A Comparison of Living Standards Across the United States of America[1]

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[1] The views presented are the Authors' only and do not represent the views of the Federal Reserve Board of Governors or the Federal Reserve System as a whole

Introduction

- Real per-capita income varies from $38,800 in NM to $60,700 in CT in 2015
- Real per-capita consumption ranges by a factor of 1.5
- Life expectancy at birth varies by almost 7 years
- Large heterogeneity in leisure, educational attainment, and inequality

- **Question 1**: How do living standards vary across the U.S.?
- **Question 2**: How have each state's living standards evolved over time?

This paper

- Constructs a welfare measure to quantify differences in living standards in the U.S.
  - Accounts for cross-state variations in mortality risk, real (cost-of-living adjusted) consumption, leisure, educational attainment, and inequality
- Compares welfare across states by means of consumption equivalent variation
  - How much must consumption adjust in all ages in the richest state, CT, to make an unborn individual behind the veil of ignorance indifferent between living her entire life in CT compared with any other state?
- Quantifies and decomposes welfare differences across the U.S. in 2015
- Quantifies and decomposes each state's welfare growth rate from 1999 to 2015

Related literature

- **Macro**: Nordhaus and Tobin (1972), Becker, Philipson, and Soares (2005), Boarini, Johansson, and d'Ercole (2006), Córdoba and Verdier (2008), Fleurbaey and Gaulier (2009), Fleurbaey (2009), Jones and Klenow (2016), Brouillette, Jones, and Klenow (2021), Curtis, Garín, and Lester (2021)

- **Micro**: Gabriel, Mattey, and Wascher (2003), Albouy (2011), Moretti (2004), Shapiro (2006), Glaeser and Gottlieb (2009), Oswald and Wu (2011), Glaeser, Gottlieb, and Ziv (2016), Diamond (2016), Zerecero (2022)

- **Main contributions**:
  - Extend Jones and Klenow (2016) welfare measure following recommendations by Stiglitz, Sen, and Fitoussi (2009) Commission: incorporate education
    - Sensitivity analysis: incorporate housing, gender, race, endogenous migration
  - Compare welfare both across U.S. states and over time for an unborn individual behind the veil of ignorance in the tradition of Lucas (1987)

Data

- Relationship between **real (cost-of-living adjusted) income and consumption** Details
  - Real income pc varies by facor of 1.6. Real consumption pc varies by factor of 1.5
  - Richer states tend to have higher consumption than poorer states (corr=0.78)
- Relationship between **real income and life expectancy** Details
  - Life expectancy at birth varies from 74.6 years in MS to 81.5 years in HI
  - Richer states tend to have higher life expectancy than poorer states
- Relationship between **real income and leisure** Details
  - Leisure (measured as annual hours worked pc) varies from 800 in MS to 1,170 in ND
  - Richer states tend to have lower leisure than poorer states
- Relationship between **real income and college attainment** Details
  - Share of 25–29 year-olds with college degree varies by 32.0 p.p.
  - Richer states tend to have higher college attainment rates than poorer states
- Relationship between **real income and inequality (dispersion of income)** Details
  - Inequality does not vary systematically with income
  - Large variations in GINI coeff. across states with comparable real income pc

Model

Lifetime expected utility

- Idiosyncratic state given by agent's age, a, education, e, and state of residence, s
- Assume agent lives her entire life in the state she is born in and that educational attainment is revealed at birth
  - π_e^s denotes state-specific probability of being college-educated
- Agent derives utility from consumption, c, and leisure, ℓ
- Expected lifetime utility in state s is given by

$$U^s = \mathbb{E}_{ae}^s \sum_{e=1}^{2} \pi_e^s \sum_{a=0}^{100} \beta^a \Psi_{ae}^s u\left(c_{ae}^s \exp\left(ga\right), \ell_{ae}^s\right)$$

Welfare comparison

- $U^s(\lambda)$ denotes lifetime expected utility in state s if consumption is multiplied by factor λ

$$U^s(\lambda) = \mathbb{E}^s_{ae} \sum_{e=1}^{2} \pi^s_e \sum_{a=0}^{100} \beta^a \Psi^s_{ae} u\left(\lambda c^s_{ae} \exp(ga), \ell^s_{ae}\right)$$

- Quantify welfare difference between state s and $\hat{s}$ by computing how much consumption must adjust in all ages in $\hat{s}$ to equalize their lifetime expected utility

$$U^{\hat{s}}\left(\lambda^s\right) = U^s(1)$$

- Given log-preferences, we can decompose welfare difference as follows Details

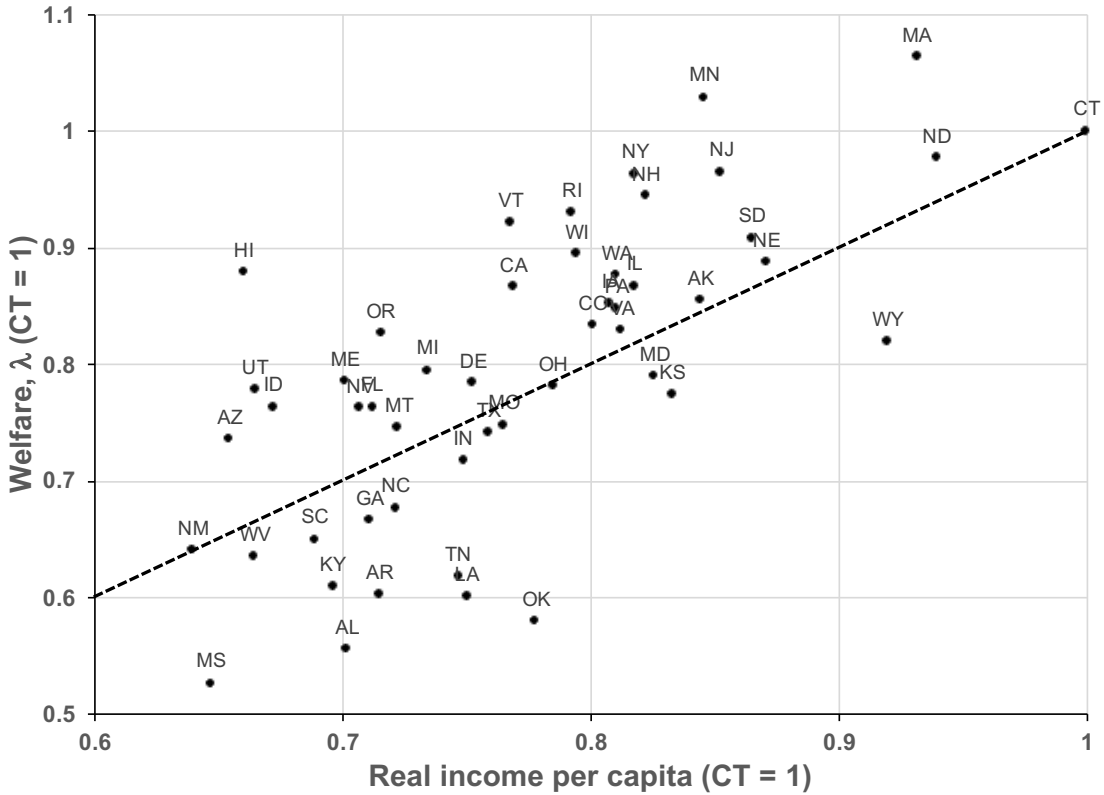
$$\begin{aligned}
\log(\lambda^s) \equiv \quad & \sum_{e=1}^{2}\sum_{a=0}^{100} \Delta\phi^{\hat{s}}_{ae} u^s_{ae} && \text{Life expectancy} \\
& + \sum_{a=0}^{100} \chi^{\hat{s}}_a \left(\left[\pi^s_2 - \pi^{\hat{s}}_2\right]\left[\Psi^s_{a2} u^s_{a2} - \Psi^s_{a1} u^s_{a1}\right]\right) && \text{College attainment} \\
& + \sum_{e=1}^{2}\sum_{a=0}^{100} \phi^{\hat{s}}_{ae}\left(\log\left(\bar{c}^s_{ae}\right) - \log\left(\bar{c}^{\hat{s}}_{ae}\right)\right) && \text{Average consumption} \\
& + \sum_{e=1}^{2}\sum_{a=0}^{100} \phi^{\hat{s}}_{ae}\left(v\left(\bar{\ell}^s_{ae}\right) - v\left(\bar{\ell}^{\hat{s}}_{ae}\right)\right) && \text{Average leisure} \\
& + \sum_{e=1}^{2}\sum_{a=0}^{100} \frac{\phi^{\hat{s}}_{ae}}{2}\left(\left(\sigma^{\hat{s}}_{ae}\right)^2 - \left(\sigma^s_{ae}\right)^2\right) && \text{Inequality of consumption}
\end{aligned}$$

Results

Comparison of welfare across states (2015)

- Quantify welfare differences relative to richest state, CT, by means of consumption equivalent variation Parameterization
- Decompose the welfare differences into differences in: life expectancy, college attainment, cost-of-living adjusted consumption, leisure, inequality

Relationship between income and welfare



- Welfare and real per-capita income are positively correlated (correlation=0.75)

Model with endogenous migration

Decomposition of welfare differences across states

			Decomposition				
State	**Welfare λ**	**Income**	**Life expec.**	**College**	**Consumption**	**Leisure**	**Inequality**
MA	**106.3**	**93.2**	−0.044 (80.2)	0.047 (51.1)	0.029 (36.9)	0.011 (929)	0.018 (0.59)
MN	**102.9**	**84.6**	0.024 (80.7)	0.001 (43.8)	−0.012 (35.4)	−0.046 (1048)	0.062 (0.51)
CT	**100.0**	**100.0**	0.000 (80.6)	0.000 (43.8)	0.000 (35.8)	0.000 (960)	0.000 (0.62)
ND	**97.7**	**94.0**	−0.038 (79.5)	−0.083 (32.6)	0.140 (41.2)	−0.088 (1143)	0.047 (0.54)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
LA	**60.0**	**75.0**	−0.300 (75.6)	−0.080 (29.2)	−0.142 (31.1)	0.013 (915)	−0.002 (0.63)
OK	**57.9**	**77.8**	−0.302 (75.5)	−0.115 (23.4)	−0.170 (30.2)	0.002 (956)	0.038 (0.56)
AL	**55.5**	**70.2**	−0.329 (75.2)	−0.120 (22.0)	−0.175 (30.1)	0.017 (905)	0.019 (0.59)
MS	**52.6**	**64.7**	−0.356 (74.6)	−0.127 (19.6)	−0.210 (29.0)	0.034 (863)	0.017 (0.59)

- Decompose $\log(\lambda)$ into: life expectancy, college attainment, consumption, leisure, and inequality
  - Values in parentheses: state-specific life expectancy, share of 25–29 year-olds with college degree, average consumption, average annual hours worked, and inequality of consumption

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- Higher life expectancy, higher college attainment, and lower inequality increase welfare in MN by a total of 8.7 log points relative to CT
- Lower real cons. and lower leisure reduce welfare in MN by a total of 5.8 log points relative to CT

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- Lower life expectancy, lower college attainment, and lower real consumption reduce welfare in MS by a total of 69.3 log points relative to CT
- Higher leisure. and lower inequality increase welfare in MS by a total of 5.1 log points relative to CT

Evolution of each state's welfare over time: 1999–2015

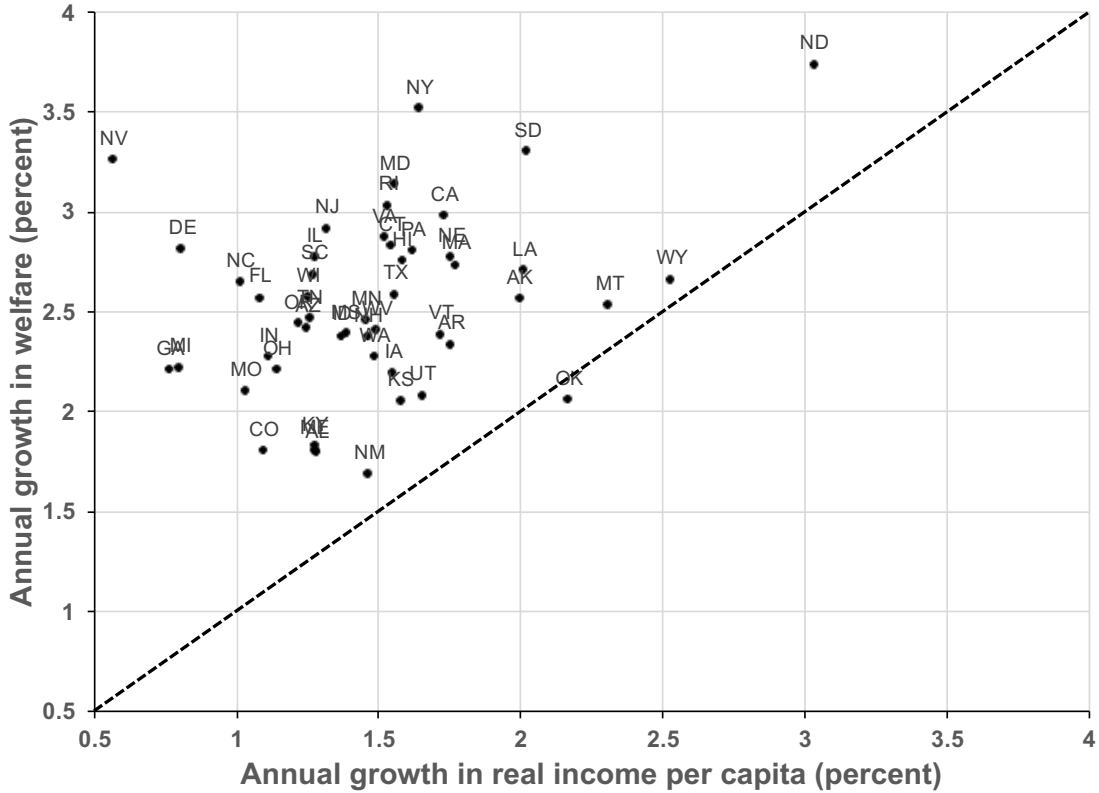
- Examine how each state's living standards have evolved over time by quantifying each state's annual welfare growth rate between 1999 and 2015

$$g_{\lambda}^{s} = -\frac{1}{T}\log\left(\lambda^{s}\right)$$

where $T = 2015 - 1999 = 16$

- Decompose the growth rate into changes in: life expectancy, college attainment, cost-of-living adjusted consumption, leisure, inequality

Relationship between income growth and welfare growth



- Welfare has risen more rapidly than real per-capita income between 1999 and 2015 in all states except for OK (correlation=0.42)
- Population-weighted average welfare growth rate=2.61 percent per year
  - Large heterogeneity in welfare growth rates (1.68–3.73 percent per year)

Decomposition of each state's welfare growth rate

			Decomposition				
State	g_λ	g_Y	**Life expec.**	**College**	**Consumption**	**Leisure**	**Inequality**
ND	**3.73**	**3.04**	0.83 (77.4,79.5)	0.15 (28.8,32.6)	2.80 (24.8,41.2)	−0.02 (1106,1143)	−0.03 (0.53,0.54)
NY	**3.51**	**1.64**	1.34 (77.4,80.6)	0.44 (32.6,45.6)	1.63 (24.3,33.4)	0.14 (914,894)	−0.03 (0.66,0.67)
SD	**3.30**	**2.03**	0.79 (77.2,79.0)	0.19 (28.1,33.0)	2.16 (25.1,37.7)	0.15 (1129,1110)	0.01 (0.52,0.51)
NV	**3.25**	**0.57**	1.16 (75.0,78.0)	0.20 (15.6,21.4)	1.57 (24.5,33.6)	0.38 (1029,930)	−0.06 (0.51,0.53)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
ME	**1.80**	**1.28**	0.27 (77.4,78.5)	0.02 (23.9,24.6)	1.29 (25.7,33.6)	0.25 (998,965)	−0.03 (0.52,0.53)
CO	**1.80**	**1.10**	0.88 (77.7,80.1)	−0.07 (40.6,38.7)	0.71 (26.4,31.4)	0.23 (1046,996)	0.05 (0.54,0.53)
AL	**1.79**	**1.28**	0.27 (74.4,75.2)	−0.04 (23.3,22.0)	1.20 (23.3,30.1)	0.34 (984,905)	0.03 (0.60,0.59)
NM	**1.68**	**1.47**	0.13 (77.0,77.7)	−0.07 (21.3,19.1)	1.42 (22.1,29.5)	0.24 (927,873)	−0.04 (0.56,0.57)

- Decompose g_λ into changes in: life expectancy, college attainment, cost-of-living adjusted consumption, leisure, inequality. Values in brackets: state-specific statistics in 1999 and 2015

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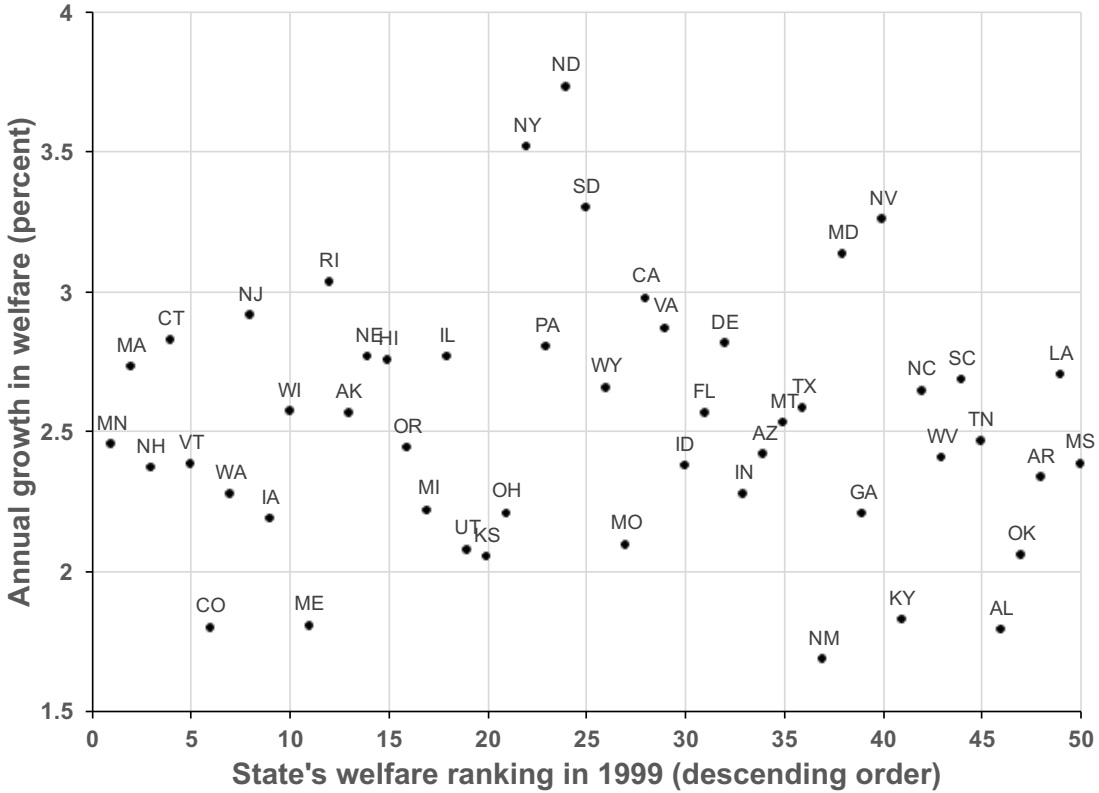
- Increase in life expec. and real consumption increased welfare by 0.83 and 2.80 percent per year in ND
- Reduction in leisure reduced welfare by 0.02 percent per year in ND

Testing for convergence in welfare



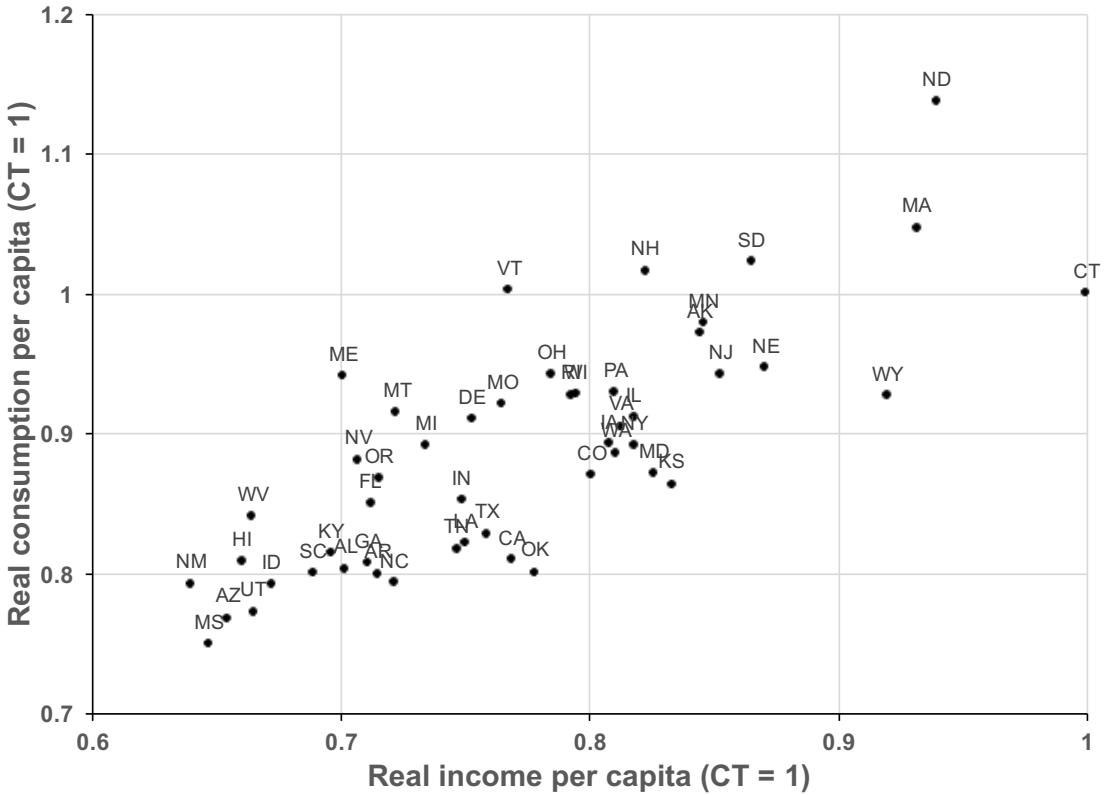
- Do states have different welfare growth rates because they are in the process of converging toward similar welfare levels?
- States' 1999–2015 welfare growth not systematically related to their 1999 welfare ranking
  - No evidence of convergence in welfare during the 21st century

By year and region

Conclusion

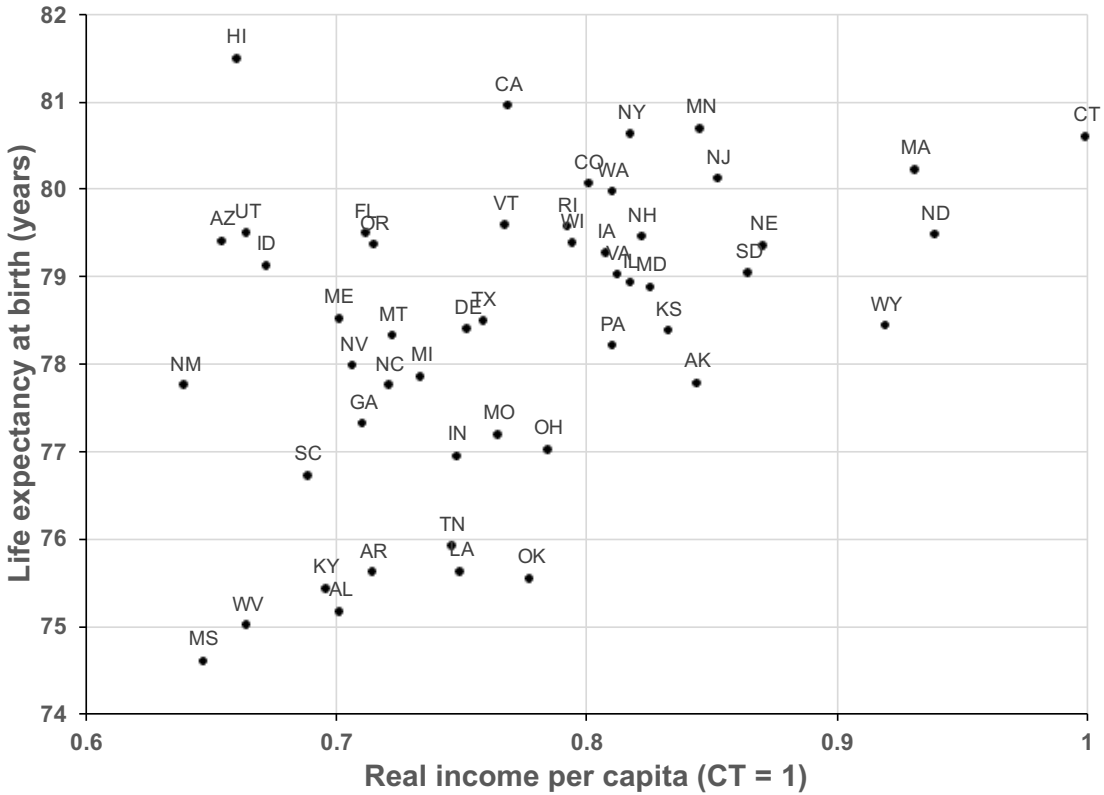
- We have developed a welfare measure to:
  - Quantify the welfare differences across the U.S. in 2015
  - Quantify each state's welfare growth between 1999 and 2015
- Model accounts for cross-state variations in mortality risk, cost-of-living adjusted consumption, leisure, college attainment, and inequality
- Main findings:
  - Welfare and per capita income are positively correlated (correlation=0.75), but deviations between the two measures can be large
  - All states experienced rising living standards between 1999 and 2015
  - Annual welfare growth varied from 1.68 to 3.73 percent across states due to varying gains in life expectancy, consumption, and college attainment
  - Welfare growth and real per-capita income growth are only weakly correlated (correlation=0.42), and deviations are often large
  - No evidence of convergence in welfare levels, including during the sub-periods preceding and following the Great Recession

Relationship between income and consumption



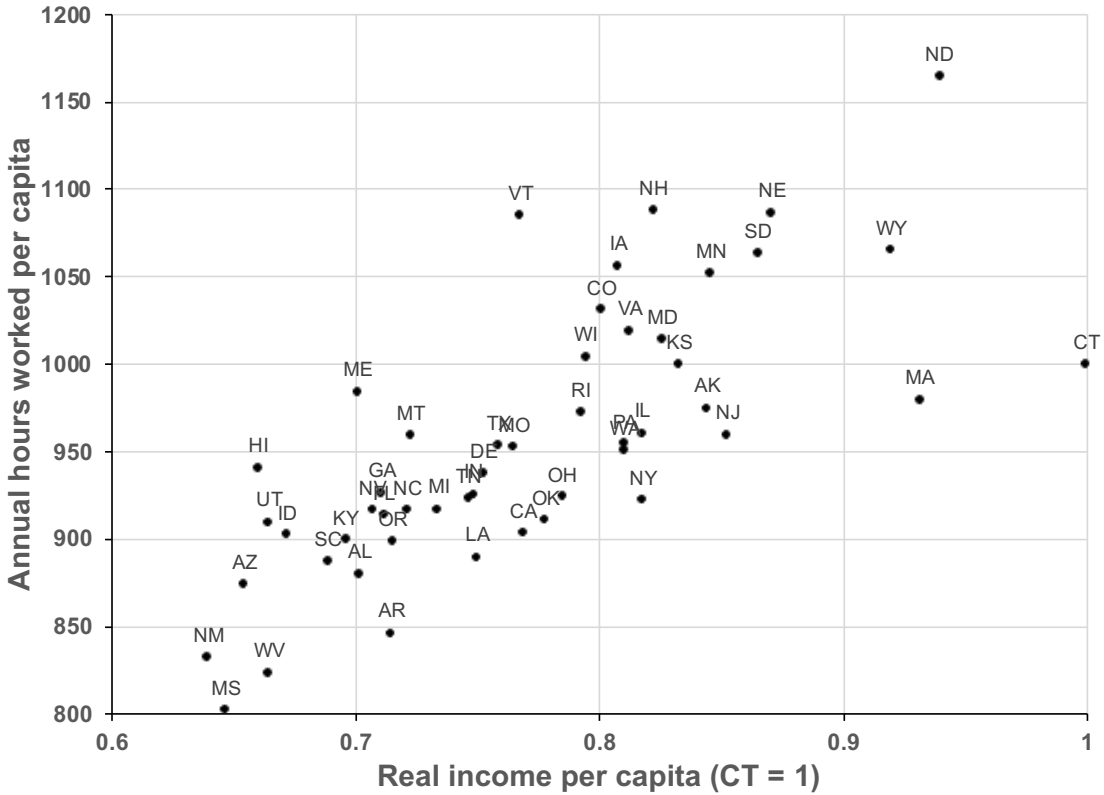
- Data on real personal income per capita and real consumption per capita from BEA
  - Using Regional Price Parities from BEA to adjust for differences in cost-of-living
- Richer states tend to have higher consumption than poorer states back

Relationship between income and life expectancy



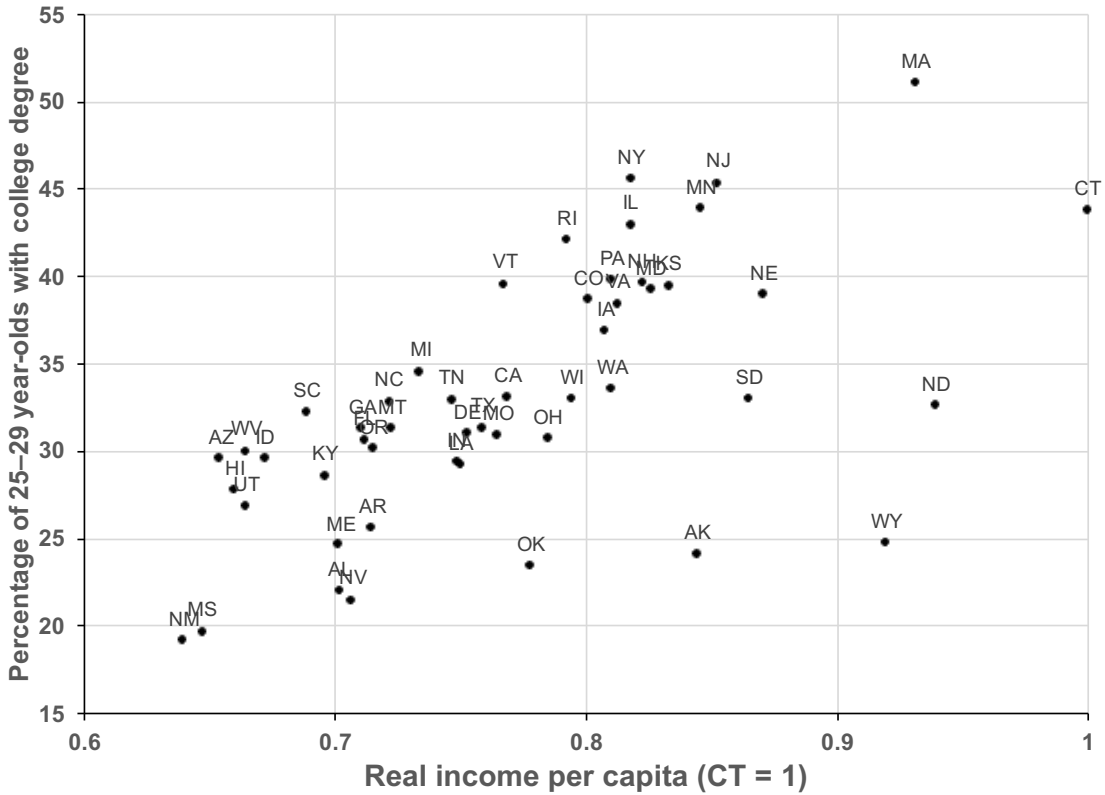
- Use age-specific mortality data from CDC to compute life expectancy at birth
- Life expectancy at birth varies from 74.6 years in MS to 81.5 years in HI
- Richer states tend to have higher life expectancy than poorer states back

Relationship between income and leisure



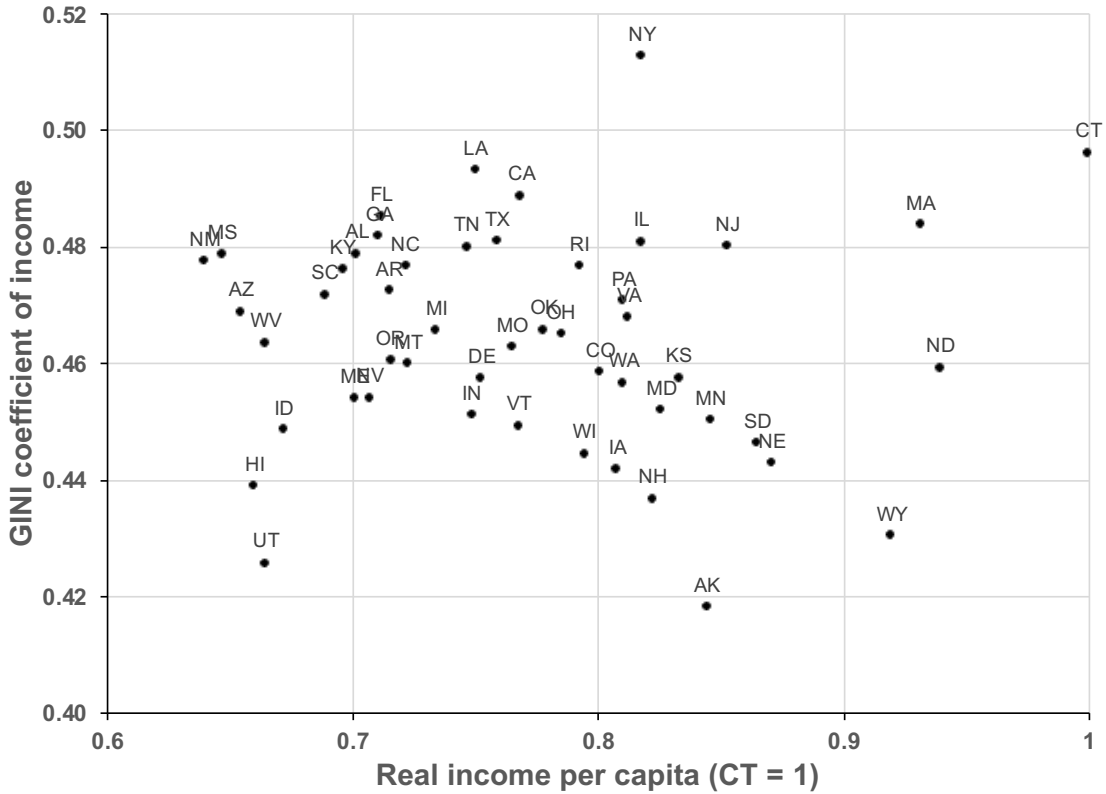
- Use data on annual hours worked from CPS
- Richer states tend to have higher hours worked per capita (lower leisure) back

Relationship between income and college attainment



- Use data from CPS to compute share of 25–29 year-olds with college degree
- Share of 25–29 year-olds with college degree varies by 32.0 p.p.
- Richer states tend to have higher college attainment rates than poorer states back

Relationship between income and inequality



- Compare inequality by means of GINI coeff. of household income from ACS back
- Inequality does not vary systematically with income
  - Large variations in GINI coeff. across states with comparable real per-capita income

Flow utility

- Extending the welfare measure Jones and Klenow (2016) develop to measure cross-country differences in living standards
  - Choice of variables follow recommendations by Stiglitz et al. (2009) Commision
- Idiosyncratic state given by agent's age, a, education, e, and state of residence, s
- Flow utility from consumption, c, and leisure, ℓ

$$u\left(c_{ae}^{s}, \ell_{ae}^{s}\right) = b + \log\left(c_{ae}^{s}\right) + v\left(\ell_{ae}^{s}\right)$$

- b governs value of life as in Hall and Jones (2007)

Consumption and mortality risk

- Assume consumption is drawn from lognormal distribution: $c^s_{ae} \sim LN\left(\mu^s_{ae}, \sigma^s_{ae}\right)$
- Then $\mathbb{E}^s_{ae}\left[\log\left(c^s_{ae}\right)\right] = \log\left(\bar{c}^s_{ae}\right) - \frac{\left(\sigma^s_{ae}\right)^2}{2}$
  - $\bar{c}^s_{ae} = \exp\left(\mu^s_{ae} + \frac{\left(\sigma^s_{ae}\right)^2}{2}\right)$ is age-education-state-specific arithmetic mean of cons.
- Assume consumption grows at rate g per year in all states
- $\Psi^s_{ae} = \prod_{k=0}^{a-1} \psi^s_{ke}$ denotes education-state-specific probability of surviving from age 0 to age $a \geq 1$, with $\Psi^s_{0e} = 1$ for all e and s
- Agents live at most 100 years and discount the future at rate β in all states back

Parameterization

Back

- **Age-, education- and state-specific survival probabilities, ψ^s_{ae}** Details
  - Underlying Cause of Death Database and National Vital Statistics System from CDC

- **Age-, education- and state-specific consumption process** Details
  - Consumer Expenditure Survey
  - Growth rate of consumption: $g = 2$ percent per year

- **Preferences**
  - Discount factor: $\beta = 0.99$
  - Disutility from working, $1 - \ell$, given by: $v(\ell) = -\frac{\theta\epsilon}{1+\epsilon}(1-\ell)^{\frac{1+\epsilon}{\epsilon}}$
    - $\epsilon = 1$ and $\theta = 14.2$ as in Jones and Klenow (2016)
  - Constant term in utility function: $b = 6.21$ Details
    - Calibrated as in Jones and Klenow (2016): 40-year-old, facing the avg. uncertainty in the U.S., has value of remaining life equal to \$6.5m (2012 USD)

Survival probabilities

- Underlying Cause of Death Database from CDC reports each person's age and state of legal residence at the time of death in the U.S. Back
  - Used to compute age- and state-specific survival probabilities: ψ_a^s
- National Vital Statistics System from CDC reports each person's age and educational attainment at the time of death in the U.S.
  - Used to compute age-specific *college survival premium*: $\psi_{a2} - \psi_{a1}$
- Use Current Population Survey to compute distribution of age and education by state: Λ_{ae}^s
- Solve for ψ_{ae}^s that solve the following system of equations:

$$\begin{aligned} \psi_a^s &= \sum_{e=1}^{2} \Lambda_{ae}^s \psi_{ae}^s \\ \psi_{a2} - \psi_{a1} &= \psi_{a2}^s - \psi_{a1}^s \end{aligned}$$

Consumption

- Use data from Consumer Expenditure Survey (CEX)
  - Focus on consumption of non-durables and services
  - Aggregate from quarterly to annual, then convert from household-level to individual-level by allocating uniformly across household members
  - For each year, adjust consumption in the CEX to match per capita expenditures in the U.S. as reported by the BEA to correct for well-known underestimation

Back

- Assume that consumption in the U.S. is drawn from lognormal distribution
  - Estimate age- and education-specific moments with CEX data: μ_{ae} and σ_{ae}

- Adjust the parameters to match each state's demographic-adjusted per capita consumption and consumption inequality relative to the U.S.

$$\begin{aligned} \frac{\sum_e \sum_a \Lambda^s_{ae} \exp\left(\mu_{ae}+\nu^s+\frac{(\sigma_{ae}\kappa^s)^2}{2}\right)}{\sum_e \sum_a \Lambda^{US}_{ae} \exp\left(\mu_{ae}+\frac{\sigma^2_{ae}}{2}\right)} &= \frac{C^s}{C^{US}} \\ \text{GINI}^s\left(\boldsymbol{\Lambda}^s, \boldsymbol{\mu}, \boldsymbol{\sigma}; \nu^s, \kappa^s\right) - \text{GINI}^{US}\left(\boldsymbol{\Lambda}^{US}, \boldsymbol{\mu}, \boldsymbol{\sigma}\right) &= d^s \end{aligned}$$

Constant term in utility function

- Calibrate constant term in utility function, b, s.t. 40-year-old has value of remaining life equal to \$6.5m (2012 USD)

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- Convert dollar-amount of statistical value of life to utility units by multiplying by marginal utility of consumption evaluated at age 40
  - Equal to $\frac{1}{\bar{c}(40)}$ with log-preferences, where $\bar{c}(40) \equiv \sum_{e=1}^{2} \pi_e^{US} \exp\left(\mu_{40e} + \frac{\sigma_{40e}^2}{2}\right)$

- Solve for b :

$$\begin{aligned} \frac{\$6{,}500{,}000}{\bar{c}(40)} &= \sum_{e=1}^{2} \pi_e^{US} \sum_{a=40}^{100} \beta^{a-40} S_{ae}^{US} \left[b + g(a-40) + \mu_{ae} + v\left(\bar{\ell}_{ae}^{US}\right) \right] \\ b &= \frac{\frac{\$6{,}500{,}000}{\bar{c}(40)} - \sum_{e=1}^{2} \pi_e^{US} \sum_{a=40}^{100} \beta^{a-40} S_{ae}^{US} \left[g(a-40) + \mu_{ae} + v\left(\bar{\ell}_{ae}^{US}\right) \right]}{\sum_{e=1}^{2} \pi_e^{US} \sum_{a=40}^{100} \beta^{a-40} S_{ae}^{US}} \end{aligned}$$

Model with vs. model without migration

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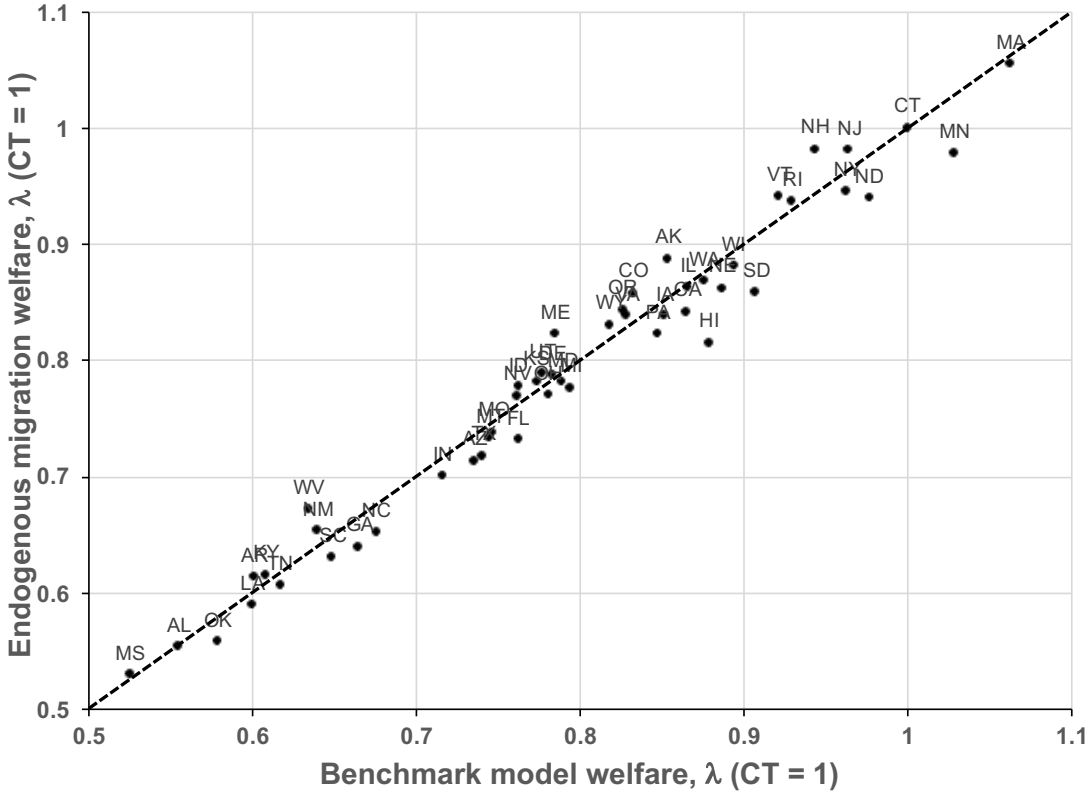

- Benchmark model without migration vs. alternative model with endogenous migration

$$V(a, e, x, r, s; s_b) = \max_{s'} u^s_{aexr} - m(s; s_b) + \beta \psi^s_{aexr} V\left(a+1, e, x, r, s'; s_b\right)$$

- Calibrating utility cost of residing in a state other than one's birthstate, $m(s; s_b)$, to match each state's *retention rate*
  - Percentage of residents in a state that were also born in that state: ranges from 45.4 percent in WY to 82.0 percent in TX (data from Minnesota Population Center)

Calibrated utility cost $m(s; s_b)$

- Large pecuniary and/or non-pecuniary costs of residing in a state other than one's birth state are required to rationalize observed retenion rates
- Residing in a state other than one's birth state reduces consumption-equivalent welfare by 36.3 percent on average when the welfare payoff to moving is ignored
- Permanently residing in a state other than one's birth state would lower the value of remaining life of an average 40-year-old by approximately $\$462,000$ when the welfare payoff to moving is ignored ($\approx \$11,000$ per year)
  - Kennan and Walker (2011) estimate a moving cost for the average mover of $\$326,000$ when the payoff to moving is ignored back

Sensitivity analysis

- Welfare results are robust to several changes: back
  - Model with two goods: consumption and housing
  - Including gender and race in the welfare measure
  - Using alternative utility specifications, parameterizations, and calibration targets
  - Computing welfare conditional on educational attainment, gender, and race
  - Excluding healthcare spending from non-durable consumption
  - Including durable consumption goods
  - Changing age at which individuals enter/exit the model
  - Using compensating rather than equivalent variation to measure welfare

Relationship between income and welfare

- While the ranking of real per-capita income and the ranking of welfare are positively correlated, there are large differences between the level of real income pc and the corresponding welfare level for some states
    - MN has 15.4 percent lower real income pc than CT, but 2.9 perc. higher welfare
- Dispersion in living standards is higher than dispersion in real per-capita income
    - Real income pc varies by 36.0 p.p.; welfare varies by 53.7 p.p.
- Living standards in several states in the South appear lower relative to CT than their difference in real per-capita income would suggest
    - AL has 29.8 percent lower real income pc than CT, but 44.5 perc. lower welfare

Welfare across time

- Living standards increased in all states. Population-weighted average welfare growth rate=2.61 percent per year
- Large heterogeneity in welfare growth rates (1.68–3.73 percent per year)
- Real per-capita income growth and welfare growth only weakly correlated (corr=0.42)
  - Deviations are often large: Ex.: $g_\lambda\left(NV\right) = 3.25$; $g_Y\left(NV\right) = 0.57$
  - Largely due to low corr. btw. real per-capita income growth and life expectancy gains

Testing for convergence in welfare by year and region

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Region	Average welfare ranking (year)			Average annual welfare growth (percent)		
	1999	2007	2015	1999–2007	2007–2015	1999–2015
United States				**3.59**	**1.65**	**2.62**
Midwest	**18**	**21**	**22**	**3.46**	**1.33**	**2.40**
East North Central	20	23	23	3.40	1.43	2.41
West North Central	15	17	19	3.59	1.12	2.35
Northeast	**15**	**9**	**9**	**4.33**	**1.73**	**3.03**
Middle Atlantic	19	12	10	4.36	1.97	3.17
New England	4	3	5	4.23	1.06	2.64
South	**39**	**38**	**37**	**3.34**	**1.69**	**2.51**
East South Central	45	45	46	3.36	0.88	2.12
South Atlantic	36	35	33	3.54	1.72	2.63
West South Central	40	41	39	2.98	2.07	2.52
West	**24**	**23**	**21**	**3.51**	**1.82**	**2.66**
Mountain	26	29	31	3.18	1.34	2.25
Pacific	24	20	16	3.64	2.02	2.83