Proposition 13: An Equilibrium Analysis*

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Abstract

In 1978, California passed one of the most significant tax changes initiated by voters in the United States. Proposition 13 lowered property tax rates and restricted future property tax increases. In this paper, we study the implications of Proposition 13 on house prices, housing turnover, and household welfare. In our benchmark calibration, the introduction of Proposition 13 leads to a 25% increase in house prices and a 4% decrease in the moving rates. We find that elimination of Proposition 13 in a revenue-neutral way leads to small changes in house prices and modest increases in mobility but large welfare gains.

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Introduction

Property taxes are the largest source of state and local tax revenues in the United States. Economists in general favor property taxes, arguing that they are less distortionary than other taxes. Yet, over the years, voters in many states have passed measures that limit the ability of the government to raise revenues through property taxes. The first voter-approved, state level restriction was enacted in 1978 where Californians passed Proposition 13, which lowered property tax rates, stipulated rolling back property assessments for tax purposes to 1975 market value levels, and restricted future tax increases. This was one of the most significant tax changes initiated by voters in the United States, and since then, 19 other states have passed similar measures.¹

Under Proposition 13, property value assessments are conducted only upon a change in ownership or completion of new construction. In the case of no change in ownership, a property’s assessed value is set equal to its purchase price adjusted upward each year by 2%. Since house prices rose on average 7% a year after its inception, Proposition 13 has led to large differences in the taxes paid by individuals owning similar properties depending on the timing of their purchases.² Because of the implicit tax break enjoyed by homeowners living in the same house for a long time, it has also generated a redistribution in favor of older households and raised concerns about a decline in mobility. Revenue implications of Proposition 13 have also been very significant. California tax revenues as a percent of personal income declined from 13% in 1978 to 10% in 1979. At the same time the share of tax revenues generated through property taxes declined from 40% to 25%.

Despite its popularity among voters, Proposition 13 remains controversial, partly due to its revenue implications, and discussions about its impact and possible modifications continue. Opponents of Proposition 13 point out the large disparities in taxes it generates while proponents passionately argue against any changes to it.³ While Proposition 13 generates continu-

¹See Haveman and Sexton (2008) for a list of the characteristics of property tax assessment limits in these states.

²In 2003, in an interview with the Wall Street Journal, Warren Buffet gave an example of a home he purchased in the early 1970s in Laguna Beach that had a market value of $4 million and carried an annual tax bill of $2,264. He compared this to an adjacent home he purchased in the mid-1990s, which had a market value of $2 million, and a property tax bill of $12,002. The tax rate on the second house was roughly 10 times the rate on the first house.

³Proposition 13 has been politically untouchable for 40 years where numerous proposals
ous attention, very little is known about some of its implications, especially about the potential consequences of its elimination on the housing market.

In this paper, we use a dynamic general equilibrium model to study the implications of Proposition 13 on house prices, housing choices, household mobility, and welfare of households. We examine the impact of introducing Proposition 13 as well as the consequences of its elimination under alternative revenue-neutral regimes. We measure the amount of support different elimination schemes might garner and the kind of voters who are in favor of eliminating it.

Overall, we find that while introducing Proposition 13 leads to a sizable increase in house prices, its revenue-neutral elimination will most likely have a small effect on house prices and mobility regardless of how revenue neutrality is achieved. Steady state welfare gains of reform are quite large and stem mostly from the decline in the tax burden when people are young and borrowing constrained. However, once transitions are taken into account, there is very little support for reform. According to our findings, the case where revenue neutrality is accomplished by a reduction in the sales tax rate generates the highest level of support, and the case where the income tax rate is reduced generates the least amount of support for the reform. Lastly, if property prices increase as a result of the reform, this reduces overall support especially of the renters and the young individuals, the main groups to benefit from such reform.

Our model economy consists of overlapping generations of individuals facing mortality risk, income risk, move shocks, and borrowing constraints. Working-age agents face an inverse U-shaped labor income profile that is subject to idiosyncratic shocks. Older agents are assumed to retire and receive a certain income through Social Security. Retired agents face a constant probability of dying, but on average spend 20 years at that stage. All agents face shocks that may force them to move out of their current homes. Agents start life as renters decide whether to rent or buy, the size of their house, and how much to spend on the consumption of goods every period. They can borrow subject to collateral constraints or accumulate savings. Homeowners pay property taxes annually, and face transaction costs if they sell their homes.

We start by studying an economy without Proposition 13 where the aimed at tweaking it have failed. In 2013, the Democratic Convention in Sacramento pledged to revise Prop. 13, citing its negative impact on state revenues, but lost ground shortly after. In 2015, another proposal to close a loophole associated with the impact of Proposition 13 on commercial real estate was discussed in California. See also, McCarty, Sexton, Sheffrin, and Shelby (2002) and Sexton, Sheffrin, and O’Sullivan (1999).
property tax rate is set at 2.5% (roughly the average property tax rate in California in 1978, before Proposition 13), and the property taxes are calculated based on the current market value of the property. With the introduction of Proposition 13, the property tax rate is reduced to 1%, and property taxes are based on the value of the house at the time it was purchased (adjusted at 2% per year). This second feature results in effective taxes that decline in housing tenure, and therefore by age, distorting housing choices over the life-cycle. In our benchmark calibration, we find that introducing Proposition 13 leads to a 25% increase in house prices and a 4% decrease in the average moving rates. The increase in house prices mainly reflects the present value of the decline in property tax payments and is consistent with the empirical estimates in Rosen (1982).

We make several interesting observations about mobility. Our findings point to a small lock-in effect, especially in economies with high transaction costs and idiosyncratic move shocks. Transactions costs create a major deterrent against frequent moves while the possibility of involuntary move shocks reduce the frequency of the planned moves by individuals. In addition, we find that differences in the level of property taxes also impact mobility. The impact of Proposition 13 on mobility, therefore, depends on the existing transaction costs, move shocks, and the implied change in the property tax rate. These findings may explain why it has been challenging to tease out the lock-in effect of Proposition 13 in empirical studies. For example, Wasi and White (2005) find that, from 1970 to 2000, the average tenure length of owners in California increased by 6% relative to that of owners in comparison states due to Proposition 13. However, Stohs, Childs, and Stevenson (2001) find smaller lock-in effects when they compare single family home sales records in California versus Illinois and Massachusetts. O'Sullivan, Sexton, and Sheffrin (1993) also report a small impact of Proposition 13 on mobility. Similarly, Nagy (1997) reports that the change in mobility between 1975 and 1981 was insignificantly different between three metropolitan areas in California and seven metropolitan areas outside California. To precisely isolate the lock-in effect, Ferreira (2010) examines the behavior of 55-year-old homeowners who, due to some later propositions, were given the privilege to carry the Proposition 13 benefits with them if they purchased a house of equal or lesser value. He finds that this age group has a 30-38% higher likelihood of moving compared to 54-year-olds who do not have the same privilege.

We examine the consequences of eliminating Proposition 13 by removing

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4We define housing tenure as the number of years since the house has been purchased.
the link between housing tenure and property taxes. Everything else being equal, this leads to higher effective property tax rates for individuals who have been living in the same property for a long time and results in higher property tax collections. We conduct several counterfactual experiments where we keep the total tax revenues at the level of the Proposition 13 economy by reducing sales, income, or property tax rates. We find that the elimination of Proposition 13 leads to modest changes in prices, mobility, and housing allocations. Depending on the calibration of the model and the way in which revenue neutrality is achieved, the change in house prices due to the reform ranges between -3% to 4%. Support for the elimination from those alive during the reform is quite mixed and partially depends on how revenue neutrality is achieved. However, the welfare benefit of being born into an economy without Proposition 13 is found to be as high as having 4% higher consumption every period in the economy with Proposition 13.

Our overlapping generations framework with idiosyncratic shocks as well as differences in incomes of different generations creates a rich environment to tease out different aspects of Proposition 13. While the focus of this paper is on Proposition 13, our framework also contributes to the literature on equilibrium models of consumption and housing by constructing a rich and yet tractable model of housing, as in Corbae and Quintin (forthcoming), Anagnostopoulos, Atesagaoglu, and Carceles-Poveda (2013); Favilukis, Ludvigson, and Nieuwerburgh (2012); Sommer and Sullivan (2012); Chatterjee and Eyigungor (2011); Kiyotaki, Michaelides, and Nikolov (2011); Fisher and Gervais (2011); Chambers, Garriga, and Schlagenhauf (2009a,b); Diaz and Luengo-Prado (2008); Ortalo-Magné and Rady (2006); or Davis and Heathcote (2005), among others.

There are several other interesting questions related to Proposition 13 that we do not investigate in this paper. The relationship between the state and the local governments, as well as between the federal and the state government in California, has changed after Proposition 13. The resulting political economy questions and whether or not Proposition 13 was an effective way for voters to curb government spending are beyond the scope of this paper.\footnote{See, for example, McCubbins and McCubbins (2009).} Another important issue, the impact of Proposition 13 on commercial real estate, is left for future research.
1 The Model

1.1 Demographics and income

The economy is populated with overlapping generations of agents who have five life-stages. Every agent in life-stage \( a \) moves into the subsequent life-stage, \( a + 1 \), with probability \( \pi_a \). With probability \( 1 - \pi_a \) the agent spends another period in the same life-stage. The first four life-stages represent the working-age years while the last life-stage represents retirement years. During the first four stages, an individual’s earnings efficiency, \( w^a \), depends on the life-stage, which is meant to capture a deterministic age-earnings profile during the life-cycle. Working age individuals also face a stochastic shock to their income every period, given by \( e_t \), so that in the first four stages of life, the individual labor income, \( y^a_t \), is given by:

\[
\log(y^a_t) = \log(w^a) + e_t, \tag{1}
\]

where \( e_t \) is given by:

\[
e_t = \Theta e_{t-1} + \varepsilon_t. \tag{2}
\]

The disturbance term \( \varepsilon_t \) is distributed normally with mean zero and variance \( \sigma^2 \) and \( \Theta < 1 \) captures the persistence of the stochastic component of labor income. The realization of the current period income shock evolves according to the transition function \( \Gamma(e_t, e_{t-1}) \).

In the last stage of life, individuals are retired and face a certain retirement income. During this stage of life, \( \pi_a \) represents the probability of death. When an agent dies, it is replaced by an agent in the first life-stage.

1.2 Housing

Our framework is similar to Gervais (2002) where individuals can either rent or own houses. Households obtain housing services directly from their housing capital. Housing capital is discrete and the size of houses in the rental market are smaller than the size of the smallest house available for purchase. Thus, in equilibrium, poorer and younger households are on average renters. A new cohort of individuals are born each period and start life with the smallest amount of housing that is available for rent. Individuals have access to the mortgage market, but face a down payment requirement when purchasing a house. Homeowners face transaction costs when they

\(^6\)This feature is similar to Corbae and Quintin (forthcoming) where households go through four life-stages and to Castaneda, Díaz-Gimenez, and Ríos-Rull (2003) where households go through two life-stages.
sell their homes and must pay property taxes annually. Renters do not face property taxes directly. In addition to labor income shocks, individuals face exogenous (involuntary) move shocks, similar to Cocco (2004) that are meant to capture the other reasons for households to move, such as family related shocks, health shocks, changes in employment, or location preferences. Each period, after observing their labor income and move shocks, households make their consumption decisions along with their housing and mortgage arrangements for the next period.

There are financial institutions in the background who pool individuals’ deposits, provide loans to homeowners, and hold residential rental capital. All rental housing units are owned by these financial institutions and turned into housing services via a linear technology. In this framework, the housing stock corresponds to the owner-occupied housing plus the housing stock held by financial institutions. We take the total housing stock, $H$, as fixed.\footnote{This assumption seems reasonable since our main focus is on the transitions after a change in policy. However, even in the long run in California, the per capita supply of single family homes has been relatively stable since the 1970s. We compute per capita housing supply in California by using data from the Census of Housing, which is available every 10 years, and data on housing permits, which is available annually. Between 1975 and 2014, the average per capita supply of single family homes has been between 0.36 and 0.39. Nevertheless, we also present results where housing supply is assumed to be fully flexible.}

We model California as a small open economy and take the interest rate on deposits and mortgages given by the United States market. We assume that agents can either be savers, earning an interest rate of $r^d$ or borrowers in the mortgage market facing a mortgage interest rate of $r^m$. We do not allow uncollateralized borrowing.

1.3 Individual’s problem

Individuals derive utility from a composite of consumption goods and housing services. Let $h_t$ denote the quantity of housing services consumed by an agent at date $t$ and $\bar{h}$ indicate the set of house sizes available for renters. $h_t \in \bar{h}$ indicates an agent who rents, and $h_t \notin \bar{h}$ indicates an agent who is a homeowner. Current homeowners are responsible for paying property taxes and face a transaction cost if they sell their house. We assume that at each period $t$, individuals may receive an idiosyncratic shock that will force them to move to a new house. Let $v_t = 1$ denote the state with the move shock, and $v_t = 0$ denote the state without the shock. For a homeowner, the move shock results in the sale of the current house and triggers the transaction cost of selling. An individual who is a renter may be forced to move as well.
(where they might choose to move to a rental or an owner-occupied house) but does not incur a transaction cost.

Transaction costs, \( F(h_t, h_{t+1}, v_t) \), which are triggered by the sale of a house, are given by:

\[
F(h_t, h_{t+1}, v_t) = \begin{cases} 
\varphi p_t h_t & \text{if } h_t \notin h \text{ and } v_t = 1 \\
\varphi p_t h_t & \text{if } h_t \notin h \text{ and } h_{t+1} \neq h_t \text{ and } v_t = 0 \\
0 & \text{otherwise}
\end{cases}
\]  

(3)

where \( p_t \) is the price of a unit of housing, and \( \varphi \) represents the proportion of the housing value paid as transaction costs such as fees paid to real estate agents. Homeowners who receive a move shock \( (v_t = 1) \) automatically face transaction costs even if they move to an identical house. In the absence of a move shock, homeowners who move to a home of a different size (rental or owner-occupied) face transaction costs. All renters, including those who buy homes \( (h_t \in h \text{ and } h_{t+1} \notin h) \), or homeowners who remain in the same home \( (h_t \notin h \text{ and } h_{t+1} = h_t \text{ and } v_t = 0) \) do not pay the transaction cost.

Property taxes are paid by current homeowners \( (h_t \notin h) \). In the absence of Proposition 13, property taxes are equal to the property tax rate, \( \tau^p_t \), times the value of the house, \( p_t h_t \). With Proposition 13, the value of the house for tax purposes, \( B_t \), depends on whether or not there has been a change in ownership, and is given by:

\[
B_t = \begin{cases} 
(1 + g)B_{t-1} & \text{if } h_t = h_{t-1} \text{ and } v_t = 0 \\
p_t h_t & \text{otherwise.}
\end{cases}
\]  

(4)

For homeowners who stay in the same house, the value of the house for tax purposes grows by \( g \). Finally, total property taxes paid is given by:

\[
T^p_t (h_t) = \tau^p_t B_t.
\]  

(5)

Homeowners are allowed to borrow against the value of the house (mortgage \( m_{t+1} \)), subject to a loan-to-value constraint \( \eta \), given by:

\[
m_{t+1} \leq \eta p_t h_{t+1} \quad \text{if } h_{t+1} \notin h.
\]  

(6)

We do not allow homeowners to default on their mortgages. Renters \( (h_{t+1} \in h) \) do not have access to the mortgage market and are only allowed to save. A negative mortgage represents savings with a deposit rate of \( r^d \).
\[ r = \begin{cases} 
  r^m & \text{if } m_{t+1} > 0 \\
  r^d & \text{if } m_{t+1} < 0. 
\end{cases} \] (7)

We assume that the interest paid on mortgages \((rm_t)\) and property taxes paid \((T^p_t)\) are tax deductible while interest on savings is taxable. Thus, total income taxes paid by an individual before retirement is given by:
\[ T^i_t = \max(0, \tau^i_t[y^a_t - rm_t - T^p_t]), \] (8)
where \(\tau^i_t\) is the labor income tax rate. Social Security income of retired agents is not subject to the income tax. However, the property taxes they pay are still tax deductible from their interest income. Thus, for \(a = 5\), the total income taxes are equal to:
\[ T^i_t = \max(0, \tau^i_t[-rm_t - T^p_t]). \] (9)

In case of the death of an agent, which occurs after the housing and saving decisions are made, the financial institution sells the house and distributes the net assets of all the deceased (accidental bequests) to the agents alive in the next period in a way proportional to their incomes. We denote this inheritance by \(q_t\).\(^8\) Homes depreciate at the rate \(\delta\), and homeowners must pay this fraction of the value of their homes, conceptually maintenance costs, in order to continue living in their home.

An agent’s budget constraint is a function of current and future homeownership status of the agent. A homeowner who continues to be a homeowner (if \(h_t \notin h\) and \(h_{t+1} \notin h\)) faces the following budget constraint:
\[ c_t(1 + \tau^p_t) = y^p_t(1 + q_t) + p_t((1 - \delta)h_t - h_{t+1}) \]
\[ + (m_{t+1} - (1 + \tau)m_t) - T^i_t - T^p_t - F_t. \] (10)
where \(c_t\) represents the non-housing consumption of an agent at time \(t\). The agent pays property taxes \(T^p_t\), and if they move, the transaction cost \(F_t\).

A homeowner who decides to rent in the next period (if \(h_t \notin h\) and \(h_{t+1} \in h\)) is responsible for current property taxes and the transaction cost of selling the house. However, instead of paying for a new house, the agent pays rent, \(rent_t\):
\[ c_t(1 + \tau^a_t) = y_t^a(1 + q_t) + p_t(1 - \delta)h_t - rent_t h_{t+1} + \left( m_{t+1} - (1 + r)m_t \right) - T^i_t - T^p_t - F_t. \] (11)

A renter who decides to buy a house \((h_t \in \mathbb{h} \text{ and } h_{t+1} \notin \mathbb{h})\) is not responsible for property taxes or the transaction cost but pays for the purchase of the new house:

\[ c_t(1 + \tau^a_t) = y_t^a(1 + q_t) + p_t h_{t+1} + \left( m_{t+1} - (1 + r)m_t \right) - T^i_t. \] (12)

A renter who continues to rent \((h_t \in \mathbb{h} \text{ and } h_{t+1} \in \mathbb{h})\) is also not responsible for property taxes or the transaction cost:

\[ c_t(1 + \tau^a_t) = y_t^a(1 + q_t) - rent_t h_{t+1} + \left( m_{t+1} - (1 + r)m_t \right) - T^i_t. \] (13)

The rental rate is determined by the competitive financial institutions such that it covers the depreciation expenditures, property taxes, and the mortgage interest payments, namely:

\[ rent_t = (r^m + \delta + \tau^p_t)p_t. \] (14)

### 1.4 Government

We assume that the state government abides by a balanced budget and finances its government expenditures, \(G_t\), with tax revenues collected through sales, property, and income taxes.

### 2 Equilibrium

Individuals at time \(t\) are heterogeneous with respect to life-stages \(a_t\), assets (mortgage) \(m_t\), housing \(h_t\), employment state \(e_t\), the move shocks they receive, \(v_t\), and the value of their house for tax purposes \(B_t\). Let \(\Gamma(e, e')\) be the transition matrix for labor income, \(\Pi(a, a')\) be the transition function for life-stages and \(\Omega_t\) represent the state \((a, m, h, e, v, B)\) faced by an agent at time \(t\). Let \(\Lambda^a(v')\) be the age-dependent probability for the move shock.
and $V_t(\Omega)$ be the (maximized) value of the objective function at state $\Omega_t$. The dynamic programming problem for the agent is given by:

$$V_t(\Omega) = \max_{c,h'} u(c,h) + \beta \sum_{a'} \sum_{\Omega'} \Pi(a,a') \Gamma(e,e') \Lambda^a(e') V_{t+1} (\Omega')$$

subject to the constraints (1) - (14).

Given a sequence of government policy $\{\tau^i_t, \tau^s_t, \tau^p_t\}_{t=1}^\infty$ and mortgage and deposit rates $\{r^m_t, r^d_t\}_{t=1}^\infty$, a competitive equilibrium is a sequence of value functions $V_t(\Omega)$, individual decision rules for consumption of goods, housing, and mortgage holdings, a measure of agent types $\lambda_t(\Omega)$ and a price of housing $p_t$, such that, for all $t$:

1. Given the house price, the mortgage and deposit interest rates and the government policy, the individual decision rules solve the individual’s dynamic programming problem.

2. $p_t$ clears the housing market

$$\sum_\Omega \lambda_t(\Omega) h_t(\Omega) = \bar{H}$$

where $h_t(\Omega)$ is the optimal housing allocation resulting from the dynamic programming problem of the household.

3. Accidental bequests are given by:

$$q_t = \pi_5 \sum_{m,h,e,v} a = 5 \lambda_t(\Omega) \left[ (1 - \delta)(p_t(\Omega) h_t(\Omega)) - (1 + r) m_t(\Omega) \right] \sum_\Omega \lambda_t(\Omega) y_t^a.$$

Deaths occur (with probability $\pi_5$) after agents of generation five have made their homeownership, mortgage, and savings decisions.

3 Calibration

We mostly use post Proposition 13 data for California to calibrate the initial steady state of the model economy.\textsuperscript{9} For the aggregate statistics where there is no state level data, we use national level data (USA). The time period is

\textsuperscript{9}Excluding data from the Great Recession in our calibration of the steady state does not change our results in any significant way.
selected to be a year. The subjective time discount factor, $\beta$, is assumed to be 0.96, which implies an annual subjective time discount rate of 4.2 percent. The per period utility function is given by:

$$U(c_t, h_t) = \frac{\bar{c}_t^{1-\sigma}}{1-\sigma}$$

where

$$\bar{c}_t = \left[c^\chi h_t^{1-\chi}\right].$$

(17)

The relative weight of consumption in the utility function, $\chi$, is set so that the share of non-housing consumption is approximately equal to 0.71 as in the United States data. The risk aversion parameter in the utility function impacts the saving behavior of the households. We set this equal to 5 in our benchmark case as it helps the model match net financial wealth to income data better than lower values for this parameter that are more typical in the macro literature. In Section 5, we check the sensitivity of our results for the case where the risk aversion parameter is set to 2.

Agents live through five life-stages. They work during the first four life-stages, on average representing ages 21-31, 32-42, 43-53, and 54-64 and are retired in the last life-stage representing ages 65-84. They face a constant probability $\pi_a$ of moving from life-stage $a$ to the next life-stage $a + 1$. We set $\pi_a$ such that agents, on average, spend eleven years in the first four stages of life, and twenty in the last. This implies $\pi_a = 0.09$ for the first four life-stages. In the last life-stage, $\pi_a = 0.05$ represents the probability of death. The transition function $\Pi(a, a')$ for life-stages is given by:

$$\Pi(a, a') = \begin{bmatrix}
0.91 & 0.09 & 0 & 0 & 0 & 0 \\
0 & 0.91 & 0.09 & 0 & 0 & 0 \\
0 & 0 & 0.91 & 0.09 & 0 & 0 \\
0 & 0 & 0 & 0.91 & 0.09 & 0 \\
0 & 0 & 0 & 0 & 0.95 & 0.05
\end{bmatrix}.$$  

In the data, there are significant differences in the probability of moving across age groups. While the overall mobility across all ages is 12.5%, it declines sharply by age. We calibrate the exogenous move shocks for agents in each life-stage such that the resulting moving rates by age, which are the results of both exogenous and endogenous moves, mimic their counterparts.

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10The share of non-housing consumption to income is calculated from National Income and Product Accounts. We calculate non-housing consumption as the personal consumption expenditures net of housing, furnishing, and utilities. Income is the sum of compensation of employees, proprietor’s income, and personal current transfers.
These exogenous move probabilities (for $v' = 1$) are given by \( \Lambda = [0.30, 0, 0.02, 0.06, 0.03] \) for life-stages 1-5, respectively.

During the working years (first four life-stages), individual labor income, \( y^a_t \), is given by:

\[
\log(y^a_t) = \log(w^a) + e_t,
\]

where, \( w^a \) captures the life-cycle age-earnings profile, and \( e_t \) represents the idiosyncratic component of labor income. \( w^a \) is calibrated to match the earnings profile of the agents with median lifetime earnings, computed by Guvenen et al. (2015), and takes the values \([0.58, 1.00, 1.25, 1.55]\) for life-stages 1-4, respectively. \( e_t \) is based upon the estimates in Storesletten et al. (2004):

\[
e_t = \Theta e_{t-1} + \varepsilon_t
\]

where we take \( \Theta = 0.95 \) and \( \sigma^2_e = 0.01 \). We approximate this income process with a four-state Markov chain using the methodology presented in Adda and Cooper (2003). The discretized values for \( e_t \) are:

\([–0.41, –0.10, 0.10, 0.41]\)

and the transition matrix is:\(^{13}\)

\[
\Gamma(e, e') = \begin{bmatrix}
0.84 & 0.16 & 0.00 & 0.00 \\
0.16 & 0.64 & 0.20 & 0.00 \\
0.00 & 0.20 & 0.64 & 0.16 \\
0.00 & 0.00 & 0.16 & 0.84
\end{bmatrix}.
\]

During retirement, agents receive 40% of the average employed earnings.\(^{14}\) Note that in this framework, life-stage captures the earning capabilities of agents and not their actual age. Therefore, some agents may end

\(^{11}\)The data are from IPUMS for the years 2000 - 2007. The probability of moving is the sum of people moving within state or out of state divided by the total number of households in that age group. Our data includes both homeowners and renters.

\(^{12}\)Guvenen et al. (2015) document that the median worker experiences much lower earnings growth over the life-cycle than the mean earnings growth computed from the entire sample. We target the earnings profile for the median earners for ages 25-60, such that the age-income profile for the median earners in the model mimics its counterpart in the data. See Section 7.2 for more details.

\(^{13}\)While we do not allow agents to strategically default on their mortgages, in the presence of income and move shocks, accidental defaults (or negative consumption) can be an issue. We confirmed that in our simulations agents always stay away from choices that could make accidental default a possibility.

up spending more or less than the average years in a given earnings stage, leading to, for example, some agents being “poor” for a long time. This feature of the model generates an increase in the dispersion of earnings by age that is present in the data but is difficult to generate in typical overlapping generations models.\(^{15}\)

We set the income tax rate (federal+state), \(\tau^i\), at 21% based on McDaniel (2007). The sales tax rate, \(\tau^s\), and the property tax rate, \(\tau^p\), are set to 10% and 1%, respectively. The resulting average tax revenues to income (and average government expenditures to income) is 25%. In our simulations, we investigate the consequences of changing each one of these tax rates separately in order to conduct revenue-neutral experiments.

We treat California as a small open economy and set the mortgage interest rate and the rate of return on deposits as constant at 4.2% and 1.7%, respectively.\(^{16}\) The transaction cost of selling a house is assumed to be 6%, which, according to Gruber and Martin (2003), is on the conservative side of the estimates. However, given the changes in this industry with online brokers and agents, we also investigate the sensitivity of our results to lower transaction costs. We set the maximum loan-to-value, \(\eta\), at 80%. Table 1 summarizes the parameters used in our baseline calibration.

The parameter \(g\) in equation (4) captures the part of Proposition 13 that restricts the nominal growth in house values for tax purposes to 2% annually. In a world where house prices increase by more than 2% per year, this implies a decline in the real value of a house for tax purposes. We calibrate \(g\) to capture this decline. Since the late 1970s, nominal per capita income in California has grown by 5.2%.\(^{17}\) In a model with exogenous growth of per capita incomes, nominal house values for tax purposes would have also grown by 5.2%. During the same period, house prices in California have increased by 6.9% on average, implying approximately a 5% decline in real tax base due to Proposition 13.\(^{18}\) To capture the full effect of Proposition 13, we calibrate \(g\) to -5%. As we will show in Section 4.1, this \(g\) generates a decline in the effective property taxes by age that is similar to the one observed in

\(^{15}\)In our model, the variance of log income over ages increases from 9% at age 21 to 40% at the age of 60. Heathcote, Perri, and Violante (2010) report a similar increase in the variance of log wages using several different controls and data sets (their figures 14 & 15).

\(^{16}\)This mortgage rate corresponds to the average 30 year fixed mortgage rate from Freddie Mac since the 1970s, adjusted for inflation. Over the same time period, the real saving rate (based on one-year Treasury rate, 6-month CD rate, and 6-month Euro Dollar deposit rate) ranges between 1.4% and 2%. We picked the mid-point and set the saving rate to 1.7%.

\(^{17}\)Bureau of Economic Analysis, regional NIPA data.

\(^{18}\)Data from FHFA house price index.
Table 1: Calibration of the Steady State

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\chi$</td>
<td>relative weight of $c$ in utility</td>
<td>0.7</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>relative risk aversion</td>
<td>5</td>
</tr>
<tr>
<td>$\beta$</td>
<td>time discount factor</td>
<td>0.96</td>
</tr>
<tr>
<td>$\delta$</td>
<td>housing depreciation rate</td>
<td>2%</td>
</tr>
<tr>
<td>$\eta$</td>
<td>maximum loan-to-value</td>
<td>80%</td>
</tr>
<tr>
<td>$\pi_a$</td>
<td>prob. of advancing to next life-stage</td>
<td>9% for $a=1-4$; 5% for $a=5$</td>
</tr>
<tr>
<td>$w^a$</td>
<td>life-stage efficiency profile</td>
<td>0.58, 1.00, 1.25, 1.55, 0.4</td>
</tr>
<tr>
<td>$r^m$</td>
<td>mortgage interest rate</td>
<td>4.2%</td>
</tr>
<tr>
<td>$r^d$</td>
<td>deposit interest rate</td>
<td>1.7%</td>
</tr>
<tr>
<td>$\tau^p$</td>
<td>property tax rate</td>
<td>1%</td>
</tr>
<tr>
<td>$\tau^s$</td>
<td>sales tax rate</td>
<td>10%</td>
</tr>
<tr>
<td>$\tau^i$</td>
<td>income tax rate</td>
<td>21%</td>
</tr>
<tr>
<td>$\phi$</td>
<td>transaction cost of selling a house</td>
<td>6%</td>
</tr>
</tbody>
</table>

the data, allowing us to capture the benefit of Proposition 13 for different age groups properly.\textsuperscript{19}

We implement Proposition 13 by keeping track of the number of years that an agent has stayed in the same house. We choose 30 grid points for the possible number of years an agent may stay at the same house. For each year a house is unsold, we lower the value of the house for tax purposes by 5% up to 30 years. The house value for tax purposes remains constant after 30 years. We examine the sensitivity of our results to different values of $g$ in Section 5.

We calibrate the housing grid based on data on the square footage of houses for homeowners and renters from the U.S. Census Bureau, American Housing Survey 2013. We normalize the average home size to 2, and let the agents choose from two different rental sizes (1 and 1.5) and four different sized owner-occupied units (1.75, 2.25, 3, and 4.5).\textsuperscript{20} The size of the rental units correspond to 33rd and 66th percentile of the size distribution of rentals, while the size of the owner-occupied units correspond to 33rd, 50th, 75th, and 95th percentiles of owner-occupied units in the data. With this calibration, we are able to match the homeownership rate by age observed in the data reasonably well (see Section 4.1).\textsuperscript{21}

\textsuperscript{19}We examine the sensitivity of our results to different levels of $g$ in Section 5.
\textsuperscript{20}Average home size is 1,739 square feet in the data. See Section 7.2 for more details.
\textsuperscript{21}We check the sensitivity of our results to the grid on housing in Section 5.
The state variables in the dynamic programming problem consist of life-stages $a_t$, (net) assets (where negative values represent saving, positive values represent mortgage) $m_t$, housing $h_t$, employment state $e_t$, move shock $v_t$, and the value of their house for tax purposes $B_t$. Average labor income is normalized to 1. We have 5 grid points for life-stages, 76 grid points for mortgage (ranging from -9.9 to 3.6), 6 values for housing (ranging from 1 to 4.5), 4 values for idiosyncratic labor income, 2 values for move shocks, and 30 values for $B$, all together resulting in 547,200 possible combinations of states.

4 Results

We start this section by examining the properties of the benchmark economy. We show that the model economy is able to mimic some of the key observations in the data about housing, and the tax implications of Proposition 13 over different age groups. Next, we examine the consequences of implementing Proposition 13 on house prices, housing allocations, and mobility. Finally, we examine the implications of eliminating Proposition 13 by collecting property taxes based on the current market value of the property.

4.1 Properties of the Model Economy

In order to assess if this framework presents a good platform to conduct our counterfactual experiments, we examine several key statistics generated by the model that we expect to be important for our analysis.

We start by comparing the homeownership rate and housing and non-housing consumption generated by the model to their data counterparts.\textsuperscript{22} The model generates an average homeownership rate of 67% which is closer to the nationwide rate of 66% and somewhat higher than the California rate of 56%.\textsuperscript{23} In Table 2, we present homeownership rate by age in California and the one generated by the model. The model captures the increase in the homeownership rate by age reasonably well.\textsuperscript{24}

\textsuperscript{22}In cases where data are not readily available for California, we make comparisons with the U.S. data.
\textsuperscript{23}The nationwide homeownership rate is from the Census Bureau and is an average of all years since 1978. California data are from IPUMS, ownership of primary residence, available for years 1990 and then 2000-2012. We report the averages for these years.
\textsuperscript{24}The model’s performance in matching the data on homeownership rate by age is similar to those in the literature, such as Chambers, Garriga, and Schlagenhauf (2009a,b) and Fisher and Gervais (2011).
Table 2: Homeownership Rate

<table>
<thead>
<tr>
<th>Age</th>
<th>22-34</th>
<th>35-49</th>
<th>50-64</th>
<th>65-74</th>
<th>75-88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>0.29</td>
<td>0.62</td>
<td>0.77</td>
<td>0.81</td>
<td>0.80</td>
</tr>
<tr>
<td>Model</td>
<td>0.19</td>
<td>0.64</td>
<td>0.85</td>
<td>0.91</td>
<td>0.93</td>
</tr>
</tbody>
</table>

In Figure 1, we display housing and non-housing consumption over the life-cycle generated by the model. Empirical evidence presented in Jeske (2005) and Yang (2009) point out that the consumption profile of non-housing goods is hump-shaped while the consumption profile of housing is not. Our model does indeed generate different life-cycle profiles for housing and non-housing consumption despite the standard Cobb-Douglas utility function we have used. Yang (2009) shows that borrowing constraints are important for the slow accumulation of the housing stock early in life and transaction costs lead to the slow downsizing of the housing stock later in life. In our setup, in addition to the borrowing constraints and transaction costs, Proposition 13 further contributes to the slow downsizing of housing in the old age.

The model also generates a reasonable house price. The ratio of median house price to median income in California has been roughly 5.1 since 1980.\textsuperscript{25} The same ratio generated by the model is equal to 4.2.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Housing and Non-Housing Consumption over the Life-Cycle}
\end{figure}

Given that the focus of our paper is on the effect of property taxation across ages, it is important that the model economy is calibrated to cap-

\textsuperscript{25}We compute the ratio for 1980, 1990, 2000, and 2009-2013 using median house price and household income data for California from the Census Bureau. The ratio was 4.6, 5.5, 4.5, and 6 in those years, respectively.
ture the tax burden faced by individuals of different ages properly. Figure 2 displays the effective property tax rate by age in the model and the data.26 The declining pattern of tax rates by age reflects one of the implications of Proposition 13. People who had purchased their homes in the past, predominantly the older households, pay lower effective taxes as the value of their house for tax purposes remains lower than its actual market value. The model captures the magnitudes of the tax burden by age reasonably well. However, in the data there is a small benefit of Proposition 13 even for the youngest agents whose effective tax rate is slightly below 1%. These people probably had inherited homes and their tax status, which is not included in the model.27

Figure 2: Effective Property Tax Rates over the Life-Cycle

In another attempt to investigate if our model economy captures the benefits of Proposition 13 properly, we examine the magnitude of property taxes paid as a percent of income by age with and without Proposition 13. The first panel in Figure 3 presents the actual data for property taxes paid as a percent of income as well as results of a counterfactual case where we apply a 1% flat property tax rate to the reported house values and divide it by income.28 The growing difference between the two lines captures how the benefits of Proposition 13 increase with age in the data. For example,
abolishing Proposition 13 results in property taxes to increase from roughly 5% of income to 10% of income for an 80-year-old person.

The second panel in Figure 3 displays property taxes as a percent of income for the economy with Proposition 13 simulated from the model, and the counterfactual case with a 1% flat property tax rate. The magnitude of the tax to income ratio is slightly smaller in the model than in the data. However, the relative gain due to Proposition 13 in the model is similar to its counterpart in the data. For example, for an 80-year-old, elimination of Proposition 13 leads to an 88% increase in their property tax to income ratio (from 4.8% to 9%).

There is a dimension along which the model does not mimic the data well. The Gini coefficients generated by the model for income (0.32) and wealth (0.58) are lower than their data counterparts. According to Castaneda, Díaz-Gimenez, and Ríos-Rull (2003), the earnings and wealth Gini in the data are 0.63 and 0.78, respectively. Since the main impact of Proposition 13 is expected to be across generations, however, we have chosen a simpler income process than the ones that are capable of mimicking the income and wealth distribution in the U.S., such as the income process used in Castaneda, Díaz-Gimenez, and Ríos-Rull (2003).

Overall, we conclude that our framework provides a reasonable laboratory for examining the implications of Proposition 13, as well as the potential consequences of its elimination, on house prices, mobility, and welfare.
4.2 Economies with and without Proposition 13

We start this section with a summary of the steady state characteristics of economies with and without Proposition 13. Next, we examine the impact of eliminating Proposition 13 (in particular eliminating the link between the value of the house for tax purposes to housing tenure) on housing allocations, house prices, and welfare, taking into account the behavior of the agents during the transition to the new steady state.

4.2.1 Steady-State Comparisons

In this section, we report information on house prices, mobility, and welfare in economies with and without Proposition 13. Table 3 reports the steady state house prices for several different economies. The first row presents the economy prior to Proposition 13, where the property tax rate is 2.5%, and property values for tax purposes are equal to their market values. Proposition 13 introduces two major changes to property taxation. It reduces the property tax rate to 1%, and limits the growth rate of the value of the house for tax purposes following its purchase. The second feature results in effective tax rates that decline by housing tenure, and therefore by age. In fact, the average effective tax rate in this economy is 0.7%. We label this case as the Post-1978 case. We normalize the price in the Proposition 13 economy to 100 and present all other house prices relative to this benchmark. We find that the implementation of Proposition 13 leads to a 25% increase in house prices. This increase in house prices reflects the present value of the decline in the future property tax payments.\(^{29}\)

<table>
<thead>
<tr>
<th></th>
<th>House Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1978 (2.5% flat property tax)</td>
<td>79.8</td>
</tr>
<tr>
<td><strong>Post-1978 (Proposition 13)</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Experiment 1 (0.7% flat property tax)</td>
<td>101.4</td>
</tr>
<tr>
<td>Experiment 2 (sales tax)</td>
<td>97.5</td>
</tr>
<tr>
<td>Experiment 3 (income tax)</td>
<td>100</td>
</tr>
</tbody>
</table>

In order to disentangle the effects of the two features of Proposition 13 on house prices, we examine a counterfactual case (Experiment 1) where the property tax rate is 0.7%, and the growth rate of the value of the house for tax purposes is limited to 1%.

\(^{29}\)The capitalization effect of the decrease in the property tax rate found in this experiment is consistent with the empirical estimates in Rosen (1982), who reports that across different jurisdictions in California, each dollar reduction in property taxes due to Proposition 13 led to seven dollars increase in property values.
only change relative to the pre-1978 case is the reduction in the property tax rate from 2.5% to 0.7%, the average effective tax rate under Proposition 13. Thus, total revenues collected in the Proposition 13 economy and the economy in Experiment 1 are the same; the only difference between the two cases is that, in Experiment 1, the value of a house for tax purposes is not related to housing tenure. We find that in this case, house prices increase by 27% compared to the Pre-1978 case (from 79.8 to 101.4). This comparison reveals that the increase in house prices would have been slightly higher if it were not for the link between property assessments and housing tenure. Distortions due to Proposition 13 limit the growth of house prices to 25%.

Comparison of the housing allocations over the life-cycle in Proposition 13 economy to those in Experiment 1, plotted in Figure 4, gives an idea about the life-cycle aspect of the distortion created by Proposition 13. On average, Proposition 13 leads to slightly lower housing consumption for the young and the middle-aged agents. Young people try to buy their first homes earlier and start accumulating Proposition 13 benefits, their first homes turn out to be smaller. Since moving implies the loss of their tax benefits, these agents are hesitant to move to larger homes as their incomes rise. The same mechanism leads to higher housing consumption in older agents: Even though incomes decline in retirement, many agents do not downsize their homes, and end up with rather steep housing allocations over the life-cycle. Such distortions in housing allocations lead to slightly lower house prices in the Proposition 13 economy.

In addition to Experiment 1, we consider two additional scenarios where Proposition 13 is eliminated and replaced with economies with 1% flat property tax rate, while total tax revenues are kept constant by lowering the sales tax (Experiment 2) or the income tax rate (Experiment 3) below their benchmark levels. In Experiment 2, a reduction in the sales tax rate from 10% to 7.7% allows government revenues to stay unchanged. In Experiment 3, a reduction in the income tax rate from 21% to 19.4% keeps the government revenues constant as we eliminate Proposition 13. Our results indicate that house prices may slightly increase or decrease relative to Proposition 13 levels, depending on how revenue-neutrality is achieved.  

\footnote{In the Appendix, using a simple model that abstracts from Proposition 13 and transaction costs, we examine the relationship between house prices and different taxes analytically. We show that, everything else being equal, changes in the sales tax rate have no effect on house prices, whereas lower property and income tax rates lead to higher house prices. Reduction in the property tax rate is entirely capitalized in house prices, leading to the highest house prices, while a lower income tax rate is partially captured by house prices. On the other hand, with Proposition 13, the link between housing tenure...}
Among our three revenue-neutral experiments, house prices turn out to be highest in the lower property tax case (Experiment 1). Elimination of Proposition 13 leads to a 1.4% increase in house prices in this case. This increase in house prices is entirely due to the elimination of the link between the property tax assessments and housing tenure, since effective average property taxes are the same in these two economies. In Experiments 2 and 3, the property tax rate is higher at 1%, while the other taxes are lower. House prices are slightly lower in Experiment 2. A decline in the sales tax does not have a direct impact on house prices, while the other two policies, namely higher property taxes and elimination of the link between property taxes and housing tenure, have opposite effects, resulting in the slightly lower prices found in Experiment 2. In Experiment 3, house prices remain the same as in the Proposition 13 economy. The effect of higher property taxes is offset by the effect of the lower income tax rate and the elimination of the Proposition 13 distortion. Overall, all the price changes we find are quite modest. It is important to note that our assumption about a fixed housing supply allows us to capture the upper-bound on the changes in

and property assessments creates a distortion in housing allocations that depresses house prices. The overall change in house prices due to elimination of Proposition 13, therefore, reflects the relative impact of the changes in different taxes and the elimination of this distortion.
house prices. If the housing supply were allowed to adjust, the change in house prices would be even smaller.

The results of the revenue neutral experiments reinforce our interpretation that the increase in house prices that happened after the implementation of Proposition 13 were mainly due to the lower property taxes associated with it, and the elimination of Proposition 13 in a revenue-neutral way is unlikely to lead to significant changes in house prices.

<table>
<thead>
<tr>
<th>Moving rate %</th>
<th>Age Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>Pre-1978 (2.5% tax)</td>
<td>13.0</td>
</tr>
<tr>
<td>Post-1978 (Prop. 13)</td>
<td>12.5</td>
</tr>
<tr>
<td>Experiment 1 (0.7% tax)</td>
<td>12.8</td>
</tr>
</tbody>
</table>

In Table 4, we examine the consequences of Proposition 13 on mobility. The moving rate, measured as the number of households that move in a given year as a fraction of total number of households, is 12.5% for the Proposition 13 economy. As explained in the calibration section, exogenous move shocks are used to calibrate the economy with Proposition 13 to generate moving rates that mimic the data, and assumed to stay the same in all experiments. Comparison of the moving rates in the Pre-1978 economy to Post-1978 economy reveals the impact of Proposition 13 on mobility. We find that Proposition 13 leads to a modest 3.5% decrease in the moving rate, from 13% to 12.5%.

Why is the effect of Proposition 13 on mobility so small? The answer lies within the additional mechanisms that have a major effect on mobility, namely the transaction costs and the move shocks. Transactions costs, which are assumed to be 6% in the calibrated economy, are already major deterrents against frequent moves. Move shocks, on the other hand, force agents into moving, hence increasing mobility. However, since the agents anticipate the possibility of these forced moves in the future, they reduce the frequency of their planned moves, and coincide their moves with the move shocks they receive. Both these channels create substantial distortion in housing allocations. The additional distortion created by Proposition 13 is somewhat limited and therefore its elimination does not have a big impact on mobility.\footnote{In Section 5, we examine the consequences of eliminating Proposition 13 in an economy} In addition, we find that a decrease in the property tax rate
also results in lower mobility, especially for younger households, even when there is no link between housing tenure and effective taxes. For example, the decline in the tax rate from 2.5% in the Pre-1978 economy to a flat tax rate of 0.7% (Experiment 1) results in a 1.6% decrease in mobility (from 13% to 12.8%). The lower tax rate in Experiment 1 results in higher house prices and therefore higher transaction costs. Mobility declines as higher transaction costs discourage individuals from moving. Furthermore, bad income shocks are more likely to force agents (especially the younger households who face tighter borrowing constraints) to move to smaller homes when property tax rates are high. This experiment reveals that it may be incorrect to blame the entire decline in mobility on the lock-in effect of Proposition 13. Part of the decline in mobility happens due to the indirect effects of lower tax rates.

Elimination of Proposition 13 results in a small overall increase in mobility, about 2% (from 12.5% to 12.8%), for all the revenue-neutral cases considered. However, while the overall effect is quite small, the effects on the move rates for individuals from different age groups, also reported in Table 4, are more interesting. Elimination of Proposition 13 leads to roughly 10% increases in the moving rates of the middle-aged and older individuals, while it leads to a slight decline in the mobility of the youngest people. Without the lock-in effect of Proposition 13, young people stay longer in rentals before their first home purchases, while middle-aged individuals find it easier to move to larger houses as their incomes rise. Also, the oldest agents (75+) find it easier to move to smaller homes.

Finally, we examine the welfare implications of being born into an economy with or without Proposition 13 by asking how much an individual’s non-housing consumption has to be increased (keeping housing constant) in an economy with Proposition 13, so that his expected future utility equals his utility under the economy without Proposition 13. We find that the welfare gains of being born into an economy without Proposition 13 is 1.4% in the case of lower property taxes (Experiment 1), 3.5% in the case with lower sales taxes (Experiment 2), and 2.9% in the case with lower income taxes (Experiment 3). The welfare benefits, especially in the latter two cases, are quite large, and stem mostly from the decline in the tax burden while the agents are young and borrowing constrained. The lower welfare benefit obtained in the case with lower property taxes (Experiment 1) is partly due to the increase in house prices that takes place in this case, which is disliked by most agents in this framework.\footnote{We find that almost all agents dislike higher property prices. This is because housing} The opposite is true for the higher welfare with no transaction costs and no involuntary move shocks.
benefit in Experiment 2.

All three revenue-neutral cases allow agents to allocate housing more optimally over their life-cycle, removing the distortion due to Proposition 13. However, the tax implications of these three cases over the life-cycle, as well as their implications on house prices, are different. Figure 5 displays the average total taxes paid as a fraction of income, by age, in the economy with Proposition 13 versus the economies without Proposition 13 for each of the revenue-neutral cases. Overall, elimination of Proposition 13 leads to a significant decline in the tax burden faced by young individuals, especially when revenue-neutrality is achieved via lower income tax rates (Experiment 3). For an agent in her early 20s, there are 0.7 to 1.4 percentage point declines in the tax burden in the economies without Proposition 13, which contribute to the size of the welfare gains. Reform with lower property taxes leads to the smallest decline in the tax burden of the younger agents, which makes reform less desirable for those households. Increasing house prices further reduce the attractiveness of this reform. While reform with lower sales taxes doesn’t provide the largest drop in the tax burden of the young, lower house prices in this case makes this the most attractive reform for the young. On the other hand, the tax burden of the older agents increases significantly in all cases, 1.5 to 3.5 percentage points for the average 90-year old agent.

So far, we assumed a constant housing supply, partly because we are interested in capturing the full impact of Proposition 13 on house prices. In the absence of quantity adjustments, house prices absorb all the changes in housing demand resulting from changes in the tax regime. The price changes we report in Table 3, therefore, represent an upper bound. However, housing supply may change, especially in the long run. In fact, we find that small changes in the housing supply are sufficient to keep house prices constant. This impacts the welfare consequences of the first two experiments where prices are changing. With a flexible housing supply, the welfare gain of being born into an economy without Proposition 13 increases to 2.2% in Experiment 1 since the young agents no longer face the negative effects of higher prices. For the opposite reasons, welfare benefits of eliminating Proposition 13 decreases to 2% in Experiment 2. Nevertheless, all the welfare

is a consumption good, and higher house prices imply higher consumption prices. Owning a house does not provide a complete hedge against higher consumption prices because of proportional ownership costs such as property taxes and maintenance (depreciation) and uncertain life spans.

About a 1.25% increase (decrease) in housing supply is needed to keep prices constant when revenue neutrality is achieved via property taxes (sales taxes).
effects we find are quite large.

Of course, steady state welfare results do not properly capture the level of support that may be generated for the elimination of Proposition 13 at a given point in time. To examine this issue further, we turn our attention to modeling transitions from a steady state with Proposition 13 to another one without Proposition 13.

### 4.2.2 Transitions

We now assume that the economy starts in a steady state where property taxes are determined under Proposition 13. At the beginning of period 2, the government announces an unexpected change in tax policy and eliminates Proposition 13. From that period on, agents adjust their behavior, anticipating a future where effective property tax rates remain flat. After a number of periods, the economy converges to a new steady state without Proposition 13. During the transition, agents change their housing allocations to reach their optimal allocations in a world without Proposition 13. We examine the impact of tax policy changes by analyzing the changes in house prices and housing allocations along the transition to the new steady state.
Even though house prices experience small changes, it usually takes around 20 periods for the prices to completely converge to the new equilibrium levels that are given in Table 3. House prices decline slightly along the transition in Experiment 2 (sales tax) and increase in Experiment 1 (property tax). In Experiment 3 (income tax), they stay the same. Changes in housing allocations over the life cycle occur at different speeds, while most changes are completed by the time prices converge to the new equilibrium. All of these changes, however, are quite modest.

Next, we evaluate the welfare of agents with and without reform. We quantify the welfare effects of reform for different individuals by using the consumption equivalent variation measure along the transition. The welfare effect of a reform for an individual of type \((a_t, m_t, h_t, e_t, v_t, B_t)\) is found by asking how much this individual’s non-housing consumption has to be increased in all future periods so that his expected future utility with Proposition 13 equals his utility under that reform. Given the form of the utility function, consumption compensation, as a fraction of lifelong consumption, is calculated as:

\[
EV(a_t, m_t, h_t, e_t, v_t, B_t) = \left( \frac{V_R(a_t, m_t, h_t, e_t, v_t, B_t)}{V_{NR}(a_t, m_t, h_t, e_t, v_t, B_t)} \right)^{\frac{1}{\chi(1-\gamma)}},
\]

where \(V_R\) and \(V_{NR}\) represent the value function in economies with and without reform, respectively. We report both the percent of agents at each age who are in favor of the reform (those whose utility is higher under the reform) and the consumption compensation by age.

The first panel of Figure 6 summarizes the percent of agents in favor of the reform and the second panel displays the average consumption compensation needed to equate the welfare in the Proposition 13 economy with welfare in alternative regimes, by age, for three different revenue-neutral cases. The overall support levels are quite low in all the cases, and almost none in Experiment 1 (property tax case). We find that the reform that receives the highest support among agents is the one where the sales tax rate is reduced to keep tax revenues constant (Experiment 2). While the youngest agents favor the transition, the reform loses the approval of the

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34 Accidental default on mortgages could be an issue if house prices declined precipitously during the transition. However, the tax experiments we consider never lead to a major decline in prices, making default irrelevant.

35 In some cases, prices slightly overshoot in the first few periods, but revert back to their new equilibrium levels.
majority in all age cohorts over the age of 35. The welfare benefit of the reform is around 2% additional consumption per year for 21-year-olds. While the small steady-state decline in house prices is favored by most agents in the economy, it does not increase the support in a transition economy since house prices adjust slowly. Overall, 44% of the agents that are alive at the time of transition favor elimination of Proposition 13 in this case.\footnote{In the model economy all agents are assumed to vote, while in the data, voter turnout increases by age. On the other hand, older people are overrepresented in the model economy since we abstract from population growth. Correcting for generation size and voting patterns in California results in 38% approval of reform.}

Support for reform among the younger agents is smallest when revenue neutrality is achieved by reducing property taxes (Experiment 1). Only 3% of households favor the transition. One major difference between this case and the other two reforms is the lack of support from the younger individuals, mainly due to two underlying factors. Younger agents experience a smaller drop in their total tax burden compared to the other two cases, making reform less appealing. In addition, house prices initially overshoot in transition, immediately rising by 5%, and gradually declining to the new steady state levels, 1.4% above the Proposition 13 prices. All agents, but especially the young agents who start life as renters, and others who want to move to larger houses are adversely effected by the increase in house prices, reducing the welfare benefits of the reform. The average welfare benefit is slightly negative for the 21-year-olds, and remains negative for all age cohorts.

Older agents have very low levels of support for the reform in all three cases. But the welfare effect of the reform on the older agents is noticeably lower in the case where the labor income tax rate is reduced to keep tax revenues constant (Experiment 3). Lowering the labor income tax rate does not benefit the elderly since Social Security income is not taxed. Consequently, welfare effects of the reform are around -3% for the older agents. The overall support for the reform is 31% in this case.

As discussed before, lower property tax rates generate an increase in house prices, hurting especially the renters and younger individuals. This results in lower support for reform, especially by the younger agents, when revenue neutrality is achieved through a lower property tax rate as opposed to a lower sales tax rate. If we allow housing supply to change so that house prices remain constant, the overall support for the reform goes up to 35% for the property tax case and down to 37% for the sales tax case. Support for the reform via income taxes remains unchanged (31%) since the reform has a negligible effect on house prices. Nevertheless, we find quite low overall
In Table 5, we report more information on the types of agents who are in favor of the reform in our benchmark cases where house prices are allowed to change. Renters favor the reform in sales and income tax cases, whereas they completely oppose it in the property tax case. Owners in general have very low support levels, but some owners are inclined to show support when the reform is financed via sales taxes.\textsuperscript{37} Among the owners, the level of support depends on the value of their house for tax purposes ("low base" versus a "high base" in rows four and five of Table 5). Those with a low tax base, that is, the individuals whose house value for tax purposes is low, do not favor the reform since the effective tax rates increase substantially more for this group. When elimination of Proposition 13 is accompanied by a reduction in the sales tax, for example, 29\% of the individuals with a high tax base support the reform, as opposed to almost no one with a low tax base.

It is also interesting to examine the last three rows, where we present the level of support for the reform from different labor income groups. The model generates quite a bit of heterogeneity of incomes by age. Low labor income individuals (labor incomes in the zero to 33rd percentile) include both the very young and the elderly, although the elderly make up the

\textsuperscript{37}Differences in the voting behavior of owners and renters with respect to different taxes that we find in the model are consistent with the empirical findings in Brunner, Ross, and Simonsen (2014) who investigate the political economy of property taxation using micro-level survey data provided by the Public Policy Institute of California (PPIC) and the Field Poll. They report that renters are indifferent between the sales tax and the property tax to fund public services. Homeowners, on the other hand, are more likely to support a sales tax increase to fund public services than a property tax increase.
majority of this group, and they typically oppose the reform. There is significant support for the reform from the middle income group if sales or income taxes are reduced to keep revenues unchanged. Very few agents in this group are elderly; the majority of the agents in this group are not adversely affected by the reform, resulting in higher support levels (72% and 64%, respectively). High income agents are exclusively homeowners, who have very low support levels for the reform.

<table>
<thead>
<tr>
<th>Table 5: Percent in Favor of Eliminating Prop. 13</th>
<th>sales tax</th>
<th>property tax</th>
<th>income tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>44</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>Renters</td>
<td>100</td>
<td>0</td>
<td>97</td>
</tr>
<tr>
<td>Owners</td>
<td>16</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Low Base</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>High Base</td>
<td>29</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>34</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Middle</td>
<td>72</td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>High</td>
<td>23</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Overall, our findings highlight the importance of policies surrounding the reform if Proposition 13 were to be eliminated. We find that steady state welfare gains from the reform can be quite large and stem mostly from the decline in the tax burden while young and borrowing constrained. However, the level of support for reform is quite low once transitions are taken into account. For example, even though a reduction in the income tax rate generates large welfare benefits at the steady state (2.9% of consumption per year), it generates less than one third of the agents’ support along the transition. In this case, the transition period is especially painful for the middle aged and older individuals since they lose all their benefits without much in return. Even though future generations who are born into the world without Proposition 13 will be able to optimize over their expected lifetime utility and be better off, the reform currently has little chance of passing.

We show how the welfare gains and the level of support varies across different ages and different revenue-neutral cases along the transition. In most of our calibrations, a reduction in the sales tax rate generates the highest level of support, while a decline in the property tax rate generates the least amount of support. Lastly, if property prices increase as a result of the reform, this reduces the overall support, especially of the renters and the
young individuals, the main groups who normally benefit from such reform.

5 Sensitivity Analysis

In this section, we report the sensitivity of the results to our calibration as well as to some of the modeling choices we have made. We are particularly interested in examining the effects of eliminating Proposition 13 on house prices, mobility, and welfare. We find that elimination of Proposition 13 leads to quite modest changes in house prices and mobility under many different parameterizations. The main reason for this finding is the existence of transaction costs and moving shocks, which preempt the effect of Proposition 13 on housing allocations. In a world without these frictions, Proposition 13 does lead to much larger changes in prices and mobility. The percent of voters in support of elimination depends on the price implications of the reform. Below, we summarize a number of different experiments in more detail.

One of the parameters that is potentially important for our results is the choice of $g$, which governs the decline in the effective property tax rate. Proposition 13 is especially valuable to agents who have owned their house for a long time during periods of high growth in housing prices. Higher $g$ (in absolute value) in the model corresponds to periods of high growth in house prices where agents who live in the same house enjoy larger tax benefits due to Proposition 13. In our benchmark calibration, we chose $g = -5\%$ based on the difference between the nominal house price growth rate observed in the data and 2\%, the growth in tax assessments with Prop 13. We subsequently confirmed that the effective tax rates generated by the model along the life-cycle mimics the data reasonably well (Figure 2). This was a way of assessing the benefits of Proposition 13, especially for older agents. In the third and fourth columns of Table 6, we report the results for a lower (-3\%) and a higher (-7\%) $g$, representing periods of lower and higher growth rates in housing prices. We normalize the price level for the benchmark case presented in the first row to 100, and scale all other prices relative to this benchmark. Our findings indicate that house prices, mobility, and the amount of support generated for elimination of Proposition 13 are generally similar for the three values for $g$. However, the steady state welfare gain from the reform goes up with $g$, as higher $g$ leads to more distortion in the housing decisions. These findings support our main conclusion that, despite the considerable welfare benefits of the reform at the steady state, its elimination does not generate much support. The reason for low support
even for a high level of $g$ is that, while the elimination of Prop 13 implies larger benefits, especially to younger agents, the older agents do benefit more from the existence of Proposition 13 during periods of high price growth rates, and are likely to veto the reform.

Table 6: Sensitivity Analysis

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Low $g$</th>
<th>High $g$</th>
<th>No move shock</th>
<th>No TC &amp; No move sh.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposition 13</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>100</td>
<td>98</td>
<td>101</td>
<td>103</td>
<td>114</td>
</tr>
<tr>
<td>Mobility</td>
<td>12.5</td>
<td>12.5</td>
<td>12.5</td>
<td>5.4</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Elimination of Proposition 13</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>98</td>
<td>97</td>
<td>97</td>
<td>101</td>
<td>115</td>
</tr>
<tr>
<td>Mobility</td>
<td>12.8</td>
<td>12.8</td>
<td>12.8</td>
<td>5.6</td>
<td>16.1</td>
</tr>
<tr>
<td>In favor %</td>
<td>37</td>
<td>48</td>
<td>35</td>
<td>38</td>
<td>77</td>
</tr>
<tr>
<td>Property Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>101</td>
<td>101</td>
<td>103</td>
<td>107</td>
<td>123</td>
</tr>
<tr>
<td>Mobility</td>
<td>12.8</td>
<td>12.9</td>
<td>12.9</td>
<td>5.0</td>
<td>25.3</td>
</tr>
<tr>
<td>In favor %</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Income Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>100</td>
<td>99</td>
<td>101</td>
<td>104</td>
<td>116</td>
</tr>
<tr>
<td>Mobility</td>
<td>12.8</td>
<td>12.8</td>
<td>12.8</td>
<td>6.1</td>
<td>19</td>
</tr>
<tr>
<td>In favor %</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>29</td>
<td>37</td>
</tr>
</tbody>
</table>

Another feature of the model economy that is potentially important for our results is the assumption about move shocks. The exogenous move shocks that are present in the benchmark model are meant to capture the reasons to move, above and beyond the idiosyncratic shocks to income and changes in income along the life-cycle, which are both calibrated to data for the U.S. economy. In the last column of Table 6, we present the results for an economy without the exogenous move shocks. The mobility rate found in this case (5.4%) is lower than the one observed in the data (12.5%). Moves by renters, who do not incur transaction costs upon moving, account for a large part of this mobility. This exercise establishes that the two reasons for moving that are present in the model (idiosyncratic shocks and life-cycle changes in income) account for 43% of the mobility observed in the data. The equilibrium house price is also higher in this economy (103), since agents
do not have to move as often and therefore incur less frequent transaction costs.

Without exogenous move shocks, elimination of Proposition 13 leads to a larger increase in mobility of the middle-aged and older agents (roughly 20 and 70%, respectively) compared to the benchmark case. However, the mobility of the young typically gets lower after the elimination, since agents buy their first homes later in life. The overall effect on mobility, which can be higher or lower, masks these interesting dynamics. House price patterns are similar to the benchmark case. The steady state welfare benefits of the reforms are typically higher than the model with move shocks. Proposition 13 leads to more distortions in housing decisions as agents are not forced to move for exogenous reasons and hence stay longer in their homes to accumulate Proposition 13 benefits. The percent of voters in favor of elimination are comparable to the benchmark case.

In Section 4.2.1, we briefly discussed the effects of transaction costs and moving shocks on mobility. As part of our sensitivity analysis, we study an economy where households are not subject to any transaction costs or move shocks. Proposition 13, along with the usual borrowing constraints, are the only frictions in this economy. This exercise, and comparisons to the benchmark case, allows us to tease out the effects of Proposition 13 versus the other frictions (transaction costs and move shocks) separately. We present the results in the last column of Table 6. We find that the impact of these frictions on housing allocations is very similar to the impact of Proposition 13. Both transaction costs and Proposition 13 result in individuals buying slightly larger houses in their younger years, not moving to larger houses during middle ages, and remaining in a larger house when older, compared to the housing allocations in economies without these three frictions.

Transaction costs are capitalized into home prices: therefore, their removal results in 14% higher house prices in the Proposition 13 economy compared to the benchmark case. The moving rate is higher than the case with no move shocks, but only slightly more than half of the mobility observed in the data. Elimination of Proposition 13, which is the leading friction in this economy, has much more dramatic effects compared to other cases. Prices go up in all revenue neutral elimination cases, and the rise is especially high in the property tax case. Since almost all distortions in housing allocations were due to Proposition 13, elimination leads to bigger changes in allocations. Better allocations push prices higher. Mobility jumps more than 100% and exceeds the levels observed in the data. Steady-state welfare gains reflect the effects of better allocations, tax burden on the constrained agents, and higher house prices. Negative average welfare gain
in the property tax case is primarily the result of major price increase, and the support for elimination in this case is low. In the income tax case, the average welfare gain is high, but older agents dislike this reform and support is again low. However, the majority of agents support the reform in the sales tax case.

In addition, we checked the robustness of our findings to some preference parameters and our choice of grid points while solving the model. An economy with a finer housing grid generates very similar results for both the Proposition 13 economy and the alternative regimes.\textsuperscript{38} Lower risk aversion ($\sigma = 2$ instead of $\sigma = 5$ used in the benchmark) leads to slightly lower house prices and higher mobility in the economy with Proposition 13. Elimination of Proposition 13 leads to smaller increases in mobility and larger increases in the price level. In all of the cases we have examined, a revenue-neutral elimination of Proposition 13 reducing sales taxes, generated the highest level of support.

It is important to note that elimination of Proposition 13 generates low levels of support in the model, despite the fact that our experiments are conducted in a revenue-neutral manner. In California, many associate elimination of Proposition 13 with an increase in property tax collections. We also examine the consequences of eliminating Proposition 13 without maintaining revenue-neutrality. In these counterfactuals, we set the property tax rate at 1% as before and kept income and sales tax rates unchanged. Eliminating the link between housing tenure and property taxes implies that individuals of all ages now face a 1% property tax rate, resulting in higher effective tax rates faced especially by the older agents. In this case, for all the models we have examined, elimination of Proposition 13 generates almost no support (about 3.5%). Only the older agents who are not homeowners support the reform.

6 Conclusions

In this paper, we study the implications of Proposition 13 on house prices, mobility, and welfare of the households in an economy populated with overlapping generations of agents. Proposition 13 introduces two major changes to property taxation. It reduces the property tax rate from 2.5% to 1%, and links the value of the house for tax purposes to housing tenure. The second feature results in effective taxes which decline in housing tenure, and there-

\textsuperscript{38}Very few agents choose house sizes of four or above. Therefore, extending the maximum house size beyond 4.5 also has no impact on our results.
fore by age, and distorts housing allocations. We find that the introduction of Proposition 13 leads to a 25% increase in house prices and a 4% decrease in the moving rate.

We use this framework to examine the consequences of eliminating Proposition 13, in particular eliminating the link between the value of the house for tax purposes to housing tenure. We find that such a reform is likely to have a small effect on house prices and mobility. Depending on the calibration of the model and the way in which revenue neutrality is achieved, the change in house prices due to the reform ranges between -3% and 4%. Our findings about the price changes represent an upper bound since we have assumed a fixed housing supply. In experiments where we allow the housing supply to adjust, often small changes in supply are sufficient to keep prices constant.

Change in mobility due to reform generated in all our calibrations is even more modest. We also find that while the benefits of being born into an economy without Proposition 13 is quite high, support for its elimination is quite low and depends on how revenue neutrality is achieved. Keeping revenues constant by lowering the sales tax generates the most amount of support, while achieving revenue neutrality via a reduction in property tax rates generates the least amount of support, particularly due to its positive impact on house prices.

References


7 Appendix: For Online Publication

7.1 Simple Model

In order to understand the effect of different taxes on the price of housing, we present a simple infinite horizon framework without any transaction costs, Proposition 13, or income tax deductibility of property taxes.

A representative agent chooses housing, \( h_t \), and non-housing consumption, \( c_t \), to maximize:

\[
\sum_{t=0}^{\infty} \beta^t u(c_t, h_t)
\]

where \( 0 < \beta < 1 \) is the subjective time discount factor. The individual with an income \( y_t \) faces income taxes, \( \tau^i \), sales taxes, \( \tau^s \), and property taxes, \( \tau^p \). Let \( m_{t+1} \) be the agent’s mortgage holdings (if positive), or savings (if negative) at the beginning of period \( t+1 \), \( p_t \) be the price of a unit of housing, and \( r \) the real interest rate. The budget constraint of the individual is given by:

\[
y_t(1 - \tau^i) + (1 - \delta)p_t h_t + m_{t+1} = c_t(1 + \tau^s) + p_t h_{t+1} + (1 + r(1 - \tau^i))m_t + \tau^p p_t h_t.
\] (18)

At the steady state, the first order conditions of this maximization problem result in:

\[
\frac{u_h}{u_c} = \frac{(r(1 - \tau^i) + \delta + \tau^p)p}{1 + \tau^s}.
\] (19)

With the Cobb-Douglas utility function in equation 17, we get:

\[
\frac{u_h}{u_c} = \frac{1 - \chi}{\chi} \frac{c}{h}.
\] (20)

In this framework, expenditure shares of housing and non-housing consumption remain constant. Combining equations 19 and 20 yields:

\[
\frac{1 - \chi}{\chi} \frac{c}{h} = \frac{(r(1 - \tau^i) + \delta + \tau^p)p}{1 + \tau^s}.
\]

Assuming a zero net supply of mortgages and substituting this first order condition in the budget constraint results in a relationship between house prices and different taxes:
\[ p = \frac{(1 - \chi)(1 - \tau^i)y}{h(\delta + \tau^p + \chi(r(1 - \tau^i)))} \]  

(21)

We can make several observations based on equation 21, under the assumption of a fixed supply of housing and income. First, we can see that house prices are not a function of the sales tax rate. This is due to the constant expenditure shares of housing and consumption goods. The decline in the sales tax results in higher consumption, keeping the total expenditures on consumption goods unchanged. Consequently, it has no effect on housing consumption or price. Second, a decline in the property tax rate is capitalized in house prices. With constant housing supply, a lower property tax leads to an offsetting increase in house prices and maintains the constant expenditure share of housing. Finally, a lower income tax rate leads to higher disposable income and higher total expenditures. With constant expenditure shares and housing supply, only a part of the increase in expenditures is capitalized in higher house prices. Lower income taxes lead to a smaller increase in house prices compared to the property taxes since part of the effect is absorbed in the non-housing consumption.

7.2 Data

Age-Earnings Profile

We target the earnings profile for the median earners for ages 25 through 60 such that, the age-income profile for the median earners in the model mimics its counterpart in the data. We calculate the earnings efficiency as \([0.77, 0.86, 1.06, 1.13, 1.25, 1.21, 1.05, 0.9]\), for ages \([25, 30, 35, 40, 45, 50, 55, 60]\), respectively, from mean earnings of P50 (median lifetime income) group, provided by Guvenen et al. (2015). In our calibration of \(w^a\), we search over different values of \(w^a\) until we minimize the mean square errors between the model-generated income profile for medium-income agents and the data. Our calibration yields the income profile plotted in Figure 7.

Housing Grid

We use data on the square footage of a unit for homeowners and renters to help us calibrate the housing grid. According to the American Housing Survey (U.S. Census Bureau) the average square footage of homes for homeowners in 2013 was 2,014. For renters, the average was 1,185 square feet. Overall average size of a house was 1,739 square feet. To calculate the
available square footage, we took the midpoint of the home size ranges given in Table C-02-AO.

**California Data**

We use Integrated Public Use Microdata Series (IPUMS-CPS) to construct the effective tax rates and property taxes to income for all the available years between 1990 and 2007.

Coding for property taxes: Each household (HH) is given a code (ranging from 00-69). Most of these codes designate a particular tax bucket (e.g., “$50-99,” “$100-149,” “$150-199,” etc.). These buckets designate the total property taxes that a HH paid in a particular year. In our data, we take the average of the extreme points of a bucket as the actual total property taxes paid by a HH in a particular year. Certain codes do not designate a tax bucket. For instance, code 00 stands for “N/A,” and code 01 stands for “None.” These missing values are removed from the data. Code 57 does not link to a bucket, but rather to the value of “$4,500.” Naturally, we take this as the total property tax value for any HH with the code 57. Finally, code 69 is for total property tax values of “$10,000+.” Because there is no upper limit for code 69, we assume, for simplicity, that any HH coded as 69 pays
total property taxes of $10,001.

Coding for HH values: As before, each HH is given a 7 digit code. Most of these codes designate a particular range of HH values (e.g., “Less than $500,” “Less than $999,” “$5,000-7,499,” “$7,500-9,999,” etc.). As before, for those buckets with lower and upper limits, we take the average of the limits as the HH’s value in a particular year. For those codes that do not have lower or upper limits (e.g., “Less than $500,” “$35,000+,” “$50,000+,”) we simply assume the HH value to be the closest integer to the provided limit. For example, a code that links to values of “Less than $500” would be assumed to indicate a HH value of $499; a code that links to values of “Less than $999” would be assumed to indicate a HH value of $998; a code that links to values of “$35,000+” would be assumed to indicate a HH value of $35,001, and so forth. Code 0000000 indicates a $0 HH value; code 9999999 stands for “N/A”. These last two codes are removed from the data.

Calculation of effective property tax rates: For each HH, effective property tax rates are calculated as total property taxes over HH value. We sort, in ascending order, effective property tax rates according to the maximum of the age of HH head and spouse. If only one age is provided (HH head or spouse), we take that age. If neither age is provided, the HH is removed from the data. We have data for the year 1990 and then for the years 2000-2011. We do not include the years 2008-2011 as these years are affected by the financial crisis. Therefore, for the years 1990 and 2000-2007, we take the average across all years for each age from 20 and upwards.

Calculation of Property tax/income and the counterfactual: Property tax/HH income is simply the aforementioned total property taxes divided by HH income. HH income values are directly provided in IPUMS without any coding scheme. Naturally, those HHs that have an income value of 0 are removed from this data. Note that we use a particularly conservative assumption and remove all HHs with property tax/HH income ratios greater than 7 and less than 0. For the counterfactual, we take 1% of the aforementioned HH values as the numerator, and HH income as the denominator. As before, we sort the data by age from 20 upwards. Then, for each age, we take the average across the years 1990 and 2000-2007.

7.3 Computation Method

We solve the steady state decision rules for the economy with Proposition 13 and the one without. For each steady state, we start with a guess for the house price (and a guess for accidental bequests) and solve the decision rules by using value function iterations. Using these decision rules, we simulate
an economy with 10,000 individuals for 3,750 periods (and discard the data on the first 750 years) and generate aggregate statistics for the economy. We find the aggregate housing demand and compare it with the housing supply. If there is excess demand (excess supply), we increase (decrease) the initial price and redo the values function iterations. We continue this procedure until the beginning house price is equal to the ending one.

Transitions: We start the economy at a steady state with Proposition 13 in the first period. We then eliminate Proposition 13 unexpectedly (in period two) and solve for the transition path to the next steady state, which we assume to be reached in $T$ periods. We set $T = 60$, but in all experiments convergence takes fewer than 60 periods.

1. We assume a price path between the two steady states where $t = 1$ represents the steady state with Proposition 13 and $t = T$ represents the steady state without Proposition 13.

2. Solve for the optimal behavior given the price path and the conditions in the “after” equilibrium by backward recursion along the transition path, using the value function from one period as the continuation value in the previous period.

3. Aggregate the decision rules along the transition to obtain the housing demand. Check to see if there is excess demand or supply in housing for each $t$.

4. Adjust the guess for the price path accordingly and go back to step 2. Continue until the path for the house price results in housing demand to equal housing supply.