors that measures the effect of the MID on tenure choice and home price. They simulate the price effects of eliminating the MID alone, allowing for behavioral responses in a general equilibrium framework.

Most studies that consider the distributional impacts of the tax preference for housing note that the subsidy accrues disproportionately to high-income, high-home-value households with substantial mortgage debt, which are clear consequences of how the MID is implemented in the US tax code.

3. Model

I simulate price changes with the user cost model, populated with proxies from a variety of empirical data sets with fine spatial resolution. The model implies that, at a competitive equilibrium, a homeowner's marginal cost of housing services is equal to the opportunity cost of homeownership, since the homeowner earns zero economic profit from homeownership.[2] The cost of services derived from a home is termed the homeowner's imputed rent. The imputed rent is a function of the user cost of housing services and the price of the home:

$$R = P * UC \tag{1}$$

where R is the imputed rent over a given period, P is the purchase price, and UC is the marginal user cost of a dollar of housing capital.[3] The user cost of a dollar of capital for a general asset can be thought of in the simplest terms as the interest rate. If the dollar spent is borrowed, the interest rate is an explicit cost; if it is spent from savings, the interest rate is the forgone interest one could earn from otherwise investing it. The user cost should also include the cost of maintenance and depreciation, as well as the expected gain (or loss) from future sale of the asset, since it is durable. Housing capital is often taxed at the local level, and this tax rate adds to the user cost of housing:

$$UC = r_T + \tau_P + m + \delta - \pi \tag{2}$$

where r_T is the risk-free rate of return, m and δ are the maintenance and depreciation rates, τ_P is the property tax rate, and π is the expected appreciation rate.

[2] An early discussion of the model appears in Poterba (1984).
[3] This equation assumes that the marginal cost of capital is uniform for all funds expended on housing services. A more nuanced approach recognizes that tax policy causes rent to be a piecewise function of price and is discussed below.

The federal income tax code subsidizes housing through the mortgage interest and property tax deductions, allowing itemizers to deduct these expenses from their income before paying income tax.[4] The after-tax user cost of capital is therefore:

$$UC = (1 - \tau_{inc})(r_T + \tau_P) + m + \delta - \pi \tag{3}$$

where τ_{inc} is the marginal tax rate to the homeowner. Additional components include differentiating the opportunity cost of debt versus equity financing, a risk premium associated with housing over risk-free assets, the option to pre-pay and default on standard mortgages, and the degree to which property tax pays for local public goods consumed by the homeowner. These features are contemplated in Poterba and Sinai (2011). I base my simulation on the model presented therein with slight modifications.

$$UC_{itemize} = \left[1 - \left\{\tau_{inc} * \lambda + \tau_y * (1 - \lambda)\right\}\right] r_T + \left(1 - \tau_y\right) * \beta - \tau_{inc} * \lambda * (r_M - r_T) + m \quad (4)$$
$$+ (1 - \tau_{inc} - \kappa) * \tau_p - \pi$$

$UC_{itemize}$ is the marginal user cost for homeowners who itemize their returns, τ_{inc} is the marginal income tax rate on ordinary income, λ is the loan-to-value (LTV) ratio, τ_y is the marginal tax rate on capital gains, r_T is the risk-free rate of return, β is a risk premium to housing as an investment class, r_M is the mortgage interest rate, m is the maintenance rate, κ signifies the degree to which homeowners perceive the property tax to be a benefit tax, τ_P is the local

[4] Additional subsidies come from relatively liberal exemptions of capital gains on the sale of owner-occupied homes from taxation. This subsidy is recognized in the term π, which would be discounted by a marginal tax rate if capital gains were subject to tax. The exemption is for \$250,000 of capital gains (double for a married couple filing jointly) from the sale of a home in which the tax filer has lived for at least two of the last five years. The TCJA introduces no changes in this area, but the model that follows diverges from actual policy by allowing all capital gains to be claimed tax free, regardless of length of tenure.

property tax rate, and π is the anticipated home price appreciation rate net of depreciation. I depart from Poterba and Sinai (2011) in my treatment of depreciation. [5]

Many tax filers do not itemize their returns and instead face the marginal user cost:

$$UC_{standard} = r_T\lambda + (1-\tau_y)[(1-\lambda) * r_T + \beta] + m + (1-\kappa) * \tau_P - \pi \tag{5}$$

Itemizing households receive a marginal tax advantage over standard deduction tax filers, namely, a subsidy at their marginal income tax rate on mortgage interest and property tax payments.

I trace out the homeowner's imputed or owner equivalent rent (hereafter rent) as a function of price for both itemizers and standard deduction filers using the following equations:

$$R_{std} = UC_{std} * P \tag{6}$$

$$R_{ite} = UC_{ite} * P + (\lambda * r_m * \tau_{inc}) * C + \left(1 - \frac{msr_{PT} * PT + msr_{MI} * MI}{PT + MI}\right) * \max\{0, standard - other\}$$

Homeowners choose a purchase price (P) according to the rent expense (R) and the optimal tax choice given their other expenditures. The optimal tax choice for a homeowner is traced out by the solid line in Figure 1, at the minimum of the two functions R_{std} and R_{ite}. In a model where user cost is constant over the range of feasible expenditure levels, rent is simply the user cost times price. Homeowners who choose to itemize their deductions instead select a rent on R_{ite}.

Itemized deductions are said to be "wasted" (Follain and Ling 1991) when they are spent below the standard deduction threshold. In order to itemize deductions, an amount of deductible expenses equal to the standard deduction must be wasted. In this model, wasted deductions

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[5] A more robust model considers that homes depreciate in value owing to deferred maintenance and changing consumer tastes, and that an underlying constant-quality appreciation rate also exists. I use the market appreciation rate for an area, which is derived from changes in price at the time of sale for the existing housing stock as well as new construction. Depreciation is assumed to be netted out through market valuation and is not included as a separate parameter in this model.

appear in the final term of R_{ite} and determine the intercept on the y-axis in Figure 1. The first part is the rate of tax subsidy to housing expenditure, computed as a weighted average of the marginal subsidy (msr) on dollars deducted for property taxes (PT) and mortgage interest (MI). The second part computes wasted mortgage interest and property tax payments, while bounding the amount between zero and the value of the standard deduction; $standard$ is the standard deduction that applies to the tax filer and $other$ is all other itemized deductions not related to housing. The lower limit binds if nonhousing deductible expenses are greater than the standard deduction. The upper limit binds if a household only has mortgage interest and property tax as its deductible expenses. This characterization assumes that households take all itemized expenses that are unrelated to housing as given when selecting and bidding for housing. For example, an increase in a household's charitable contributions would increase $other$ and shift R_{ite} downward. A household spending the same amount on mortgage interest as before would receive a tax subsidy from more of the mortgage interest expense. The amount of mortgage interest and property tax that is not subsidized because it falls under the standard deduction is known as a wasted deduction, because it provides no marginal subsidy. At the extreme, a household whose nonhousing deductible expenses are at least equal to the standard deduction has every dollar of mortgage interest and property tax subsidized at the federal level; the intercept in this case is zero, and none of the housing-related deductions are wasted.[6]

Because homeowners face a choice of whether to itemize their income tax deductions, the relationship between rent and prices has a kink at P^* (Figure 1): homeowners who do not have sufficient deductions to justify itemizing their tax returns instead claim the standard deduction. The mortgage interest and property taxes they pay do not receive a marginal subsidy, and their

[6] A household with nonhousing itemized deductions greater than the standard deduction does not see its intercept sink below zero. That state would imply that negative mortgage interest and property tax can be subsidized, which is not the case.

imputed rent is the relationship traced out in the R_{std} curve in Figure 1. Homeowners who *do* have deductible expenses that add up to more than the standard deduction receive a subsidy to all mortgage interest and property taxes that exceed the standard deduction, adjusted for other deductible expenses.[7] These homeowners trace their rent on the R_{ite} curve in Figure 1.

P^* is the price at which a particular homeowner is indifferent to choosing the standard deduction or itemizing and is the highest price at which a particular homeowner receives no effective subsidy to housing through the tax policies discussed here. For all prices higher than P^*, the itemizing homeowner receives an effective subsidy equal to the distance between the R_{std} and R_{ite} curves on the y-axis.

I also include a cap on the MID to reflect the limits on deducting mortgage interest for balances that exceed the legal cap. For mortgage balances greater than the cap, only interest on the balance up to the cap is deductible. This introduces a kink in the rent function for itemizers at the point where additional mortgage interest ceases to be deductible. I adapt the method presented in Anderson et al. (2007) to my model by charging the subsidy on mortgage payments on loan balances in excess of the legal cap back to the homeowner as an addition to their rent in the second term of equation (6). The subsidy to an additional dollar of housing capital appears as a cost to the homeowner in parentheses.

$$C = \max\left\{0, 1 - \frac{cap}{P * \lambda}\right\} * P \qquad (7)$$

I define C as the amount spent on mortgage balances in excess of the cap, or zero if a household's mortgage balance does not exceed the cap.[8] Although the kink appears on the price

[7] It is an open question how homeowners perceive their "wasted" deductions across different eligible expense categories; the order selected here is an assumption only.

[8] Anderson et al. (2007) compute the user cost of the average dollar of capital for a given housing unit. I treat user cost strictly as a marginal cost, resulting in a conceptually different but mathematically equivalent formula for the homeowner's rent.

axis, it is, in fact, a function of loan balance. A household moves the kink on the price axis by changing its loan-to-value ratio (higher ratios move the kink to the left). This fact is captured in equation (7). The cap causes rent to increase by the borrowing cost of an additional dollar of capital (r_m) times the marginal tax rate (τ_{inc}) times the share of the capital value that is debt financed (λ) times the amount of the mortgage balance that exceeds the cap (C).

Under prior law, the legal cap on mortgage balances from which interest payments could be deducted was \$1 million, cumulative across first and subordinate liens, and first and second homes. The TCJA lowers the legal cap to \$750,000 on new loans. The model that follows incorporates this change by changing the cap in equation (7).

In the simulations to come, I allow the rent function to change in response to tax reform. To simulate price changes, I fix rent for each filing status at level $\bar{R}$, the imputed rent after subsidy to the average homeowner in a zip code and income class under the current tax law. I then locate $\bar{R}$ on the rent function that would obtain for the average homeowner under the proposed tax regime and solve the inverse function for P_{new}, the predicted price under that regime. Reported price changes are given in terms of percent change from current prices, or $\left({}^{P_{new}}/_{P_{obs}} - 1\right)$.

In Figure 1, this process is illustrated for an itemizer facing the new tax law. The homeowner whose utility-maximizing choice of housing services is at capital price P_{obs} pays rent $\bar{R}$. Introducing the TCJA raises the standard deduction sufficiently that he no longer itemizes his return. Were he to bid for his home under the new tax regime, I assume he would seek to pay $\bar{R}$ in rent, which in this case is now located on the curve R_{std}, resulting in a price change from P_{obs} to P_{new}.

This discussion presumes that the price elasticity of supply is zero; that is, that the supply of housing services does not decrease in response to a rise in rent, but that the rent difference is fully capitalized into housing prices. Some studies either assume (Bruce and Holtz-Eakin 1997) or empirically estimate (Malpezzi and Maclennan 2001) supply elasticity to be greater than zero. Others argue that supply elasticity rests near zero (Capozza, Green, and Hendershott 1996; Glaeser, Gyourko, and Saks 2006; Harris 2013). In general, it is agreed that elasticity is higher at the city edge, where undeveloped land is available, than it is within a mature city structure. The simulation takes the view that supply elasticity is zero. This is further supported by an argument put forward in Glaeser et al. (2006) that supply elasticity is unlikely to be symmetric owing to the durable nature of housing: while rising prices might elicit construction starts, falling prices rarely invoke housing destruction. The policies I simulate suggest almost universal subsidy reductions (rent increases) at given prices, which favor an inelastic interpretation of supply in the near term.

Tax Cuts and Jobs Act

On December 22, 2017, the Tax Cuts and Jobs Act was signed into law. While the main thrust of the tax reform was to reduce corporate income tax rates, the law broadly reforms several aspects of the personal income tax that affect after-tax housing costs. First, the law nearly doubles the standard deduction from the previous schedule. Second, it substantially revises the expenses that qualify as itemized deductions under the tax code. Third, it revises the marginal tax rates and some tax brackets.

In 2018, the standard deduction was scheduled to be $6,500 for single filers and $13,000 for those married filing jointly. The TCJA raises those deductions to $12,000 and $24,000, respectively, an increase by a factor of approximately 1.85. Because much of the tax preference for housing is received through itemized deductions, a higher standard deduction implies less tax preference for housing for all households; for those whose itemized deductions no longer exceed the standard deduction, the tax preference for housing through itemization is effectively ended. This means that the after-tax price of mortgage interest and property taxes rises by the taxpayer's marginal subsidy rate under the new law to the extent that it is subsumed by the higher standard deduction.

The expenses that qualify for itemization have been substantially revised under the TCJA. A range of deductions have been eliminated entirely; the only deductions that remain are for mortgage interest, charitable contributions, and state and local property and income tax. Whereas mortgage interest could once be deducted from mortgage balances of up to $1 million across first and second homes, the balance cap has been reduced to $750,000 under the new law. Additionally, mortgage interest on home equity lines can no longer be deducted. While property taxes may still be deducted, a cap of $10,000 on all state and local taxes (both income and property) has been introduced.[9]

Finally, the marginal tax rates and brackets have been adjusted under the new bill. Rates have been adjusted downward for most brackets, but some brackets are narrower than they once were. These changes affect the marginal subsidy available to remaining itemizers.

Taken together, these changes substantially reduce the number of households that would benefit from the housing tax preference and reduce the effective subsidy to households that

[9] This provision allows state and local income tax (SALT) to "crowd out" property tax from deductibility. I account for this in the model by defining itemizable property tax payments as $\max\{0, min\{property\ tax, 10{,}000 - SALT\}\}$, which guarantees any property tax remaining after SALT deductions will provide tax preference to housing, so long as it does not exceed the new combined cap.

continue to claim it under the new law. The Tax Policy Center estimates that the rate of MID claims would drop from 21 percent of households to just 4 percent (Burman 2017).[10]

The simulations that follow diverge from the TCJA because of limitations in the data or model. While the TCJA revokes the MID for home equity loans, the simulation does not. Also, various provisions of the TCJA expire in 2025; this model treats the tax reform as permanent.

4. Data

I draw data from a number of sources to populate the model, including the Census Bureau's American Community Survey (ACS) five-year estimates from 2011-2015, the Internal Revenue Service's Statistics of Income division (SOI), the National Bureau of Economic Research (NBER) TAXSIM model, the Tax Policy Center, Zillow, and proprietary loan-servicing data from Black Knight Financial Services' McDash Analytics data. In each case, the objective is to identify zip-code- and income-class-level aggregates useful in computing user costs, rent functions, and price changes.

Zillow provides monthly estimates of median home values over several geographies. I use Zillow's zip-code-level estimates of home values for all homes. Estimates of historical price changes are computed as the average annual growth rate of the monthly median estimated home value from 2001 to 2015, drawn from Zillow. I also use the current (2015) home price in the analysis.

The state tax regime affects the user cost of housing because some states provide tax preference to housing. I collect information on state-level tax policy as well as state marginal tax

[10] This estimate is based on the unified framework, a document that guided the writing of the TCJA. Some substantive differences between it and the final tax bill exist. See http://www.taxpolicycenter.org/taxvox/mortgage-interest-deduction-would-be-worth-much-less-under-unified-framework for a discussion of the unified framework's implications.

rates (which add to the subsidy rates to mortgage interest in the case where itemized deductions are allowed at the state level). Hilber and Turner (2014) draw estimates of the marginal subsidy to housing through the MID at the state level by polling NBER's TAXSIM model. NBER staff provided a downloadable series of state-level marginal tax rates and an indication of whether the state allows the mortgage interest deduction on state returns.[11]

The NBER's top marginal tax rate by state is compared to the statutory top rates listed by both the Tax Foundation and the Tax Policy Center and is often times (but not always) lower. This is due to the fact that the NBER solution contemplates a single representative tax filer whose income may be lower than that needed to trigger the highest marginal rate. I prefer using the top statutory marginal tax rates from the Tax Policy Center in the analysis and simulations; an indicator of the deductibility of mortgage interest is retained from the NBER solution.

The IRS's SOI division provides data summarized by zip code and adjusted gross income (AGI) class for many individual tax return line items, including adjusted gross income, rate of itemization, amount of itemized deductions (including mortgage interest and property tax), and number of itemizing tax filers. I use these data to construct the proportion of itemizing households, wasted housing deductions, and an estimate of the average marginal tax rate for each zip code and income class.

Using the SOI data, I identify a zip-code-by-income-class average standard deduction threshold,[12] which is a weighted average of the single and married-filing-jointly thresholds according to the proportion of each type of filer in the zip code:

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[11] Thanks to Dan Feenberg at the NBER for the data set on state marginal rates and MID allowance, available here: http://users.nber.org/~taxsim/mortgage-state/.

[12] While the SOI data reveal the proportion of filers of each filing type, other data in SOI and across other data sets do not break down by filing type; the simulation is therefore based on a linear combination of the two common types of tax filers.

$$Standard_{current,cj} = Standard_{single} * \left(prop_{single}\right) + Standard_{joint} * \left(prop_{joint}\right) \qquad (8)$$

As an example, filers in class c of zip code j face an average current (2015) threshold of $9,450 if half of the filers are single (with a standard deduction of $6,300) and half are married filing jointly (with a standard deduction of $12,600). I then calculate the new average standard threshold that would obtain under the Tax Cuts and Jobs Act, resulting in a threshold of $17,446 in this example. (I simulate the TCJA as though it applied to the 2015 tax code, the most recent year for which data are available across data sets used in the simulation.) I also recalculate the expenditures that qualify for itemization (namely, mortgage interest, charitable contributions, and some property tax). These values are used to identify the intercept of the rent function for itemizers under the old tax law and the TCJA in the model.

The average federal marginal tax rate is computed similarly, where the MTR for the average taxable income across all filing types is averaged by the weight of each filing type:

$$\begin{aligned} mtravg_{current,cj} & \qquad\qquad (9) \\ &= mtr_{single}(taxableavg) * \left(prop_{single}\right) + mtr_{joint}(taxableavg) \\ &\quad * \left(prop_{joint}\right) \end{aligned}$$

McDash Analytics produces a series of monthly performance data on individual loans from Lender Processing Services (LPS). I use a snapshot of LPS data from June 2015 to derive zip-code-level aggregates of the current interest rate and loan-to-value ratios. LPS directly reports the current interest rate of each loan as well as a loan-to-value ratio based on mark-to-market appraisals of the units securing the loans. LPS provides broad market coverage, but it is a convenience sample based on the participating servicers.

LPS contains microdata on loan characteristics and monthly payments for all existing loans within participating servicers' portfolios. Loans are identified at the zip code level. I derive zip code average LTV ratios using mark-to-market LTV ratios[13] for each loan in the portfolio.[14] Servicers handle both first mortgages and subordinate loans, but loans are not linked to properties in the LPS data. This makes estimating an individual homeowner's LTV ratio difficult. Because I am interested in zip-code-level aggregates, however, I avoid this problem by constructing the zip code average LTV in the following way. I sum the LTV ratios of all loans (first and subordinate) and divide by the number of first mortgages only.[15]

$$LTV_{j,debt} = \frac{\sum_j LTV_{first} + \sum_j LTV_{sub}}{n_{first}} * 1.05 \quad (10)$$

This effectively stacks all subordinate loans on top of first mortgages in the same zip code. LPS contains limited information about home equity lines of credit (HELOCs), which makes estimating their contribution to LTVs at the local level difficult. Because HELOCs make up approximately 5 percent of all loans during this time frame, I inflate each local LTV estimate by 5 percent to compensate for this lack of coverage.[16]

This estimate applies to all homes for which a mortgage exists; for a geographic area, it overestimates the LTV to some degree because some homes are owned free and clear. I compensate for this by adjusting the zip code area LTV according to data from the 2011-2015 ACS on the mortgage status of owner-occupied homes:

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[13] McDash Analytics computes home price appreciation since the last appraisal or sale was recorded to construct mark-to-market LTV ratios.

[14] LTV ratios are sensitive to left-side outliers in value; a single reporting of a $1 value, for instance, leads to an LTV *ratio* of the balance of the loan, conceivably in the hundreds of thousands. There are three ways to handle this sensitivity: 1) filter out low property values, 2) censor high LTV ratios, or 3) use median LTV ratios instead of averages. Because property values are not normally distributed and my target is average user costs, I prefer to avoid medians where possible. I also don't have a clear picture of how low is too low of a property value; LPS does not indicate when a property value is based on an arm's-length transaction. I choose to censor high LTV ratios, with a high ratio considered in excess of 200 percent. LTV ratios exceeding 100 percent are possible, especially post housing crisis, owing to declines in property values. In the LPS sample considered, this filter removes 0.11 percent of first mortgages and 0.01 percent of subordinate loans with an LTV ratio over 200 percent. All ratios higher than 200 percent are recoded to 200 percent.

[15] I consider a first mortgage to be a first-lien loan. Any loans that are subordinate to a first mortgage I call "subordinate loans."

[16] HELOC composition according to internal estimates. This strategy assigns HELOC debt proportional to the total amount of debt in a zip code; the actual distribution of HELOCs is unknown to the author.

$$LTV_j = LTV_{j,debt} * \frac{n_{ooc,mort}}{n_{ooc}} \tag{11}$$

where $\frac{n_{ooc,mort}}{n_{ooc}}$ is the share of owner-occupied housing units secured by a mortgage. (The weighted average is composed of this and the share of owner-occupied units owned free and clear times the LTV for same, with the latter term equal to zero.)

In order to simulate the cap on mortgage interest deductibility, I compute the amount of loan balances that exceed the cap of $1 million (and of $750,000 under the TCJA) at the loan level. Approximately 0.4 percent of all loans in LPS have balances in excess of $1 million, and 1.0 percent have balances in excess of $750,000; balances affected by the caps are 1.5 percent and 2.5 percent, respectively. Because I observe capped balances only at the loan level, this strategy necessarily underestimates the true level of mortgage balances affected by the caps, which apply at the household level across all mortgage debt.

I use data from the ACS to obtain information on owner occupancy status and property tax rates. Owner occupancy counts are used to weight resulting estimates based on the number of owner occupiers in a zip code. I compute median property tax rates as the median property tax amount divided by the median home value in a given zip code, both as reported in the ACS.

I also combine data from the ACS on home price distribution with the Zillow data to assign distinct prices to each income class in a zip code. Determining the average price of housing for an income-class zip code observation is not a trivial task, as there are no data on prices conditional on income in the ACS at this spatial level. Even were such data to exist, the measures of income in the SOI data differ definitionally from measures of income in census data. To overcome these limitations, I assume that higher-priced housing is allocated monotonically to higher-income tax filers and lexicographically to itemizing filers of any income class before standard filers. The ACS contains counts of owner-occupied households in a zip code in each of

26 price bins; I order the counts of filers in income classes from the highest to lowest itemizers, then highest to lowest standard filers. I then match the median household of each income class to its respective price in the ACS distribution.[17] Finally, I compute the ratio of the ACS assigned price to the ACS median price and multiply the Zillow median home value for the zip code by this ratio to obtain a market-based measure of home value for each income-class zip code observation.

I use a similar technique to allocate LTV ratios and capped MID dollars across income classes. Using LPS's mark-to-market value, I assign LPS loans to the price bin in which they fall using the ACS price distribution. I compute LTV ratios within class only for those loans in a zip code allocated to the given income class. Capped mortgage dollars are assigned only to itemizing households, on the assumption that a household with a mortgage balance high enough to meet the cap itemizes its deductions.

In addition to these data, I adopt several parameters from the literature to round out the user cost model. I follow Poterba and Sinai (2011) in adopting geographically invariant values for the risk-free rate of return (using the 10-year interest rate on Treasury bonds), the federal capital gains tax rate, the cost of maintenance, and an assumed risk premium on housing. Table 1 summarizes the data used in the simulation, including the geographically constant parameters.

I depart from Poterba and Sinai in selecting a proxy for π and κ; they use a national historical price appreciation as a proxy for π and leave the determination of κ a matter of assumption rather than empirics. Using local historical price appreciation as a proxy for expected future price appreciation provides my model with greater local validity than a national

[17] It is often the case that there are more tax filers than there are owner-occupied units in a zip code. In this case, I assume that the balance of tax filers in the lowest income classes, and those who claim the standard deduction, are renters. It is less frequently the case that there are more owner occupiers in the ACS than there are tax filers in the SOI data. In this case, I assume all filers are owner occupiers, and I scale the ACS price distribution to match the number of filers, such that price assignments are derived from the entire price distribution.

proxy would, yet the estimate of user cost is quite sensitive to this parameter. Martin (2015) conducts a calibration of the user cost model with a focus on these two parameters by regressing a proxy for user cost on its constituent components. The paper estimates linear coefficients for each and finds that κ has a value of approximately 0.24, consistent with the interpretation that households perceive property taxes to be mostly excise taxes. The coefficient on π is 0.40, which is consistent with consumers who discount local historical price trends when forming expectations about future price trends. I adopt these values in the simulations that follow.

Table 1 presents summary statistics for the parameters used in the simulation, weighted by the number of owner-occupied housing units in a zip code. Note that while the average values of these parameters fall largely in line with expectations, the degree of variation across zip code can be large. For instance, while the average zip code faces a median property tax burden of 1.3 percent of home value, the lowest burden is just 0.2 percent and the highest is 4.4 percent. More dramatic are the swings in historical home price appreciation, which ranges from -14.0 percent to +9.9 percent at the zip code level. The variation in each of these parameters, combined with the variation in tax situations, drives the geographic and income-class differences in price response to a change in tax policy.

Simulation

The simulation is conducted for the representative homeowner in each of six income classes within each zip code, for all observations in which sufficient data exist to conduct the simulation. Data in the SOI are sometimes censored to preserve the privacy of taxpayers, in which case observations of more than one income class are combined. In the results that follow, I present analysis at both the zip-code level and the zip-code-by-income level. In the former, I include all observations regardless of whether some income classes were combined for reporting purposes to preserve privacy. In the latter, I exclude observations in which two or more income classes were combined. The average characteristics of the population in each observation are used to populate the user cost model described above and to generate a new price based on tax reform.

In addition to the base simulation in which all possible features of the TCJA are modeled, I conduct four simulations, each one of which removes a major feature of the TCJA. In the first case, I simulate the TCJA, but with the old standard deductions left intact. In the second, I restore the old law's expenses that qualify for itemizing. In the third, I restore the old tax brackets and marginal tax rates. In the fourth, I restore the old cap of $1 million on mortgage balances. These alternate simulations reveal to what degree each feature of the TCJA drives the simulated price changes.

5. Results

This study simulates price changes from tax reform in over 13,000 zip codes across six income classes, which represent approximately 69 percent of the 145 million tax filers in 2015.[18] Zip codes are selected based on data availability and are not nationally representative. They tend to belong to metro areas, and certain parts of the country have no representation. I also exclude observations in which the parameters of the model predict a negative user cost (11 observations) or the annual average historical price appreciation over 15 years is greater than 10 percent (169 observations). As described above, in income-class-level simulations, I exclude any zip code in which SOI data are combined across two or more income classes (17,742 of 70,549 observations). Finally, I exclude the highest and lowest percentile of price changes to limit the

[18] Results based on income class, which exclude observations with data combined over income classes, cover 58 percent of tax filers.

impact of incidentally extreme parameter values. The statistics that follow are computed on the remaining subsample of observations.

Table 2 shows that the average zip code is expected to experience a 5.7 percent decline in prices. There is, however, great variation across zip codes; the greatest expected decline in prices is 23 percent, while a sizable share of zip codes face almost no price decline. Additional variation occurs across income classes, where average price changes range from a 0.6 percent decline for those earning under $25,000 to an 11.3 percent decline for those earning $100,000 to $200,000. Extremes are driven by the higher income classes. The TCJA has the largest impact on home prices for upper middle-income homeowners.

Figure 3 illustrates the distribution of price impacts of the TCJA broken out by income class. These distributions show how the TCJA drives gradually increasing price declines as incomes increase through the penultimate class, and then retreat for the highest earners. There are even a handful of households that would expect to see average increases in price resulting from lower rents. I discuss this phenomenon in greater detail below.

Table 3 aggregates the zip-code-level price impacts to individual metro areas. I exclude metro areas in which fewer than 80 percent of homeowners could be simulated with the data at hand (coverage of each metro area is described in the table). Average price changes by metro area range from a modest 2.4 percent decline in Scranton, PA, to an 11.5 percent decline in Washington, DC.

While the TCJA does not directly eliminate tax preference for housing, it changes the effective subsidy indirectly through multiple channels. In each of the following versions of the simulation, one of these channels is switched back to the old tax code to illustrate which parts of the TCJA are driving price changes in the model. In four alternate scenarios, I turn off one each of the following channels: the raising of the standard deduction, the reduction in qualifying deductible expenses, the new tax brackets and marginal rates, and the lower cap on mortgage balance deductibility.

Figure 4 illustrates the change in prices under all five simulations at the zip code level. Reverting to the old standard deduction or to the old itemization schedule (panels 2 and 3) cuts the impact of the TCJA substantially, from average price declines of 5.7 percent. The median price change decreases in absolute terms, from -4.3 percent to -2.8 and -3.5 percent, respectively, and the tail is dramatically shortened. The impact of the TCJA but with the old brackets and rates, or with the old cap on mortgage balances (panels 4 and 5), is very similar to the full TCJA in the aggregate, with median price declines of -4.2 and -4.3 percent, respectively. The very minor impact of restoring the mortgage balance cap is unsurprising, given the small number of loans I am able to identify that exceed the cap. This is likely an underestimate of the impacts of the reduced cap, however, because I am unable to link loans held by the same household.

Figures 5 through 8 illustrate how each of these simulations differs from the full TCJA across income classes. Each figure presents a scatter plot of price changes under the full TCJA on the y-axis, and price changes under the partial TCJA on the x-axis. Each point is the representative agent of the zip code income class observation; income classes are presented individually over the six panels in the figure. Observations that experience no difference in price between the full and partial TCJA simulations appear on the diagonal. If an observation experiences a greater price decline under the full TCJA than under the partial, it appears in the lower right triangle beneath the diagonal.

In Figure 5 I compare the full TCJA to a version in which the old standard deduction is retained. Note that in all six income classes, the partial TCJA represents a weakly more generous subsidy; points fall either on or below the diagonal. The existence of points on the diagonal imply that the average household sees no difference in rent, and therefore implied prices, between the full and partial TCJA. In many places, however, returning the standard deduction to a lower level would lessen the implied price declines due to the TCJA. This is particularly true for the top two income classes; nearly all observations descend off the diagonal, implying that the higher standard deduction increases the wasted housing deductions these households accrue.

In Figure 6, one can compare the full TCJA with a version in which qualifying deductible expenses are unchanged in the new law. This restores lesser-used deductions such as high medical expenses and more common ones such as the full deductibility of state and local taxes and property tax (rather than the capped version in the TCJA). There is less movement off the diagonal for the higher income classes in this comparison and more movement for the lower classes, as compared to Figure 5. This indicates that the average household in the lower income classes receives a greater subsidy from retaining the qualifying deductions from the prior law than they do from retaining the old standard deduction. On-diagonal observations reflect the fact that, for some households, restoring the old schedule of qualifying deductions does not by itself increase the subsidy to housing relative to the full TCJA.

Figure 7 compares the full TCJA with a version in which the old tax brackets and marginal tax rates are retained. This mechanism subsidizes housing by raising or lowering the subsidy rate (the marginal tax rate) for mortgage interest and property tax payments. By lowering the marginal tax rate on many income levels, the TCJA also lowers the value of the subsidy for these types of expenses. For each of the five income classes below $200,000, retaining the old tax brackets and rates (which are higher for these groups than under the TCJA) results in slightly smaller declines in prices. Those earning more than $200,000 may face either a higher or lower price compared to the full TCJA, depending on the bracket and rate they face. That is because the TCJA contracts some of the higher brackets, forcing certain income ranges into the next higher bracket. This is despite the fact that the TCJA lowers the rate on each bracket. For instance, single filers earning between $193,660 and $411,500 face a marginal tax rate of 33 percent under the old law and reside in the fifth bracket. Under the TCJA, they reside in the sixth bracket and face a rate of 35 percent (the bracket has been expanded downward to capture lower earners than it did under the old law).[19] While this phenomenon is not isolated to brackets for filers above $200,000 in income, the average marginal tax rates computed in these simulations only reach this high in the tax brackets for the highest income classes.

It is also worth noting that the few households facing price *increases* as a result of the TCJA do not experience them when the new brackets and rates are removed; reviewing the few observations with positive values on the y-axis (that is, price increases under the full TCJA), they all now fall to the left of the x-axis. This reveals that the new bracket structure is the factor driving an effective overall subsidy *increase* under the TCJA for a handful of places in the highest income group.

In Figure 8, I show what happens when implementing the TCJA minus the reduced cap on mortgage balances. Because the cap affects only balances over $1 million (or $750,000 under the TCJA), the simulation places the effects only on those with high income, who, by assumption, face the highest housing prices. The effect is very modest, returning some of the subsidy to some households in the higher income classes.

[19] Recall that I have scaled the TCJA brackets down to what they would have been in the 2015 tax code, relative to the scheduled 2018 brackets prior to the passage of the TCJA.

6. Discussion and Conclusion

There are several reasons to be cautious about accepting these simulations of price change as predictive of observable price change. For one, they rely on the user cost model, which could fail due to misspecified form as well as mismeasured parameters and parameter proxies. Parameters are constructed with unknown error, especially across smaller geographies, and the model is quite sensitive to changes in certain ones. Anticipated home price appreciation, for example, is proxied by long-term historical price appreciation, which varies dramatically across small geographies, and changes have a large impact on user cost. Some parameters are measured based on convenience samples or from samples in sparsely populated areas, which may lead estimates to be biased or noisy, respectively. Caution advises against relying on the results of any one zip code simulation for this reason; the purpose of the study is to observe the pattern of price changes that might obtain given the relative geographic variation of tax preference to housing.

Second, this model contemplates housing in the context of asset pricing theory, and its simplicity fails to account for the transactional and geographic frictions of the market. For instance, the model predicts price declines of a certain magnitude for the entire housing stock, but only a fraction of the housing stock is sold in any given period. One might expect that homes whose values fall enough to erase all equity might enter foreclosure (which would potentially magnify price declines due to knock-on effects of blight and principal agent problems in maintaining the quality of bank-owned homes), or simply be held off the market until prices recover sufficiently to return the owner to a positive equity position. It is also possible that there would be sorting effects due to the relative change in pricing and effective subsidies across income groups and space within a metro area. Measuring such effects is beyond the scope of this study.

Third, there are constraints in the model owing to data availability. For instance, Figures 5 and 6 suggest that lower income classes are equally affected by the full TCJA and by the partial versions of the law that retain either the old standard deduction or the old itemization schedule. This stands in contrast to higher income classes, in which some observations suffer less severe price declines under these partial reforms. This is due to the limitation that the model computes the average impact on current itemizers in the income class. For lower income classes, returning to *either* the old standard deduction *or* the old itemization schedule alone does not change the fact that the average itemizer in those income classes rarely finds it worthwhile to continue itemizing under the given policy. Yet some individual filers in some of these zip code income classes, whose itemized deductions are higher than the average, surely would continue to itemize. Variation in the impact of the partial TCJA does not appear in the aggregate except in the higher income classes, where the average household more easily sits on the margin of having sufficient deductions under the new vs. the old threshold, or under the new vs. the old schedule of qualifying deductions.

A similar limitation occurs when mapping market prices to filing status. I observe only one market price, unconditional on tax filing status. In fact, it is almost certain that itemizers who claim the mortgage interest and property tax deductions pay higher prices and obtain more housing within a zip code than do homebuyers who take the standard deduction. The fact that prices vary within small geographies owing to differences in home quality and quantity is captured by assumption in the adjustments I make for prices across income classes, but these assumptions are not tested for validity here.

Finally, these simulations ignore several second-order effects that may amplify or dampen price changes. I do not allow the amount of mortgage interest and property tax to adjust based on the change in the after-tax price of each, though evidence in Hanson and Martin (2014) suggests there is indeed a price elasticity of mortgage debt. Adjustments along the dimensions of portfolio reallocation, home size choice, etc. would dampen the price declines somewhat, as unconstrained households would wring greater total utility out of re-optimizing all dimensions of consumption. This simulation forces them to hold all other dimensions constant and only to re-optimize housing expenditure. Holding the price elasticity of supply to zero also implies that there is no quantity effect to absorb the tax policy. As mentioned before, this may be relatively realistic in the face of price declines in the near term, as the housing stock is durable and relatively indivisible, making reductions in supply a process of waiting for depreciation to draw certain units out of service.

This model also does not speak to a transition path. It is possible that given the unanticipated nature of the change in the law and the immediate impact it will have on homeowners' tax bills starting in tax year 2018, buyers will begin to account for the new user cost of capital immediately. If the changes are not highly salient, or perceived as reversible through future action by Congress, the effects may be muted. In any case, the simulation reflects only a shift factor to housing demand; it does not quantify an impulse response or dynamic adjustment toward a new steady state.

Taken as a whole, this study suggests modest but real price declines resulting from eliminating tax preference for housing. As with nearly all tax reform, there are winners and losers. Expanding on the existing literature, I show that the dispersion of these price changes across small geographies is likely high, with the largest declines concentrated in high-income, high-valued neighborhoods whose tax filers often itemize deductions, and with modest price gains in places where there are no wasted housing deductions under the new law and the marginal tax rate becomes steeper.

References

Albouy, David, and Andrew Hanson. 2014. "Are Houses Too Big or in the Wrong Place? Tax Benefits to Housing and Inefficiencies in Location and Consumption." *Tax Policy and the Economy* 28 (1): 63–96.

Anderson, John E., Jeffrey Clemens, and Andrew Hanson. 2007. "Capping the Mortgage Interest Deduction." *National Tax Journal* 60 (4): 769–85.

Brady, Peter, Julie-Anne Cronin, and Scott Houser. 2003. "Regional Differences in the Utilization of the Mortgage Interest Deduction." *Public Finance Review* 31 (4): 327–66. https://doi.org/10.1177/1091142103031004001.

Bruce, Donald, and Douglas Holtz-Eakin. 1997. "Apocalypse Now? Fundamental Tax Reform and Residential Housing Values." Working Paper 6282. National Bureau of Economic Research. http://www.nber.org/papers/w6282.

Burman, Leonard E. 2017. "The Mortgage Interest Deduction Would Be Worth Much Less Under the Unified Framework." Tax Policy Center. October 24, 2017. http://www.taxpolicycenter.org/taxvox/mortgage-interest-deduction-would-be-worth-much-less-under-unified-framework.

Capozza, Dennis R., Richard K. Green, and Patric H. Hendershott. 1996. "Taxes, Mortgage Borrowing, and Residential Land Prices." In *Economic Effects of Fundamental Tax Reform*. Washington, DC: Brookings Institution Press.

Dunsky, Robert M., and James R. Follain. 1997. "The Demand for Mortgage Debt and the Income Tax." *Journal of Housing Research* 8 (2): 155–99. https://doi.org/http://business.fullerton.edu/finance/jhr/.

———. 2000. "Tax-Induced Portfolio Reshuffling: The Case of the Mortgage Interest Deduction." *Real Estate Economics* 28 (4): 683–718. https://doi.org/http://www.blackwellpublishing.com/journal.asp?ref=1080-8620.

Follain, James R., and David C. Ling. 1991. "The Federal Tax Subsidy to Housing and the Reduced Value of the Mortgage Interest Deduction." *National Tax Journal* 44 (2): 147–68.

Glaeser, Edward L., Joseph Gyourko, and Raven E. Saks. 2006. "Urban Growth and Housing Supply." *Journal of Economic Geography* 6 (1): 71–89. https://doi.org/10.1093/jeg/lbi003.

Glaeser, Edward L., and Jesse M. Shapiro. 2003. "The Benefits of the Home Mortgage Interest Deduction." *Tax Policy and the Economy*, no. 17: 37–82.

Green, Richard K., and Kerry D. Vandell. 1999. "Giving Households Credit: How Changes in the U.S. Tax Code Could Promote Homeownership." *Regional Science and Urban Economics* 29 (4): 419–44. https://doi.org/10.1016/S0166-0462(99)00005-8.

Gyourko, Joseph, and Todd Sinai. 2003. "The Spatial Distribution of Housing-Related Ordinary Income Tax Benefits." *Real Estate Economics* 31 (4): 527–575. https://doi.org/10.1046/j.1080-8620.2003.00076.x.

Hanson, Andrew. 2012. "Size of Home, Homeownership, and the Mortgage Interest Deduction." *Journal of Housing Economics* 21 (3): 195–210. https://doi.org/10.1016/j.jhe.2012.06.001.

Hanson, Andrew, Ike Brannon, and Zackary Hawley. 2013. "The Geographic Distribution of the Mortgage Interest Deduction." *Fiscal Federalism Initiative*. http://epublications.marquette.edu/econ_fac/411/.

Hanson, Andrew, and Hal Martin. 2014. “Housing Market Distortions and the Mortgage Interest Deduction.” *Public Finance Review* 42 (5): 582–607. https://doi.org/10.1177/1091142113505679.

Harris, Benjamin H. 2013. “Tax Reform, Transaction Costs, and Metropolitan Housing in the United States.” Urban-Brookings Tax Policy Center. http://www.taxpolicycenter.org/UploadedPDF/412835-Discrete-Period-Housing.pdf.

Hilber, Christian A. L., and Tracy M. Turner. 2014. “The Mortgage Interest Deduction and Its Impact on Homeownership Decisions.” *Review of Economics and Statistics* 96 (4): 618–37. https://doi.org/10.1162/REST_a_00427.

Malpezzi, Stephen, and Duncan Maclennan. 2001. “The Long-Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdom.” *Journal of Housing Economics* 10 (3): 278–306. https://doi.org/10.1006/jhec.2001.0288.

Martin, Hal. 2015. “Essays on Housing Tax Policy and Discrimination in the Mortgage Market.” Dissertation, Atlanta: Georgia State University. http://scholarworks.gsu.edu/econ_diss/109.

Martin, Hal, and Andrew Hanson. 2016. “Metropolitan Area Home Prices and the Mortgage Interest Deduction: Estimates and Simulations from Policy Change.” *Regional Science and Urban Economics* 59 (July): 12–23. https://doi.org/10.1016/j.regsciurbeco.2016.03.006.

Office of Tax Analysis. 2017. “Tax Expenditures FY 2019.” US Department of the Treasury. https://www.treasury.gov/resource-center/tax-policy/Documents/Tax-Expenditures-FY2019.pdf.

Poterba, James M. 1984. “Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach.” *The Quarterly Journal of Economics* 99 (4): 729–52. https://doi.org/10.2307/1883123.

Poterba, James M., and Todd Sinai. 2008. “Tax Expenditures for Owner-Occupied Housing: Deductions for Property Taxes and Mortgage Interest and the Exclusion of Imputed Rental Income.” *American Economic Review* 98 (2): 84–89. https://doi.org/http://www.aeaweb.org/aer/.

———. 2011. “Revenue Costs and Incentive Effects of the Mortgage Interest Deduction for Owner-Occupied Housing.” *National Tax Journal* 64 (2): 531–64.

Sinai, Todd, and Joseph Gyourko. 2004. “The (Un)Changing Geographical Distribution of Housing Tax Benefits: 1980-2000.” *Tax Policy and the Economy* 18 (January): 175–208.

Sommer, Kamila, and Paul Sullivan. 2018. “Implications of US Tax Policy for House Prices, Rents, and Homeownership.” *American Economic Review* 108 (2): 241–74. https://doi.org/10.1257/aer.20141751.

Tables and Figures

Table 1. Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
median property tax as % of median ooc value (ACS)	13,231	1.32%	0.7%	0.2%	4.4%
proportion of filers who file MFJ	13,231	56.3%	11.5%	7.9%	93.7%
average federal marginal tax rate	13,231	21.0%	3.5%	11.9%	39.6%
state marginal subsidy rate of MID (NBER)	13,231	3.4%	3.5%	0.0%	9.3%
annual growth of ZHVI for All Homes, zip level	13,231	1.8%	1.8%	-14.0%	9.9%
2015 Price (ann avg of monthly median in $1,000s, Zillow)	13,231	253.5	208.7	30.0	5,227.4
interest rate on mortgage debt (LPS, zip Average)	13,231	4.8%	0.5%	3.5%	8.3%
adjusted LTV (zip Average, LPS, ACS)	13,231	44.2%	9.2%	8.0%	94.7%
10-year Treasury rate	--	2.14%	--	--	--
risk premium to housing	--	2.0%	--	--	--
maintenance cost	--	2.5%	--	--	--
proportion of property tax as benefit (kappa)	--	0.24	--	--	--
adjustment coefficient to price appreciation	--	0.4	--	--	--

Statistics are weighted by the number of owner-occupied housing units in a zip code (ACS 2011-15). Parameters with no dispersion are geographically constant and adopted by assumption.

Table 2. Summary of Simulated Price changes (Percent)	Share	Obs	Mean	Std. Dev.	Min	Max
zip code aggregated over income class	100%	13,231	-5.7%	3.1%	-23.0%	0.0%
by income class:						
< $25,000	4%	4,929	-0.6%	0.4%	-5.7%	0.0%
$25,000 - $50,000	18%	7,668	-1.9%	1.1%	-11.1%	0.0%
$50,000 - $75,000	23%	10,632	-4.5%	2.6%	-17.9%	0.0%
$75,000 - $100,000	18%	11,167	-5.5%	3.5%	-30.4%	0.0%
$100,000 - $200,000	27%	9,271	-11.3%	3.7%	-32.5%	0.0%
> $200,000	11%	9,021	-6.6%	5.8%	-35.9%	2.9%

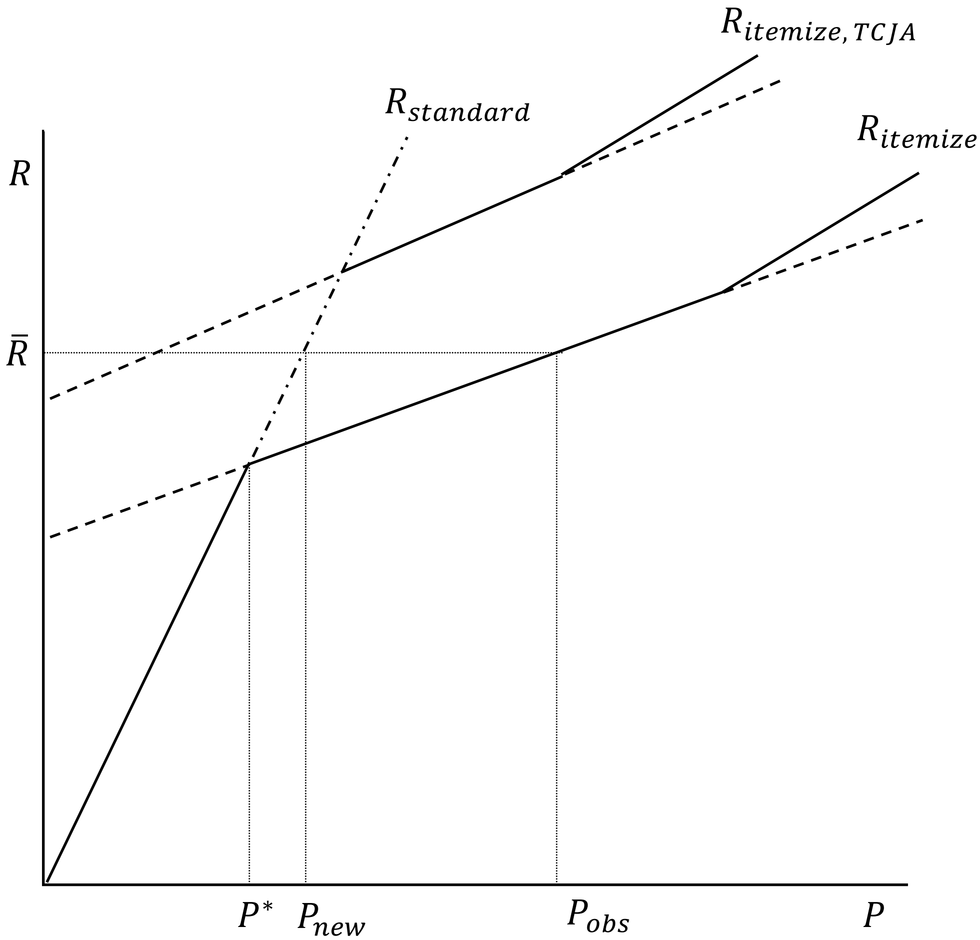
Table 3. Summary of Zip-Code-Level Price Changes by Metro Area (Percent)

Metro area	Min	Mean	Max	Coverage
Akron, OH	-8.5	-3.6	-0.4	94.8
Albany-Schenectady-Troy, NY	-14.7	-8.6	-1.5	89.7
Albuquerque, NM	-7.7	-4.6	-1.5	98.9
Allentown-Bethlehem-Easton, PA	-6.7	-4.0	-0.3	96.0
Ann Arbor, MI	-7.1	-5.0	-1.7	98.4
Atlanta, GA	-12.5	-7.2	-1.7	98.3
Bakersfield, CA	-14.1	-8.4	-0.8	95.7
Baltimore, MD	-16.6	-10.8	-3.2	98.9
Baton Rouge, LA	-9.1	-4.8	-1.4	95.4
Birmingham, AL	-9.0	-4.8	-1.2	92.7
Boston-Worcester-Lawrence, MA-NH-ME-CT	-11.3	-5.5	0.0	96.4
Buffalo-Niagara Falls, NY	-12.1	-4.9	-0.8	89.2
Charleston-North Charleston, SC	-9.1	-6.0	-0.4	93.1
Charlotte-Gastonia-Rock Hill, NC-SC	-12.0	-6.4	-1.0	98.0
Chicago, IL	-11.7	-5.5	-0.9	99.0
Cincinnati, OH-KY-IN	-10.3	-4.8	-0.7	95.2
Cleveland-Lorain-Elyria, OH	-9.2	-3.9	-0.1	96.6
Colorado Springs, CO	-10.8	-4.6	-1.1	98.5
Columbia, SC	-10.3	-6.5	-1.6	98.8
Columbus, OH	-11.1	-5.8	-1.2	97.7
Dayton-Springfield, OH	-7.4	-3.5	-1.0	94.1
Denver, CO	-12.4	-5.9	-1.3	95.8
Detroit, MI	-9.1	-4.3	-0.4	96.5
Fort Wayne, IN	-5.8	-3.0	-1.0	95.2
Fresno, CA	-12.2	-7.0	-0.5	94.4
Gary, IN	-6.7	-4.1	-1.4	98.1
Grand Rapids-Muskegon-Holland, MI	-5.8	-2.8	-0.7	96.7
Greensboro–Winston-Salem–High Point, NC	-9.2	-4.5	-0.5	96.6
Greenville-Spartanburg-Anderson, SC	-8.3	-4.5	-1.1	93.3
Harrisburg-Lebanon-Carlisle, PA	-7.9	-3.8	-0.2	92.7
Hartford, CT	-12.4	-7.4	-1.5	95.5
Indianapolis, IN	-9.4	-4.6	-0.6	96.5
Jersey City, NJ	-16.5	-8.8	-5.6	99.7
Kansas City, MO-KS	-11.6	-6.1	-0.8	95.9
Los Angeles-Long Beach, CA	-17.5	-8.4	-2.1	97.5
Louisville, KY-IN	-7.9	-5.4	-1.4	97.4
Milwaukee-Waukesha, WI	-9.8	-6.5	-1.6	98.8
Minneapolis-St. Paul, MN-WI	-15.7	-8.0	-2.4	98.0
Mobile, AL	-6.9	-3.7	-0.6	93.1

New Haven-Meriden, CT	-10.6	-8.3	-4.2	98.3
New Orleans, LA	-8.8	-4.0	-1.3	96.6
New York, NY	-15.2	-7.9	-2.3	97.8
Newark, NJ	-13.6	-8.6	-3.4	99.0
Norfolk-Virginia Beach-Newport News, VA	-12.7	-8.7	-1.8	98.0
Oakland, CA	-18.1	-8.6	-3.8	98.8
Oklahoma City, OK	-13.9	-5.4	-0.5	92.3
Omaha, NE-IA	-14.0	-7.2	-1.8	96.5
Philadelphia, PA-NJ	-14.9	-7.0	-0.4	98.3
Phoenix-Mesa, AZ	-11.1	-5.5	-1.1	99.1
Pittsburgh, PA	-9.7	-3.4	0.0	90.7
Portland-Vancouver, OR-WA	-14.0	-8.7	-1.5	97.4
Providence-Fall River-Warwick, RI-MA	-9.9	-5.8	-1.5	98.0
Raleigh-Durham-Chapel Hill, NC	-13.8	-7.1	-1.2	98.3
Richmond-Petersburg, VA	-17.4	-8.5	-4.5	99.0
Riverside-San Bernardino, CA	-21.8	-8.6	-0.2	97.3
Rochester, NY	-11.3	-6.1	-1.4	89.8
Salt Lake City-Ogden, UT	-8.8	-5.3	-1.2	98.4
San Diego, CA	-15.7	-8.5	-3.3	98.1
San Francisco, CA	-9.3	-5.9	-1.5	96.3
San Jose, CA	-14.7	-7.7	-1.7	95.4
Scranton--Wilkes-Barre--Hazleton, PA	-5.4	-2.4	-0.3	89.3
Springfield, MA	-8.9	-4.2	-0.2	93.3
St. Louis, MO-IL	-12.0	-5.7	-0.2	96.4
Stockton-Lodi, CA	-16.6	-7.1	-3.0	93.7
Syracuse, NY	-13.0	-6.3	-1.0	87.3
Toledo, OH	-6.8	-3.7	-1.0	91.3
Tucson, AZ	-8.1	-4.5	-0.9	97.6
Tulsa, OK	-9.4	-5.1	-0.5	94.1
Vallejo-Fairfield-Napa, CA	-11.3	-8.7	-3.9	98.4
Ventura, CA	-11.3	-8.6	-2.8	99.9
Washington, DC-MD-VA-WV	-23.0	-11.5	-1.4	98.9
Wichita, KS	-10.6	-4.3	-1.2	94.1
Wilmington-Newark, DE-MD	-12.2	-8.5	-2.7	98.1

Metro boundaries are either PMSAs or MSA/CMSAs in 2000. Metros with fewer than 80 percent of all owner-occupied households simulated are omitted. Prices are first averaged within zip code, weighted by the number of imputed owner-occupier filers in each income class. The reported min and max are zip-code-level average price changes.

Figure 1. Illustration of Simulated Price Changes



Note: The relationship between a household's imputed rent and the price of the home is determined by the user cost of specific lots of capital, which changes owing to features of the tax code. The first kink occurs where a household is indifferent to taking the standard deduction or itemizing. The second kink occurs where mortgage balances are capped for the purposes of deducting mortgage interest.

Figure 2. Distribution of Price Changes (Percent Change) at the Zip-Code Level

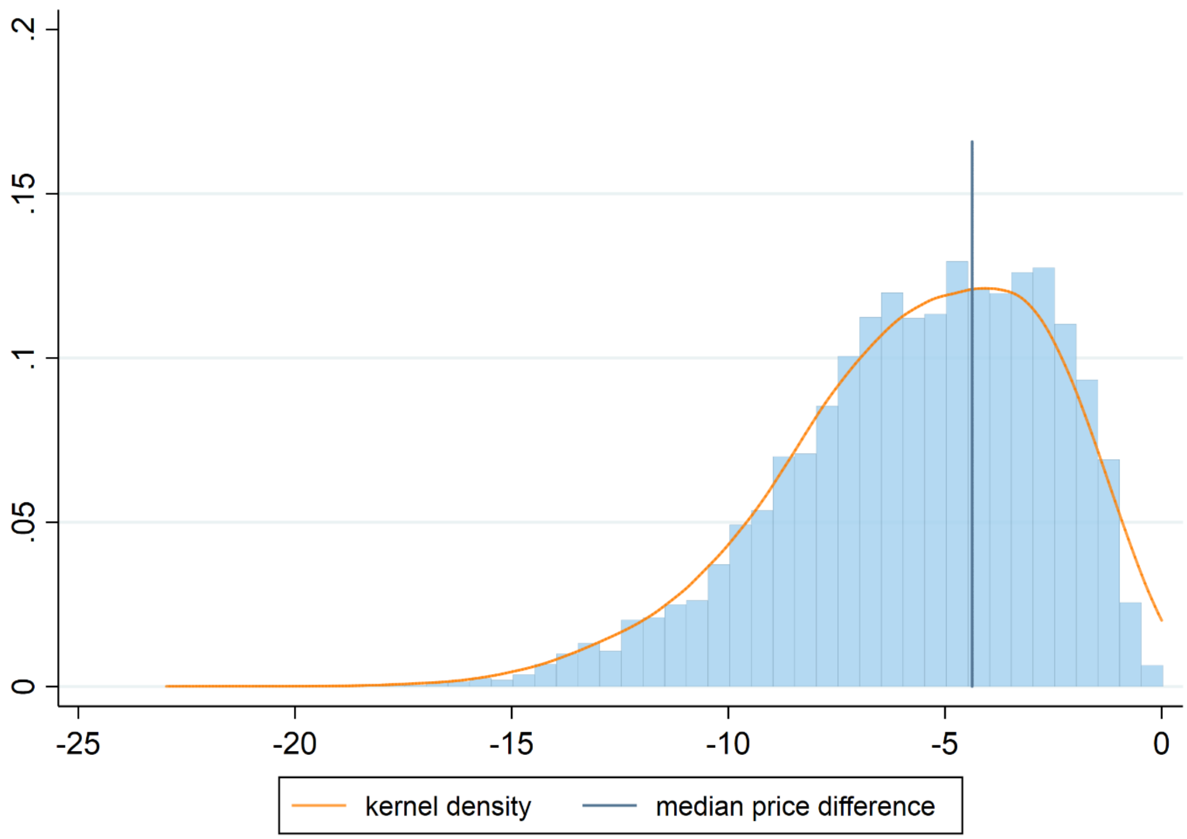


Figure 3. Distribution of Price Changes (Percent Change) at the Zip-Code-by-Income-Class Level

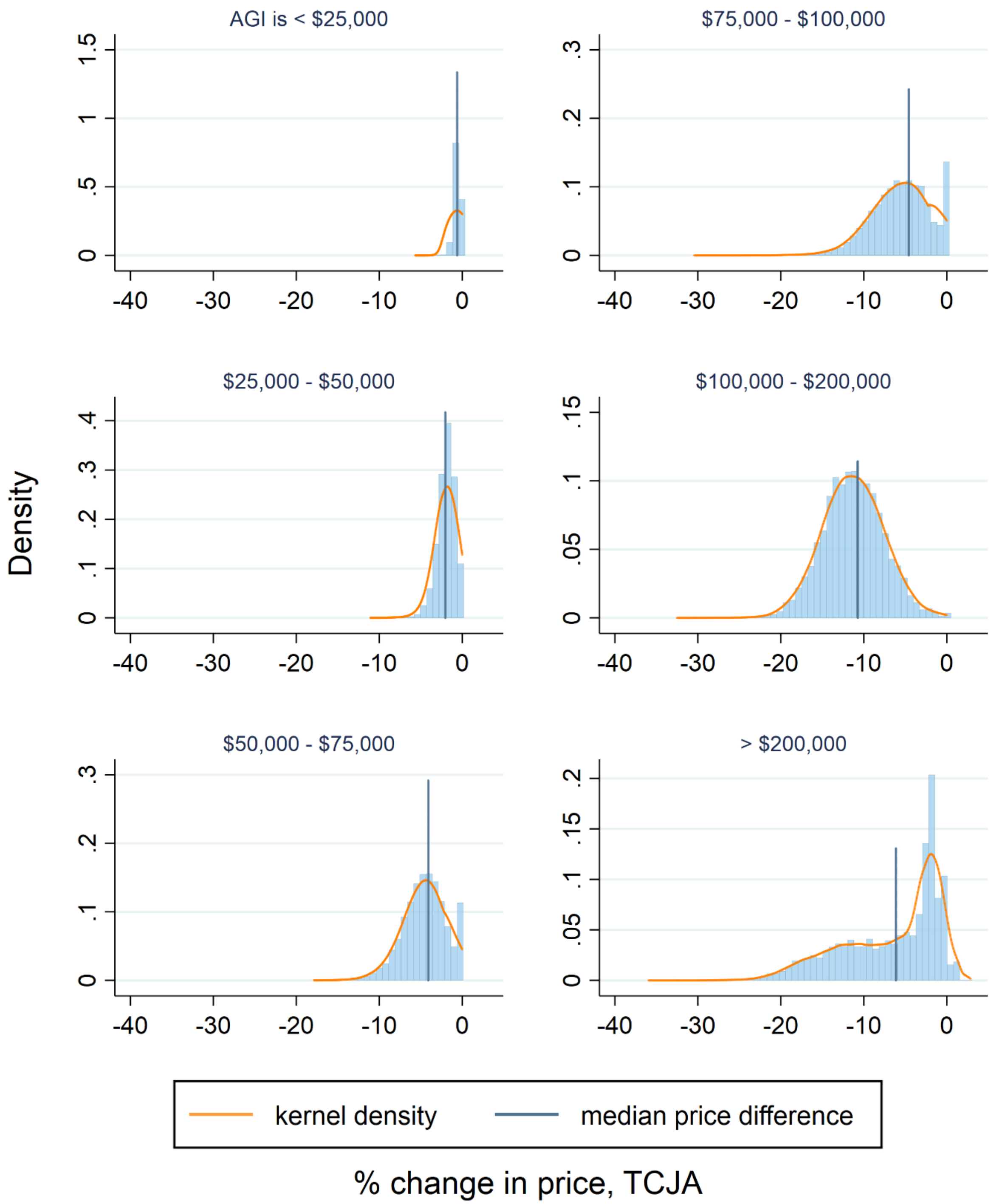


Figure 4. Distribution of Price Changes (Percent Change) from Partial Reforms, Using at the Zip-Code Level

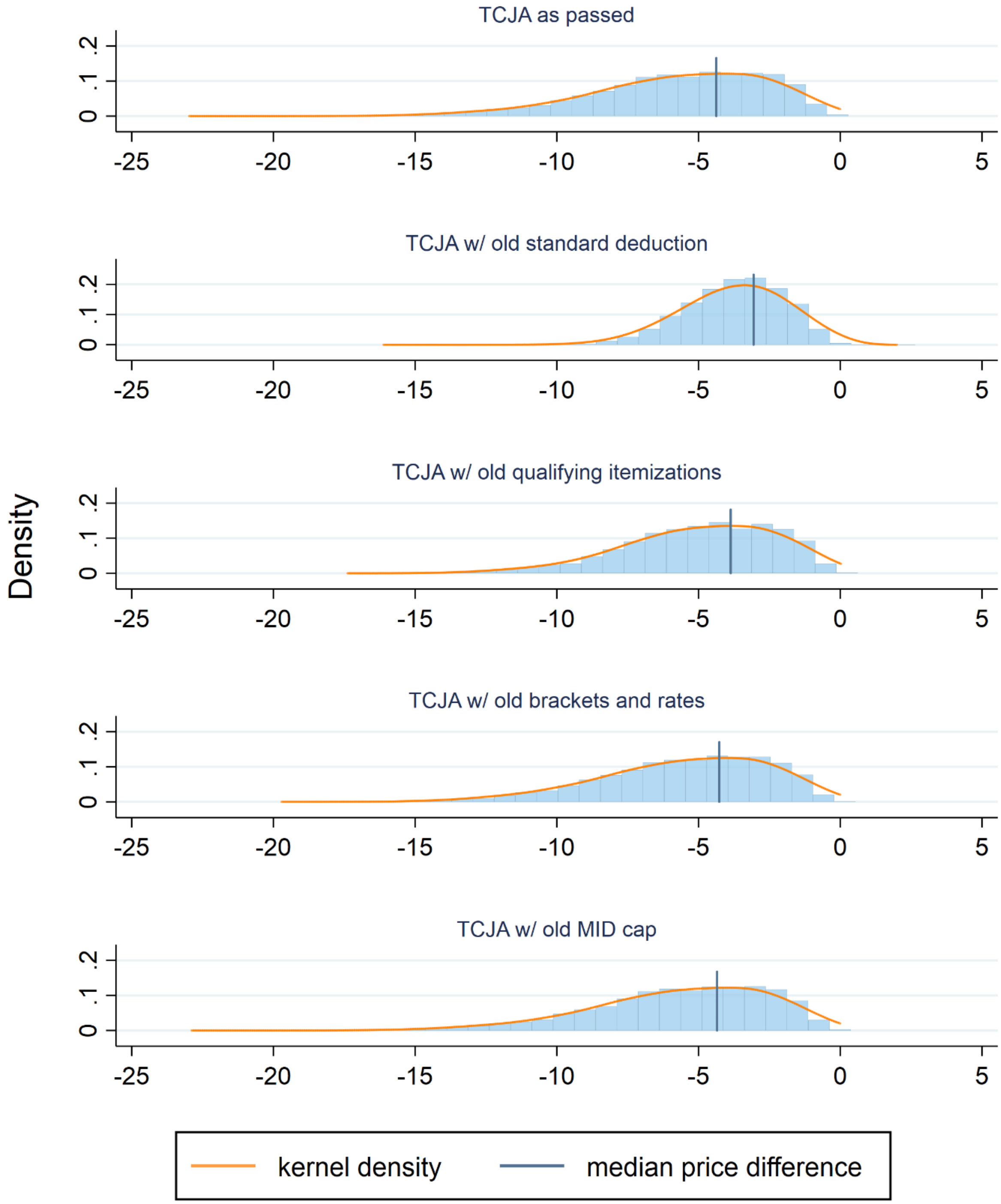


Figure 5. Comparison of Price Changes Under the Full TCJA and the TCJA with the Old Standard Deduction

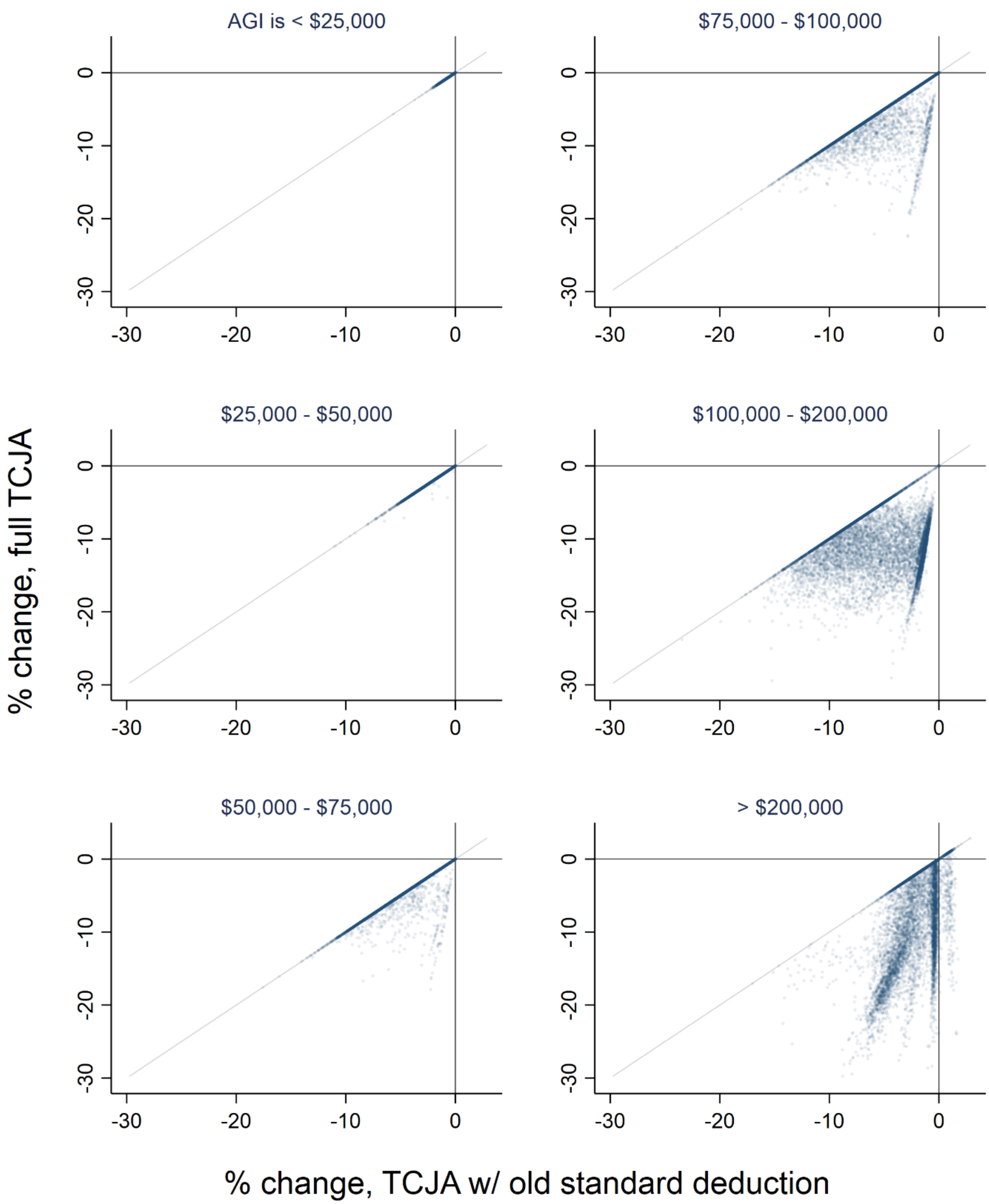


Figure 6. Comparison of Price Changes Under the Full TCJA and the TCJA with the Old Qualifying Deductions

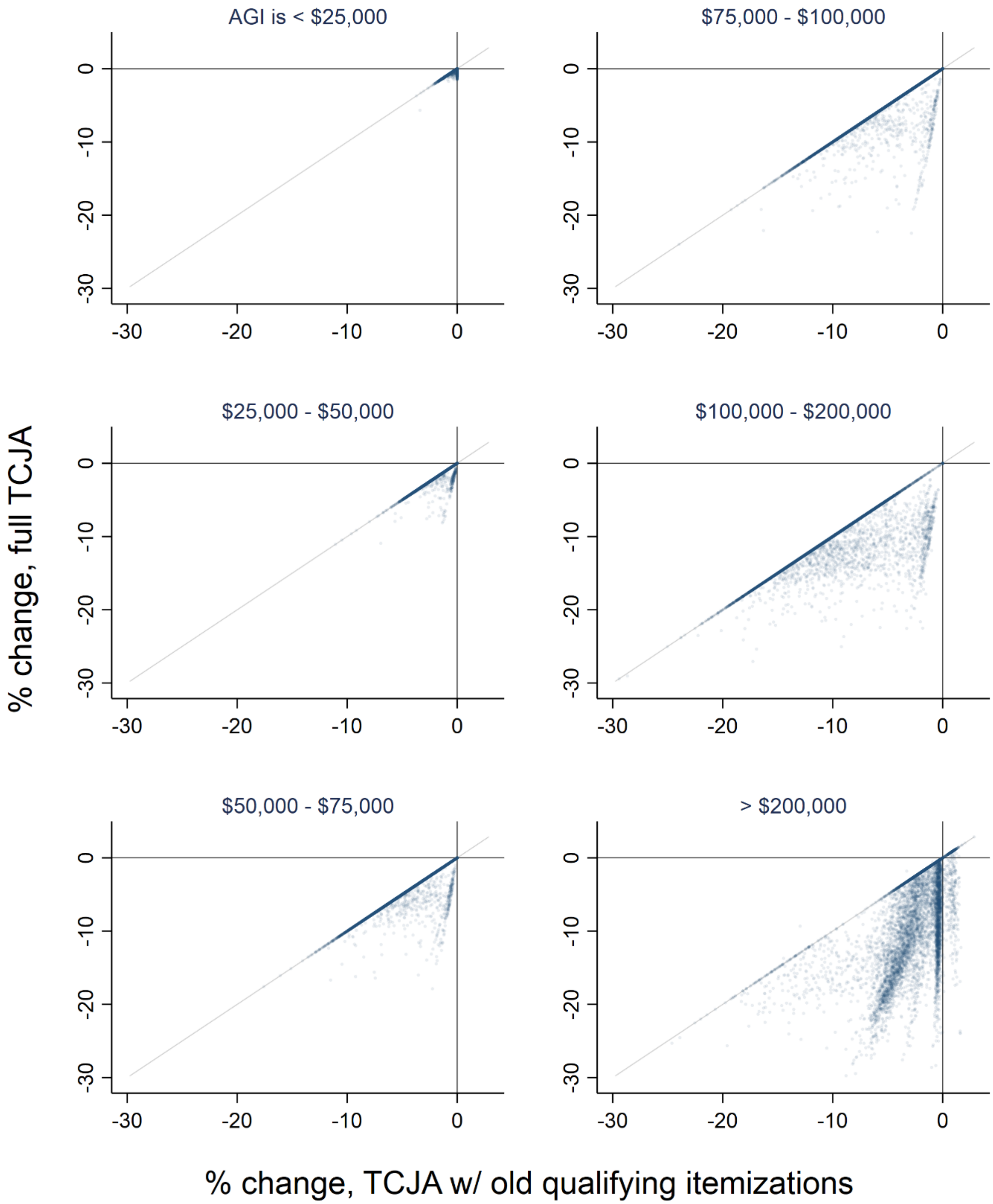


Figure 7. Comparison of Price Changes Under the Full TCJA and the TCJA with the Old Brackets and Marginal Tax Rates

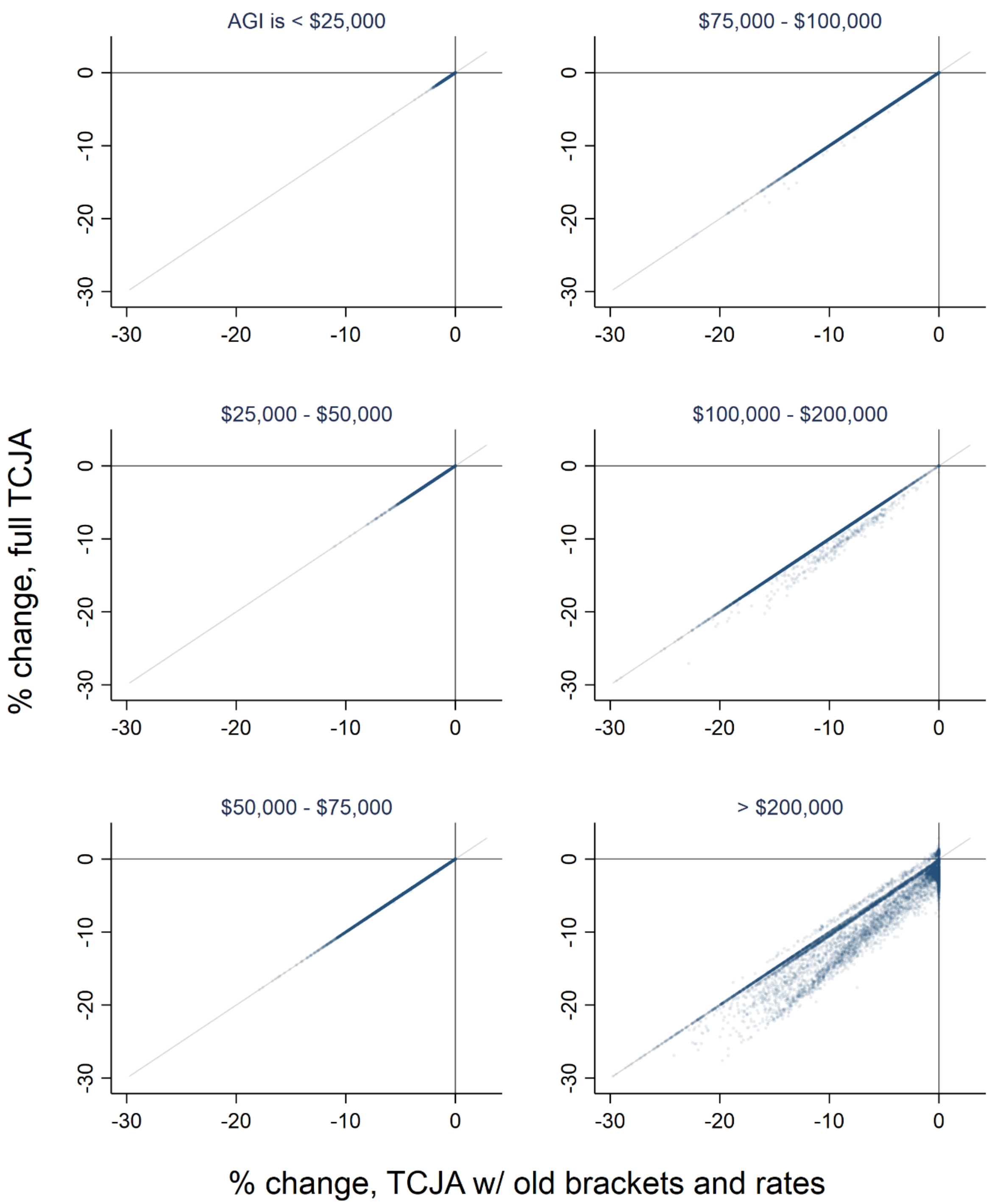


Figure 8. Comparison of Price Changes Under the Full TCJA and the TCJA with the Old Mortgage Balance Cap