Tarnishing the Golden State: Regulations and the US Slowdown*

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Abstract

We study the impact of state-level housing and land restrictions on the recent slowdown in US economic activity relative to trend. We use a variety of state-level data sources, including the USDA, the Census and the BEA to develop a general equilibrium spatial model of the US states, to estimate a time series of land restrictions across states, and to analyze how changing these restrictions impact aggregate economic activity and the allocation of workers across states. We show that land regulations have tightened significantly over the last several decades, particularly in California and New York. Deregulating *existing* urban land from 2014 restriction levels back to 2000 restriction levels would increase US GDP growth by nearly .5% per annum from 2000 to 2014, bringing output and TFP growth roughly in line with their historical trends. The most significant expanding regions from these hypothetical deregulations are California, New York, and the Mid-Atlantic. However, general equilibrium congestion forces in the market for housing and land offset some of the gains from deregulation.

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1 Introduction

The U.S. record of 250 years of roughly constant economic growth has gone hand-in-hand with enormous reallocation of human capital across U.S. regions. This includes the country's westward expansion into the Midwest and the Great Plains states in the 1800s and 1900s, the urbanization of the 1900s, and the remarkable expansion of California in the 1900s.

In 1900, 18 states were larger than California, including Alabama, Iowa, Kentucky, Georgia, and Mississippi. At that time, Illinois was roughly three times as large as CA, Missouri was more than twice as large, and Kansas was roughly the same size. By 1990, roughly 12 percent of the country's population resided in California, compared to less than 2 percent in 1900. And by 1990, CA was as much as 11 times larger than some of the states that dominated California in 1900.

Recently, however, regional human capital reallocation patterns have declined, and California's relative population growth has stopped. Frey [2009] documents that the U.S. migration rate has declined by about 40 percent since the 1980s, and he shows that this decline in reallocation appears across all demographic groups. California's population share stopped growing at this same time, as California has exhibited net out-migration since 1990.

These changes in regional reallocation, and the sudden stop in the expansion of California's population share, have coincided with three other observations of interest. One is the decline in aggregate economic activity relative to historical trend that predates the Great Recession and that has continued afterwards. This period of relatively low productivity growth and low output growth has been characterized by Decker et al. [2014] as a decline in U.S. Dynamism, with a less vibrant economy characterized by much less factor reallocation.

A second observation is that housing prices in productive locations, including California, rose considerably around the same time. Between 1940 and 1980, Census data show that California housing prices were on average around 35 percent higher than those in the rest of the country. By 1990, however, the California housing price premium had risen to 262 percent.

A third observation is that that state-level income convergence has slowed. Ganong and Shoag [2013] show that income convergence across states, which we primarily interpret as workers moving out of states with relatively poor job opportunities, to states with better job opportunities, began to slow in the 1980s. Moreover, the states with the highest housing prices, such as California, continue to have higher worker productivity.

This paper interprets these observations as reflecting state-level policies that have constrained housing supply and raised housing prices that have slowed migration and the efficient reallocation of factors, and which in turn have depressed productivity and output.

We do this within a multi-regional optimal growth model of the U.S., in which regions feature: (1) exogenous differences in usable land, (2) exogenous, state-specific productivity levels, (3) exogenous differences in amenities, and (4) exogenous differences in region-specific policies that affect the supply and price of housing, and/or affect the productivity of capital and labor.

The simple idea is that regions offer different bundles of goods, and that human capital moves out of regions with relatively poor opportunities, such as the exodus of the Rust Belt after World War II, to regions with better opportunities, such as California.

This analysis models these policies as a factor that affects the quantity of effective land that is available for housing and production of a good that is used for consumption and investment. We view this factor as representing policies such as density restrictions, zoning restrictions, environmental restrictions, building restrictions, and other factors that affect land-use. We call this factor a state-specific productivity distortion.

We calibrate the model using historical, state-level data for the 48 continental states between 1950 and 2014 on labor productivity, housing and land prices, and employment shares. This approach allows us to use the model to infer a time series of the state-specific policy distortions. It also allows us to infer state-level TFP and state-level amenities. We find that the model-inferred state policy distortions are quite highly correlated with other measures of state-level distortions, and we also find that the model-inferred state-level amenities are quite highly correlated with existing measures of quality-of-life measures across states. We find that California and New York are among the states with the highest state-level TFP, but also have the highest level of distortions. In contrast, we find that Texas has the lowest level of distortions among the states.

We use the model to study the impact of these state-level policy restrictions on output, productivity, labor, consumption, investment, and the allocation of the population across states. We conduct a number of counterfactual experiments that we call deregulation experiments, in which we reduce year 2014 distortions in some states, such as California, or all states, to their levels in either an earlier year, or to a level based on the model-inferred 2014

Texas distortion level.

We find that these deregulation experiments lead to a substantial reallocation of human capital across the U.S. states, with California's population growing substantially, and that aggregate (U.S.) TFP, output, consumption, and investment would be significantly higher in 2014 as a consequence of these deregulations. In particular, in a model with a modest agglomeration productivity externality, and with all states moving halfway to the 2014 Texas policy level, we find that that U.S. labor productivity could be 17 percent higher, and that consumption could be 14 percent higher.

The paper is organized as follows. Section 2 provides a literature review. Section 3 presents the model economy. Section 4 summarizes the data. Section 5 discusses the quantitative approach and model calibration. Section 6 presents the counterfactual experiments. Section 7 concludes.

2 Literature Review

This paper, which focuses on the impact of land-use regulations on aggregate economic activity, is related to a number of papers that have separately studied the issues of land-use regulation, declining regional mobility, and rising housing prices.

Glaeser [2014] and Furman [2015] both argue that land and housing regulations slow economic growth. Both papers synthesize existing work that provides a set of facts relating economic performance and regulation.

Ganong and Shoag [2013] studies the relationship between house prices and regional mobility and income convergence across states. They use land-related court cases as a proxy for land-use regulations, and they argue that declining migration rates and declining regional income convergence reflects regulations and rising house prices in high income regions. Our paper's theme regarding land regulations is related to Ganong and Shoag [2013], but we develop a very different approach of measuring regulations by using a regional optimal growth model in conjunction with data on home and land prices.

Hsieh and Moretti [2015] study how US cities have grown, and how different cities have contributed to US output. Our paper and Hsieh and Moretti [2015] study similar issues, and are very complementary to each other, as there are several important, complementary differences in terms of focus, methodology, and the economic mechanisms that are at work. This paper is based on a dynamic general equilibrium framework, in which land is a fixed factor in production, with a focus on using a model-based time series of changes in regulations to analyze how regulations have affected productivity, real GDP, consumption, investment, employment, and the reallocation of the population.

In contrast, Hsieh and Moretti [2015]'s compute the contribution of each major city to US GDP in 1964, and in 2009, and conduct counterfactuals based on time-invariant proxies for land-use regulation. Since they do not have time series on land-use regulations, they do not address the question of whether or not, or by how much, tightening land-use regulations from 1950-2014 have slowed US GDP growth. In contrast to our paper, Hsieh and Moretti [2015] use a partial equilibrium Roback [1982] style model. The partial equilibrium flexibility of Hsieh and Moretti [2015] allows them to study some issues more easily than can be done in our framework, including differentiated outputs and regional differences in production elasticities.

Another important difference between the two papers is the treatment of the housing market in the two papers. Hsieh and Moretti [2015] assume the relationship between house prices P_i and labor L_i takes the form, $P_i = L_i^{\gamma_i}$, where γ_i is a house price elasticity with respect to labor and is proxied using the Wharton Land Regulation Index. In the present paper, we incorporate land as a fixed factor into a dynamic general equilibrium model of the U.S. economy, in which all markets, including the market for land and the market for housing, must clear.

In the analysis in this paper, housing market clearing and land market clearing impose significant congestion externalities, which offset some of the impact of land-use regulations on output growth. Since markets clear in our model and housing is produced with a mix of inputs, how house prices change with employment inflows in our model is a function of how much capital is allocated to the housing sector, as well as growth prospects in other regions. As a result, congestion forces and capital reallocation, determine the relative gains of migration. Ultimately, these forces mitigate the impact of land regulations on employment flows. Lastly, since our general equilibrium allows us to make welfare calculations of the costs of land regulation.

3 Model

The focus of our quantitative exercise is on land-use regulations. We develop a spatial, representative-agent model which generates regional wage dispersion and explicitly models land as a fixed factor. Land enters the production function of the single, final-output good, which is bought and sold in a competitive market, and land also enters the production function for housing. We model land-use restrictions as productivity distortions to land which we allow to vary over time, and across regions. The structure of our model allows us to infer land-use regulations from 1950-2014 which we then use to conduct counterfactual experiments. In particular, we study how recent changes in land-use regulations impact the distribution of employment across states as well the levels of output, productivity, investment, consumption, and the allocation of employment across states.

3.1 Household Problem

Let $j \in \{1, \ldots, N\}$ index regions, and let $t = 0, 1, \ldots$ index time. All variables are expressed in per capita terms. We assume there is a representative household that chooses the number of workers in each region n_{jt}, how many units of housing to rent h_{jt}, how much capital to rent for final goods production k_{yjt} and housing production k_{Hjt}, how land should be split between final goods production x_{yjt} and housing production x_{Hjt}, and what amount of capital to carry forward to next period k_{t+1}. We let i_t denote investment. The representative household must rent as many housing structures as workers in a region. The representative household has preferences over consumption c_t, aggregate hours worked ($n_t = \sum_j n_{jt}$), and region specific amenities a_{jt}. We assume amenities are additive and proportional to labor supplied in a region. The stock of land is given by x_{jt}, and it is assumed to be a fixed factor. Zoning laws and other land regulations are summarized by the parameters α_{Hjt} and α_{yjt}, which govern the productivity of land in final goods and housing production, respectively.

There is a single final good which serves as the numeraire. It is produced in each region and traded in a competitive market. Housing rental units are traded within a region, and p_{jt} is the rental price of housing on island j at date t. Land is also traded within a region and the rental rate of land on island j and date t is q_{jt}. Capital and labor are freely mobile across regions, subject to the constraint that there must be as many housing units in a region as people. Therefore, r_t, the price of capital, is constant across regions. The representative household owns both production and housing rental firms on both islands. The profits from final goods and housing rental production are given by π_{hjt} and π_{yjt} , respectively.

The household's problem is to maximize the following objective function,

$$\max_{\{k_{yjt},k_{Hjt},n_{jt},x_{Hjt},x_{yjt},h_{jt}\},k_{t+1}} \sum_{t=0}^{\infty} \beta^t \Big\{ u(c_t, n_t) + \sum_j a_{jt} n_{jt} \Big\},$$

subject to the resource constraint,

$$c_t + i_t + \sum_j p_{jt} h_{jt} = \sum_j (w_{jt} n_j + q_{jt} x_{jt} + \pi_{yjt} + \pi_{Hjt}) + r_t k_t$$

the law of motion for investment, i_t, in physical capital,

$$i_t = k_{t+1} - (1 - \delta) k_t,$$

the regional capital constraint,

$$k_t = \sum_{j=1}^{N} k_{jt} = \sum_{j=1}^{N} k_{yjt} + \sum_{j=1}^{N} k_{Hjt}$$

the regional worker constraint,

$$n_t = \sum_{j=1}^{N} n_{jt}$$

the housing constraint,

$$h_{jt} \geq n_{jt}$$

and the land constraint,

$$x_{jt} = x_{yjt} + x_{Hjt}.$$

3.2 Final Goods Production

On each island, a representative firm produces the final good, by combining land, x_{yjt}, labor, n_{jt}, and capital k_{yjt}. We assume there are agglomeration effects that take the form of increasing returns over production on an island, so that productivity takes the form, $A_{jt}\bar{A}(\tilde{y}_{jt})$, where $\tilde{y}_{j,t}$ is output net of agglomeration effects (e.g. Benhabib and Farmer

[1996]).[1] Therefore production occurs according to:

$$y_{jt} = A_{jt}\bar{A}(\tilde{y}_{jt})F(k_{yjt}, n_{jt}, \alpha_{yjt}x_{yjt})$$
$$\tilde{y}_{jt} = F(k_{yjt}, n_{jt}, \alpha_{yjt}x_{yjt})$$

Firms rent capital, rent land, and hire workers in order to maximize profits, and they do not internalize the agglomeration effects,

$$\pi_{yjt} = \max_{k_{yjt}, n_{jt}, x_{yjt}} A_{jt}\bar{A}(\tilde{y}_{jt})F(k_{yjt}, n_{jt}, \alpha_{yjt}x_{yjt}) - r_t k_{yjt} - w_{jt}n_{jt} - q_{jt}x_{yjt}$$

3.3 Housing Rental Units

Housing rental units are produced by combining capital with land according to:

$$h_{jt} = g(\alpha_{Hjt}x_{Hjt}, k_{Hjt})$$

Rental housing firms maximize profits by renting land and structures to combine with land:

$$\pi_{Hjt} = \max_{k_{Hjt}, x_{Hjt}} p_{jt}g(\alpha_{Hjt}x_{Hjt}, k_{Hjt}) - r_t k_{Hjt} - q_{jt}x_{Hjt}$$

The rental price of a home is $\frac{r_t}{g_k(\alpha_{Hjt}x_{Hjt}, k_{Hjt})} = p_{jt}$. To recover the purchase price of a house (P_{jt}), we discount the flow of rental payments, $P_{jt} = \sum_t \beta^t \frac{u_{ct}}{u_{c0}} p_{jt}$.

3.4 Equilibrium Definition

A competitive equilibrium consists of policy functions $\{n_{jt}, h_{jt}, x_{Hjt}, k_{yjt}, k_{Hjt}, k_{t+1}, c_t\}_{t=0}^{\infty}$, prices $\{w_{jt}, r_t, q_{jt}, p_{jt}\}_{t=0}^{\infty}$, profits $\{\pi_{yjt}, \pi_{Hjt}\}_{t=0}^{\infty}$, and exogenous land, land constraints, total factor productivity, and amenities, $\{x_{jt}, \alpha_{Hjt}, \alpha_{yjt}, A_{jt}, a_{jt}\}_{t=0}^{\infty}$ such that:

1. Given prices, profits, and land constraints, the household policy functions are optimal.

[1] Others in the urban literature have used Ciccone and Hall [1996]'s agglomeration over density, but since our model includes capital, it is difficult to reconcile their estimates with the parameters in our model. We note that their density externality approximately corresponds to an externality on labor productivity and output.

2. Given prices, and land constraints, firms optimize.
3. Capital, land, and labor markets clear on each island.Final goods market clearing then follows from Walras' law.

3.5 Discussion of Model Mechanisms

Housing rental rates, wages, and land prices vary across regions. While amenities are linear in the number of workers in a region, there are strong congestion forces in the model that work through house prices and land prices. The more individuals in a region, the greater the house price. This housing congestion prevents corner solutions where all agents enter either the most productive region or the region with the greatest level of amenities.

Land regulations, α_{yjt} and α_{Hjt}, distort both labor-productivity and the labor-leisure condition. Land regulations primarily impact the rental rate of housing units in a region. Since there must be as many houses as individuals in a region, tighter land regulations reduce employment levels. The first order condition for labor in region i is given by,

$$-\frac{u_{njt}}{u_{ct}} = w_{jt} - p_{jt} + \underbrace{\frac{a_{jt}}{u_{ct}}}_{Amenities}$$

Since land is a fixed factor, rental rates for housing, p_{jt}, differ across regions. This variation in house prices across regions generates compensating wage differentials, i.e. w_{jt} differs across regions and is greater in regions with greater house prices. Amenities also enter the labor leisure condition, allowing the model to support additional wage dispersion. Even without amenities, $a_j = 0 \;\; \forall i$, the model would generate wage dispersion. With regions that have higher house prices commanding greater wages. This positive relationship between house prices and wages is prominently featured in the data (e.g. Ganong and Shoag [2013]).

4 Data

The data used in this paper are from a variety of sources. Several regional time series are relatively easy to obtain, including employment (BLS) and population (Census). The remaining time series for house prices, output per worker, price deflators, and urban land, are drawn from a number of different sources.

Turner et al. [2007] provide an updated set of regional deflators based on the methodology of Berry et al. [2000]. Berry et al. [2000] estimate consistent, historic, state deflators using family budget sets collected by the BLS. Since their data ends in 2000, we extend this series to 2014 using the following procedure. We regress the Turner et al. [2007] time series of the state deflators on a set of regional CPI variables interacted with a full set of state indicators for the 13 years in which both data series overlap (1987-2000). During the overlap period, the R^2 is approximately .990. Given this very close fit between the regional CPI and the state CPI, we then project the time series forward using the regional CPI variables to obtain state-level deflators. The base year of the deflator is 2000.

We obtain output per worker across the states between 1950 and 2000 from Turner et al. [2007]. We extend the series to 2014 using BEA measures of state output, and then we deflate this series using our consistent state-level deflators.

We use data from the Census of Housing for median single-family house price across states from 1940-2000. Since the Census of Housing has been discontinued, we extend these data after 2000 using the American Community Survey's 100% sample. Specifically, we use these data from 2014 to compute a consistent measure of median single-family house prices across states.[2] We deflate house prices by our regional deflators to obtain the real cost of housing, in year 2000 dollars, from 1950-2014 across all US states.

The final data series we use is urban land acreage from the USDA Economic Research Services (ERS) 1945-1997. While the USDA-ERS provides imputed urban acreage estimates for 2002 and 2007, the last published, non-imputed, observation on urban land was 1997. As they note, their imputation method makes the data points in 2002 and 2007 inconsistent with their estimates in 1997. To fix this issue, we use the 2010 decennial census which includes urban land acreage estimates. We multiply total land acreage by state from the USDA-ERS (total land has been roughly constant for the last 60 years across states and is not subject to imputation inconsistencies) by the Census' estimates of the percent of total land that is urban, by state. This yields a consistent estimate of urban land acreage by state from 1950-2010. We linearly interpolate between the observation dates in the USDA-ERS urban land series. In the case of the final year, our 2010 urban acreage estimate, without additional adjustment, is used for our 2014 steady state.

[2] We impose the same conditions, including the fact that the house must be owner occupied, single-family, on a plot of land less than 10 acres, with no business or medical office on the property.

Appendix C provides additional information on the data sources.

5 Quantitative Approach

Our overall approach is to focus on the long-run evolutions of aggregate variables and regional/state employment shares, as opposed to business cycle movements. We therefore specify the model as being in steady state for each 10-year interval: 1950, 1960, ..., 2000 and also in 2014. We use this steady state approach given its simplicity and transparency. The alternative to assuming steady states in each of these long run periods would be to calculate the equilibrium path of the model, given expectations about the exogenous variables. Our steady state approach seems to us to be a useful first step in this analysis, and the next version of the paper will construct equilibrium paths so that we can trace the evolution of population flows more smoothly.

5.1 Model Calibration

In terms of model calibration, we first allocate states into regions. California is one region, given our interest in this state and given its size. We also choose New York as an individual region, given its size, and given the view in the literature that New York is also highly regulated (Glaeser et al. [2005]). In addition, we select Texas as an individual region, given its size and the view that Texas has relatively low regulation levels.

For the remaining continental states, we aggregate these states into five geographic regions. This includes the *South* (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, the Carolinas, and Tennessee). The *Rust Belt* includes the states typically specified in that group, with the exception of New York (Illinois, Indiana, Michigan, Ohio, Pennsylvania, Wisconsin, West Virginia (see Alder et al. [2014]), the *New England-mid-Atlantic region* (Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, Rhode Island, Virginia, Vermont), the *Midwest* (Iowa, Kansas, Minnesota, Missouri, Nebraska, Oklahoma, and the Dakotas), and a *Northwest-Mountain* region (Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, Wyoming).

The aggregate U.S. economy is therefore made up of these 3 states, plus five regions. We omit Alaska and Hawaii, given that both of these states became states after 1950, and given that they are not part of the continental U.S.

We choose standard preferences, and we also include additive amenities in the utility function:

$$\ln(c_t) - \frac{\phi}{1+\frac{1}{\gamma}}\Big(\sum_j n_{jt}\Big)^{1+\frac{1}{\gamma}} + \sum_j \alpha_j n_j \tag{1}$$

We choose the technology for producing the consumption/investment good as follows:

$$y_{it} = \tilde{y}_{jt}^{\lambda} A_{jt} k_{yjt}^{\theta} n_{jt}^{\chi} (\alpha_{yjt} x_{yjt})^{1-\theta-\chi} \tag{2}$$

We choose the technology for producing housing as follows:

$$h_{jt} = k_{Hjt}^{\xi} (\alpha_{Hjt} x_{Hjt})^{1-\xi} \tag{3}$$

We use standard values for the parameters in the model that typically appear in aggregate optimal growth models with elastically supplied labor. This includes the discount factor, $\beta = .9614$, the depreciation rate, $\delta = .1$ (Hansen [1985]), and the labor supply elasticity parameter, $\gamma = 2$ (e.g. Keane and Rogerson [2012]). The gross return on capital, r_t, is therefore 14% in the steady state, and the return net of depreciation is 4%.

In terms of the production of the consumption/investment good, we choose a labor share of 0.66. We choose a land share of five percent, based on Valentinyi and Herrendorf [2008]. In terms of the share parameters in the production of housing, we choose a land share of 0.38, based on Davis and Heathcote [2007].[3]

There is a large range of values for the size of the externality parameter within the literature. We consider two values for the externality parameter, λ, which are zero (purely neoclassical model), and 0.03, which is a relatively conservative choice relative to the literature in this area. We note that Ciccone and Hall [1996] choose a value that is about 0.06, and which approximately corresponds to an externality on labor productivity.

For the other model parameters, our approach is as follows. First, we normalize the value of the amenity term for the Northwest-Mountain region to zero for all years. Therefore, the

[3]This is the raw average across MSAs and across time, from 1984-Q4-2016-Q1.

amenity terms in the other regions are interpreted as relative to the Northwest-Mountain region.

For the year 2014, we estimate the remaining parameters $\{a_j, A_j, \alpha_{Hj}, \alpha_{yj}, \phi\}$ to match various targets in the data. We choose the time-invariant hours-location parameter, ϕ, so that steady-state employment per capita is 59% in 2014.[4]

In the baseline calibration we assume the same distortions to housing and production $\alpha_{Hj} = \alpha_{yj} = \alpha_j$ (the next version of the paper will relax this assumption). We choose the policy distortions (α_j) to target house prices. We choose the amenities (a_j) target employment shares, and we estimate TFP (A_j) to target regional labor productivity (y_j/n_j). We set the land masses x_{jt} to match, exactly, the acres of urban land over the US population in region j.

For the other years (1950, 1960, 1970, 1980, 1990, and 2000), we use urban land area data, we choose the amenity terms, the distortion terms, and TFP to hit the same targets as above, except for the aggregate employment level. Thus, we are only able to target aggregate employment in 2014.[5]

Table 1 illustrates the model's fit relative to the targeted moments as well as the model's parameter values. The model is able to exactly match the specified moments. We discuss the interpretation of the estimated parameters in the next section. Appendix A includes the remaining estimated parameters.

[4]This is based on the 'Civilian Employment-Population Ratio, Percent, Annual, Seasonally Adjusted' averaged over the 12-months in 2014.

[5]In this version of the paper, we do not focus on the model's ability to account for aggregate employment outside of the year 2014. The main reason is because the results from the counterfactual experiments are insensitive to the model's ability to account for the aggregate employment level. Specifically, we specified a version of the model in which we the amenity terms for the Northwest-Mountain region vary over time, which allows the model to target the aggregate employment level at each date. The counterfactual results were nearly identical to those in the baseline model. Figure 8 in Appendix B shows model and actual aggregate employment. While the model employment is above actual employment, particularly in the early years, this error does not impact the results of the experiments.

Table 1: Parameter Values and Model vs. Data Moments (CA, NY, and TX)

	Model	Data	Parameter	Value	
Productivity in CA	10.3801	10.3801	$A_{CA,2014}$	4.8058	TFP
Employment in CA Relative to Pacific/Mountain West	1.0722	1.0722	$a_{CA,2014}$	-0.2131	Amenity
House Prices in CA	27.6327	27.6327	$\alpha_{CA,2014}$	0.0053619	Land Constraint
Land Per Capita in CA	2.0835	2.0835	$x_{CA,2014}$	2.0835	Acres per 100 Individuals in US
Productivity in NY	11.8242	11.8242	$A_{NY,2014}$	4.9997	
Employment in NY Relative to Pacific/Mountain West	0.62256	0.62256	$a_{NY,2014}$	-0.53407	
House Prices in NY	19.417	19.417	$\alpha_{NY,2014}$	0.014937	
Land Per Capita in NY	1.0369	1.0369	$x_{NY,2014}$	1.0369	
Productivity in TX	9.9432	9.9432	$A_{TX,2014}$	4.0988	
Employment in TX Relative to Pacific/Mountain West	0.79159	0.79159	$a_{TX,2014}$	-0.31578	
House Prices in TX	10.2298	10.2298	$\alpha_{TX,2014}$	0.041778	
Land Per Capita in TX	1.8738	1.8738	$x_{TX,2014}$	1.8738	
Employment Per Capita	0.59	0.59	ϕ	1.5926	

Figure 1: Measures of Regulatory Constraints ($\alpha_{jt}^{1-\xi}$)

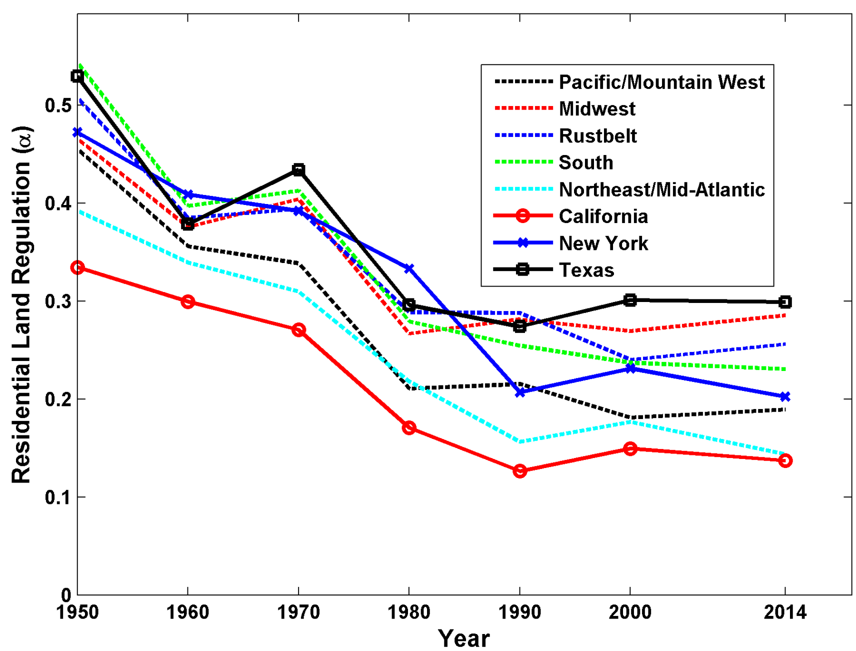


Figure 2: Measures of Amenities (a_{jt})

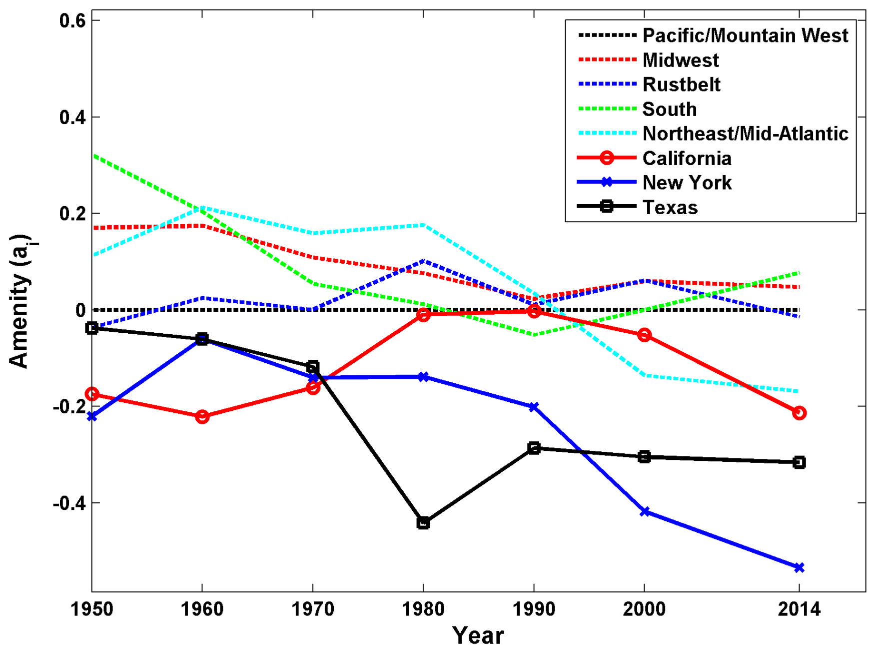
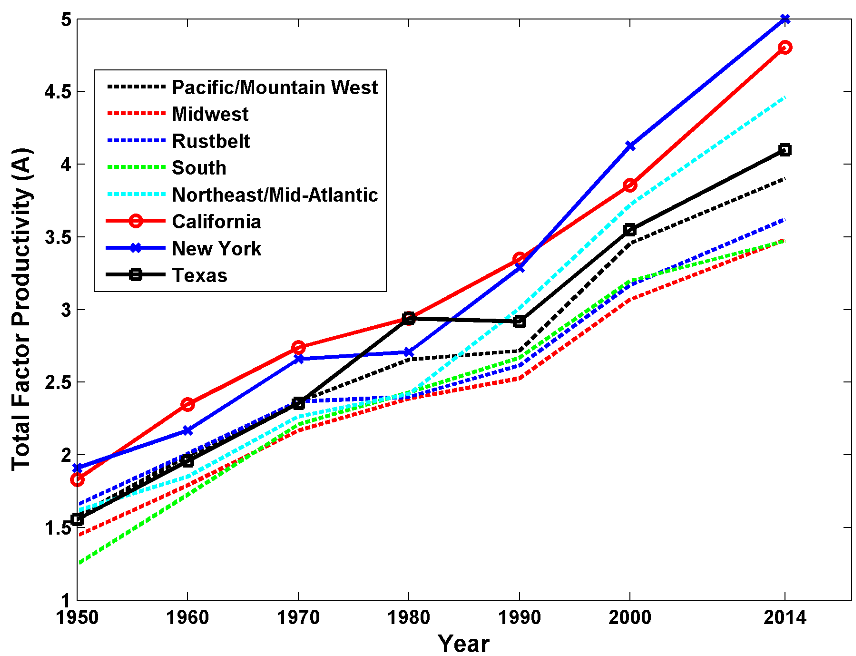


Figure 3: TFP Across Regions (A_{jt})



5.2 Model-Inferred TFP, Policies, and Amenities

Figures 1, 2, and 3 illustrate the model inferred land regulations, amenities, and total factor productivities across regions, respectively. Note that the model generates considerable variation in state-level TFP throughout this period. There is roughly a 40 percent gap between the most productive states in 1950 (New York and California) and the least productive states (the South). By 2014, the gap between the most productive (New York and California) and the least productive (the Midwest and the South) is close to 40 percent. There is also very little change in the rank-ordering of TFP in these regions over time, with California and New York at the top, the South and Midwest at the bottom, and Texas and the Northwest-Mountain region typically in the middle. This finding suggests that the "economic dynamism" that Decker et al (2014) have discussed, which may reflect frontier technological change and innovation, has persistently been strong in California and New York since World War II.

The regulatory constraints figure displays the land distortions by region, and over time. The figure shows generally *increasing* distortions (recall that lower α_j implies a tighter set of land regulations). This reflects the fact that housing prices have increased over time, particularly in California and New York. Texas has the lowest level of distortions, and there is almost no change in the Texas' distortions after 1980. As in the case of TFP, there is relatively little change in the rank ordering of these regions over time.

In terms of the model amenities, recall that these are measured relative to amenities in the Northwest-Mountain region. The amenity figure shows a large relative decline in New York, rising amenities in California up to around 1990, followed by some decline, and declining amenities in Texas up to 1990, followed by a stabilization after that.

5.3 Evaluating Model-Inferred Amenities, Policy Distortions, and TFP

Note that the amenity terms, the distortion terms, and the TFP terms are chosen so that the model can hit the targets above. We therefore compare the model-inferred values of amenities, distortions and TFP to data objects.

In terms of comparing TFP, there are no standard measures of the capital stock at the state level. We therefore construct an aggregated model TFP, and compare this model object to aggregate TFP in the data. Table 2 compares the growth rate of model TFP for 6 long-run periods to Fernald et al. [2012]'s updated measures of TFP for these same periods. The table shows that the model TFP growth rate is quite similar to the Fernald et al. [2012]. In particular, both model and data have a relatively high growth rate in the 1950s and 1960s, the growth rate falls significantly in the 1970s and 1980s, rises in the 1990s, and then declines again after 2000.

Table 2: Comparison of Model's Solow Residual to Fernald et al. [2012]'s Solow Residual

	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2014
Model Aggregate TFP Growth	1.75	1.76	0.33	0.89	1.77	0.91
Fernald et al. TFP Growth	2.12	1.81	0.86	0.50	1.12	0.87

In table 3, we compare our measure of policy distortions, α_j, to existing measures of distortions. It is common in the literature to use the Wharton Land Regulation Index (WRI) as a cross-sectional measure of land-use distortions. This index is based on a principal component analysis of questions in Gyourko et al. [2008]'s survey of land-use. This survey was sent to city managers across the country. Higher values of the index indicate greater regulation in the WRI, whereas lower values of α_j in our model indicate greater regulation. Therefore, strong negative correlations between the WRI and our measures of α_j suggest that the measures are closely aligned. Table 3 shows that our measure of distortions is highly correlated with the overall Wharton index (correlation(α_j, WRI) = -0.89), as well as the Supply Restriction Index (SRI) (correlation(α_j, SRI) = -.73). It is somewhat less correlated with the Density Restriction Index (DRI) (correlation(α_j, DRI) = -.0.46). We also show that our measure of land regulation aligns well with the Pacific Research Institute's (PRI) measure of 2015 business regulations (we take the correlation with the PRI ranks and our α_j's – repeating this exercise using ranks from our model produces an identical result).

Negative correlation indicates that our regulations are high when regulations are high in the data

Recall that we imposed the same distortion in housing production and in non-residential production ($\alpha_{hj} = \alpha_{yj} = \alpha_j$). We therefore also compare our model distortion to the Pacific Research Institute's measure of private business regulation index (Winegarden [2015]). This index is constructed along the same lines as the World Bank's *Doing Business Index*, which

Table 3: Comparison of model's Distortions to Wharton Land Regulation Indeces

	Density Restriction Index*	**Supply Restriction Index***	**Wharton Land Regulation Index***	**PRI Business Regulation Index***
Correlation between $\alpha_{j,2014}$** and Index	-0.46	-0.73	-0.89	-0.90
*Larger values indicate greater regulations, **Smaller values indicate greater regulations				

ranks countries on the basis of measures of factors that impact the cost and profitability of starting and running a private enterprise. Specifically, the PRI's index is based on a state's disability system, UI system, minimum wage, Workman's Compensation, occupational licensing requirements, whether it is a right-to-work state, energy regulations, tort system, and whether the state has a system of regulatory flexibility, in which a state has a formal protocol for a business to appeal for regulatory relief. The correlation with this index is -0.9. We conclude from these comparisons that our model-inferred distortions in 2014 are reasonable.

The final model-inferred parameter is the amenity term. Table 4 compares these amenity terms to quality of life indexes constructed by Gabriel et al. [2003] and Albouy [2008]. Their ranking convention is such that Rank 1 is the best place to live, and Rank 50 is the worst. We correlate our raw amenity terms with the ranks in each paper, i.e. we report the correlation of our estimates of a_j with the amenity rank estimates of Gabriel et al. [2003] and Albouy [2008]. Since higher values of a_j indicate better places to life, a negative correlation indicates that our amenities align with their rank measures. As in the prior cases, if we rank our regions on amenities and correlate those ranks with the Gabriel et al. [2003] and Albouy [2008] ranks, we obtain identical results. The correlations are high, ranging from -0.63 to -0.79. Given that Gabriel et al. [2003] measure quality of life at two different points in time, we can also compare the change in our measure of amenities to the changes in Gabriel et al. [2003]. This correlation is -0.24, which is not as strong of a relationship as the levels variables. This is not surprising, given that we are looking at the changes in these variables, rather than the levels.

Table 4: Comparison of Model's Amenities to Quality of Life Indeces

	Quality of Life Indeces		
	Albouy Rank (Un-adj)*	Gabriel et al. 1980 Rank*	Gabriel et al. 1990 Rank*
Correlation between $a_{j,2014}$** and Index	-0.79	-0.65	-0.63
Change in Amenities 1980-1990, Corr. b/w Model and Gabriel et al. Index			-0.24
*Higher values indicate worse places to live, **Lower values indicate worse places to live			

6 Counterfactual Experiments

This section conducts the counterfactual experiments. Our approach assumes that the α_{jt} terms represent policy differences across states/regions that could be changed. We therefore conduct experiments in which either some of these policy terms, or all of these policy terms change. The thought experiment is to deregulate *existing* urban land, keeping the geography of a state, and the mass of urban land, held fixed. This is an important distinction to make relative to the existing literature, and we are able to make this distinction because we feed in the actual urban acreage of each state. One set of experiments is designed to "roll back" regulations to a previous point in time. For these experiments, we take the 2014 steady state and change the $\alpha_{j,2014}$ terms to their values in either 1980, or in 2000. We then compare the difference in aggregate TFP, output, consumption, investment, and the allocation of the population across states in 2014 to the level in 2000.

In a second set of experiments, we change the α_{jt} terms to contemporaneous values from states with lower regulations. According to our model-based distortions, Texas is the least regulated/distorted state. Large metro areas such as Houston have no zoning laws, and in general, Texas is the least regulated state according to measures of supply or density restrictions.[6] We therefore consider experiments in which states adopt policies that move either halfway to the Texas 2014 level, or 1/4 of the way to the Texas 2014 level.

We conduct the following sequence of experiments, which we refer to as *deregulation experiments*: (1) changing just the California $\alpha_{CA,2014}$ term, changing the $\alpha_{CA,2014}$ and $\alpha_{NY,2014}$ terms for California and in New York, respectively, and changing the $\alpha_{j,2014}$ terms in all

[6] "The Department of Planning and Development regulates land development in Houston and within its extraterritorial jurisdiction (ETJ). **The city of Houston does not have zoning** but development is governed by codes that address how property can be subdivided. The City codes do not address land-use." http://www.houstontx.gov/planning/DevelopRegs/ .

states/regions. We do this for both the neoclassical model (no externality) and the model with the productive externality that has an external effect elasticity of $\lambda = 0.03$. Table 5 summarizes the $\alpha_{j,2014}$'s in each of the main experiments. The full set of estimated α_{jt} values are listed in Appendix A.

Table 5: Values of land regulations in 2014 (α_j) by experiment.

	Pacific/Mtn West	Midwest	Rustbelt	South	NE/Mid-Atlantic	CA	NY	TX
Baseline $\alpha_{j,2014}$	0.0125	0.0369	0.0277	0.0210	0.0061	0.0054	0.0149	0.0418
Deregulate CA to 2000, $\alpha_{j,2014}$	0.0125	0.0369	0.0277	0.0210	0.0061	0.0067	0.0149	0.0418
Deregulate CA to 1980, $\alpha_{j,2014}$	0.0125	0.0369	0.0277	0.0210	0.0061	0.0095	0.0149	0.0418
Deregulate CA & NY to 2000, $\alpha_{j,2014}$	0.0125	0.0369	0.0277	0.0210	0.0061	0.0067	0.0212	0.0418
Deregulate CA & NY to 1980, $\alpha_{j,2014}$	0.0125	0.0369	0.0277	0.0210	0.0061	0.0095	0.0554	0.0418
Deregulate All to 2000, $\alpha_{j,2014}$	0.0111	0.0317	0.0234	0.0227	0.0105	0.0067	0.0212	0.0425
Deregulate All to 1980, $\alpha_{j,2014}$	0.0166	0.0309	0.0380	0.0349	0.0181	0.0095	0.0554	0.0406
Deregulate 25% to TX, $\alpha_{j,2014}$	0.0199	0.0381	0.0312	0.0262	0.0150	0.0145	0.0216	0.0418
Deregulate 50% to Texas, $\alpha_{j,2014}$	0.0272	0.0394	0.0348	0.0314	0.0239	0.0236	0.0284	0.0418

Table 6 summarizes the results of these experiments. The results in this table are expressed relative to the baseline set of results, e.g. table entry for row x is the ratio $\frac{x_{2014,counterfactual}}{x_{2014,baseline}}$. Deregulating only California to its 1980 level, which is about a 6 percentage point improvement in the distortion, and leaving the policies of all other states unchanged, raises output, TFP, and consumption by about 2 percent, and increases California by about 4 million workers. The reallocation of human capital comes from every other region losing population, particularly the Rust Belt and the South which each lose about 2 percentage points of aggregate employment.

Figure 4 illustrates the impact of deregulation California graphically. Panel (A) shows how the deregulation impacts employment shares across regions. Panel (B) illustrates the impact of deregulation on measured TFP and output growth from 2000-2014. As Panel (B) illustrates, deregulating California to 1980s levels would increase the measured TFP and output growth rates by .15 percentage points per annum between 2000 and 2014. Panel (C) plots the time path, across steady states, of log consumption, and Panel (D) plots the same time path for the measured Solow Residual.

The first two columns of Table 7 illustrate the same experiment in the economy with the three percent productive externality. The presence of agglomeration doubles the impact of the deregulation on labor productivity and the measured Solow residual. The measured Solow residual (or measured TFP), which we define to be $Y/(K^{1/3}L^{2/3})$, increases by 2% following the deregulation of CA with agglomeration, rather than 1% without agglomeration.

Similarly, labor productivity increases by 4% rather than 2% without agglomeration.

Columns 4 and 5 of Table 6 show that deregulating both California and New York to their 1980 levels, in which the New York distortion improves by about 15 percentage points, results in labor productivity rising by about 8 percent and output per capita by about 4 percent in the baseline economy. Figure 5 illustrates these results graphically, in particular, Panel (A) shows that the Rustbelt and South lose the most, followed by the New-England/Mid-Atlantic region. Panel (B) of Figure 5 shows that deregulating both CA and NY would increase the measured TFP and output growth rates by .33 percentage points per annum between 2000 and 2014.

Table 7 shows that with production externalities, these gains from deregulating New York and California approximately double. Note that these latter increases would eliminate much of the current gap between current and trend productivity and current and trend output (see for instance, Prescott [2017]).

Columns 6 and 7 of Table 6 and Table 7 show that deregulating all of the regions to 1980 levels would raise labor productivity by about 9 percent, and consumption by about 8 percent in the neoclassical economy, and would raise labor productivity by about 13 percent, and consumption by about 11 percent, in the economy with the externality. Figure 6 illustrates this experiment graphically. As Panel (A) illustrates, the biggest winner would be the New-England/Mid-Atlantic region, solely due to the fact that their constraints tightened the most during this time period. New York and California would gain significantly as well. Panel (B) shows that measured TFP growth would increase by close to .5 percentage points per annum from 2000 to 2014. This would bring measured TFP growth in line with historic TFP growth rates over previous decades in the US (e.g. see Table 2).

The final experiment, which is illustrated in Columns 8 and 9 of Table 6, is to deregulate all states halfway, as well as 1/4 of the way, to Texas levels of land-use regulations. Table 6 shows that by deregulating partially to Texas levels, welfare gains reach 10% of lifetime consumption, and output gains achieve similarly large values. Measured TFP increases by nearly 8 percentage points over the 2000-2014 period. Expressing that in an annualized form, Panel (B) of Figure 7 shows that measured TFP growth and output growth would increase by nearly .7 percentage points per annum between 2000 and 2014 under these looser Texas-level land constraints. This would increase measured TFP growth from .91 percent per annum between 2000 and 2014 to roughly 1.6 percentage points per annum. This falls just shy of the 1.75, 1.76, and 1.77 annual growth rates of TFP during the 50s, 60, and 90s, respectively (Table 2).

In summary, the experiments illustrate how land regulations in highly productive regions, such as California and New York, can alter consumption, output, and measured TFP across the entire US economy. Relatively small degrees of deregulation would bring measured aggregate TFP growth back in line with the US historic record.

Table 6: Baseline Deregulation Experiments, $\lambda = 0$. Variables expressed relative to baseline values $\frac{x_{2014,counterfactual}}{x_{2014,baseline}}$. Welfare expressed as fraction of lifetime consumption.

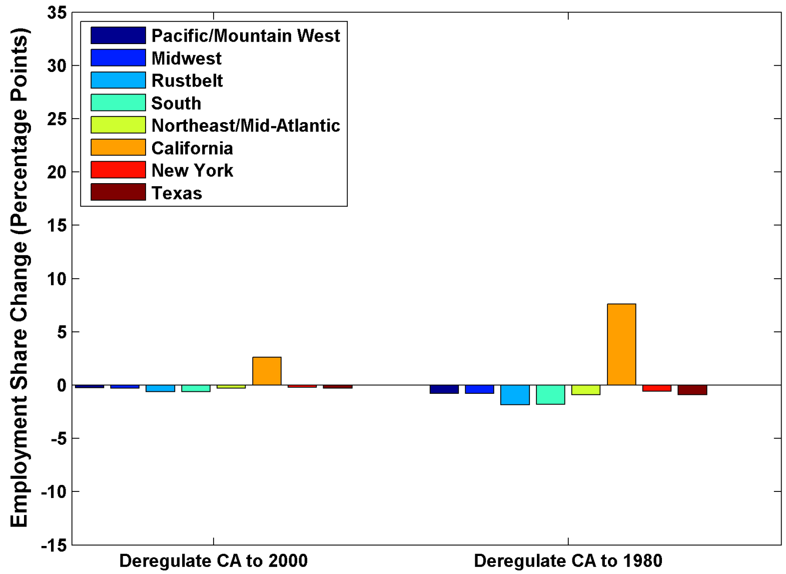
	(1) Baseline	(2) Dereg. CA to 2000	(3) Dereg. CA to 1980	(4) Dereg. CA & NY to 2000	(5) Dereg. CA & NY to 1980	(6) Der. All to 2000	(7) Dereg. All to 1980	(8) Dereg. 25% to TX	(9) Dereg. 50% to TX
Relative Consumption	1	1.01	1.02	1.01	1.05	1.02	1.09	1.07	1.11
Relative Output	1	1.01	1.02	1.01	1.04	1.02	1.07	1.06	1.10
Relative Measured Solow Resid.	1	1.01	1.01	1.01	1.05	1.02	1.06	1.05	1.08
Relative Labor Prod.	1	1.01	1.02	1.02	1.08	1.03	1.08	1.07	1.11
Cons. Equiv. Welfare Gain (percentage points)	1	0.47	1.40	0.87	3.52	1.74	6.96	5.95	9.92

Table 7: Deregulation Experiments with **Agglomeration**, $\lambda = 0.03$. Variables expressed relative to baseline values $\frac{x_{2014,counterfactual}}{x_{2014,baseline}}$.

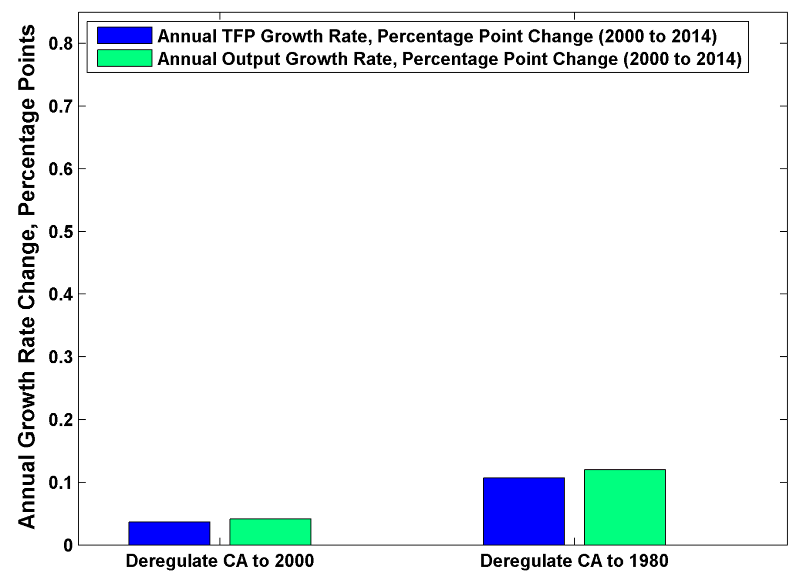
	(1) Baseline	(2) Dereg. CA to 2000	(3) Dereg. CA to 1980	(4) Dereg. CA & NY to 2000	(5) Dereg. CA & NY to 1980	(6) Dereg. All to 2000	(7) Dereg. All to 1980	(8) Dereg. 25% to TX	(9) Dereg. 50% to TX
Baseline: Relative Consumption	1	1.01	1.02	1.01	1.05	1.02	1.09	1.07	1.11
Agglom.: Relative Consumption	1	1.01	**1.02**	1.01	**1.07**	1.03	1.11	1.08	1.14
Relative Measured Solow Resid.	1	1.01	1.01	1.01	1.05	1.02	1.06	1.05	1.08
Agglom.: Relative Measured Solow Resid.	1	1.01	**1.02**	1.02	**1.09**	1.03	1.09	1.07	1.11
Relative Labor Productivity	1	1.01	1.02	1.02	1.08	1.03	1.08	1.07	1.11
Agglom.: Relative Labor Productivity	1	1.01	**1.04**	1.03	**1.14**	1.05	1.13	1.11	1.17

Figure 4: Deregulating California to 1980s and 2000s Levels.

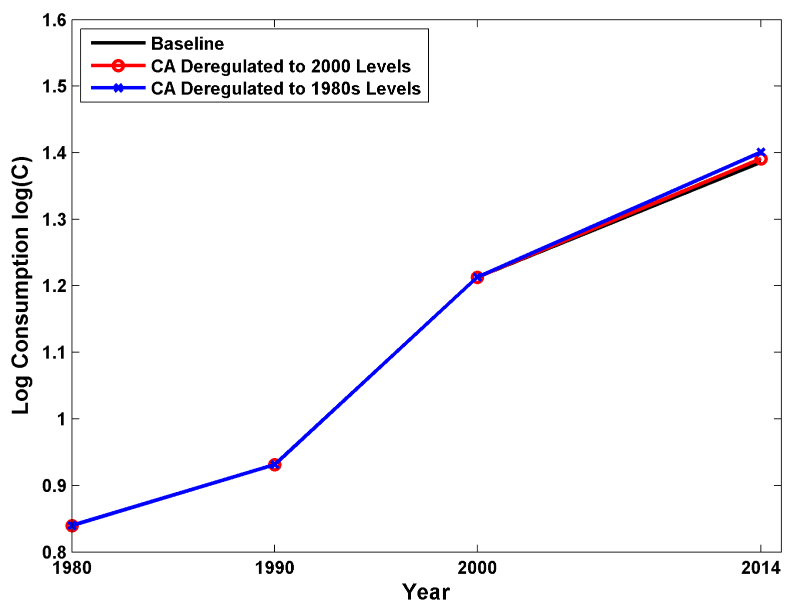
(A) Change in Employment Shares



(B) Change in Output Growth



(C) Consumption



(D) Measured TFP

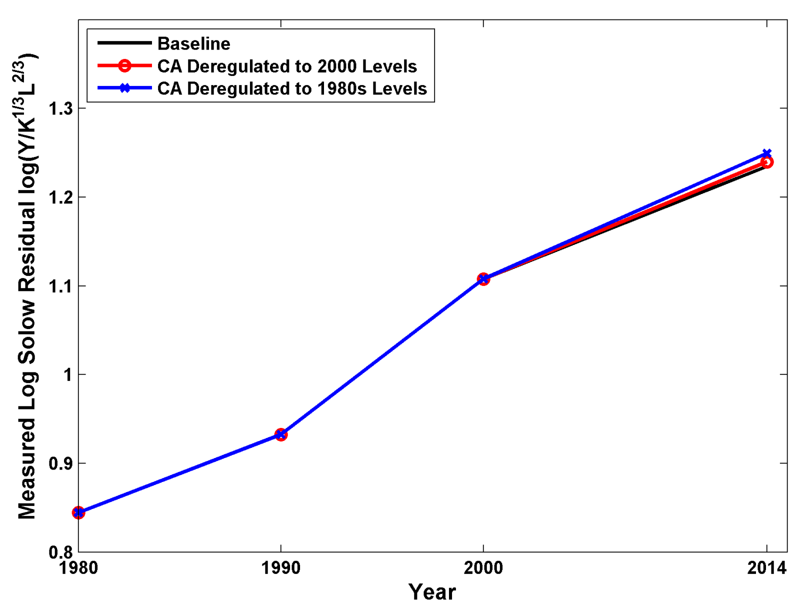


Figure 5: Deregulating CA **and NY** to 1980 and 2000 Levels

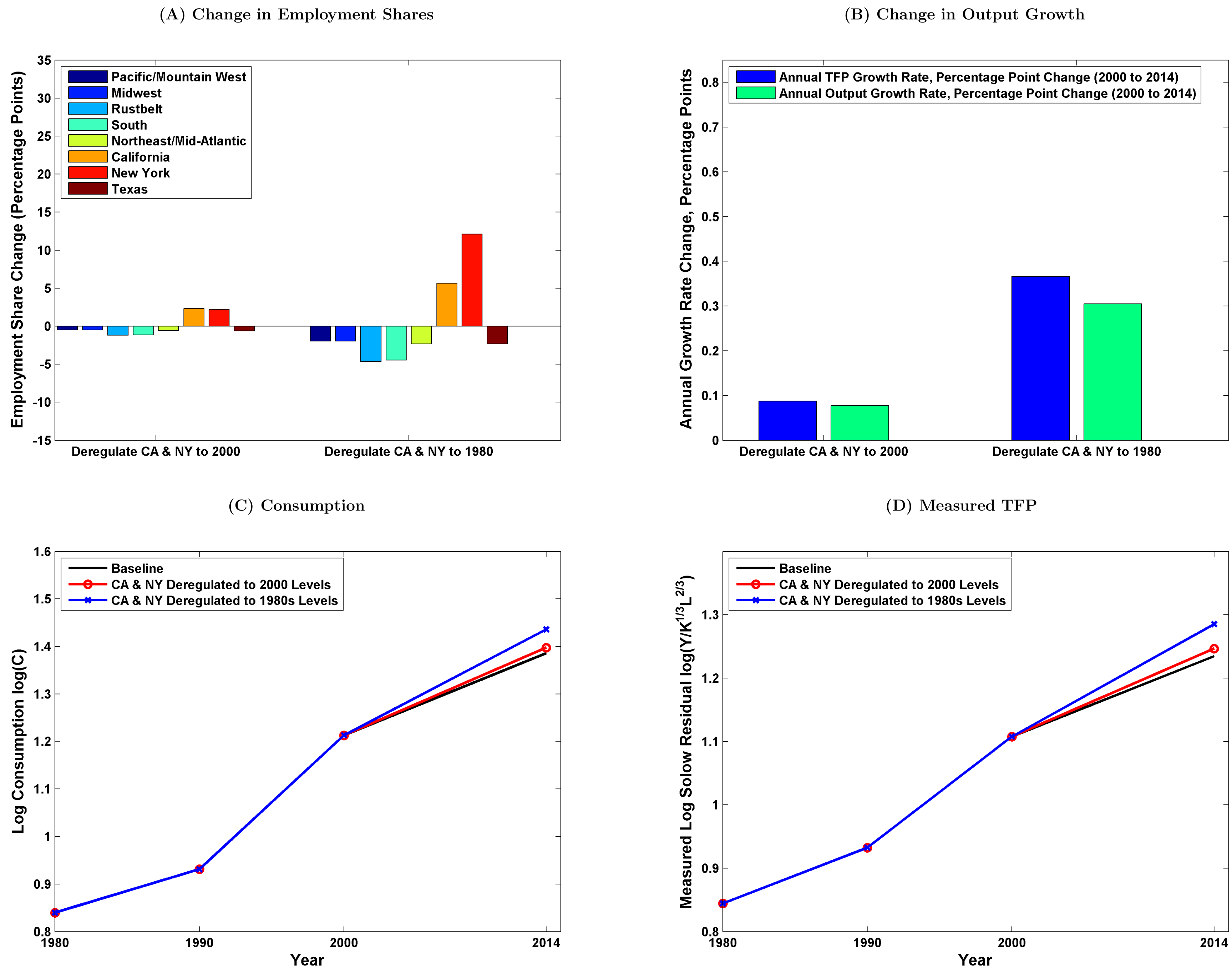
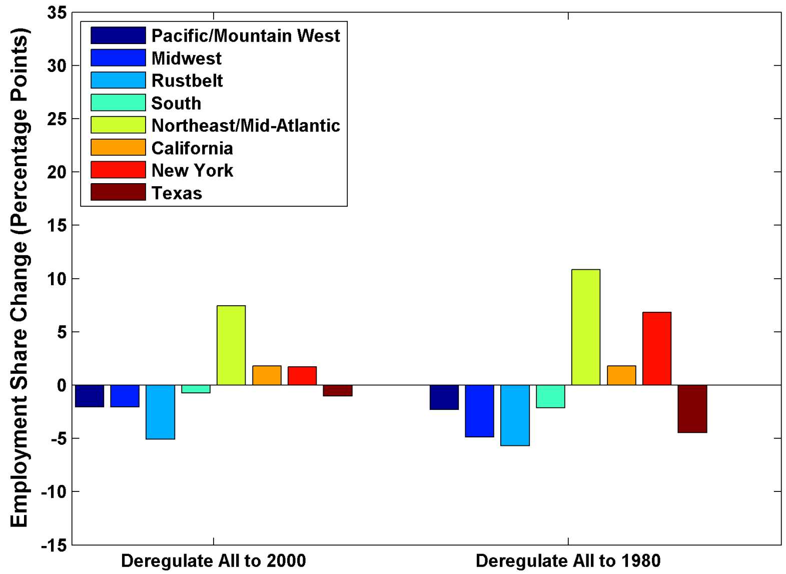
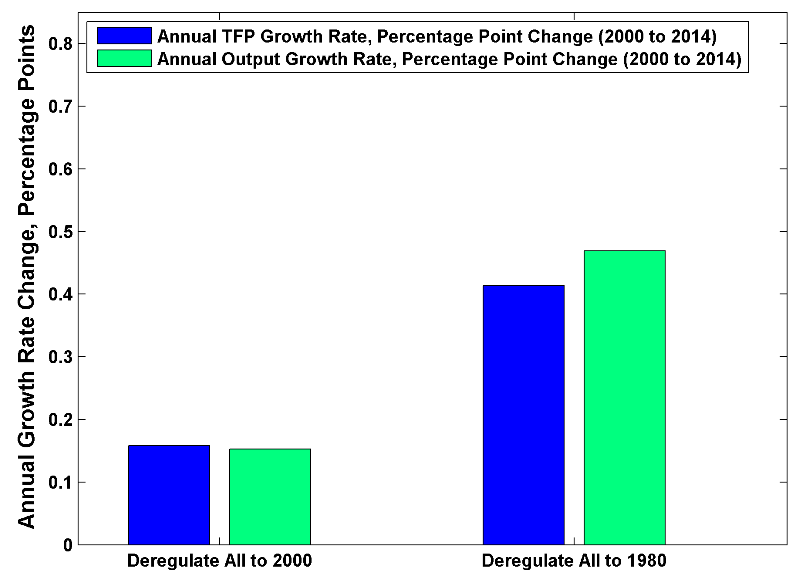


Figure 6: Deregulating All States to 1980 and 2000 Levels

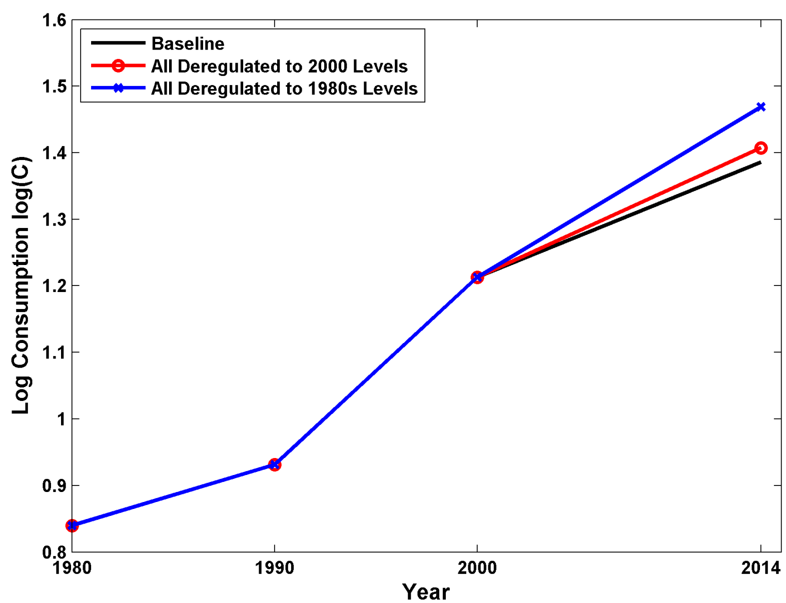
(A) Change in Employment Shares



(B) Change in Output Growth



(C) Consumption



(D) Measured TFP

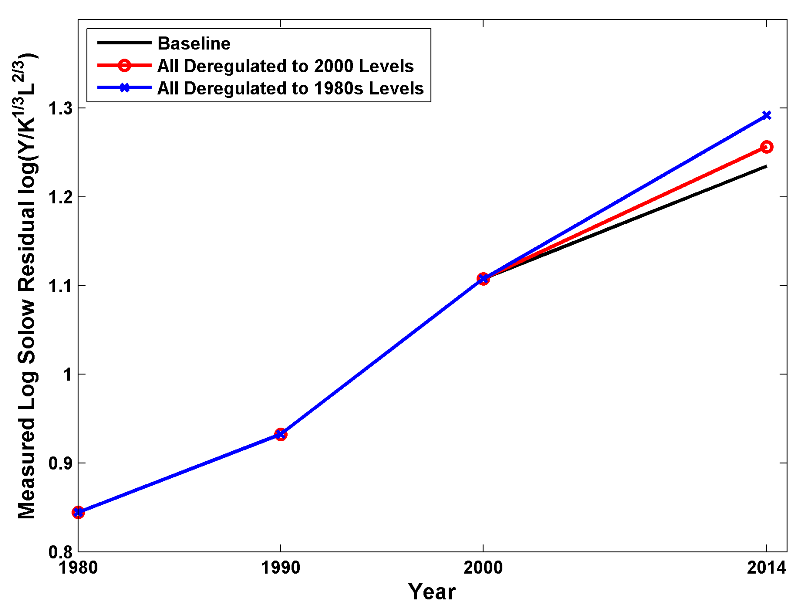
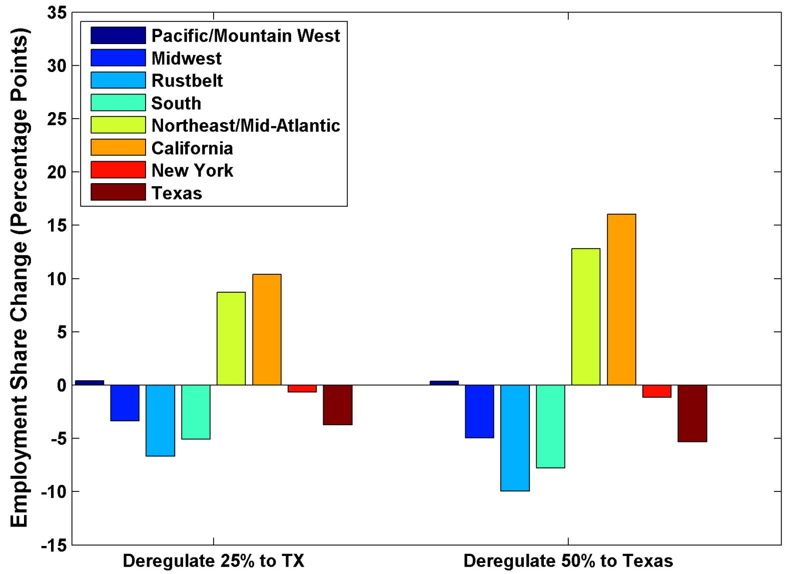
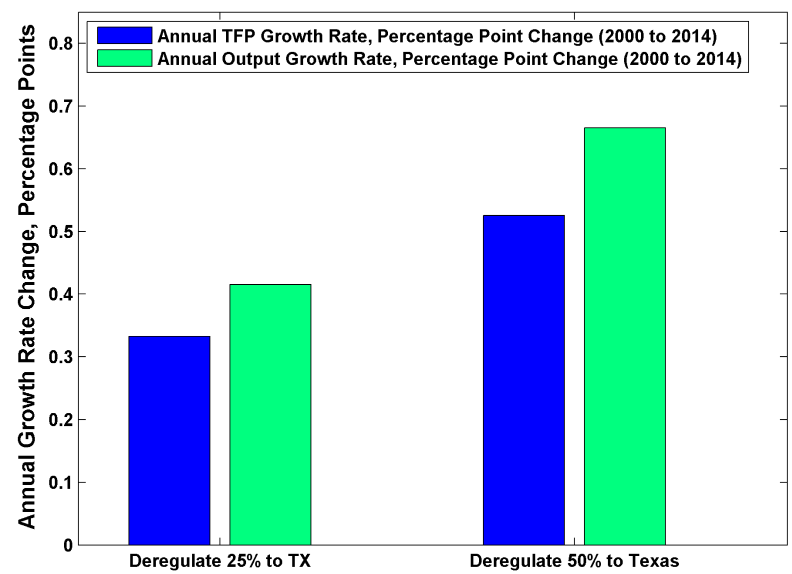


Figure 7: Deregulating All States Halfway to Texas Levels

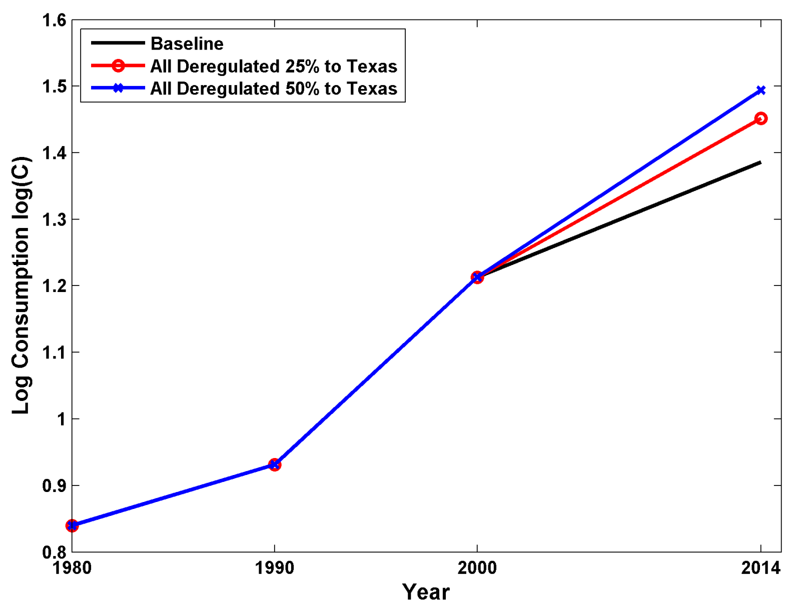
(A) Change in Employment Shares



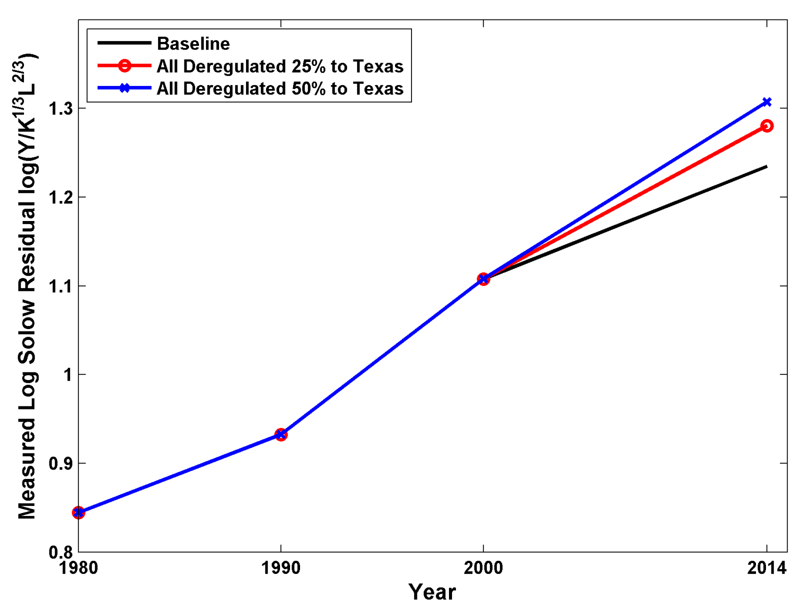
(B) Change in Output Growth



(C) Consumption



(D) Measured TFP



7 Conclusion

Economic growth and the reallocation of human and physical capital across regions have gone hand-in-hand throughout the history of the United States. This resource reallocation, however, has slowed considerably, and this decline has roughly coincided with a decline relative to trend of productivity growth and output growth, and large home price increases in high income states, including California.

We interpret resource reallocation as population shifts out of regions with relatively poor opportunities to produce, to regions with better opportunities to produce. The thesis of this paper is that the decline in resource reallocation is the consequence of policies that distort land-use, and that in turn affect the supply of effective land and the price of land.

This paper analyzed this thesis by developing a multi-region model economy of the U.S. Using historical data, including data on the stock of land, the model provides measures TFP, state/region-level distortions, and amenties. These model-inferred objects compare well with data and/or independent measures of state-level regulations and quality of life. Given our interpretation that the model distortions are policies that can be changed, we find that rolling back land-use regulations would generate substantial reallocation of capital and labor, and could considerably increase productivity and output in the last 15 years. From a planner's perspective too few people (and too little capital) are located in high productivity locations such as California and New York.

This model featured a number of simplifying assumptions, including homogeneous labor, the same housing requirement per worker across states, the same regulatory distortion parameter hitting both housing and non-residential production, and the implicit assumption that state/local government per-capita spending requirements would not change as a consequence of population changes . The next version of this paper will introduce these elements into the analysis.

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A Calibration

Table 8 describes the full set of parameters, moments, and model generate moments for the 2014 steady state calibration without agglomeration. Table 9 includes the time series of all parameters.

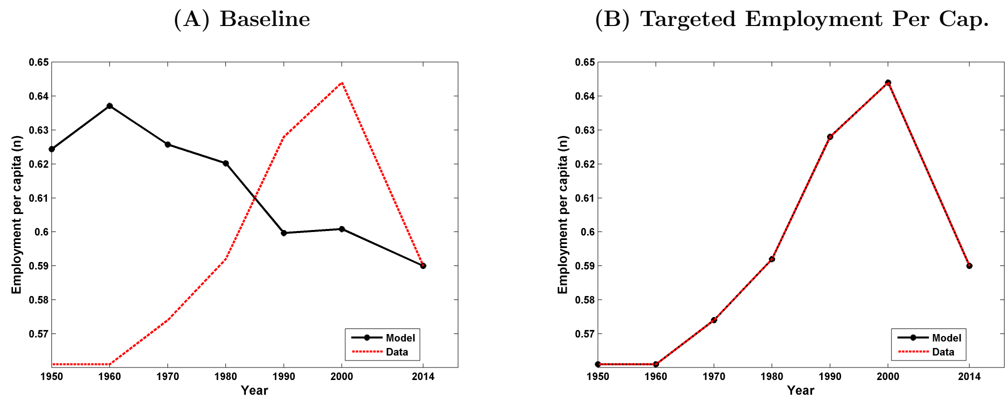
Table 8: Complete set of moments and parameters for 2014 Steady State, $\lambda = 0$.

	Model	**Data**	**Parameter**	**Value**
Productivity in Pacific/Mountain West	8.4017	8.4017	$A_{Pacific/MountainWest}$	3.9002
Employment in Pacific/Mountain West Relative to Pacific/Mountain West	1	1	$a_{Pacific/MountainWest}$	0
House Prices in Pacific/Mountain West	16.3262	16.3262	$\alpha_{Pacific/MountainWest}$	0.012546
Land Per Capita in Pacific/Mountain West	2.3598	2.3598	$x_{Pacific/MountainWest}$	2.3598
Productivity in Midwest	7.7488	7.7504	$A_{Midwest}$	3.4803
Employment in Midwest Relative to Pacific/Mountain West	0.82378	0.82379	$a_{Midwest}$	0.047327
House Prices in Midwest	10.306	10.3061	$\alpha_{Midwest}$	0.036925
Land Per Capita in Midwest	1.804	1.804	$x_{Midwest}$	1.804
Productivity in Rustbelt	8.15	8.15	$A_{Rustbelt}$	3.6197
Employment in Rustbelt Relative to Pacific/Mountain West	1.9026	1.9026	$a_{Rustbelt}$	-0.014093
House Prices in Rustbelt	10.7853	10.7853	$\alpha_{Rustbelt}$	0.027734
Land Per Capita in Rustbelt	5.1692	5.1692	$x_{Rustbelt}$	5.1692
Productivity in South	7.614	7.614	A_{South}	3.4714
Employment in South Relative to Pacific/Mountain West	1.9845	1.9845	a_{South}	0.07695
House Prices in South	11.0384	11.0384	α_{South}	0.021031
Land Per Capita in South	6.4211	6.4211	x_{South}	6.4211
Productivity in Northeast/Mid-Atlantic	9.7442	9.7442	$A_{Northeast/Mid-Atlantic}$	4.462
Employment in Northeast/Mid-Atlantic Relative to Pacific/Mountain West	1.2276	1.2276	$a_{Northeast/Mid-Atlantic}$	-0.16887
House Prices in Northeast/Mid-Atlantic	21.5828	21.5828	$\alpha_{Northeast/Mid-Atlantic}$	0.0060754
Land Per Capita in Northeast/Mid-Atlantic	3.5015	3.5015	$x_{Northeast/Mid-Atlantic}$	3.5015
Productivity in CA	10.3801	10.3801	A_{CA}	4.8058
Employment in CA Relative to Pacific/Mountain West	1.0722	1.0722	a_{CA}	-0.2131
House Prices in CA	27.6327	27.6327	α_{CA}	0.0053619
Land Per Capita in CA	2.0835	2.0835	x_{CA}	2.0835
Productivity in NY	11.8242	11.8242	A_{NY}	4.9997
Employment in NY Relative to Pacific/Mountain West	0.62256	0.62256	a_{NY}	-0.53407
House Prices in NY	19.417	19.417	α_{NY}	0.014937
Land Per Capita in NY	1.0369	1.0369	x_{NY}	1.0369
Productivity in TX	9.9432	9.9432	A_{TX}	4.0988
Employment in TX Relative to Pacific/Mountain West	0.79159	0.79159	a_{TX}	-0.31578
House Prices in TX	10.2298	10.2298	α_{TX}	0.041778
Land Per Capita in TX	1.8738	1.8738	x_{TX}	1.8738
Employment Per Capita	0.59	0.59	a	1.5926

Table 9: Time Series of Estimated Parameters

	1950	1960	1970	1980	1990	2000	2014
$A_{Pacific/MountainWest}$	1.5768	1.9944	2.3632	2.6561	2.7159	3.4555	3.9002
$A_{Midwest}$	1.4428	1.7915	2.1663	2.3867	2.526	3.0697	3.4803
$A_{Rustbelt}$	1.656	2.0075	2.3668	2.3982	2.6146	3.1679	3.6197
A_{South}	1.2486	1.7264	2.2093	2.4289	2.6696	3.1978	3.4714
$A_{Northeast/Mid-Atlantic}$	1.615	1.8502	2.2645	2.4192	3.0091	3.7212	4.462
A_{CA}	1.8292	2.3477	2.7384	2.9389	3.347	3.8559	4.8058
A_{NY}	1.9099	2.1674	2.6582	2.7081	3.2867	4.1271	4.9997
A_{TX}	1.5538	1.9577	2.3543	2.9387	2.9173	3.5496	4.0988
$a_{Pacific/MountainWest}$	0	0	0	0	0	0	0
$a_{Midwest}$	0.17033	0.17422	0.10818	0.075976	0.023189	0.059961	0.047327
$a_{Rustbelt}$	-0.03703	0.024502	0.000693	0.1018	0.011015	0.06114	-0.01409
a_{South}	0.32219	0.20365	0.054321	0.012004	-0.05159	4.53E-05	0.07695
$a_{Northeast/Mid-Atlantic}$	0.11203	0.21242	0.15883	0.17628	0.03424	-0.13569	-0.16887
a_{CA}	-0.17441	-0.22108	-0.1611	-0.00984	-0.00254	-0.05174	-0.2131
a_{NY}	-0.22029	-0.0599	-0.14	-0.1385	-0.20127	-0.41772	-0.53407
a_{TX}	-0.03756	-0.06083	-0.11786	-0.44173	-0.2863	-0.30459	-0.31578
$\alpha_{Pacific/MountainWest}$	0.12618	0.065945	0.057909	0.01659	0.017589	0.011131	0.012546
$\alpha_{Midwest}$	0.13383	0.076029	0.092203	0.03086	0.035528	0.03172	0.036925
$\alpha_{Rustbelt}$	0.16814	0.081159	0.086264	0.038047	0.037753	0.023417	0.027734
α_{South}	0.20103	0.088112	0.097397	0.034912	0.027343	0.022679	0.021031
$\alpha_{Northeast/Mid-Atlantic}$	0.085212	0.058168	0.045764	0.018135	0.007556	0.010469	0.006075
α_{CA}	0.056061	0.041929	0.032079	0.009535	0.004324	0.006731	0.005362
α_{NY}	0.13911	0.095059	0.085139	0.055392	0.015781	0.021226	0.014937
α_{TX}	0.18765	0.077605	0.11134	0.040557	0.033162	0.042472	0.041778
$x_{Pacific/MountainWest}$	1.3319	1.7531	1.8855	2.4838	3.1137	3.0162	2.3598
$x_{Midwest}$	2.0151	2.5951	2.2965	3.0302	3.0669	2.4484	1.804
$x_{Rustbelt}$	4.3135	5.6736	5.4061	5.5021	5.5462	5.7304	5.1692
x_{South}	3.3992	4.7231	4.7793	6.754	7.7188	7.4986	6.4211
$x_{Northeast/Mid-Atlantic}$	2.2635	3.063	3.2682	4.0004	3.9579	4.0004	3.5015
x_{CA}	1.9496	2.1674	2.3801	2.5202	2.872	2.5524	2.0835
x_{NY}	1.0722	1.299	1.1569	1.2316	1.1977	1.1729	1.0369
x_{TX}	1.0839	2.1725	1.8378	2.4331	2.7121	2.3661	1.8738

Figure 8: Aggregate Employment Per Capita, Model vs. Data



B Aggregate Hours Worked

In the baseline calibration, we fix $a_{Pacific/MountainWest,t} = 0$ in all years. Since ϕ, the leisure location parameter is calibrated once in 2014, we have fewer parameters than moments in the earlier years, and thus we do not target aggregate employment in 1950, 1960, ..., 2000. In this appendix, we only normalize $a_{Pacific/MountainWest,2014} = 0$ and let the remaining terms vary, $\{a_{Pacific/MountainWest,1950}, \ldots, a_{Pacific/MountainWest,2000}\}$. We are able to set ϕ to match aggregate employment in 2014, and then set $\{a_{Pacific/MountainWest,1950}, \ldots, a_{Pacific/MountainWest,2000}\}$ to exactly match hours worked in every earlier year 1950, 1960, ..., 2000. Our main results and parameter estimates are not sensitive to this change (i.e. the initial level of employment does not matter as much as the *distribution* of employment across states). Figure 8 illustrates the aggregate employment paths for both calibrations. When we target employment per capita, the model, by construction, exactly matches the data. Figures 9 and 10 illustrate the changes in TFP and output under both calibrations. The two sets of results are nearly indistinguishable.

Figure 9: Comparison of Experiment Results with Targeted vs. Non-Targeted Aggregate Employment Per Capita

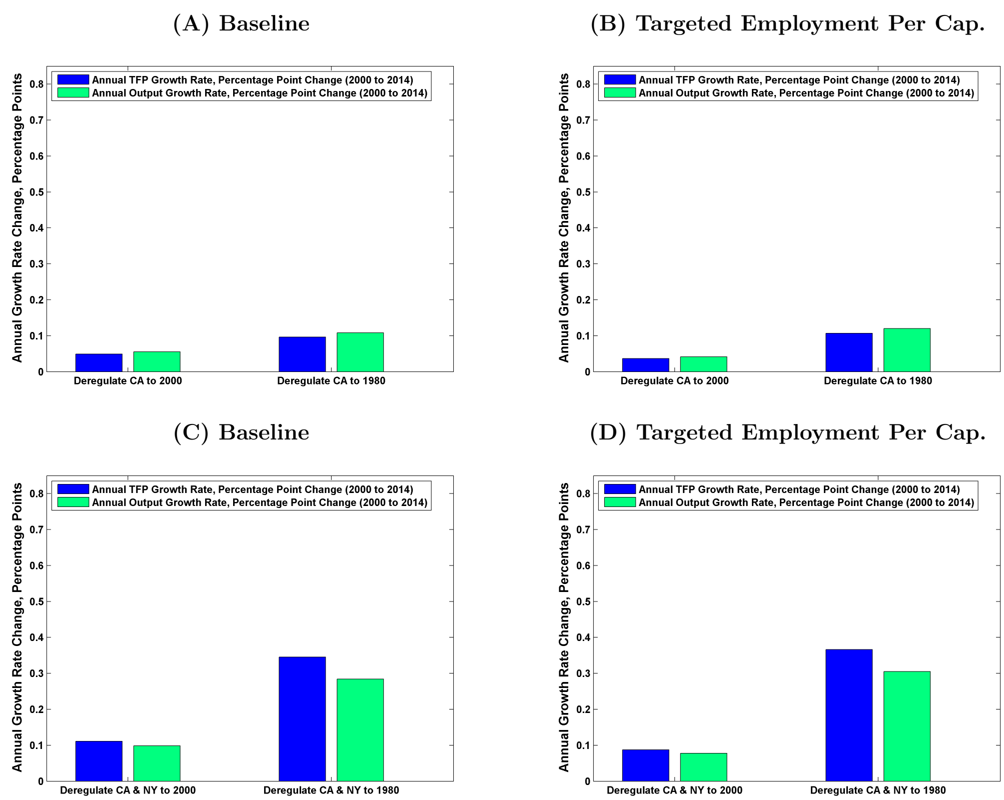
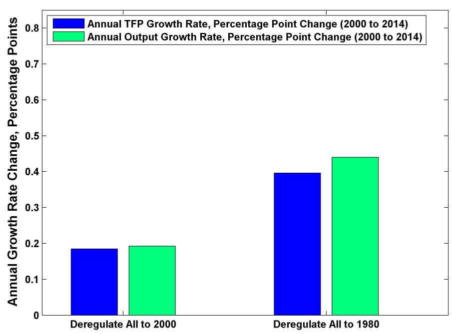
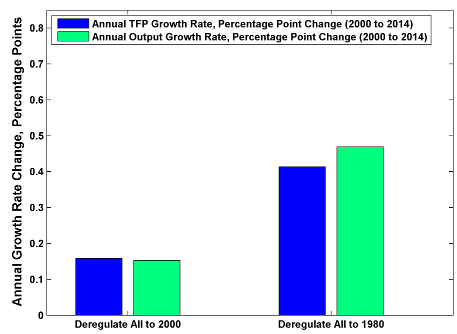


Figure 10: Comparison of Experiment Results with Targeted vs. Non-Targeted Aggregate Employment Per Capita

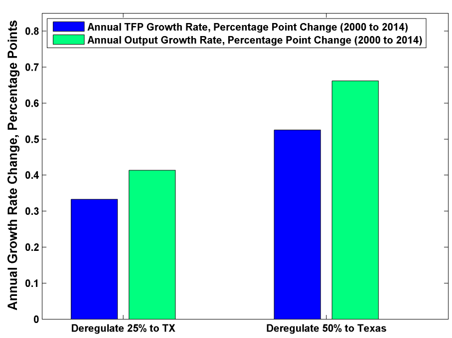
(A) Baseline



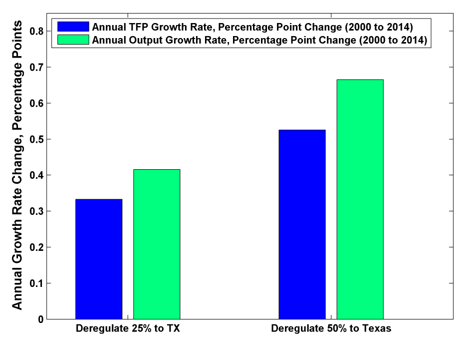
(B) Targeted Employment Per Cap.



(C) Baseline



(D) Targeted Employment Per Cap.



C Data Appendix

Table 10 describes our data sources. Figures 11 and 12 illustrate the projected CPI and projected urban land acreage.

Table 10: Data Sources

Time Series	Source	Years	Units	Additional Notes
Employment	BLS	1950-2014	Thousands	Latest version provided by Yamarik.
Population	Census	1950-2014	Thousands	Latest version provided by Yamarik.
Reginal Price Deflator	Turner et al	1950-2000	Base year 2000	Latest version provided by Tamura.
Projected Price Deflator	Project Turner et al on BLS Regional CPIs (Northeast, Midwest, South, West), R2 is .990 for 1987-2000. Project forward.	2000-2014	Base year 2000	
Real Output per worker	Turner et al	1950-2000	Real $2000	Latest version provided by Tamura.
Real Output per worker	BEA, deflated by Projected CPI	2000-2014	Real $2000	
Median Single Family House Prices	US Census of Housing	1950-2000	Nominal	https://www.census.gov/hhes/www/housing/census/historic/values.html
Median Single Family House Prices	ACS	2014	Nominal	Consistent restrictions: non-commercial, owner occupied, on land less than 10 acres.
Urban Land Acreage	USDA-ERS	1945-1997	Acres	https://www.ers.usda.gov/data-products/major-land-uses/
Urban Land Acreage	Decennial Census Urban Land Percent Multiplied by USDA-ERS Total State Land Acreage	2014	Acres	https://www.census.gov/geo/reference/ua/urban-rural-2010.html

Figure 11: Regional Deflator Projection based on BLS Regional CPIs for Midwest, Northeast, West and South (Wyoming)

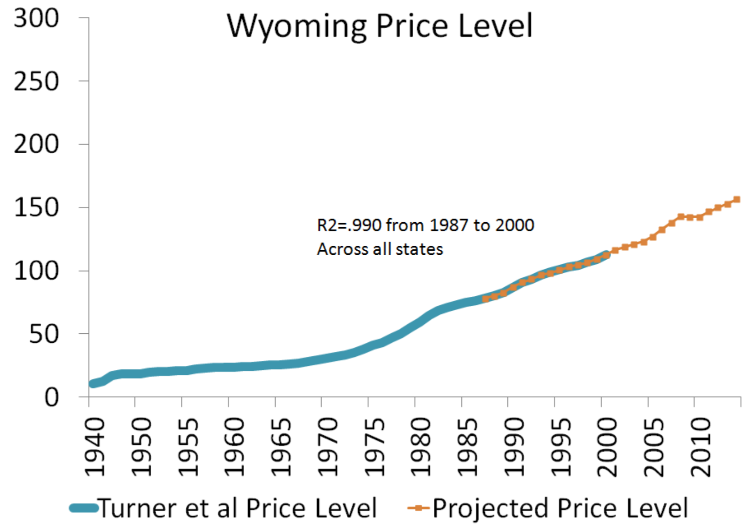


Figure 12: Urban Land Estimates based on 2010 Census Urban Land Shares