

# Causal Effect of Infrastructure Investments on Income Inequality: Evidence from US States

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- Issues at stake in US context:
  - infrastructure need maintenance and upgrading
  - rising income inequality

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- Issues at stake in US context:
  - infrastructure need maintenance and upgrading
  - rising income inequality
  
- Widely held belief is that infrastructure enhances growth

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  - infrastructure need maintenance and upgrading
  - rising income inequality
- Widely held belief is that infrastructure enhances growth
- Public investment frequently seen as stimulus for growth

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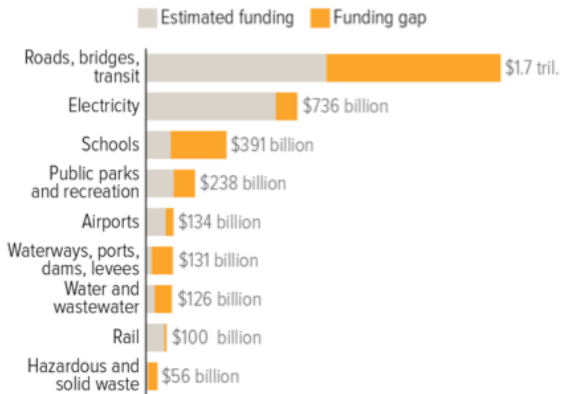
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- Issues at stake in US context:
  - infrastructure need maintenance and upgrading
  - rising income inequality
- Widely held belief is that infrastructure enhances growth
- Public investment frequently seen as stimulus for growth
- Is there any empirical evidence on **how fairly** the growth benefits from infrastructure investments are distributed?

# US Infrastructure Gap 2013-2020

- Surface transportation and schools account for 70 % of gap:



Source: American Society of Civil Engineers 2013 Report Card for American Infrastructure and Failure to Act series, published 2011-2013

# Rising Inequality 1960-2014

Hooper, Peters, Pintus

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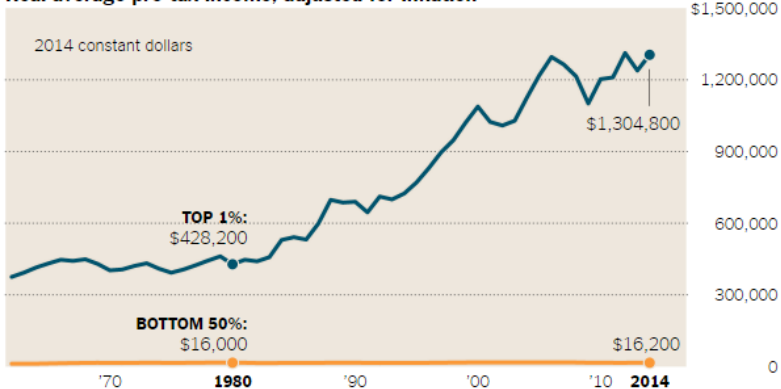
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### Real average pre-tax income, adjusted for inflation



# Rising Inequality 1960-2014 Ctd

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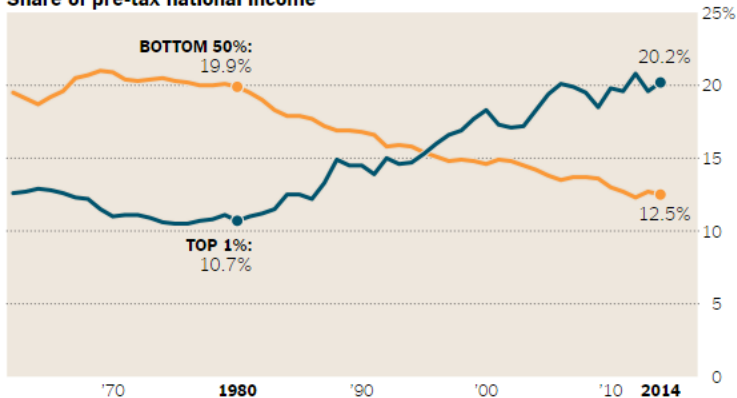
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### Share of pre-tax national income

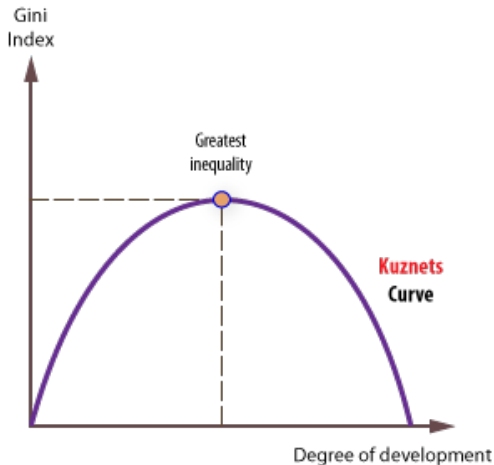


Source: NYT



# Growth and Inequality

- Kuznets (1955) and Kaldor (1960) on inequality and growth



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# Infrastructure $\Rightarrow$ Inequality?

- More recent literature disputes this view

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# Infrastructure $\Rightarrow$ Inequality?

- More recent literature disputes this view
- Possible causal effect from inequality to growth:  
concentration of wealth results in opposition to financing  
public infrastructure

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- More recent literature disputes this view
- Possible causal effect from inequality to growth: concentration of wealth results in opposition to financing public infrastructure
- Causality could also run **from infrastructure to inequality**: better access to job and education opportunities

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- More recent literature disputes this view
- Possible causal effect from inequality to growth: concentration of wealth results in opposition to financing public infrastructure
- Causality could also run **from infrastructure to inequality**: better access to job and education opportunities
- Question we ask: is there an empirical link between public infrastructure and income inequality?

# Infrastructure $\Rightarrow$ Inequality?

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- Possible causal effect from inequality to growth: concentration of wealth results in opposition to financing public infrastructure
- Causality could also run **from infrastructure to inequality**: better access to job and education opportunities
- Question we ask: is there an empirical link between public infrastructure and income inequality?
- BdF w.p. #624: “To What Extent Can Long-Term Investments in Infrastructure Reduce Inequality?”

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# What We Found

- US state-level panel data from 1950 to 2010

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- US state-level panel data from 1950 to 2010
- Inequality correlates negatively with **past** infrastructure spending growth



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# What We Found

- US state-level panel data from 1950 to 2010
- Inequality correlates negatively with **past** infrastructure spending growth
- Highways and higher education spending most effective

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## What We Found

- US state-level panel data from 1950 to 2010
- Inequality correlates negatively with **past** infrastructure spending growth
- Highways and higher education spending most effective
- Inequality reducing effect of infrastructure is stronger:
  - for highways than for higher education
  - on bottom inequality than on top inequality

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- Highways and higher education spending most effective
- Inequality reducing effect of infrastructure is stronger:
  - for highways than for higher education
  - on bottom inequality than on top inequality
- Counterfactual experiment identifies losers/winners

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- Go beyond correlation to address **causality**:  
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- Go beyond correlation to address **causality**:  
from infrastructure investments to income inequality
- Key idea: focus on the number of state representatives in  
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## What We Do

- Go beyond correlation to address **causality**:  
from infrastructure investments to income inequality
- Key idea: focus on the number of state representatives in  
Appropriations Committee
- Helps identify **exogenous** changes in state spending on  
highways

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## What We Do

- Go beyond correlation to address **causality**:  
from infrastructure investments to income inequality
- Key idea: focus on the number of state representatives in Appropriations Committee
- Helps identify **exogenous** changes in state spending on highways
- Precursor:  
Knight (2002) [Aghion et al (2009), Cohen et al (2011)]

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# What We Find

- Apply IV strategy on US state panel data 1976-2008



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- Apply IV strategy on US state panel data 1976-2008
- Number of committee members is a powerful instrument

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# What We Find

- Apply IV strategy on US state panel data 1976-2008
- Number of committee members is a powerful instrument
- Annual data frequency allows for more controls

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## What We Find

- Apply IV strategy on US state panel data 1976-2008
- Number of committee members is a powerful instrument
- Annual data frequency allows for more controls
- First stage in IV panel regressions:  
additional committee member leads to **state spending cut**

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## What We Find

- Apply IV strategy on US state panel data 1976-2008
- Number of committee members is a powerful instrument
- Annual data frequency allows for more controls
- First stage in IV panel regressions:  
additional committee member leads to **state spending cut**
- Second stage:  
committee-driven spending cut causes **rise in inequality**

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- Spending on Highways Causes Inequality Reduction
- Policy Proposal: Investment Platform
- Concluding Remarks

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# Empirical Strategy

- Need to go beyond correlation and to test **causality**

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# Empirical Strategy

- Need to go beyond correlation and to test **causality**
- IV estimation based on annual data 1976-2008:
  - inequality measures from IRS tax forms (Frank, 2009)
  - instrument for state spending (Knight, 2002)

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- Need to go beyond correlation and to test **causality**
- IV estimation based on annual data 1976-2008:
  - inequality measures from IRS tax forms (Frank, 2009)
  - instrument for state spending (Knight, 2002)
- House of Representatives Committee on Appropriations



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- IV estimation based on annual data 1976-2008:
  - inequality measures from IRS tax forms (Frank, 2009)
  - instrument for state spending (Knight, 2002)
- House of Representatives Committee on Appropriations
- Noncompetitive allocation process of federal grants to states

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- IV estimation based on annual data 1976-2008:
  - inequality measures from IRS tax forms (Frank, 2009)
  - instrument for state spending (Knight, 2002)
- House of Representatives Committee on Appropriations
- Noncompetitive allocation process of federal grants to states
- Appropriations committee's grants fund:
  - military bases
  - higher education research
  - highways (completion and upgrading)

# Data and Specification

- Main variable of interest:  
real **annual** state spending on highways

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- Main variable of interest:  
real **annual** state spending on highways
- State-level controls:
  - federal funding for highways
  - population, GDP, unemployment
  - share of financial sector
  - share of government, tax rates, federal welfare
  - high school and college graduation rates

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- State-level controls:
  - federal funding for highways
  - population, GDP, unemployment
  - share of financial sector
  - share of government, tax rates, federal welfare
  - high school and college graduation rates
- Formally, we estimate:

$$\begin{aligned} \text{Inequality}_{it} &= \alpha \cdot \mathbf{Highways}_{it} + \beta' \cdot X_{it} \\ &+ \text{FE}_i + \text{FE}_t + \sum_{k=1}^{51} \delta_k \text{STATE}_{ki} \times t + \varepsilon_{it} \end{aligned}$$

for  $t = 1, \dots, 32$  and  $i = 1, \dots, 51$

# Data and Specification Ctd

- Main instrument for spending on highways in first stage:  
**number of representatives in appropriations committee**

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- Main instrument for spending on highways in first stage:  
**number of representatives in appropriations committee**
- Accession of house representatives to committee:  
based on seniority and political balance  
(exclusion restriction likely to be met)

# Data and Specification Ctd

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- Main instrument for spending on highways in first stage:  
**number of representatives in appropriations committee**
- Accession of house representatives to committee:  
based on seniority and political balance  
(exclusion restriction likely to be met)
- Alternative instrument: lagged spending on highways



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- Main instrument for spending on highways in first stage:  
**number of representatives in appropriations committee**
- Accession of house representatives to committee:  
based on seniority and political balance  
(exclusion restriction likely to be met)
- Alternative instrument: lagged spending on highways
- Second stage: regress inequality on fitted values for spending  
on highways from first stage (and controls)

## Data and Specification Ctd

- Main instrument for spending on highways in first stage:  
**number of representatives in appropriations committee**
- Accession of house representatives to committee:  
based on seniority and political balance  
(exclusion restriction likely to be met)
- Alternative instrument: lagged spending on highways
- Second stage: regress inequality on fitted values for spending  
on highways from first stage (and controls)
- Main result:  
**lower state spending on highways causes larger inequality**

## Reduced Form

Dependent Variable	Top 1% Income Share		
	(1)	(2)	(3)
<b>L2.housemember</b>	<b>0.219***</b>		<b>0.207**</b>
	(0.083)		(0.082)
L2.highways		-0.351*	-0.312
		(0.200)	(0.194)
taxrate	-0.275***	-0.258***	-0.270***
	(0.076)	(0.075)	(0.076)
gdppc	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
unemp	-16.077***	-15.695***	-15.230***
	(4.858)	(4.439)	(4.483)
gvtsize	-20.769***	-21.504***	-21.282***
	(5.790)	(5.637)	(5.646)
Observations	1598	1598	1598
R <sup>2</sup>	0.940	0.940	0.940

Standard errors clustered at state level in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Dependent Variable	Spending on Highways		
	(1)	(2)	(3)
<b>L2.housemember</b>	<b>-0.047**</b> (0.020)		<b>-0.034**</b> (0.015)
L2.highways		0.319*** (0.034)	0.312*** (0.033)
fedhighways	0.355*** (0.089)	0.319*** (0.078)	0.319*** (0.078)
gdppc	0.000*** (0.000)	0.000*** (0.000)	0.000** (0.000)
unemp	-0.782 (1.087)	-1.554** (0.763)	-1.631** (0.769)
gvtsize	-2.792* (1.493)	-2.241** (1.009)	-2.278** (1.038)
Observations	1598	1598	1598
$R^2$	0.799	0.821	0.822

Standard errors clustered at state level in parentheses

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Dependent Variable	Top 1% Income Share		
	(1)	(2)	(3)
<b>highways</b>	<b>-4.684**</b> (2.373)	<b>-1.102*</b> (0.612)	<b>-1.357**</b> (0.621)
fedhighways	1.494* (0.821)	0.219 (0.220)	0.310 (0.233)
fedwelfare	-0.940* (0.501)	-0.548 (0.336)	-0.576* (0.335)
taxrate	-0.190* (0.099)	-0.245*** (0.073)	-0.241*** (0.073)
gdppc	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
unemp	-19.739*** (4.544)	-17.408*** (4.350)	-17.574*** (4.230)
gvtsize	-33.847*** (11.008)	-23.973*** (5.773)	-24.677*** (5.804)
Observations	1598	1598	1598
$R^2$	0.893	0.938	0.937
First-stage $F$ -stat	5.19	81.98	45.93

Standard errors clustered at state level in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Various Inequality Measures

Hooper, Peters,  
Pintus

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	Top 1%	Top 0.1%	Top 0.01%	Theil	Atkinson	Gini
<b>highways</b>	<b>-1.357**</b> (0.621)	<b>-1.302**</b> (0.543)	<b>-0.975**</b> (0.384)	<b>-0.105***</b> (0.039)	<b>-0.105***</b> (0.039)	<b>0.019</b> (0.015)
fedhighways	0.310 (0.233)	0.330* (0.179)	0.243** (0.123)	0.025 (0.018)	0.025 (0.018)	0.004 (0.007)
fedwelfare	-0.576* (0.335)	-0.540** (0.274)	-0.345* (0.196)	-0.020 (0.025)	-0.020 (0.025)	-0.001 (0.009)
taxrate	-0.241*** (0.073)	-0.132*** (0.051)	-0.048 (0.033)	-0.009** (0.005)	-0.009** (0.005)	-0.008*** (0.003)
gdppc	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000** (0.000)
unemp	-17.574*** (4.230)	-12.981*** (3.549)	-7.809*** (2.524)	-2.597*** (0.412)	-2.597*** (0.412)	0.089 (0.122)
highschool	-3.396 (3.182)	-4.008* (2.324)	-1.604 (1.409)	0.119 (0.210)	0.119 (0.210)	-0.220** (0.106)
college	-2.246 (3.682)	-0.003 (2.963)	0.471 (1.889)	0.621** (0.253)	0.621** (0.253)	0.086 (0.117)
gvtsize	-24.677*** (5.804)	-18.058*** (5.439)	-11.983*** (4.570)	-1.766*** (0.443)	-1.766*** (0.443)	0.428 (0.322)
Observations	1598	1598	1598	1598	1598	1598
$R^2$	0.937	0.911	0.875	0.957	0.957	0.921
First-stage $F$ -stat	45.93	45.93	45.93	45.93	45.93	45.93

Standard errors clustered at state level in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

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# Crowding Out

- Reduced-form coefficient of number of committee members on inequality is **positive**

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# Crowding Out

- Reduced-form coefficient of number of committee members on inequality is **positive**
- Strong crowding-out effect:  
in line with Knight (2002) on federal grants



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# Crowding Out

- Reduced-form coefficient of number of committee members on inequality is **positive**
- Strong crowding-out effect:  
in line with Knight (2002) on federal grants
- Additional committee member triggers a **cut** in state spending on highways

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# Crowding Out

- Reduced-form coefficient of number of committee members on inequality is **positive**
- Strong crowding-out effect:  
in line with Knight (2002) on federal grants
- Additional committee member triggers a **cut** in state spending on highways
- Balanced-budget requirement probably key to this mechanism

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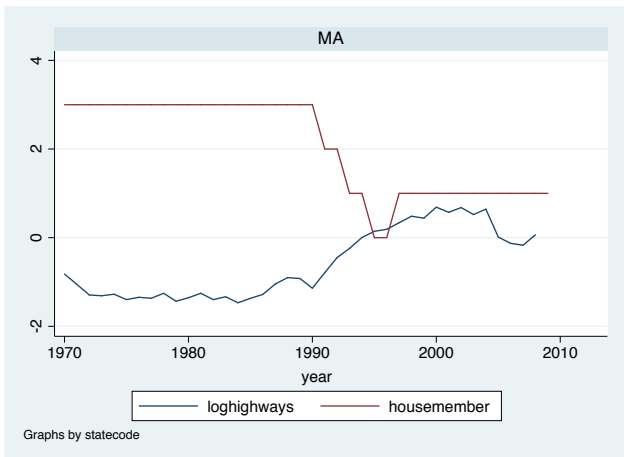
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# Crowding Out

- Reduced-form coefficient of number of committee members on inequality is **positive**
- Strong crowding-out effect:  
in line with Knight (2002) on federal grants
- Additional committee member triggers a **cut** in state spending on highways
- Balanced-budget requirement probably key to this mechanism
- Crowding-out effect confirmed by event analysis

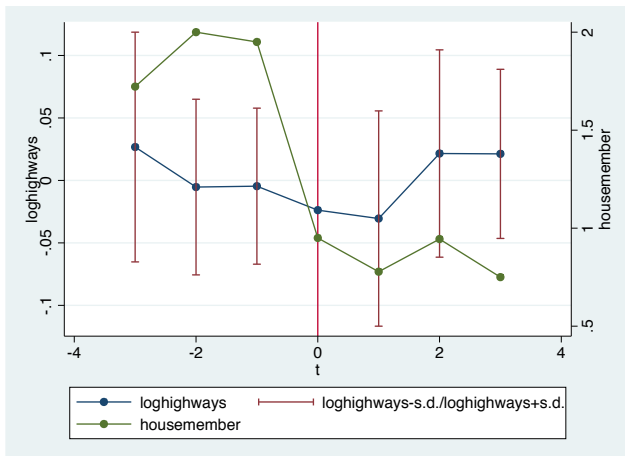
# Massachusetts

- In the 1990s:  
less committee members and more spending on highways



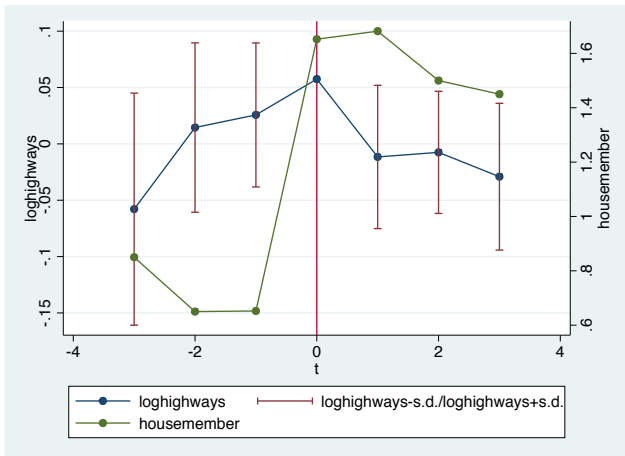
## Event Study

- Average variation of state spending during years with one committee member **less**



# Event Study Ctd

- Average variation of state spending during years with one **additional** committee member



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# Policy Proposal

- Tool to address gigantic infrastructure needs:  
enhanced PPPs through **investment platforms**

▶ GIIP

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# Policy Proposal

- Tool to address gigantic infrastructure needs:  
enhanced PPPs through **investment platforms** ▶ GIIP
- Key element:  
regional or multilateral development bank as third party



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# Policy Proposal

- Tool to address gigantic infrastructure needs:  
enhanced PPPs through **investment platforms** ▶ GIIP
- Key element:  
regional or multilateral development bank as third party
- Goals is to improve: **financing, governance, coordination**  
b/w national and sub-nationals gvts

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- Tool to address gigantic infrastructure needs:  
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- Key element:  
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- Goals is to improve: **financing, governance, coordination**  
b/w national and sub-nationals gvts
- Help mitigate crowding-out effect of federal funding on  
sub-national spending

# Policy Proposal

- Tool to address gigantic infrastructure needs:  
enhanced PPPs through **investment platforms** ▶ GIIP
- Key element:  
regional or multilateral development bank as third party
- Goals is to improve: **financing, governance, coordination**  
b/w national and sub-nationals gvts
- Help mitigate crowding-out effect of federal funding on  
sub-national spending
- Relevant for addressing specific issues in developing  
countries: corruption, transparency, projects allocation

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- Analysis reveals **shorter-run causal effect from spending on highways to income inequality**

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# Conclusion

- Analysis reveals **shorter-run causal effect from spending on highways to income inequality**
- Number of representatives in appropriations committee helps identify exogenous changes in state spending on highways

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# Conclusion

- Analysis reveals **shorter-run causal effect from spending on highways to income inequality**
- Number of representatives in appropriations committee helps identify exogenous changes in state spending on highways
- Allocating national funding for infrastructure through congressional appropriations committees not a panacea

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## Conclusion

- Analysis reveals **shorter-run causal effect from spending on highways to income inequality**
- Number of representatives in appropriations committee helps identify exogenous changes in state spending on highways
- Allocating national funding for infrastructure through congressional appropriations committees not a panacea
- Our results taken together suggest two mechanisms:
  - geographical and social mobility improved by infrastructure in the long-run
  - keynesian effect through boom in construction sector in the short-run

## Conclusion

- Analysis reveals **shorter-run causal effect from spending on highways to income inequality**
- Number of representatives in appropriations committee helps identify exogenous changes in state spending on highways
- Allocating national funding for infrastructure through congressional appropriations committees not a panacea
- Our results taken together suggest two mechanisms:
  - geographical and social mobility improved by infrastructure in the long-run
  - keynesian effect through boom in construction sector in the short-run
- Need for further research on micro-economic channels



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# Conclusion Ctd

- A few caveats to such a rosy view are in order

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## Conclusion Ctd

- A few caveats to such a rosy view are in order
- Some infrastructure investments might correlate positively with inequality: US state spending related to incarceration

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## Conclusion Ctd

- A few caveats to such a rosy view are in order
- Some infrastructure investments might correlate positively with inequality: US state spending related to incarceration
- Community development in US cities leads to gentrification: for example, Columbia University campus in Manhattanville, West Harlem

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## Conclusion Ctd

- A few caveats to such a rosy view are in order
- Some infrastructure investments might correlate positively with inequality: US state spending related to incarceration
- Community development in US cities leads to gentrification: for example, Columbia University campus in Manhattanville, West Harlem
- Possible way out: spending less on prisons and on expensive courthouses (Longbeach, CA), more on vocational schools in low-income neighborhoods

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## Conclusion Ctd

- A few caveats to such a rosy view are in order
- Some infrastructure investments might correlate positively with inequality: US state spending related to incarceration
- Community development in US cities leads to gentrification: for example, Columbia University campus in Manhattanville, West Harlem
- Possible way out: spending less on prisons and on expensive courthouses (Longbeach, CA), more on vocational schools in low-income neighborhoods
- Part of broader research program on infrastructure: infrastructure, growth and development

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- Question: bottom Gini in 2010 if growth rate on infrastructure at median level from 2000 to 2010?

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- Question: bottom Gini in 2010 if growth rate on infrastructure at median level from 2000 to 2010?

- States grouped in quartiles according to growth rate

▶ Quartiles

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- Question: bottom Gini in 2010 if growth rate on infrastructure at median level from 2000 to 2010?
- States grouped in quartiles according to growth rate ▶ Quartiles
- Each state gets median growth rate of own quartile



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- Question: bottom Gini in 2010 if growth rate on infrastructure at median level from 2000 to 2010?
- States grouped in quartiles according to growth rate ▶ Quartiles
- Each state gets median growth rate of own quartile
- Compute counterfactual Gini variations at end of decade

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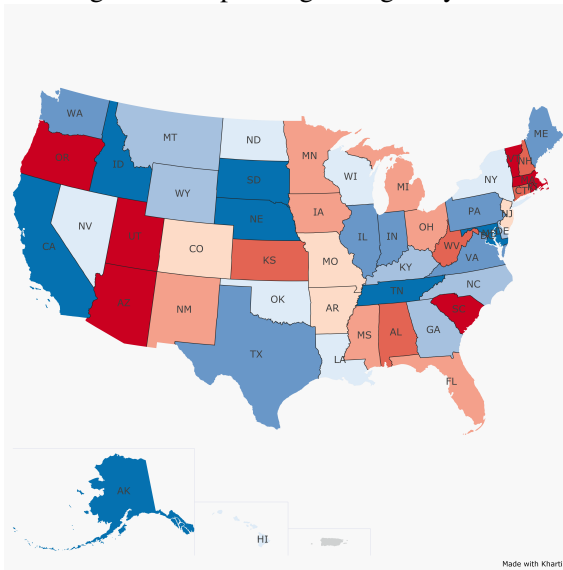
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- Question: bottom Gini in 2010 if growth rate on infrastructure at median level from 2000 to 2010?
- States grouped in quartiles according to growth rate ▶ Quartiles
- Each state gets median growth rate of own quartile
- Compute counterfactual Gini variations at end of decade
- Losers (in **red**) have **negative** counterf. Gini variations  
Winners (in **blue**) have **positive** counterf. Gini variations

# Winners and Losers

- Due to growth in spending on highways:



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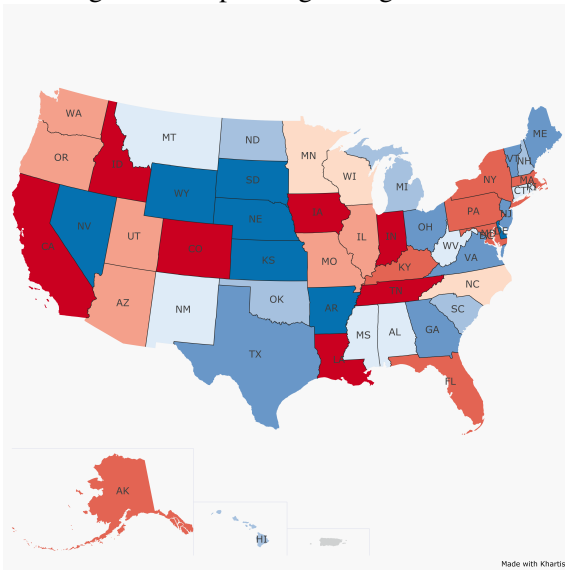
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# Winners and Losers

- Due to growth in spending on higher education:



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- Inequality losses for Massachusetts and Rhode Island:  
about 5<sup>0</sup>% of increase in bottom inequality from 2000 to 2010

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- Inequality losses for Massachusetts and Rhode Island: about 5% of increase in bottom inequality from 2000 to 2010
- If Mass. and R. I. had invested like California in highways: bottom Gini in 2010 lower by resp. 25% and 23%

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- Inequality losses for Massachusetts and Rhode Island: about 5% of increase in bottom inequality from 2000 to 2010
- If Mass. and R. I. had invested like California in highways: bottom Gini in 2010 lower by resp. 25% and 23%
- Inequality losses larger in first quartile: R. I. (in Q1) would have gained 3× more than New Hampshire (in Q2)

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- Inequality losses for Massachusetts and Rhode Island: about 5% of increase in bottom inequality from 2000 to 2010
- If Mass. and R. I. had invested like California in highways: bottom Gini in 2010 lower by resp. 25% and 23%
- Inequality losses larger in first quartile: R. I. (in Q1) would have gained 3× more than New Hampshire (in Q2)
- Symmetrically, on the winner side: California (in Q4) has avoided rise in bottom inequality twice the size of Idaho's (in Q3)



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- **Ginis data from van der Weide and Milanovic (2014):**
  - **IPUMS** micro-census data for 1960-70-80-90 and 2000-10
  - per capita income for 1% to 5% of US population

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- **Ginis data from van der Weide and Milanovic (2014):**
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  - per capita income for 1% to 5% of US population
- **Ginis for bottom 40% and top 40% of income distribution**

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- **Ginis data from van der Weide and Milanovic (2014):**
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  - per capita income for 1% to 5% of US population
- **Ginis for bottom 40% and top 40% of income distribution**
- **Infrastructure state data from Census Bureau and BEA:**  
annual real growth rates of spending averaged over decade

▶ Data

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- **GINIS data from van der Weide and Milanovic (2014):**
  - IPUMS micro-census data for 1960-70-80-90 and 2000-10
  - per capita income for 1% to 5% of US population
- **GINIS for bottom 40% and top 40% of income distribution**
- **Infrastructure state data from Census Bureau and BEA:**  
annual real growth rates of spending averaged over decade
  - ▶ **Data**
- **Four controls from IPUMS:**
  - % of household too young ( $< 15$ ) or too old ( $> 65$ ) to work
  - education shortfall for individuals b/w age 15 and age 18
  - % of household members with at least 4 years in college

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# Empirical Strategy

- Main variable of interest:  
real growth rate of infrastructure spending **over past decade**

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# Empirical Strategy

- Main variable of interest:  
real growth rate of infrastructure spending **over past decade**
- Add above controls and both state and time fixed effects

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# Empirical Strategy

- Main variable of interest:  
real growth rate of infrastructure spending **over past decade**
- Add above controls and both state and time fixed effects
- Regress Ginis in  $t$  on growth rate in decade *prior* to  $t$  for highways and higher education

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## Empirical Strategy

- Main variable of interest:  
real growth rate of infrastructure spending **over past decade**
- Add above controls and both state and time fixed effects
- Regress Ginis in  $t$  on growth rate in decade *prior* to  $t$  for highways and higher education
- Formally, we estimate:

$$\text{Gini}_{it} = \alpha \cdot \text{InfraGrowth}_{it} + \beta' \cdot X_{it} + \text{FE}_i + \text{FE}_t + \varepsilon_{it}$$

for  $t = 1, \dots, 6$  and  $i = 1, \dots, 51$



## Panel Regression

	Total Gini (1)	Bottom Gini (2)	Top Gini (3)
Higher Education	-0.012*** (0.004)	-0.016** (0.008)	-0.013*** (0.004)
Highways	-0.027** (0.010)	-0.026* (0.014)	-0.017** (0.007)
Under Age 15	0.751*** (0.111)	0.429*** (0.091)	0.480*** (0.073)
Over Age 65	0.402*** (0.117)	0.337*** (0.112)	0.222** (0.090)
Education Shortfall	0.042*** (0.015)	0.051*** (0.018)	0.010 (0.007)
College	0.374*** (0.086)	0.491*** (0.083)	0.115* (0.062)
Observations	306	306	306
$R^2$	0.825	0.638	0.899

Estimation with state and year fixed effects

Standard errors clustered at state level in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

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# Economic Significance

- One st.-dev. increase in growth rate of highways and higher education  $\Rightarrow$  overall Gini falls by 0.3% on average

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- One st.-dev. increase in growth rate of highways and higher education  $\Rightarrow$  overall Gini falls by 0.3% on average
- This would undo overall Gini increase from 2000 to 2010 (from 0.461 to 0.464)

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- One st.-dev. increase in growth rate of highways and higher education  $\Rightarrow$  overall Gini falls by 0.3% on average
- This would undo overall Gini increase from 2000 to 2010 (from 0.461 to 0.464)
- One st.-dev. increase in growth rate of highways and higher education  $\Rightarrow$  bottom Gini falls by 0.36% on average

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- One st.-dev. increase in growth rate of highways and higher education  $\Rightarrow$  overall Gini falls by 0.3% on average
- This would undo overall Gini increase from 2000 to 2010 (from 0.461 to 0.464)
- One st.-dev. increase in growth rate of highways and higher education  $\Rightarrow$  bottom Gini falls by 0.36% on average
- This would undo bottom Gini increase from 1990 and 2000 (from 0.260 to 0.262)

# Robustness Analysis

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- **Without** year fixed effects: ▶ No Year FE  
stronger results for bottom inequality  
(but lower  $R^2$ s: down to 0.686 from 0.825 for overall Gini)

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# Robustness Analysis

- **Without** year fixed effects: ▶ No Year FE  
stronger results for bottom inequality  
(but lower  $R^2$ s: down to 0.686 from 0.825 for overall Gini)
- **Without any** fixed effects (standard OLS): ▶ No FE at all  
infrastructure growth and inequality **go hand in hand**

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## Robustness Analysis

- **Without** year fixed effects: ▶ No Year FE  
stronger results for bottom inequality  
(but lower  $R^2$ s: down to 0.686 from 0.825 for overall Gini)
- Without **any** fixed effects (standard OLS): ▶ No FE at all  
infrastructure growth and inequality **go hand in hand**
- Regression of infrastructure on lagged Ginis:  
**no evidence for reverse causality**  
(lagged inequality coefficient not significant)



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## Robustness Analysis

- **Without** year fixed effects: ▶ No Year FE  
stronger results for bottom inequality  
(but lower  $R^2$ s: down to 0.686 from 0.825 for overall Gini)
- Without **any** fixed effects (standard OLS): ▶ No FE at all  
infrastructure growth and inequality **go hand in hand**
- Regression of infrastructure on lagged Ginis:  
**no evidence for reverse causality**  
(lagged inequality coefficient not significant)
- Similar results if spending **levels** added ▶ Levels



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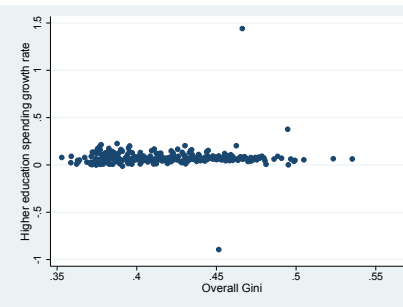
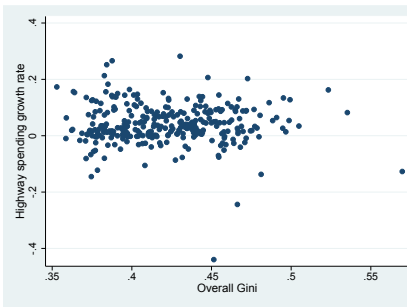
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# Overall Gini



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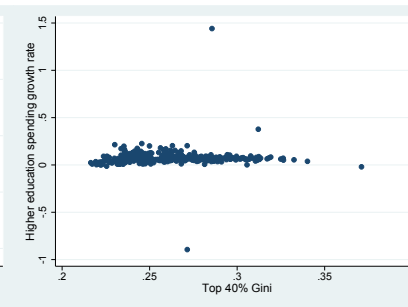
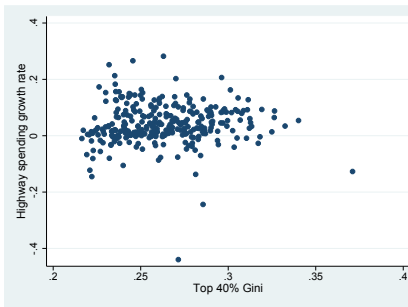
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# Top Gini



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## Regression w/o year FE

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	(1)	(2)	(3)
	Total Gini	Bottom Gini	Top Gini
Higher Education	0.010 (0.013)	-0.017*** (0.006)	0.018 (0.014)
Highways	-0.014 (0.018)	-0.033** (0.012)	0.011 (0.019)
Under Age 15	0.762*** (0.061)	0.388*** (0.056)	0.583*** (0.067)
Over Age 65	0.881*** (0.155)	0.287** (0.110)	0.906*** (0.170)
Education Shortfall	0.048*** (0.014)	0.034** (0.013)	0.039*** (0.011)
College	0.879*** (0.065)	0.578*** (0.052)	0.617*** (0.060)
Observations	306	306	306
$R^2$	0.686	0.566	0.542

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Regression w/o any FE

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	(1)	(2)	(3)
	Total Gini	Bottom Gini	Top Gini
Higher Education	0.027* (0.016)	-0.008 (0.013)	0.021* (0.012)
Highways	0.010 (0.025)	-0.011 (0.020)	0.028 (0.018)
Under Age 15	0.234*** (0.088)	-0.003 (0.072)	0.256*** (0.065)
Over Age 65	0.400*** (0.114)	0.158* (0.093)	0.471*** (0.084)
Education Shortfall	0.121*** (0.014)	0.101*** (0.011)	0.065*** (0.010)
College	0.659*** (0.067)	0.361*** (0.055)	0.474*** (0.049)
Observations	306	306	306
R <sup>2</sup>	0.361	0.300	0.355

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Regression with Level

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	(1)	(2)	(3)
	Total Gini	Bottom Gini	Top Gini
Higher Ed. Growth Rate	-0.012*** (0.004)	-0.017** (0.006)	-0.012*** (0.003)
Highways Growth Rate	-0.028*** (0.010)	-0.022* (0.013)	-0.019*** (0.007)
Higher Ed. Level	0.000*** (0.000)	0.000 (0.000)	0.000*** (0.000)
Highways Level	-0.000*** (0.000)	-0.000*** (0.000)	-0.000 (0.000)
+ Controls (dropped)			
Observations	306	306	306
$R^2$	0.839	0.650	0.907

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$





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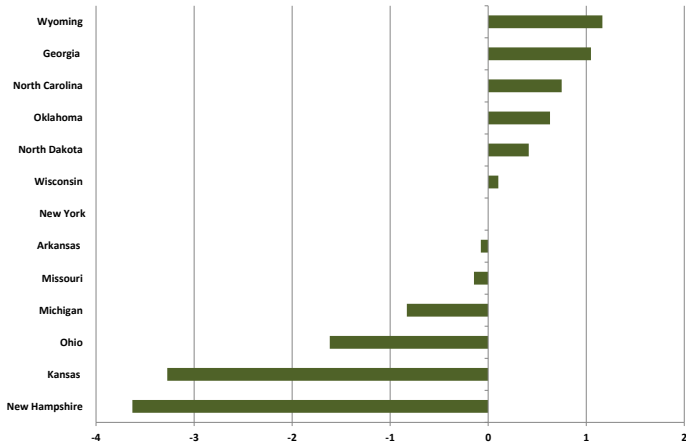
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# Winners and Losers

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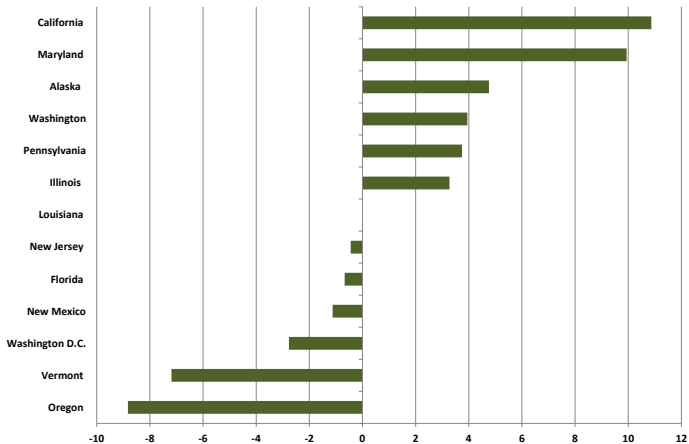
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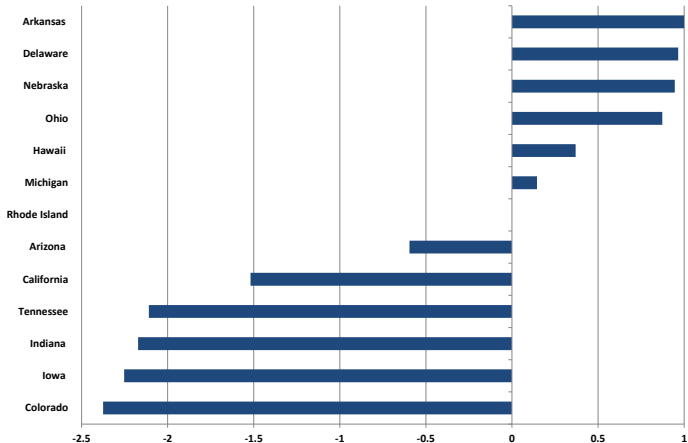
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# Winners and Losers

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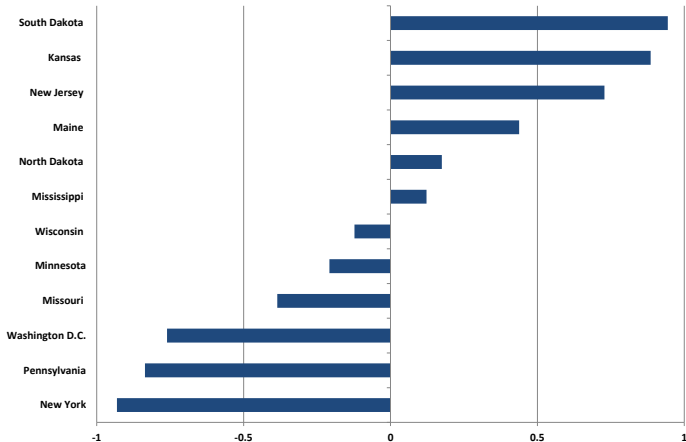
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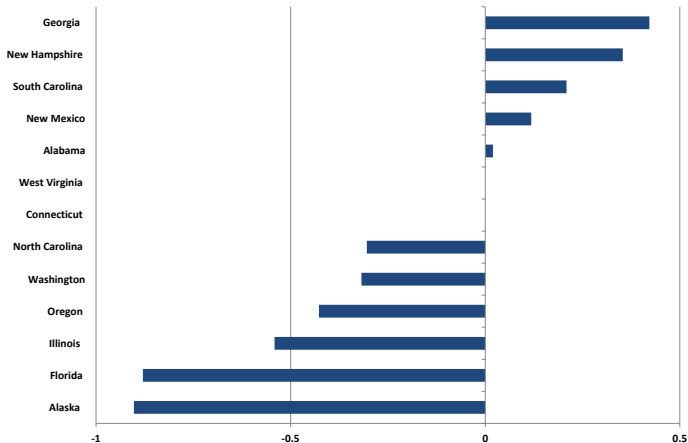
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