Land-Use Restrictions and U.S. Macroeconomic Performance

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Introduction

- *Regional resource reallocation* is central feature of U.S. economy
- 1800s - "Westward Expansion" - population moved to the Midwest and the Great Plains
- 1800s and 1900s - "Urbanization" - moved to Cities
- Mid-late 1900s - moved to California
- CA population share less than 2% in 1900
    - Alabama, Iowa, Kentucky were larger - Kansas about same size
- By 1990, CA population share 12%

Regional Population Shifts Since World War II

- 2010 populations *relative to constant 1950 population share*:
- Gainers - CA gained 15 million, TX gained 9 million, AZ gained 5 million
- Decliners - NY lost 11 million, PA lost 9 million, IL, OH, MI lost 4 million

Interpreting Regional Population Shifts

- Reallocations reflect *regional evolutions in productive opportunities and amenities*
  - Population moves from less productive, less desirable locations to more productive, more desirable locations
- Recently, regional population evolutions have slowed substantially
  - Interstate migration rate down 40 percent from previous level
  - CA pop share stopped growing in 1990, despite CA high tech boom

Figure: Employment Shares

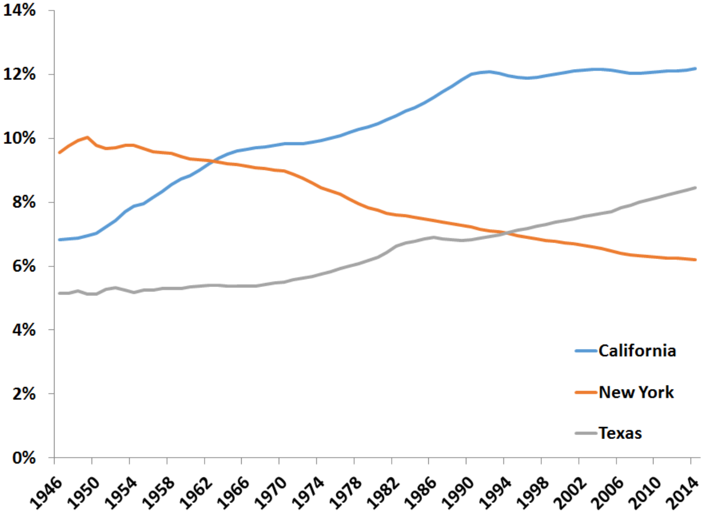
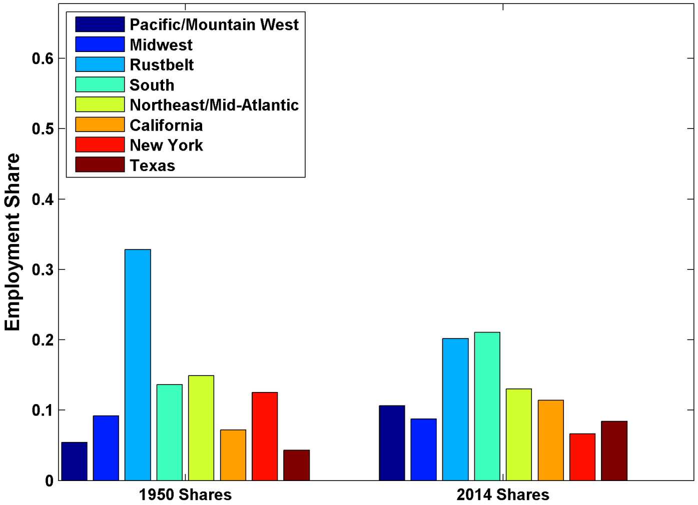


Figure: Employment Shares Across Regions



Interstate Migration Decline, Economic Performance, Housing

- *Regional Reallocation Decline* roughly coincides with:
- (1) Decline in U.S. economic performance (Haltiwanger et al (2013))
- (2) Increase in Housing Prices & Higher House Price Dispersion
    - CA house price premium rose from 28% (1940-1970 ave.) to 262% (1990)
- (3) Decline in state income convergence (Ganong and Shoag (2014))
    - (3a) Persistent income premia in states with housing price premia
- I will draw on joint research with Lee Ohanian (UCLA & FRB Minneapolis) and Ed Prescott (ASU & FRB Minneapolis)
- *Analysis ties these 3 trends together based on tighter land-use restrictions, and analyzes how land-use regulations have affected U.S. economic performance and regional reallocation of the population*

Sand Hill Road Venture Capital IPOs and Private Equity

- Microsoft
- Amazon
- Google
- Facebook
- Twitter
- Tesla
- MetroPCS
- Angies List
- Groupon
- Lyft
- Spotify
- Airbnb

Figure: Sand Hill Road

Model Economy - Overview

- Neoclassical Growth Model with Land & Housing
- Basic model includes consumers who choose how much to work, consume and save, and producers who use labor, land and capital goods to produce output, and houses
- Land is input into housing and production of final goods
- 48 States have *the following exogenous attributes*
    - *Total Factor Productivity (TFP), Amount of Land per state, Land Regulation Policies, & Amenities*
- Land regulations raise cost of land and reduce its productivity
- To conduct analysis, need quantitative measures by state for TFP, amount of land, land-use regulations and amenities - but only land acreage is available

Quantifying Land Regulations, Amenities and Productivity

- Use economic model to infer amenities, land regulations, & TFP by state and over time by observing:
  - state housing prices, state acreage, state employment shares, state labor productivity
- Analysis: exogenously change land regulations in model, and assess how GDP, TFP, & location of workers change
- Sensible land deregulation would increase U.S. GDP by more than $130 billion per year ($1.3 trillion over last decade) and generate population relocation, with CA, Middle-Atlantic & NY growing, and Rust Belt and South shrinking

Basic Approach

- For simplicity, there is a representative household that chooses where to locate family members
- Decision takes into account the TFP, amenity, and land-use regulations of each state
- At the margin, the household will be indifferent between relocating family members
- For simplicity, no moving costs - labor and capital are completely mobile
- All markets are perfectly competitive

Household Maximization

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

subject to the budget constraint,

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

$$k_t = \sum_j k_{jt} = \sum_j k_{yjt} + \sum_j k_{Hjt}, \qquad n_t = \sum_j n_{jt}$$

the housing constraint,

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

and the land constraint,

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

Land in Housing and Final Goods Production

- Maximization problem of competitive output producer:

$$\max_{k_{yjt}, n_{jt}, x_{yjt}} \{A_{jt}\bar{A}(\tilde{y}_{jt})\,F(k_{yjt}, n_{jt}, \alpha_{yjt}x_{yjt}) - w_{jt}n_{jt} - r_t k_{yjt} - q_{jt}x_{yjt}\} \quad (1)$$

- Maximization problem of housing producer:

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

  - α_{Hjt} represent policies that affect land use/housing production
  - Examples: zoning, environmental rules, building restrictions
  - α_{Hjt} is *productivity shifter*, & affects the quantity and price of housing
- Resource constraint: $y_t = \sum_j y_{jt} = c_t + i_t$

Quantitative Approach

- *Specify CA, NY, TX as individual states, and aggregate other states into 5 regions:*
  - Northwest-Mountain states, Rust Belt states, Southern states,
  - Great Plains states, New England-Mid-Atlantic states
- Utility function is standard

$$\ln(c_t) - \frac{1}{1+\frac{1}{\gamma}}\Big(\sum_j n_{jt}\Big)^{1+\frac{1}{\gamma}} + a_{jt} n_{jt} \tag{2}$$

- Production is Cobb-Douglas with cost share of land in housing 38% and in non-housing production 5%
- Analyze "steady state" (long-run affects of changes in land-use regulations)

Identifying Model Land Regulations, Amenities, & TFP

Calculate $\{a_j, A_j, \alpha_{Hj}\}$ as follows:

- Amenities (a_j) target employment shares (BLS)
- TFP (A_j) generate regional labor productivity (y_j/n_j)
  - Extend Turner et al (2007) 'family budget sets' to 2014 using BLS regional CPI and BEA output
- Land-Use Regulations (α_{Hj}) generate regional house prices
- Assume same distortions to housing and production $\alpha_{Hj} = \alpha_{yj} = \alpha_j$
  - Single family home price (Historic Census of Housing & ACS)
  - Urban acreage (USDA & Census Urban land Module)

▸ Formal Identification proof ▸ Data details

Identification of Land Regulation, α_j

$$\alpha_j = \frac{(1-\xi)}{x_j}\left(\frac{n_j}{k_{hj}}\right)^{\frac{\xi}{1-\xi}}\left[(1-\xi)n_j + (1-\theta-\chi)\frac{y_j}{p_j}\right] \tag{3}$$

- What informs the the land regulation parameters?
- For a given number of acres x_j, given number of people n_j (and amenities), given housing capital stock k_{hj}, and output in that region y_j...
- if prices are higher, $p_j \uparrow$, we infer tighter land-use regulations ($\alpha \downarrow$)
- Lower α means less productive land

2014 Steady State Calibration – No Agglomeration

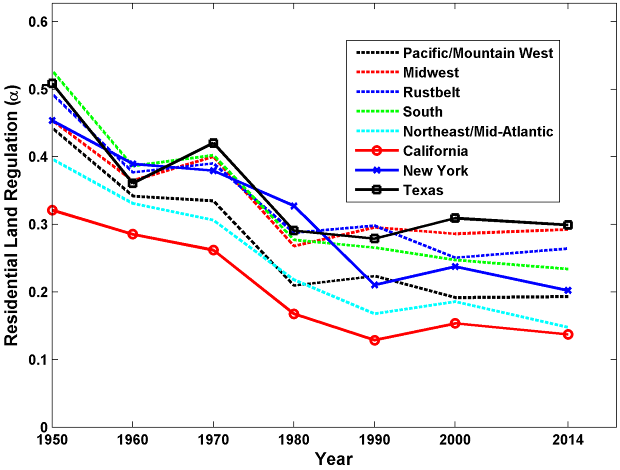
- Matches calibration targets in all regions, here we show CA, NY, and Texas in 2014:

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

	Model	Data	Parameter Value		Parameter Name
Labor Productivity in CA ($\frac{y_{CA}}{n_{CA}}$)	10.380	10.380	$A_{CA,2014}$	4.806	TFP
Employment in CA (n_{CA})	0.067	0.067	$a_{CA,2014}$	-0.668	Amenity
House Prices in CA (p_{CA})	27.633	27.633	$\alpha_{CA,2014}$	0.005	Land Regulation
Land Per Capita in CA (x_{CA})	2.084	2.084	$x_{CA,2014}$	2.084	Acres per 100 Individuals in US
Labor Productivity in NY	11.824	11.824	$A_{NY,2014}$	5.000	
Employment in NY	0.039	0.039	$a_{NY,2014}$	-0.989	
House Prices in NY	19.417	19.417	$\alpha_{NY,2014}$	0.015	
Land Per Capita in NY	1.037	1.037	$x_{NY,2014}$	1.037	
Labor Productivity in TX	9.943	9.943	$A_{TX,2014}$	4.099	
Employment in TX	0.050	0.050	$a_{TX,2014}$	-0.771	
House Prices in TX	10.230	10.230	$\alpha_{TX,2014}$	0.042	
Land Per Capita in TX	1.874	1.874	$x_{TX,2014}$	1.874	

Other years: Repeat SS calibration for 1950, 1960, 1970, 1980, 1990, and 2000 ▸ graphs

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



▸ Full calibration

Land Use Regulations Similar to Prior Literature

Model land regulations are correlated with residential and business regulation indexes in 2014 cross-section.

	Regulation Indices	
	Wharton Land Regulation Rank*	PRI Business Regulation Rank*
Correlation between Model Land-Use Regulation Rank* and Regulatory Index Rank*	0.82	0.60

**Rank equal to 1 indicates least regulated region, Rank equal to 48 indicates most regulated region.*

- Amenities highly correlated with Albuoy (2009) measures ▸ Amenities
- Aggregate TFP growth follows Fernald et al closely ▸ TFP

Counterfactual Experiments

Change land regulations within model and analyze response in economic growth, state population shares, and productivity

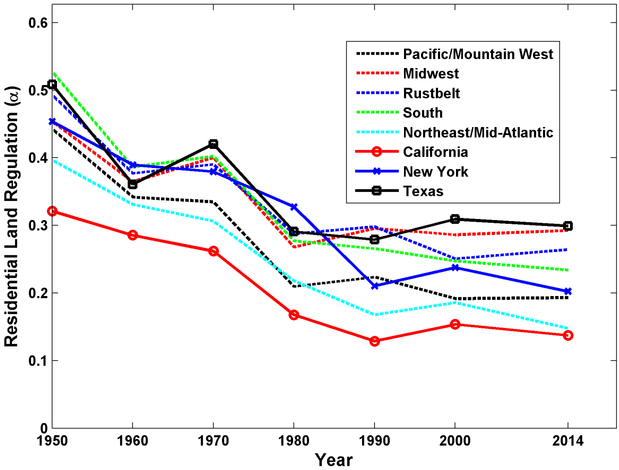
- Two experiments:
- (1) roll back land regulations in each state to a previous year
- (2) change state regulations so they move toward Texas regulation level

I pick Texas, because it has the weakest land regulations (Note: TX has country's weakest zoning laws)

- Deregulate all states halfway to Texas levels in 2014

$$\alpha'_j = \alpha_j + \frac{1}{2}(\alpha_{TX} - \alpha_j)$$

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



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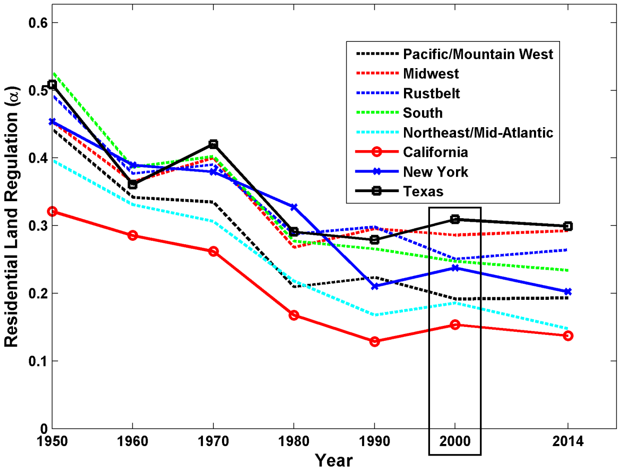

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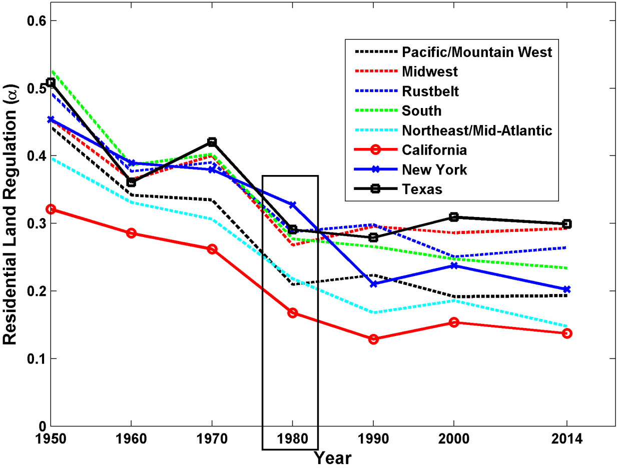

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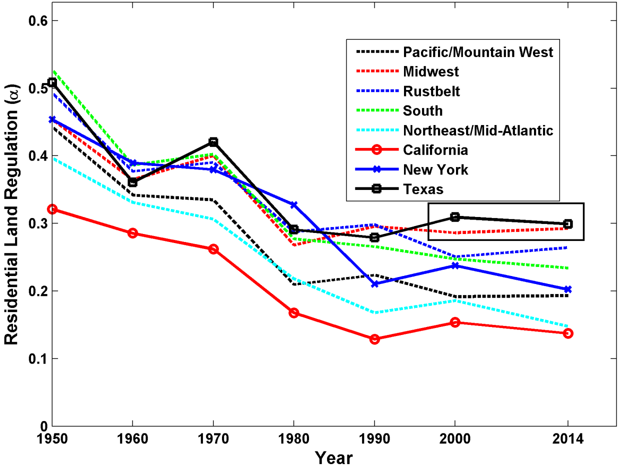
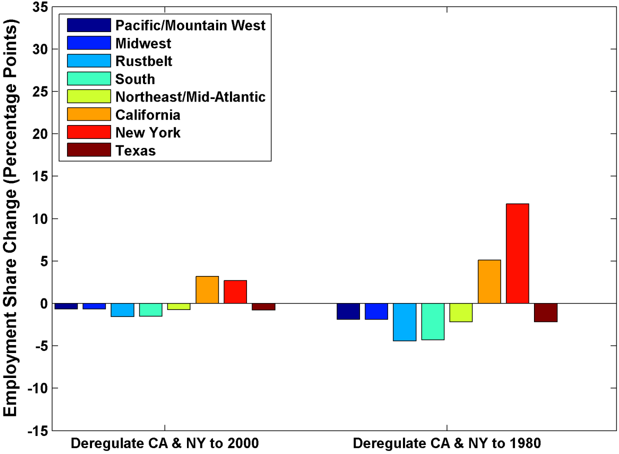


Figure: Deregulating CA **and NY** to their 1980 and 2000 Regulation Levels



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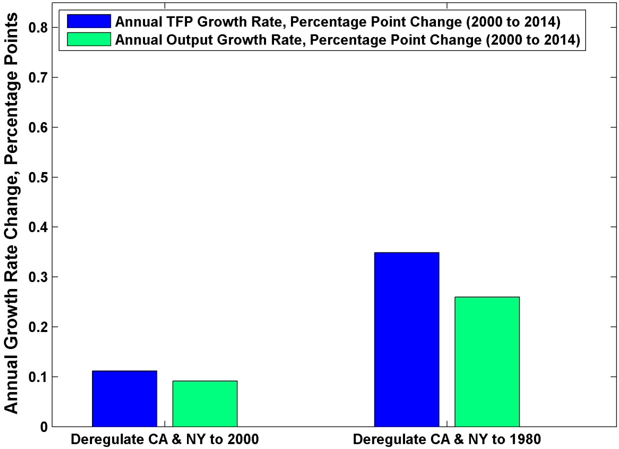
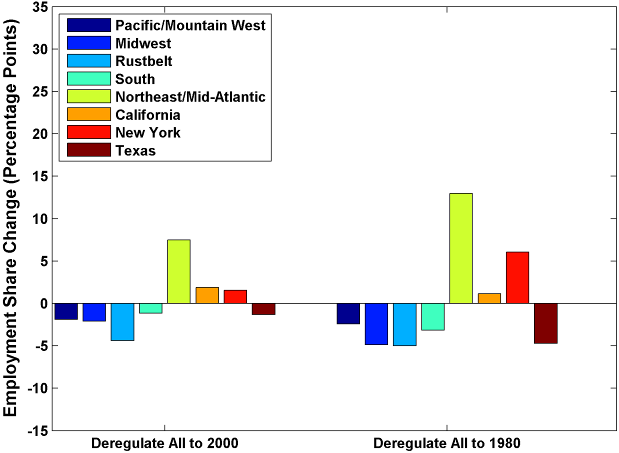


Figure: Deregulating All States to their 1980 and 2000 Regulation Levels



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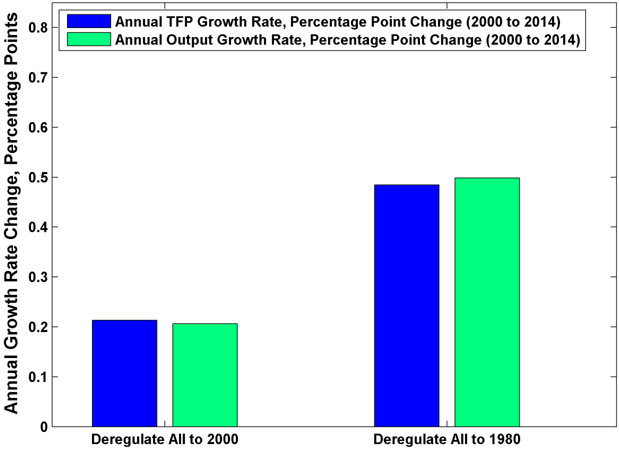


Figure: Log TFP, Deregulate All to their 2000s and 1980s Regulation Levels

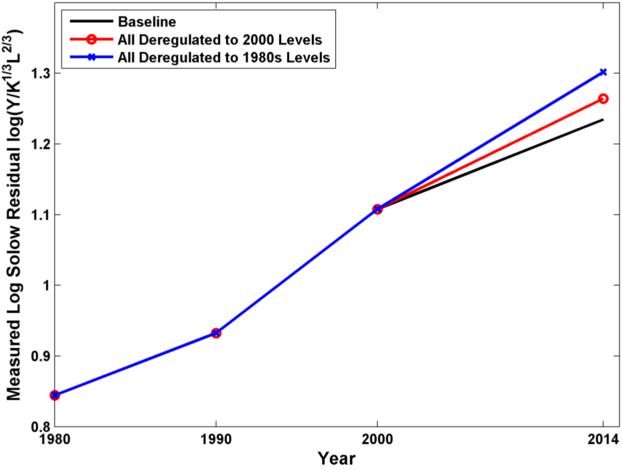
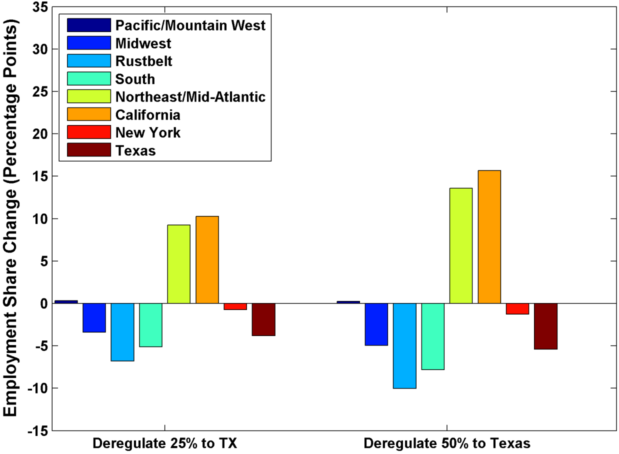


Figure: Deregulating All States Halfway to Texas Regulation Levels



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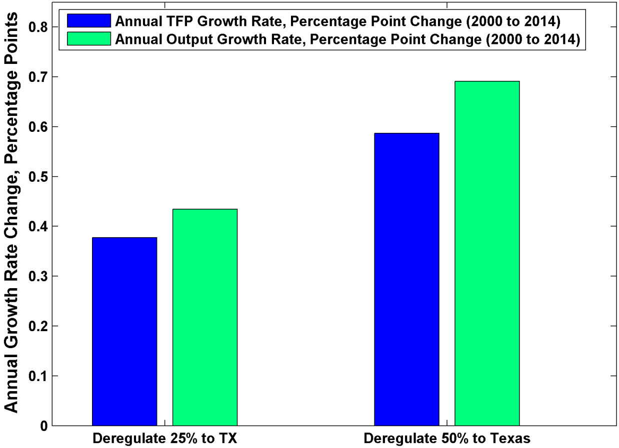


Summary Table of Experiments

Table shows relative gains in variables across experiments $\frac{x_{2014,counterfactual}}{x_{2014,baseline}}$

Largest gains come from moving toward Texas-level regulations

	(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
Relative Consumption	1.000	1.007	1.013	1.014	1.045	1.033	1.090	1.071	1.119
Relative Output	1.000	1.007	1.015	1.013	1.037	1.029	1.072	1.062	1.101
Relative TFP	1.000	1.007	1.014	1.016	1.050	1.030	1.069	1.054	1.085
Relative Labor Productivity	1.000	1.011	1.021	1.023	1.073	1.044	1.100	1.079	1.124
Relative Investment	1.000	1.008	1.015	1.012	1.032	1.026	1.060	1.057	1.089
Relative Labor	1.000	0.997	0.994	0.990	0.967	0.986	0.974	0.984	0.979
Cons. Equiv. Welfare Gain (percentage points)	0	0.633	1.253	1.106	3.250	2.760	7.341	6.210	10.317

Summary and Conclusions

- Land-use regulations have tightened over time, particularly in NY, CA
- Land regulations are an important factor for labor reallocation across regions - highly productive states (NY,CA) have very expensive housing
- Deregulating existing urban land in each state from 2014 regulation levels back to 1980 levels would increase US GDP and productivity by about 6 percent.
- Deregulating existing urban land in each state from 2014 regulation levels back to 1980 levels would permanently increase US GDP and productivity by about 7 percent.
- Land deregulation reduces housing costs and costs of producing output, and leads people to relocate from low productivity states to high productivity states
- Biggest winners are CA, NY, and the Mid-Atlantic

Appendix

Agglomeration

Increasing returns of 3%, $\lambda = .03$.

Increases gains from deregulating NY and CA alone by 30-40%

	(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
Relative Consumption	1.000	1.007	1.015	1.017	1.063	1.040	1.112	1.082	1.144
Relative Output	1.000	1.010	1.021	1.017	1.059	1.040	1.102	1.086	1.142
Relative TFP	1.000	1.010	1.020	1.023	1.087	1.043	1.106	1.080	1.127
Relative Labor Productivity	1.000	1.015	1.032	1.035	1.131	1.066	1.160	1.123	1.195
Relative Investment	1.000	1.011	1.024	1.018	1.057	1.040	1.096	1.089	1.141
Relative Labor	1.000	0.995	0.989	0.983	0.936	0.976	0.950	0.967	0.956
Cons. Equiv. Welfare Gain (percentage points)	0	0.746	1.558	1.322	4.559	3.399	9.396	7.672	13.125

Decomposition of Gains from Deregulation

Table below illustrates output gains from deregulation, holding one or more inputs fixed.

Table: Decomposition of Output Gains from Deregulation

	Deregulate All to 2000	Deregulate All to 1980	Deregulate 25% to TX	Deregulate 50% to Texas
All Inputs Vary	1.029	1.072	1.062	1.101
Only Land Regulation Changes, (x,k,n) are fixed	1.006	1.017	1.014	1.023
Land regulation and x change, (k,n) fixed	1.008	1.022	1.019	1.030
Land regulation and (x,k) change, n fixed	1.009	1.026	1.021	1.035
Land regulation and (x,n) change, k fixed	1.012	1.031	1.028	1.044

Alternate Land Share of Final Goods Sector

Table: 3% Land Share of Final Goods Sector. 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) Dereg. All to 2000	(7) Dereg. All to 1980	(8) Dereg. 25% to TX	(9) Dereg. 50% to Texas
Relative Consumption	1	1.0055	1.0113	1.0117	1.0376	1.0269	1.0731	1.0517	1.0873
Relative Output	1	1.0062	1.0127	1.0105	1.0298	1.0228	1.0547	1.0448	1.0723
Relative Measured Solow Residual	1	1.0062	1.0126	1.014	1.0448	1.0256	1.0578	1.0416	1.0656
Relative Labor Productivity	1	1.0095	1.0193	1.0208	1.0657	1.0375	1.0828	1.0612	1.0959
Relative Investment	1	1.0067	1.0135	1.0098	1.0256	1.0205	1.0448	1.0411	1.0643
Relative Labor	1	0.99677	0.99351	0.98989	0.96628	0.98585	0.97405	0.98461	0.97849
Cons. Equiv. Welfare Gain (percentage points)	0	0.51806	1.0602	0.86953	2.5339	2.1297	5.6513	4.4179	7.3592

Table: Undistorted Final Goods Sector: $\alpha_{yj} = 1 \quad \forall j$. 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) Dereg. All to 2000	(7) Dereg. All to 1980	(8) Dereg. 25% to TX	(9) Dereg. 50% to Texas
Relative Consumption	1	1.0031	1.0058	1.0058	1.014	1.0128	1.0297	1.0268	1.041
Relative Output	1	1.0022	1.0039	1.0032	1.0065	1.0062	1.011	1.012	1.0166
Relative Measured Solow Residual	1	1.0023	1.0041	1.0048	1.0115	1.0081	1.0139	1.0117	1.016
Relative Labor Productivity	1	1.0031	1.0056	1.0064	1.0149	1.0102	1.0151	1.0131	1.0165
Relative Investment	1	1.0016	1.0027	1.0016	1.002	1.0022	0.99958	1.0029	1.0017
Relative Labor	1	0.99906	0.99835	0.99684	0.99172	0.99609	0.99597	0.99894	1.0001
Cons. Equiv. Welfare Gain (percentage points)	0	0.23878	0.43543	0.35922	0.78829	0.81617	1.8182	1.8203	2.723

Covariance between amenities and regulation

Using model data from 1950 -2014 we estimate the following relationship between amenities and state regulations:

$$a_{jt} = -1.323\alpha_{jt} + \hat{\gamma}X_{jt} + \hat{u}_{jt} \quad (4)$$
$$(0.262) \quad (5)$$

The point estimate on α_{jt} is significant at the 1 percent level.

	(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 Texas
Relative Consumption	1	1.0065	1.0128	1.0132	1.0377	1.031	1.079	1.0662	1.1082
Relative Output	1	1.007	1.0137	1.0117	1.0296	1.0263	1.0606	1.0566	1.0884
Cons. Equiv. Welfare Gain (percentage points)	0	0.60642	1.1871	1.0143	2.6187	2.49	6.1022	5.6173	8.9873

Data

- State population and Employment: U.S. Census and BLS

- No official long-run state CPI
- Turner, Tamura, Mulholland, & Baier (2007) construct this to 2000
  - Extension of Berry, Fording, and Hanson (2000), who use historic 'family budget sets' from BLS

- After 2000, we project their series onto regional CPIs (R^2 of .99 for 30 years of overlap), extrapolate to 2014.

- Real state GDP: Deflate nominal state output from BEA using constructed deflators

Back to calibration

Data

- Land constraints: Literature uses Wharton Land Regulation Index & Saiz MSA Supply Elasticities
  - Atemporal, do not measure usable land, unitless index, not designed for this type of model

- Our approach: feed in actual urban land acreage, infer regulations using market prices
  - State urban land from USDA Economic Research Services (ERS) 1945-1997
  - Extend ERS data using 2010 Census Urban Acreage estimates

- Historic single-family house price data from US Census of Housing (1940- 2000)
- Extend with same criteria to 2014 American Community Survey

Back to calibration

Formal Identification Proof

- Have share parameters, r, n_j, y_j, p_j, and x_j
- Solve for k_{hj}: Use first order condition for k_{hj} in housing, $\frac{rk_{hj}}{p_j h_j} = \xi$, and the fact that the stand-in household sets $h_j = n_j$.
- Solve for k_{yj}: Use first order condition for k_{yj} in final goods, $\frac{rk_{yj}}{y_j} = \theta$
- Solve for w_j: Use first order condition for n_j in final goods, $\frac{w_j n_j}{y_j} = \chi$
- Solve for c: Finals goods resource constraint yields c and y, $\sum_j (k_{yj} + k_{hj}) = k$, $y = \sum y_j$, and in steady state $i = \delta k$, $c = y - i$.
- Solve for amenities a_j using the labor leisure condition:

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

- Solve for effective units of land $\alpha_{hj} x_{hj}$: Use definition of production function, $h_j = (k_{hj})^{\xi} (\alpha_{hj} x_{hj})^{1-\xi}$, and solve for $\alpha_{hj} x_{hj} = \left(\frac{n_j}{(k_{hj})^{\xi}}\right)^{(1/(1-\xi))}$

Back to calibration Back to Identification

Formal Identification Proof

- Solve for land price q_j: Use land share in housing, $\frac{q_j x_{hj}}{p_j n_j} = 1 - \xi$, and land share in final goods, $\frac{q_j x_{yj}}{y_j} = 1 - \theta - \chi$. Rearrange and add these equations, and use $x_j = x_{hj} + x_{yj}$:

$$q_j x_{hj} + q_j x_{yj} = (1 - \xi) p_j n_j + (1 - \theta - \chi) y_j$$

Thus

$$q_j = \frac{1}{x_j}[(1 - \xi) p_j n_j + (1 - \theta - \chi) y_j]$$

- Recover x_{hj} and x_{yj}: $x_{hj} = \frac{(1-\xi) p_j n_j}{q_j}$, and land share in final goods, $x_{yj} = \frac{(1-\theta-\chi) y_j}{q_j}$
- Solve for α_{hj} using x_{hj} and the expression for effective units of land, $\alpha_{hj} x_{hj} = \left(\frac{n_j}{(k_{hj})^{\xi}}\right)^{(1/(1-\xi))}$, and substitute in the definition of q_j

$$\alpha_{hj} = \frac{(1 - \xi)}{x_j} \left(\frac{n_j}{k_{hj}}\right)^{\frac{\xi}{1-\xi}} [(1 - \xi) n_j + (1 - \theta - \chi) \frac{y_j}{p_j}]$$

Back to calibration Back to Identification

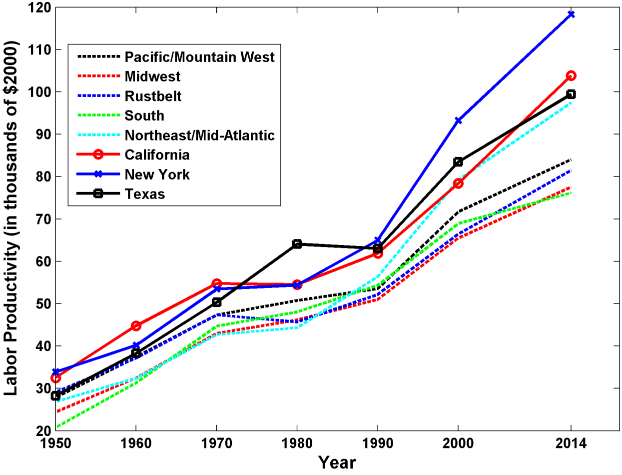
Formal Identification Proof

- Impose $\alpha_j = \alpha_{hj} = \alpha_{yj}$. This allows us to identify TFP.
- Now using $(x_{hj}, x_{yj}, \alpha_{yj})$ and n_j, k_{yj}, y_j, we can recover total factor productivity A_j:

$$y_j = A_j k_{yj}^{\theta} n_j^{\chi} (\alpha_{yj} x_{yj})^{1-\theta-\chi}$$

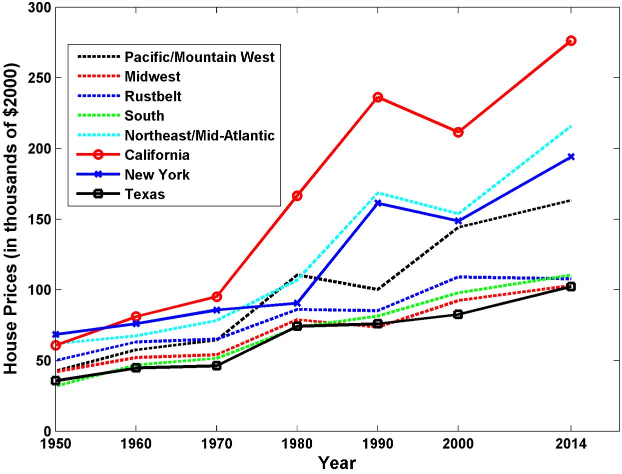
Back to calibration Back to Identification

Figure: Labor Productivity Across Regions ($\frac{y_j}{n_j}$)



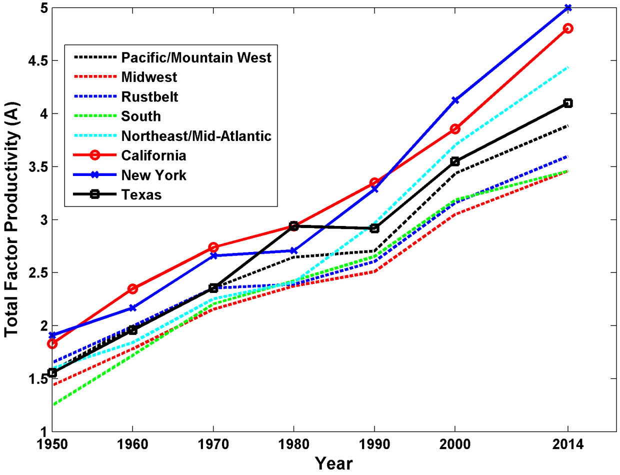
Back to Calibration

Figure: House prices



Back to Calibration

Figure: Total Factor Productivity Across Regions



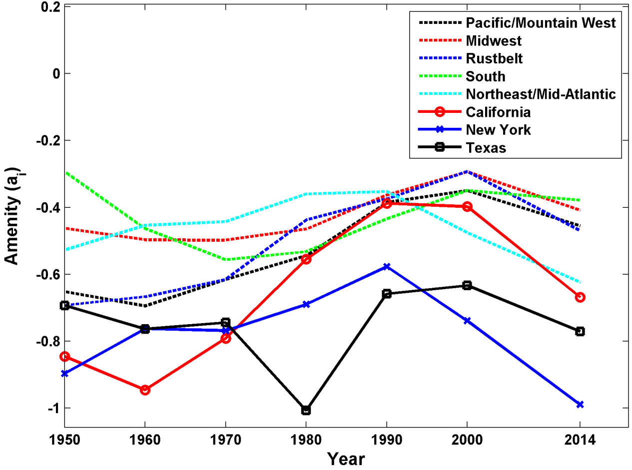
Testing the Model Fit for TFP

We aggregate model state TFP to the national level and compare to actual TFP. It is very close.

Table: Comparison of aggregated Model TFP to Actual

	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2014
Model TFP Growth Rate	1.75	1.76	0.33	0.89	1.77	0.91
Actual TFP Growth Rate	2.12	1.81	0.86	0.50	1.12	0.87

Figure: Measures of Regional Amenities (a_j)



- Amenities highly correlated with Albuoy (2009) measures

What are amenities a_j capturing?

Our amenities generally align with quality of life indeces, as well as changes over time

Table: Comparison of Model's Amenities to Quality of Life Indices

		Quality of Life Indices	
	Albouy Rank*	Gabriel et al. 1980 Rank*	Gabriel et al. 1990 Rank*
Correlation between Model Amenity Rank* and Quality of Life Index Rank*	0.56	0.03	0.30

**Rank equal to 1 indicates best place to live, Rank equal to 48 indicates worst place to live.*