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, restricted future property tax increases, and tied property assessments for tax purposes to housing tenure. In this paper, we study the implications of Proposition 13 on house prices, housing turnover, and welfare of the households in an economy populated with overlapping generations of agents who derive utility from consuming goods and housing. For our benchmark calibration, the introduction of Proposition 13 leads to an 18% increase in house prices and a 17% decrease in the probability of moving. We study the transition dynamics of moving from an economy featuring Proposition 13 to alternative revenue-neutral regimes with proportional real estate taxes. Overall, our findings indicate that elimination of Proposition 13 leads to small changes in house prices and modest increases in mobility depending on how revenue neutrality is achieved. Welfare gains of reform are quite large and stem mostly from the decline in the tax burden when young and borrowing constrained.

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Introduction

In 1978, 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 many states have passed similar measures.[1] Despite its popularity among voters, Proposition 13 remains controversial partly due to its revenue implications, and discussions about its impact and possible modifications to it continue.[2]

Under Proposition 13, property value assessments are conducted only upon a change in ownership or completion of new construction. In case of no change in ownership, a property's assessed value is set equal to its purchase price adjusted upward each year by two percent. Since its inception, Proposition 13 has led to large differences in the assessed values and the taxes paid by individuals owning similar properties depending on the timing of their purchases. 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 resulted in a decline in mobility.[3] 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, while the share of tax revenues generated through property taxes declined from 40% to 25% during the same time.[4]

In this paper, we study the implications of Proposition 13 for house prices, housing choices, household mobility, and welfare of households in an economy populated by overlapping generations of heterogeneous agents. We examine the impact of introducing Proposition 13, as well as the consequences of its elimination under alternative revenue-neutral regimes with proportional real estate taxes. The model economy consists of agents who have five life-stages. At each life-stage, agents face a constant probability of transitioning to the next stage of life, representing aging in aggregate. In the first four life-stages (spanning 21 to 64 years old, on average), working-age agents face an inverse U-shaped labor income profile that is subject to

[1]See Haveman and Sexton (2008) for a list of the characteristics of property tax assessment limits in 20 states.

[2]See for example, McCarty, Sexton, Sheffrin, and Shelby (2002) and Sexton, Sheffrin, and O'Sullivan (1999).

[3]See Sexton, Sheffrin, and O'Sullivan (1999) for a summary of intended and unintended consequences of Proposition 13.

[4]Author's calculations from data provided by U.S. Census Bureau: Government Finances.

idiosyncratic shocks. These agents on average spend eleven years at each stage. Older agents (roughly, 65 years to 84 years old), are assumed to retire and receive a certain income through social security. Retired agents face a constant probability of dying, but on average spend twenty years at that stage. Agents start life as renters, receive shocks to their income and decide to rent or buy, the size of their house, and how much to spend on consumption of goods every period. They can save or borrow subject to collateral constraints.

We study several economies with different property tax regimes. In the initial steady state economy without Proposition 13, property tax rate is set at 2.5%, and property taxes are based on the current market value of the property. With the introduction of Proposition 13, property tax rate is reduced to 1%, and property taxes are based on the value of the house at the year it was purchased. This second feature results in effective taxes which decline in housing tenure, and therefore by age, distorting housing choices over the life cycle.[5] In our benchmark calibration we find that introducing Proposition 13 leads to an 18% increase in house prices and a 17% decrease in the probability of moving. 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). Our counterfactual experiments also reveal that the increase in house prices would have been even higher (20%) if property tax base was not related to housing tenure. This distortion limits the increase in house prices to 18%. In addition, while Proposition 13 leads to lower mobility, we find that only a part of this decline stems from the link between housing tenure and property taxes. Lower property tax rate also contributes to lower mobility. We find that individuals facing income shocks are more likely to move to different size houses (or to rental) in economies with high property taxes as opposed to economies with low property taxes. This channel turns out to be as significant as the lock in effect of Proposition 13.[6]

Our quantitative analysis complements the empirical literature on household mobility that has faced challenges in untangling the effects of Proposition 13 from other factors. For example, Wasi and White (2005) find

[5]We define housing tenure as the number of years since the house has been purchased.

[6]An example of this channel was evident before the passage of Proposition 13, where increases in house prices, combined with high property tax rates, were resulting in a high tax burden especially for older individuals on social security and forcing them to consider moving to smaller homes or to rental. In our model, individuals receiving a bad shock to their labor income are more likely to change their housing allocations if property taxes are high.

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 relatively 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 estimate the lock in effect, Ferreira (2010) examines the behavior of fifty-five year old homeowners who due to some later propositions were given the privilege to carry the Proposition 13 benefits with them if they purchase a house of equal or lesser value. He finds that this age group has a 30-38% higher rate of moving.

Using this framework, we investigate the consequences of eliminating Proposition 13 on house prices, mobility, and welfare. We assume that starting from an economy in a steady state with Proposition 13, 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 house prices for tax purposes are no longer a function of housing tenure, and the economy converges to a new steady state without Proposition 13. We examine the consequences of this reform under three different revenue neutral schemes.

Overall, our findings indicate that elimination of Proposition 13 leads to small changes in house prices and modest increases in mobility depending on how revenue neutrality is achieved. Welfare gains of reform are quite large and stem mostly from the decline in the tax burden when young and borrowing constrained. However, welfare gains and the level of support for reform varies across different ages and different revenue neutral cases along the transition. According to our findings, a reduction in the sales tax rate generates the highest level of support and a decline in the income tax rate generate the least amount of support for the reform. 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 to benefit from such reform.

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 (2009); Diaz and Luengo-Prado (2008); Ortalo-Magné and Rady (2006); or Davis and Heathcote (2005), among others.

There are several 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 government and the state governments, has changed after Proposition 13. 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.[7] 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.[8] Every agent in life-stage a moves into the subsequent life-stage, $a+1$, with probability π_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_t^a, is given by:

$$\log(y_t^a) = \log(w^a) + e_t, \tag{1}$$

where e_t is given by:

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

[7]See, for example McCubbins and McCubbins (2009).

[8]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.

The disturbance term ε_t is distributed normally with mean zero and variance σ_ε^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, π_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 a house in the rental market is 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 a small amount of housing that they rent. Individuals have access to the mortgage market, but face a down payment requirement when purchasing a house. Homeowners face a transaction cost of selling their homes and must pay property taxes annually. Renters do not pay property taxes. Each period, after observing their labor income 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, $\overline{H}$, as fixed.[9]

We model California as a small open economy and take the interest rate on deposits and mortgages given by the broader US market. We assume that agents can either be savers or borrowers, facing a constant interest rate of r.

[9]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.

1.3 Individual's problem

Let h_t indicate the quantity of housing services consumed by an agent at date t , where $h_t = \underline{h}$ indicates an agent who rents, and $h_t > \underline{h}$ 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.

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

$$F(h_t, h_{t+1}) = \begin{cases} \varphi p_t h_t & \text{if} \quad h_t > \underline{h} \quad \text{and} \quad h_{t+1} \neq h_t \\ \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

where p_t is the price of a unit of housing, and φ represents the transaction costs such as fees paid to real estate agents. Notice that a renter who buys a house ($h_t = \underline{h}$ and $h_{t+1} > \underline{h}$), or a homeowner who remains in the same house ($h_t > \underline{h}$ and $h_{t+1} = h_t$) do not pay the transaction cost. If a homeowner becomes a renter ($h_t > \underline{h}$ and $h_{t+1} = \underline{h}$), or continues to be a homeowner but changes the quantity of the home consumed, transaction costs are paid as a result of the sale of the house.

Property taxes are paid by current homeowners ($h_t > \underline{h}$). In the absence of Proposition 13, property taxes are equal to the property tax rate, τ_t^p, 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:

$$B_t = \begin{cases} (1+g)B_{t-1} & \text{if} \quad h_t = h_{t-1} \\ \\ p_t h_t & \text{if} \quad h_t \neq h_{t-1} \end{cases} \tag{4}$$

If there is no change in ownership, the value of the house for tax purposes is allowed to grow by g. Finally, total property taxes paid is given by

$$T_t^p(h_t) = \tau_t^p B_t. \tag{5}$$

Agents who are purchasing a house are allowed to borrow against the value of the house (mortgage m_{t+1}), subject to a loan-to-value constraint η, given by:

$$m_{t+1} \leq \eta p_t h_{t+1} \quad \text{if } h_t > \underline{h} \tag{6}$$

Thus, an agent who decides to be a renter ($h_{t+1} = \underline{h}$) does not have access to the mortgage market and is only allowed to save. A negative mortgage

($m_{t+1} \leq 0$) represents savings. We assume that the rate on deposits are the same as the mortgage rate, r.[10]

We assume that the interest paid on mortgages (rm_t) and property taxes paid (T_t^p) are tax deductible while interest on savings is taxable. Thus, total income taxes paid by an individual before retirement is given by:

$$T_t^i = \max(0, \tau_t^i[y_t^a - rm_t - T_t^p]), \tag{7}$$

where τ_t^i 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 deductible from their interest income. Thus, for $a = 5$, total income taxes are equal to:

$$T_t^i = \max(0, \tau_t^i[-rm_t - T_t^p]). \tag{8}$$

In case of the death of an agent, which occurs after the homeownership decision is made, the financial institution buys the house, and distributes the net assets of all the deceased (accidental bequests) to the agents alive next period in a way proportional to their incomes.[11] We denote this inheritance by q_t. Homes depreciate at the rate δ, and a homeowner must pay this fraction of the value of their homes, conceptually maintenance costs, in order to continue living in the 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 $h_t > \underline{h}$ and $h_{t+1} > \underline{h}$) faces the following budget constraint:

$$\begin{aligned} c_t(1+\tau_t^s) &= y_t^a + p_t((1-\delta)h_t - h_{t+1}) \\ &\quad + (m_{t+1} - (1+r)m_t) + q_t - T_t^i - T_t^p - F_t, \end{aligned} \tag{9}$$

where c_t represents the non-housing consumption of an agent at time t. The agent pays property taxes T_t^p, and a transaction cost F_t if there is a change in the amount of housing consumption, relative to the current period.

A homeowner who decides to rent in the next period ($h_t > \underline{h}$ and $h_{t+1} = \underline{h}$) is responsible for property taxes and the transaction cost of selling the house. However, instead of paying for a new house, the agent pays a rent, $rent_t$.

[10]We examine the sensitivity of our results to this assumption in Section 5.

[11]This redistribution scheme preserves the age-endowment profile (income and bequest). Distributing the accidental bequests equally to all agents generates qualitatively similar results.

$$
\begin{aligned}
c_t(1+\tau_t^s) &= y_t^a + p_t(1-\delta)h_t - rent_t h_{t+1} \\
&\quad +(m_{t+1}-(1+r)m_t) + q_t - T_t^i - T_t^p - F_t, \qquad (10)
\end{aligned}
$$

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

$$
\begin{aligned}
c_t(1+\tau_t^s) &= y_t^a - p_t h_{t+1} \\
&\quad +(m_{t+1}-(1+r)m_t) + q_t - T_t^i. \qquad (11)
\end{aligned}
$$

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

$$
\begin{aligned}
c_t(1+\tau_t^s) &= y_t^a - rent_t h_{t+1} \\
&\quad +(m_{t+1}-(1+r)m_t) + q_t - T_t^i. \qquad (12)
\end{aligned}
$$

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

$$
rent_t = (r + \delta + \tau_t^p)p_t. \qquad (13)
$$

1.4 Government

We assume that the state government does abide by a balanced budget and finance 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; 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 Ω_t represent the state (a, m, h, e, B) faced by an agent at time t. Let $V_t(\Omega)$ be the (maximized) value of the objective function at state Ω_t. The dynamic programing problem for the agent is given by

$$V_t(\Omega) = \max_{c,h',m'} u(c,h) + \beta \sum_{a'} \sum_{e'} \Pi(a,a')\Gamma(e,e')V_{t+1}(\Omega') \tag{14}$$

subject to the budget constraints (1) - (13).

Given a sequence of government policy $\{\tau_t^i, \tau_t^s, \tau_t^p\}_{t=1}^{\infty}$, and mortgage and deposit rates $\{r_t\}_t^{\infty}$, 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 interest rate and the government policy, the individual decision rules solve the individual's dynamic programming problem

2. At each time, p_t clears the housing market

$$\sum_a \sum_m \sum_h \sum_e \sum_B \lambda_t(\Omega) h_t(\Omega) = \overline{H} \tag{15}$$

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

3. Government budget is balanced

$$\sum_a \sum_m \sum_h \sum_e \sum_B \lambda_t(\Omega) \left[T_t^p(\Omega) + T_t^i(\Omega) + \tau_t^s c_t(\Omega) \right] = G_t.$$

4. Accidental bequests are given by:

$$q_t = \pi_5 \sum_m \sum_h \sum_B \lambda_t(\Omega) \left[(1-\delta)(p_t(\Omega) h_t(\Omega)) - m_t(\Omega) \right]$$

where members of generation five may die with probability π_5 after having made their home purchase and mortgage decisions.

3 Calibration

We use post Proposition 13 data for California during 1990-2007, to calibrate the initial steady state of the model economy.[12] For the aggregate statistics

[12]We exclude data from the Great Recession in our calibration of the steady state as that period represents particularly unsteady times. However, including those years does not change our results in any significant way.

where there is no state level data, we use national level data (USA). The time period is selected to be a year. The subjective time discount factor, β, is assumed to be 0.96, which implies an annual subjective time discount rate of 4 percent. The per period utility function is given by:

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

where

$$\widetilde{c}_t = \left[c_t^{\chi} h_t^{1-\chi} \right]. \tag{16}$$

The relative weight of consumption in the utility function, χ, is set so that share of non-housing consumption is approximately equal to 0.71 as in the U.S. data.[13] 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 provide results for the case where risk aversion parameter is set to 2.

Agents live through five life-stages. On average, they work during the first four life-stages, representing ages of 21-31; 32-42; 43-53; and 54-64, and are retired in the last life-stage representing ages 65 to 84. They face a constant probability π_a of moving from life-stage a to the next life stage $a+1$. We calibrate π_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, $\pi_a = 0.05$ represent the probability of death. The transition function $\Pi(a, a')$ for life-stages is given by:

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

Note that in this framework, some agents may end up spending more or less than the average years in a give life-stage.

During the working years individual labor income, y_t^a, is given by:

[13] Share of non-housing consumption to income is calculated from National Income and Product Accounts. We calculate non-housing consumption as personal consumption expenditures net of housing, furnishing, and utilities. Income is the sum of compensation of employees, proprietor's income, and personal current transfers.

$$\log(y_t^a) = \log(w^a) + e_t,$$

where, w^a is a deterministic component that captures the life-cycle age earnings profile taken from Hansen (1993). e_t captures the stochastic component, and 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 $\sigma_\varepsilon^2 = 0.01$. 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

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

During retirement, agents receive 40% of the average employed earnings.[14] We set the income tax rate, τ^i, at 21% based on McDaniel (2007). The sales tax rate, τ^s, and the property tax rate, τ^p, are set to 10% and 1% respectively. Average taxes to income (and average government expenditures to income) is set at 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 set the mortgage interest rate and the rate of return on deposits as constant at $1/\beta$. 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 a transaction cost of 3%. We set the maximum loan-to-value, η, at 80%. Table 1 summarizes the parameters used in our baseline calibration.

The parameter g in equation (4) represents the part of Proposition 13 which restricts the growth in house values for tax purposes to 2% annually. We implement the effect of Proposition 13 as a 3% decline in the real value of a house for tax purposes in case of no change in ownership. During the post-Proposition 13 period, nominal per capita income in California has grown

[14]Social security replacement rate from Mitchell and Phillips (2006).

Table 1: Calibration of the Steady State

χ	relative weight of c in utility	0.7
σ	relative risk aversion	5
β	time discount factor	0.96
δ	housing depreciation rate	2%
η	maximum loan-to-value	80%
π_a	prob. of advancing to next life-stage	9% for a=1-4; 5% for a=5
w^a	age efficiency profile	0.68, 1.05, 1.18, 1.08, 0.43
r	mortgage and deposit interest rate	$1/\beta$
τ^p	property tax rate	1%
τ^s	sales tax rate	10%
τ^i	income tax rate	21%
φ	Transaction cost of selling a house	6%

by 5%.[15] In a model with exogenous growth of per capita incomes, nominal house values for tax purposes would have grown by 5%.[16] We assume that Proposition 13 restricted this growth to 2% nominally, thus resulting in a 3% decline in the real assessments.[17] This approach allows us to simplify the dynamic programming problem by only keeping track of the 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 3% up to 30 years. The benefits of Proposition 13 for tax purposes remain constant after 30 years.

We set the housing grid to [1.5, 2, 3, 4, 5], where the average size of the house is 2.[18] We compute the size of the rental unit similar to Gervais (2002). Over the 1978-2012 period, the average homeownership rate in the United States was roughly 66%. However, owner occupied housing accounted for 74% of the stock of residential fixed assets (NIPA Fixed Assets tables) in-

[15]Bureau of Economic Analysis, regional NIPA data.

[16]In fact, according to the Freddie Mac price index, the average annual house price increase between 1980 and 2007 was 5.6% in California.

[17]This approach is equivalent to writing the model with exogenous growth in income per capita which would lead to an exogenous increase in house prices by the same amount. In that case, Proposition 13 would be restricting the nominal increase in house prices for tax purposes to 2% annually. We examine the sensitivity of our results to assuming a faster growth rate for house prices (7%) as well. In such a case Proposition 13 would have led to a 5% decline in the nominal value of the house for tax purposes.

[18]We check the sensitivity of our results to finer grids on housing.

dicating that the average size of owner occupied houses were approximately 50% larger than the average size of rental units. In our calibration where the average house size is equal to 2, we set the size of a rental unit equal to 1.5. In equilibrium, the average size of owner occupied housing turns out to be 2.25 which is consistent with these facts.

The state variables in the dynamic programming problem consist of life-stages a; (net) assets (where negative values represent saving, positive values represent mortgage) m_t; housing h_t; employment state e_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; 91 grid points for mortgage (which ranges from -9.9 to 3.6); 5 values for housing (ranging from 1.5 to 5); 4 values for labor income, and 30 values for B, all together 273,000 possible combinations of states.

4 Results

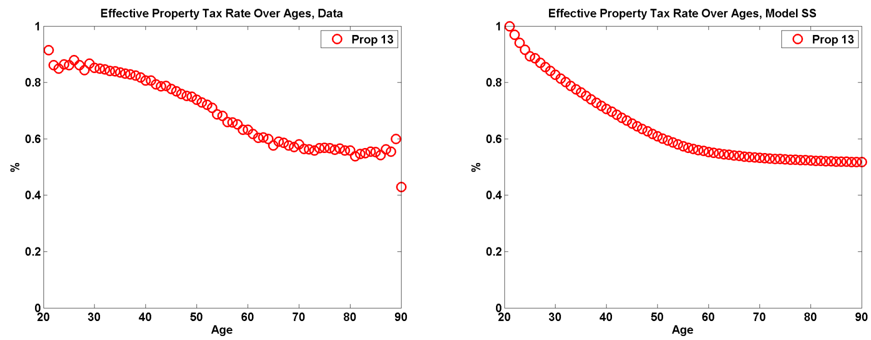
We start this section by comparing the properties of the benchmark economy with Proposition 13 to the data in California after the passage of Proposition 13. Next, we study the housing allocations, mobility, and house prices in economies with and without Proposition 13 at the steady state and along the transition path. Finally, we examine the welfare impact of eliminating Proposition 13.

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.

Since the focus of the paper is on property taxation, we investigate how the model economy captures the tax burden faced by individuals of different ages. Figure 1 displays the effective property tax rate by age in the model and the data. Following Ferreira (2010), we use Integrated Public Use Microdata Series (IPUMS) and construct the effective tax rates as the average of property taxes paid divided by house values for each household for all the available years between 1990 and 2007 in California. 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, that is, 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.[19]

Figure 1: Effective Property Taxes



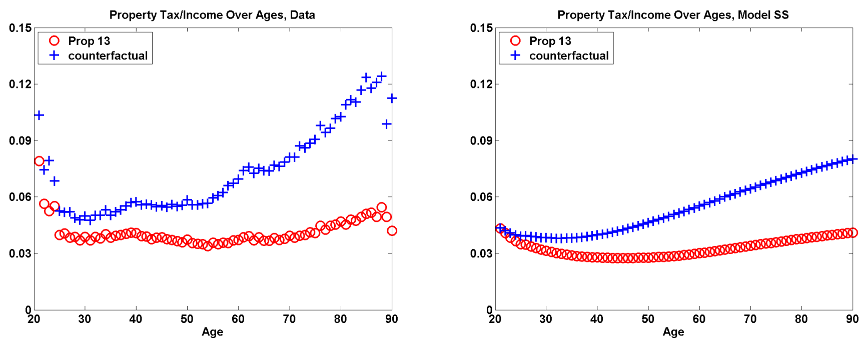
In Figure 2, we examine the magnitude of property taxes paid as a percent of income by age with and without Proposition 13. The data is from IPUMS where we take the average of property taxes divided by income for each household in California over all the available years between 1990 and 2007. We also report the results of a counterfactual case where we apply a 1% flat property tax rate to the reported house values and divide it by income. The growing difference between the two lines captures how the benefits of Proposition 13 increase with age. For example, abolishing Proposition 13 results in property taxes to increase roughly from 5% of income to 10% of income for an 80 year old person.

The second panel in Figure 2 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 doubling of their property tax to income ratio from 4% to 8%.

Table 2 reports the average behavior of housing, saving, and consumption generated by the model at the initial steady state with Proposition 13 and their data counterparts. The first two statistics presented in Table 2 are averages for the United States and they are not readily available for

[19]In 1986, California voters adopted Proposition 58, which allows the transfer of certain property between parents and children without reassessment of the home values.

Figure 2: Property Tax/Income



California over a long time horizon. The homeownership rate is available for the United States and California and we report both.

Table 2: Properties of the Economy

	Data	Model
Avg (net financial wealth/income)	0.65	0.94
Avg (housing value/income)	2.52	3.59
Homeownership rate (USA/CA)	0.66/0.56	0.70

Homeownership data are from the Census Bureau. Average net financial wealth to income and average housing value to income are from the Survey of Consumer Finances for the 1989-2007 period for the United States.[20] We do not try to calibrate the model to these statistics, but simply examine how the model generated values compare with the data. While the model generates higher financial wealth and housing to income ratios than the data, overall magnitudes are reasonably close. The homeownership rate generated

[20]We construct net financial wealth as the sum of all financial assets minus all liabilities from the Survey of Consumer Finances for the 1989-2007 period. Financial assets are bank accounts, bonds, IRA, stocks, mutual funds, other financial wealth, private business wealth, and cars. Liabilities are credit card debt, home loans, mortgage on primary home, mortgage on other properties, and other debt. In the model economy, financial wealth is the savings of an agent net of mortgages. Definition of house includes all real estate (house value plus other real estate). We use "primary economic unit-level" (PEU) weights on all SCF data to get the annual statistics (The Survey of Consumer Finances codebook, 2010). All variables are Winsorized by replacing the top and bottom 1% of values for each variable, with the first top and bottom value, respectively, that falls outside of that 1% region. The data we present is sensitive to these measurement issues and there are significant differences between the mean and the median of the ratios.

by the model is closer to the nationwide rate and somewhat higher than the California rate.[21]

Overall, we conclude that this framework provides a reasonable laboratory for examining the implications of Proposition 13 on house prices and mobility, as well as the potential consequences of its elimination on welfare.

4.2 Economies with and without Proposition 13

In this section, we study characteristics of economies with and without Proposition 13. Table 3 reports the steady state house prices and the probability of moving per year 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. The price of one unit of housing in this economy is 1.60, where average labor income is normalized to be 1, and the average house size is 2. The probability of moving, measured as the number of households that move in a given year as a fraction of total number of households, is 2.83%.[22]

Table 3: Steady States

	House Price	Prob. of Moving
Pre-1978 (2.5% flat property tax)	1.60	2.83
Post-1978 (Proposition 13)	**1.89**	**2.36**
Experiment 1 (0.64% flat property tax)	1.93	2.53
Experiment 2 (sales tax)	1.88	2.63
Experiment 3 (income tax)	1.90	2.63

Proposition 13 introduces two major changes to property taxation. It reduces the property tax rate to 1%, and links the value of the house for tax purposes to its purchase price (and not to its current market value). The second feature results in effective taxes which decline by housing tenure, and therefore by age, and be less than 1% for the average household. In fact, the average effective tax rate in this economy is 0.64%. We label this case as the Post-1978 case. We observe that Proposition 13 leads to an 18% increase in house prices and a 17% decrease in the probability of moving.

[21] We abstract from other issues such as migration that might also affect home ownership rates.

[22] The average mobility found in the model is smaller than its data counterpart. In Section 5 we introduce exogenous (involuntary) move shocks to capture other potential reasons for households to move, such as family related shocks, health shocks, changes in employment, or location preferences.

The capitalization effect of the decrease in the property tax rate found in this experiment is consistent with the results in Rosen (1982).[23] The increase in house prices reflects the present value of the decline in the property tax payments.

In order to disentangle the effects of the two features of Proposition 13 on house prices and mobility, we examine a counterfactual case (Experiment 1) where the only change relative to the pre-1978 case is the reduction in the property tax rate from 2.5% to 0.64%. 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 20%, while the probability of moving decreases by 11%, compared to the Pre-1978 case. This comparison reveals that the increase in house prices would have been even slightly higher (20%) if it were not for the link between house values for tax purposes and housing tenure. Distortions due to Proposition 13 limit the growth of house prices to 18%.

Interestingly, we also find that a decrease in the property tax rate results in lower mobility 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 0.64% (Experiment 1) results in an 11% decline in mobility. There are several reasons behind this decline in mobility. First, higher house prices in the lower tax economy lead to higher transaction costs, discouraging mobility. Second, individuals who receive bad income shocks are less likely to downsize their homes in economies with lower property taxes since the tax burden they face is lower.[24] Proposition 13, which link effective taxes to housing tenure (post-1978) results in a further reduction in mobility to 2.36%, with an overall decline of 17%. This experiment reveals that it may be incorrect to blame the entire decline in mobility to the lock-in effect of Proposition 13. Part of the decline in mobility happens due to lower tax rates.

Comparison of the economies in Experiments 1 to 3 to the Proposition 13 economy provides information about the consequences of eliminating Proposition 13 using three different revenue neutral schemes. In Experiment 1, the property tax rate is reduced to a flat tax rate of 0.64% while keeping

[23] Rosen (1982) reports that across different jurisdictions in California, each dollar reduction in relative property taxes due to Proposition 13 increased relative property values by seven dollars.

[24] We uncover these forces through a set of counterfactual experiments, that are available upon request.

the income and sales tax rates unchanged. In Experiment 2, a reduction in the sales tax rate from 10% to 7.5% (with a flat property tax rate of 1%) allows government revenues to stay unchanged. In Experiment 3, a reduction in the income tax rate from 21% to 19.1% keeps the government revenues constant as we eliminate Proposition 13. Our results indicate that house prices may increase or decrease depending on how revenue neutrality is achieved. 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 sales taxes have no effect on house prices whereas lower property and income taxes lead to higher house prices. Between property and income taxes, property taxes have a larger quantitative impact on house prices. In the model economy with Proposition 13, the link between housing tenure and house values for tax purposes creates another distortion which depresses house prices. The overall change in house prices due to elimination of Proposition 13, therefore, reflects the relative impact of the changes in taxes and the elimination of this distortion. These results are presented in Table 3.

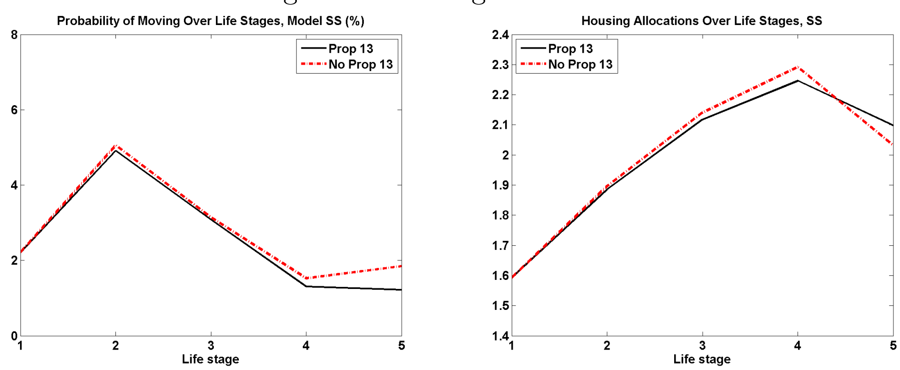
Among our three revenue neutral experiments, house prices turn out to be highest in the lowest property tax case (Experiment 1). Elimination of Proposition 13 leads to about 2% increase in house prices in this case. This increase in house prices is mainly due to the elimination of the link between house values for tax purposes 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%. House prices are slightly lower in Experiment 2. Decline in the sales tax does not have a direct impact on house prices, while the other two factors, 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, where three separate factors (higher property tax rate, lower income tax rate, and the elimination of the link between housing tenure and property taxes) play a role, house prices turn out to be slightly higher. However, all the price changes we find are quite modest.

Mobility increases by 7-11% when Proposition 13 is eliminated depending on how revenue neutrality is achieved. Keeping the effective property tax rate constant (Experiment 1), and eliminating the link between property taxes and housing tenure increases the probability of moving by 7%. In Experiments 2 and 3, where revenue neutrality is achieved via sales and income taxes, mobility increases by 11%. As discussed earlier, an economy with a lower property tax rate (Experiment 1) leads to lower mobility compared to economies with higher property taxes (Experiments 2 and 3).

To understand the differences in mobility with and without Proposition 13 better, we examine the probability of moving and housing allocations for agents in different life-stages. We use Experiment 2, where revenue neutrality is achieved via sales taxes, to document our findings. The results are similar for the other two revenue neutral cases.

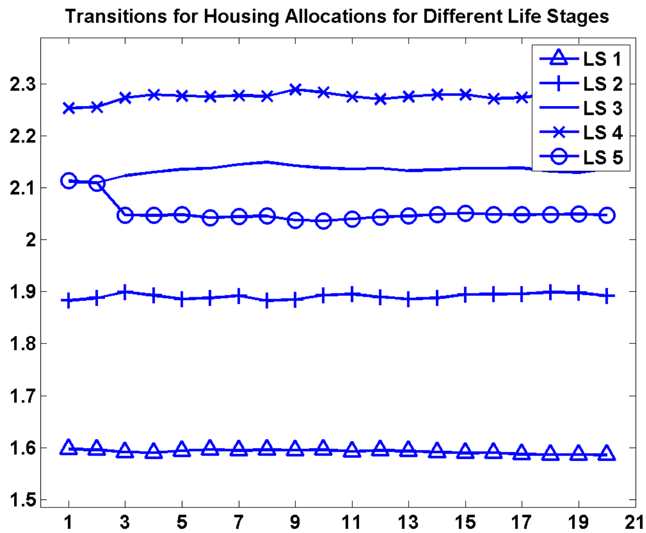
Figure 3 displays the housing allocations and probability of moving by life-stage in these two economies. All agents start life as renters and typically increase the size of their house in later life-stages. The probability of moving jumps in the second life-stage since many agents buy their first house at this stage, and declines until retirement. Comparison of the two economies reveals that Proposition 13 reduces mobility of all agents but especially the agents in their last life-stage. Agents in the middle life-stages live in smaller houses than they would otherwise prefer due to Proposition 13, while agents in the last life-stage remain in larger houses.

Figure 3: Housing Decisions



The results we have summarized so far compared different steady states. Next, we examine the impact of Proposition 13 by analyzing the changes in housing allocations along the transition to the new steady state once Proposition 13 is eliminated. We 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. Figure 4 displays housing allocations along the transition where Propo-

Figure 4: Transitions-Sales Tax



sition 13 is eliminated and tax policy in Experiment 2 is implemented. In this case a reduction in the sales tax rate from 10% to 7.5% ensures revenue neutrality. The two generations that make large adjustments in their housing allocations are middle-aged agents (life-stages 3 and 4) who move into larger houses and old agents (life-stage 5) who downsize their houses. All three revenue-neutral experiments yield similar transition dynamics in allocations. As found in the steady state results, house prices decline slightly along the transition in Experiment 2. House prices along the transitions in the other two cases increase slightly. Transitions happen relatively quickly; in all cases the economy converges to the new steady state in a few periods.

Overall, our findings indicate that while the introduction of Proposition 13 has had a large effect on house prices, its revenue-neutral elimination will not. During the introduction of Proposition 13, property tax rates were reduced significantly which led to higher property prices. Its elimination, on the other hand, will lead to small changes in house prices as long as the property tax rate remains similar after the reform.

The differences in house prices as well as the different tax implications of the three revenue neutral schemes lead to differences in welfare and the overall support for the elimination of Proposition 13, which we discuss in the next section.

4.3 Welfare

In this section, we examine the welfare effects of eliminating Proposition 13 for the three different revenue neutral schemes discussed in Section 4.2. The economy starts in a steady state where property taxes are determined under Proposition 13. At the beginning of period 2, the government proposes elimination of Proposition 13. Agents evaluate their welfare with and without reform to decide whether they support it.

We quantify the welfare effects of reforms for different individuals by using a consumption equivalent variation measure. The welfare effect of a reform for an individual of type $(a_t, m_t, h_t, e_t, B_t)$ is found by asking how much (in percent) this individual's consumption has to be increased (keeping housing constant) in all future periods of the steady state with Proposition 13 so that his expected future utility equals to his utility under that reform. Given the form of the utility function, consumption compensation is calculated as

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

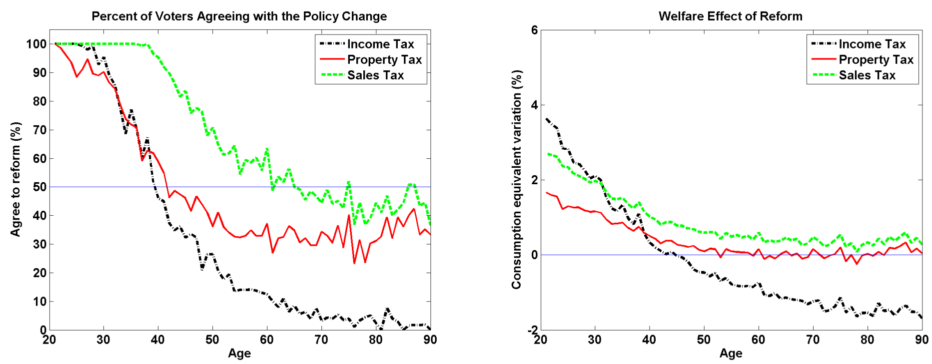
where V_R and V_{NR} represent the value function in economies with and without reform respectively. We report both the percent of agents at each age who are in favor of the reform (those whose utility is higher under the reform) and the consumption compensation by age.

First panel of Figure 5 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. We find that almost all agents under 40 favor the transition if the sales tax rate is reduced to keep revenues constant. Welfare benefit of the reform is above 2% consumption per year for 21 year olds. Overall, 70% of agents alive at the time of transition favor elimination of Proposition 13 in this case.

Support for reform among the younger agents is smallest when revenue neutrality is achieved by reducing property taxes. Support levels decline immediately after age 21. Average welfare benefit of the reform is below 2% for 21 year olds. The reason for the lower support found in this case, as opposed to the sales tax case above, is the increase in house 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. Increase in property prices also lead to an increase in rents, making the welfare benefits of the reform, even for renters, smaller than before. Overall 52% of the agents agree with this reform.

Support for reform is noticeably lower, especially for the middle aged and older agents, in the case where the labor income tax rate is reduced to keep tax revenues constant. Lowering the labor income tax rate does not benefit the elderly much since social security income is not taxed. Consequently, welfare effects of the reform reach -2% for the very old in this case. Overall support for reform is 34% in this case.

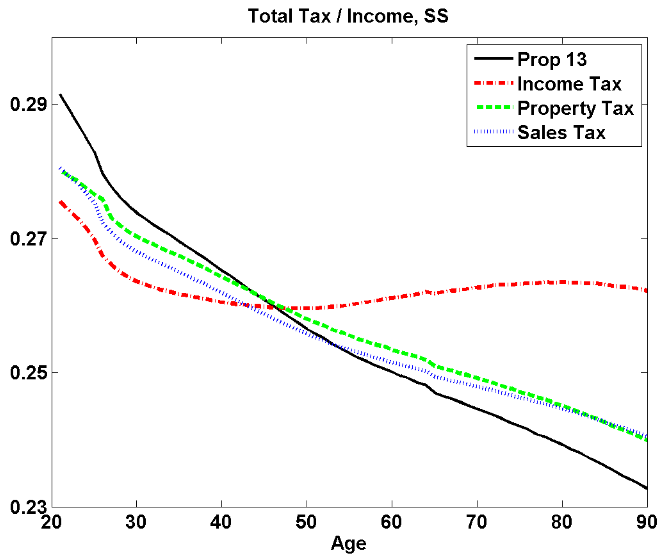
Figure 5: Welfare Comparisons



All three revenue neutral cases generate similar benefits where agents are able to allocate housing more optimally over their life cycles. Tax implications of these three cases over the life-cycle, however, are different. Figure 6 displays the total taxes paid as a fraction of income by age in the economy with Proposition 13 versus the economies without Proposition 13 for three different revenue neutral cases. The case where revenue neutrality is achieved through lower income taxes generates the largest increase in the tax burden of the middle aged and older agents, which explains why their support is especially low in this case. Overall, elimination of Proposition 13 leads to a significant decline in the tax burden faced by young individuals in this case. For example, for a 20 year old, there is almost a two percentage point decline in the tax burden in the economies without Proposition 13, which contributes to the size of the welfare gain for this group reported earlier.

Achieving revenue neutrality through sales or property taxes generates similar changes in the tax burden faced by different ages relative to the Proposition 13 case. Differences in the level of support for reform for these two cases is mainly driven by their implications on house prices. As discussed before, lower property tax rates generate an increase in house prices, hurting

Figure 6: Tax Burden



the renters and the younger individuals particularly hard. This results in the slightly lower support for reform by the younger agents when revenue neutrality is achieved through a lower property tax rate as opposed to a lower sales tax rate. It is conceivable, however, that a change in housing supply, which is not allowed in this framework, may result in house prices remaining the same. In order to tease out the importance of this channel on people's preferences, we also examine the welfare consequences of reform under the assumption of a perfectly elastic housing supply which results in constant house prices. In this case, the overall support for the reform goes down to 68% for the sales tax case and goes up to 66% for the property tax rate case.[25] The price channel is especially important for young agents. With constant prices, support for the reform by 20 to 30 year olds increases under the property tax case, leading to similar support levels for the two revenue neutral cases. Support for the reform via income taxes remains very low under constant prices (34%) since in this case tax burden implications of the reform for older agents overwhelms the price effects.

In Table 4, we report more information on the types of agents who are in favor of the reform in our benchmark case where house prices are allowed to

[25] About a 2% increase in housing supply is needed to keep prices constant when revenue neutrality is achieved via property taxes.

change. While almost all renters support the reform with reduction in sales or property taxes, a significant fraction of renters oppose it when income taxes are reduced instead. Most of the renters in the model are young individuals, but some are the elderly who downsize their homes. The elderly who are receiving social security benefits do not gain as much from a reform that involves a reduction in the income tax rate. This is the main reason why only 74% of the renters support the reform in the income tax case.

Owners in general have lower support levels compared to renters but are more inclined to show support when the reform is financed via sales taxes.[26] 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). Those with a low base, that is, the individuals whose house value for tax purposes is low, do not favor the reform since the effective tax rate increases substantially more for this group. When elimination of Proposition 13 is accompanied with a reduction in the sales tax, for example, 44% of individuals with the low base support the reform as opposed to 95% of the individuals with a high base.

It is also interesting to examine the last three rows, where we present the level of support for the reform by different labor income groups. 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 majority of this group. That is why the reform via a reduction in income taxes generates so little support for this income group. There is significant support for the reform by the middle income group regardless of the tax policy used to keep revenues unchanged. The model generates quite a bit of heterogeneity of incomes by age. Thirty five percent of the middle income individuals are in the first life-stage (between ages 21 and 31) whereas about twenty three percent belong to the second and fourth life-stages (ages 32-42 and 54-64). Only three percent of the agents in this group are the elderly. Thus, the majority of the agents in this group are not adversely effected by the reform financed via income taxes, resulting in high support levels even for this case.

In addition to the welfare effects along the transition discussed so far,

[26]Differences in the voting behavior of the owners and the renters with respect to different taxes that we find in the model are consistent with the empirical findings in Brunner, Ross, 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.

Table 4: Percent in Favor of Eliminating Prop. 13

		sales tax	property tax	income tax
All		70	52	34
Renters		100	97	74
Owners		58	34	17
	Low Base	44	23	4
	High Base	95	59	51
Income				
	Low	60	62	12
	Middle	75	66	59
	High	79	25	32

we examine the welfare consequences of the reforms at the steady state by comparing the welfare of 21 year olds born into economies with and without Proposition 13. According to our findings, the welfare benefit of being born into an economy without Proposition 13 is 1.66% in consumption equivalent variation per year under the lower property tax rate case, and 2.7% under the lower sales tax rate case. A reduction in the income tax rate generates the largest welfare benefit at the steady state, 3.63% of consumption per year, even though it generates the least amount of 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. At the steady state, all individuals are able to optimize over their expected lifetime to take advantage of the elimination of Proposition 13.

Overall, our findings highlight the importance of policies surrounding a reform if Proposition 13 were to be eliminated. We find that elimination of Proposition 13 leads to small changes in house prices and modest increases in mobility, both of which depend on how revenue neutrality is achieved. Welfare gains of reform are quite large and stem mostly from the decline in the tax burden while young and borrowing constrained. However, welfare gains and the level of support varies across different ages and different revenue neutral cases. In most of our calibrations, a reduction in the sales tax rate generates the highest level of support, while a decline in the income 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 benefit from such reform.

5 Sensitivity Analysis

In this section we examine the sensitivity of the results to our calibration as well as to some of the modeling choices we made. We are particularly interested in examining the effects of eliminating Proposition 13 on house prices, mobility, and welfare. The first row of Table 5 presents the results of our benchmark calibration described in Section 3 to provide a baseline for our sensitivity analysis. The first two columns of Table 5 displays the average house price and mobility in the economy with Proposition 13 under several different calibrations. All the other columns report the percent change in prices and mobility relative to the economy with Proposition 13 for each different calibration.

In the second row of Table 5, we examine the sensitivity of our results to the calibration of our owner occupied housing grid of 5 points ranging from 1.5 to 5. An economy with a finer housing grid (1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5) generates very similar results for both the Proposition 13 economy and the alternative regimes. This result confirms that our findings are not sensitive to our grid choice.[27]

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. A case with lower housing transaction costs φ (3% instead of 6%) leads to much higher mobility (3.68%) in the economy with Proposition 13. The impact of transaction costs on housing allocations is very similar to the impact of Proposition 13. Both transaction costs and Proposition 13 result in individuals buying a slightly larger house in their younger years, not moving to a larger house during middle ages, and remaining in a larger house when older, compared to the housing allocation in economies without transaction costs or Proposition 13. Thus an economy with lower transaction costs leads to much higher turnover compared to the benchmark. Elimination of Proposition 13 leads to larger increases in prices when revenue neutrality is achieved via property and income taxes and smaller changes in mobility.

Higher g represents a case where the effect of Proposition 13 is to lead to a 5% decline in the real value of a house for tax purposes in case of no change in ownership, instead of the 3% used in the benchmark. This leads to higher house prices in the Proposition 13 economy as the effective

[27] Very few agents choose house sizes of four or above. Therefore, extending the maximum house size beyond five has no impact on our results.

property tax rate is lower in this case relative to the benchmark. Since the tax benefit of Proposition 13 is higher in this case, mobility is lower at the benchmark and we observe larger changes in mobility as a result of its elimination. Compared to the benchmark, revenue neutrality after the elimination of Proposition 13 implies larger declines in tax rates. The effect on house prices remains small.

Lastly, we examine the sensitivity of our results to the calibration of the rental state. In the benchmark economy individuals were given access to only one size rental housing which was calibrated to be 1.5, while the average size of owner occupied housing was 2.25.[28] In this experiment we offer two different sized rental units, 1 and 1.8. This extension allows especially the young agents to move more frequently between different rental units and results in a higher mobility rate for the benchmark economy. Changes in the price of housing and mobility due to elimination of Proposition 13, however, are similar to the previous findings.

Table 5: Sensitivity Analysis I

	Prop 13		Sales Tax		Prop Tax		Income Tax	
			% change in					
	Price	Mobility	Price	Mobility	Price	Mobility	Price	Mobility
Benchmark	1.89	2.36	-0.41	11.44	2.07	7.20	0.85	11.44
Larger grid	1.89	2.35	-0.52	11.49	2.11	10.21	1.85	12.77
Lower σ	1.83	2.72	-0.15	8.82	4.15	6.99	1.81	8.46
Lower φ	1.95	3.68	-0.42	7.61	4.36	5.98	2.79	7.07
Higher g	1.94	2.04	-2.97	28.92	0.98	22.55	-0.51	27.45
Multiple rental	1.76	4.76	-0.57	3.36	3.41	2.52	1.14	2.31
Exo move shock	1.77	12.49	-1.56	0.96	1.00	0.88	-0.17	1.84

In Table 6, we present the percent of population in support of the reform under different calibrations. To abstract from the effect of house prices on welfare, we assume an elastic house supply, which leads to constant house prices. The first row presents the support for elimination for the benchmark calibration. With constant house prices, two-thirds of the voters support the proposed reforms with lower property and sales taxes, while only one-third support the reform with lower income taxes. Different calibrations reveal similar support patterns for reform proposals.

[28]This was based on the observation that in the U.S. the average size of owner occupied houses are approximately 50% larger than the average size of rental units.

Table 6: Sensitivity Analysis II

	Percent in Favor of Eliminating Prop. 13		
	Sales Tax	Property Tax	Income Tax
Benchmark	68	66	34
Larger grid	68	66	34
Lower σ	72	68	40
Lower φ	71	72	35
Higher g	65	64	37
Multiple rental	55	53	35
Exo move shock	45	50	39

Move Shocks

In our benchmark model changes in the life-stage and shocks to income were the only reasons for individuals to decide to move to different size houses, or from rental to owner occupied housing. In reality, there are many other reasons for households to move, such as family related shocks, health shocks, changes in employment, or location preferences that we have abstracted from. In this section, we introduce exogenous (involuntary) move shocks, similar to Cocco (2004), and examine the sensitivity of our results to this extension.

We assume that at each period t, individuals may receive an idiosyncratic shock that will force them to move to a new house. These involuntary move shocks introduce an additional state variable in the model, where $v = 1$ denotes the state with the move shock, and $v = 0$ the state without the shock.

For an 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 is forced to move as well (either to a rental or to an owner occupied house), but does not incur a transaction cost of selling.

Transaction costs in this case are given by $F(h_t, h_{t+1}, v_t)$:

$$F(h_t, h_{t+1}, v_t) = \begin{cases} \varphi p_t h_t & if \quad h_t > \underline{h} & & and \quad v = 1 \\ \varphi p_t h_t & if \quad h_t > \underline{h} & and \quad h_{t+1} \neq h_t & and \quad v = 0 \\ 0 & if \quad h_t = \underline{h} & & for \quad \forall\, v \end{cases} \tag{17}$$

We modify the dynamic programming problem to incorporate the move shock, where, in addition to life-stages, a_t; assets (mortgage), m_t; housing,

h_t; employment state, e_t; the value of their house for tax purposes, B_t; individuals are also heterogeneous with respect to the move shocks they receive, v_t. Let $\Lambda^a(v, v')$ be the transition matrix for the move shock which is a function of the life-stage, $\Gamma(e, e')$ be the transition matrix for stochastic labor income, $\Pi(a, a')$ be the transition function for life-stages, and Ω_t represent the measure of the agents of type (a, m, h, e, B, v) at time t. Let $V_t(\Omega)$ be the (maximized) value of the objective function with state Ω_t. The dynamic programing problem for the agent is given by

$$V_t(\Omega) = \max_{c,h',m'} u(c, h) + \beta \sum_{a'} \sum_{e'} \sum_{v'} \Pi(a, a')\Gamma(e, e')\Lambda^a(v, v')V_{t+1}(\Omega') \quad (18)$$

subject to the budget constraints given in Equations 1-2, 4-13, and 17.

In the data there are significant differences in the probability of moving across age groups. While the overall mobility across all ages is 13.4%, it declines sharply by age. We calibrate the economy by choosing the exogenous move shocks for agents in each life-stage such that the resulting probabilities of moving by life-stage, which are the results of both exogenous and endogenous moves, mimic their counterparts in the data. These exogenous shock probabilities are given by [0.33, 0.08, 0.06, 0.07, 0.05] for life-stages 1-5, where the model targets for probability of moving by life-stage in the data are [0.33, 0.15, 0.09, 0.08, 0.06].[29] The rest of the calibration is identical to the parameters summarized in Table 1.

Introducing move shocks results in some new observations. Compared to the benchmark economy, house prices are lower (Table 5) as agents are subject to more frequent transaction costs. Agents now have less of an opportunity to remain in the same house, and are not able to take advantage of Proposition 13 as much as before the introduction of move shocks. Similar to Cocco (2004), the existence of involuntary moves reduces the probability of voluntary moves. Therefore, the elimination of Proposition 13 has a smaller effect on mobility than without the move shocks. In addition, effective property taxes do not decline as much with age as we had previously reported in Figure 1. This results in a decline in the benefits of Proposition 13. At the same time, elimination of Proposition 13 has smaller tax implications, which reduces the benefits of reform. Overall welfare effects (Table 6) are found to be smaller.

[29]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.

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 to decline by housing tenure, and therefore by age, and distorts housing allocations. We find that the introduction of Proposition 13 leads to an 18% increase in house prices and a 17% decrease in the probability of moving. The increase in house prices are due to the capitalization of the decline in property tax rate. Without the distortions resulting from the link between housing tenure and taxes, the increase in house prices would have been higher.

We use this framework to examine the consequences of eliminating Proposition 13. We find that the price effect of eliminating Proposition 13 is likely to be small. Depending on the calibration of the model and the way in which revenue neutrality is achieved, change in house prices due to the reform ranges between -1% to 4%.

We uncover several interesting observations about mobility. First, elimination of Proposition 13 leads to modest changes in mobility and housing allocations. Second, the level of the property tax rate also effects the probability of moving. In a world with idiosyncratic incomes, the agents who receive bad shocks are more likely to trade down their houses when they face high property tax rates. Consequently, the impact of Proposition 13 on mobility depends both on the implied change in the tax rate, and the distortion resulting from the link between housing tenure and taxes.

We also find that the level of support for reform depends on how revenue neutrality is achieved. The reform with the least amount of support is the one where revenue neutrality is achieved via a reduction in income tax rates. In this case, older agents do not receive any benefits since they do not receive labor income, and suffer the consequences of the elimination of Proposition 13 due to higher property taxes they face along the transition. Even though the support for the elimination of Proposition 13 from those alive during the reform is mixed, the welfare benefit of being born into an economy without Proposition 13 is quite high.

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7 Appendix

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, τ^i, sales taxes, τ^s, and property taxes τ^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:

$$y_t(1-\tau^i)+(1-\delta)p_t h_t+m_{t+1} = c_t(1+\tau^s)+p_t h_{t+1}+(1+r(1-\tau^i))m_t+\tau^p p_t h_t \tag{19}$$

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

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

With the Cobb-Douglas utility function in equation 16 we get:

$$\frac{u_h}{u_c} = \frac{1-\chi}{\chi}\frac{c}{h}. \tag{20}$$

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.

$$p = \frac{(1-\chi)(1-\tau^i)y}{h(\delta + \tau^p + \chi(r(1-\tau^i))} \tag{21}$$

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, 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

U.S. Data

Homeownership Rate: The data are obtained from the Survey of Consumer Finances (SCF), where homeownership is defined as either: (1) owns ranch/farm/mobile home/house/condo/coop/etc. or (2) otherwise. The depicted ratio for each year-age intersection is found by summing all instances of definition (1) and dividing by all available data points, i.e.: sum(1)/(sum(1) + sum(2). The averages are computed, at 3-year periods, between 1989 and 2010 since SCF data are available at 3-year intervals.

Data for Net Financial Wealth, Real Estate, and Net Worth come from the SCF and includes the data on non-homeowners as well. Data are winsorized by replacing the top and bottom 1% of values for each variable, with the first top and bottom value, respectively, that falls outside of that 1% region. Each of our statistics is first computed on an annual basis. The final statistic is obtained by averaging across all available annual values between 1989 and 2010.

Net Financial Wealth: sum of all financial assets (definition: liquid assets, certificates of deposit, directly held pooled investment funds, stocks, bonds, quasi-liquid assets, savings bonds, whole life insurance, other managed assets, and other financial assets) minus all liabilities (definition: principal residence debt (mortgages and home equity lines of credit), other lines of credit, debt for other residential property, credit card debt, installment loans, and other debt).

Income: wages, self-employment and business income, taxable and tax-exempt interest, dividends, realized capital gains, food stamps and other support programs provided by the government, pension income and withdrawals from retirement accounts, Social Security income, alimony and other support payments, and miscellaneous sources of income.

Real Estate: house value + other residential real estate (definition: includes land contracts/notes owed to the household and properties other than the principal residence, including 1-4 family residences, time shares, and vacations homes).

Net Worth: net financial wealth + house value.

California Data

We use Integrated Public Use Microdata Series (IPUMS) 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 year 1990, and then for years 2000-2011. We do not include years 2008-2011, as these years are affected by the financial crisis. Therefore, for 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 and upwards. Then, for each age, we take the average across 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 by 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 less 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. Do value function iterations starting from the second steady state without Proposition 13 and going back to period 2 and obtain decision rules along the transition.

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.