JOHNS HOPKINS
CAREY BUSINESS SCHOOL

Cities and Smoking

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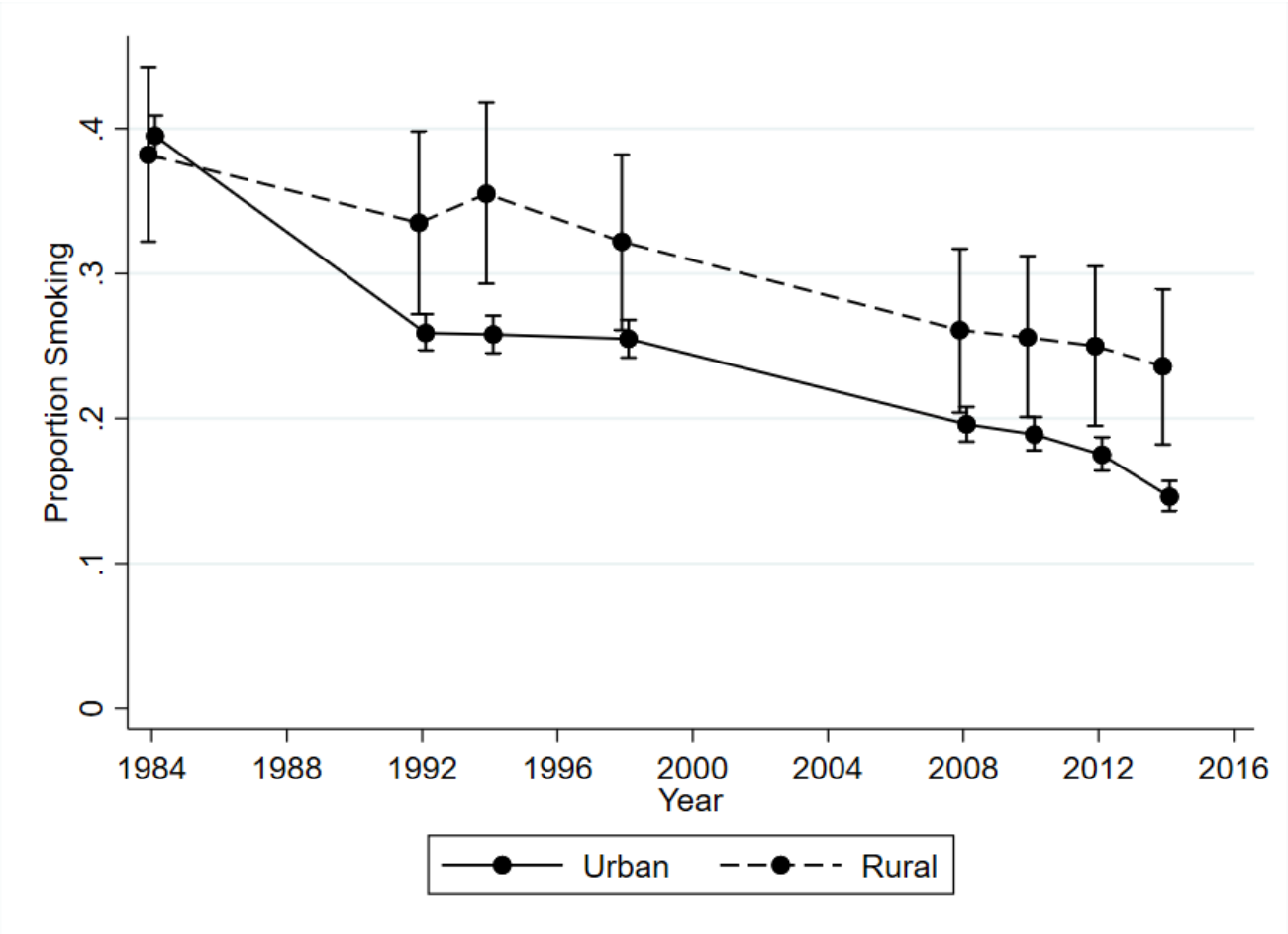
February 4th, 2021

Disclosures

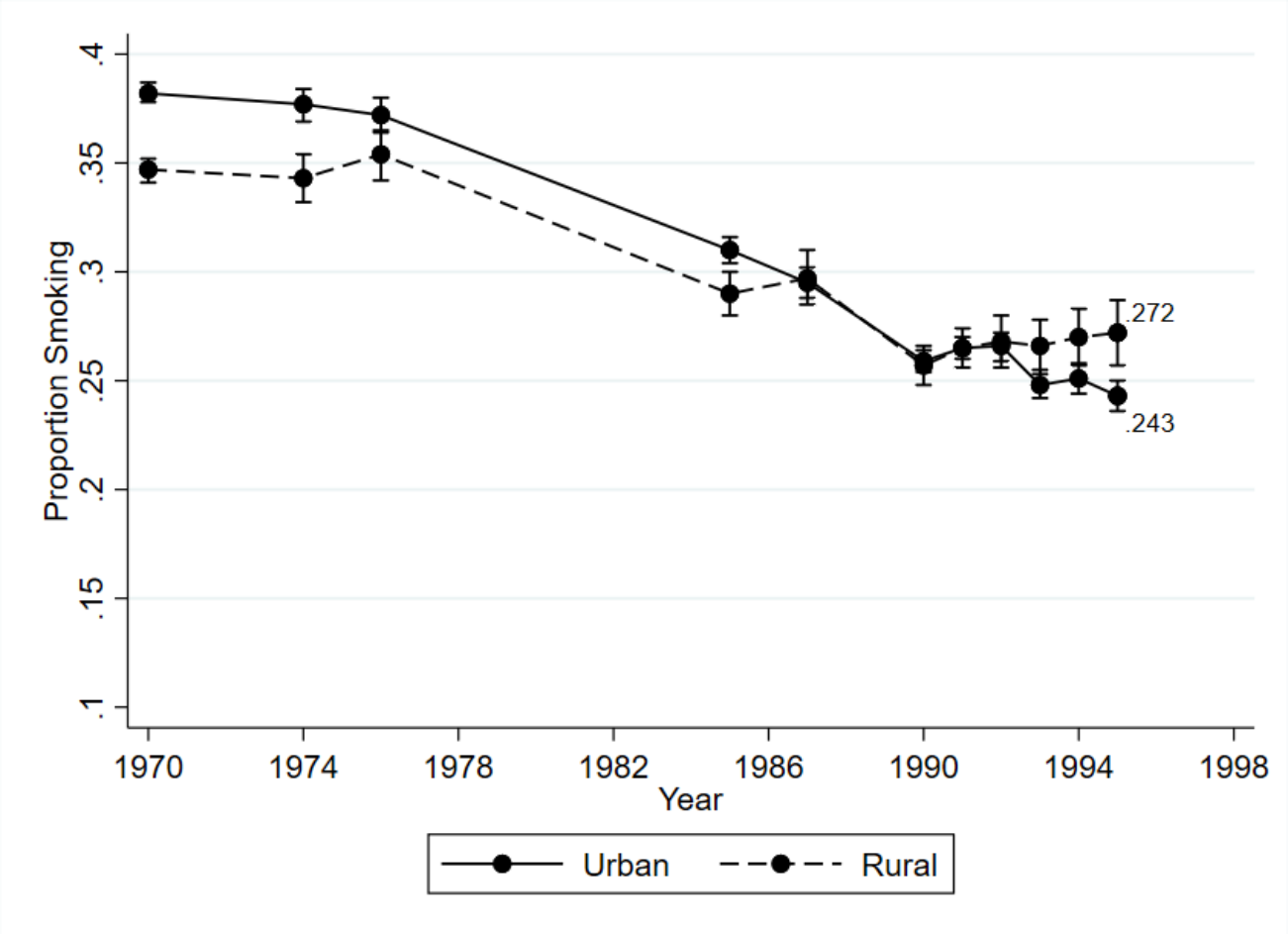
- No funding to disclose for this work
- I have no tobacco-related funding sources to disclose.

Motivation: Cigarette Smoking by Location



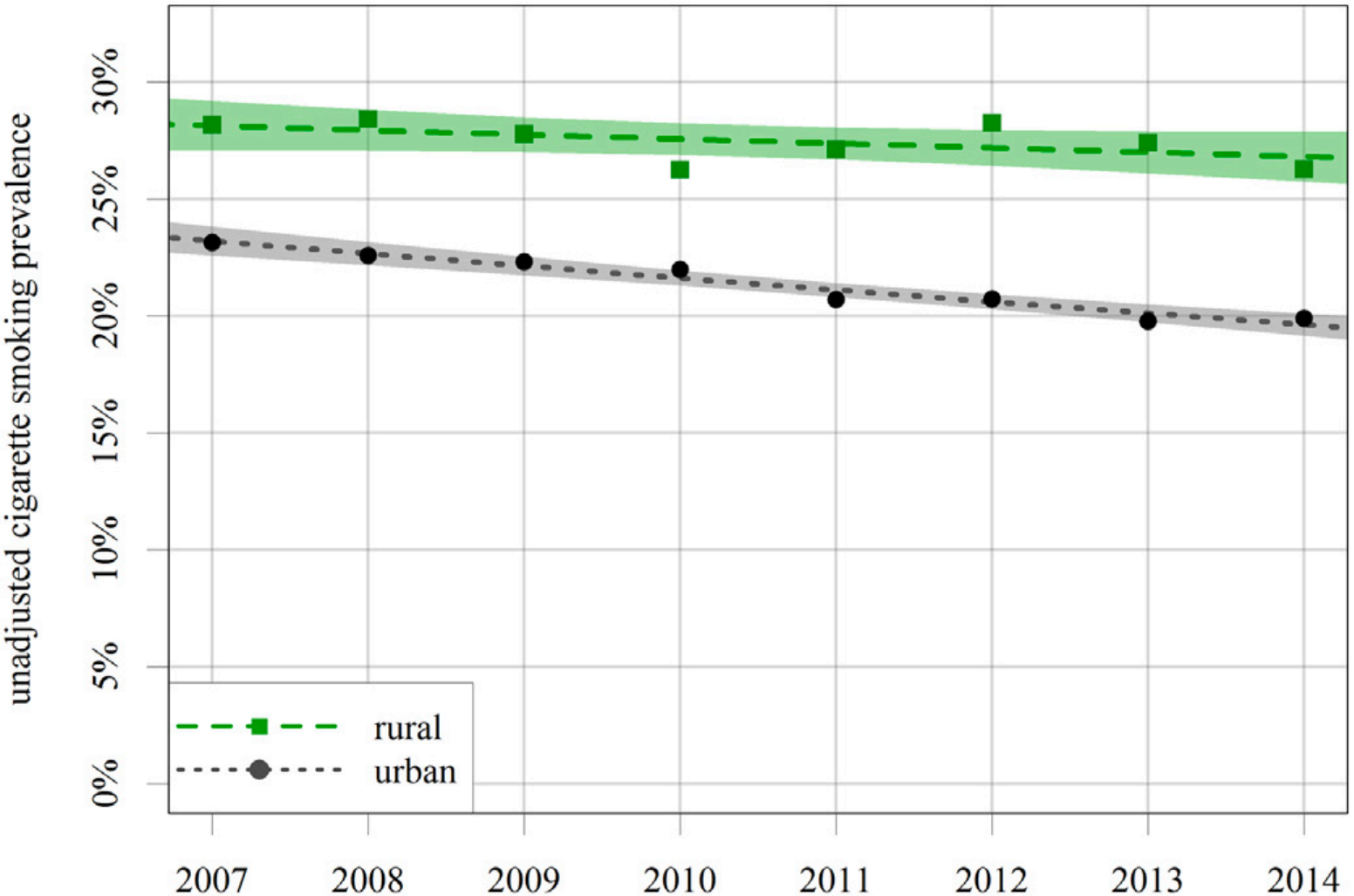
Source: Author's calculations from National Longitudinal Survey of Youth, 1979. Smoking is daily smoking and rural is residence in a non-metro or non-metro adjacent county.

Motivation: Cigarette Smoking by Location



Source: Author's calculations from National Health Interview Survey. Smoking is daily smoking and rural is anything outside of a MSA.

Motivation: Cigarette Smoking by Location



Source: Doogan *et al.* 2017

Motivation: Historical Evidence

- Evidence from Haenszel et al., 1956
  - **In 1956, 52% of urban men and 42% of rural men smoked cigarettes.**
- Evidence from the American Lung Association:
  - **In 2010, 24.7% of urban men and 30.6% of rural men smoked cigarettes.**

Rural Health

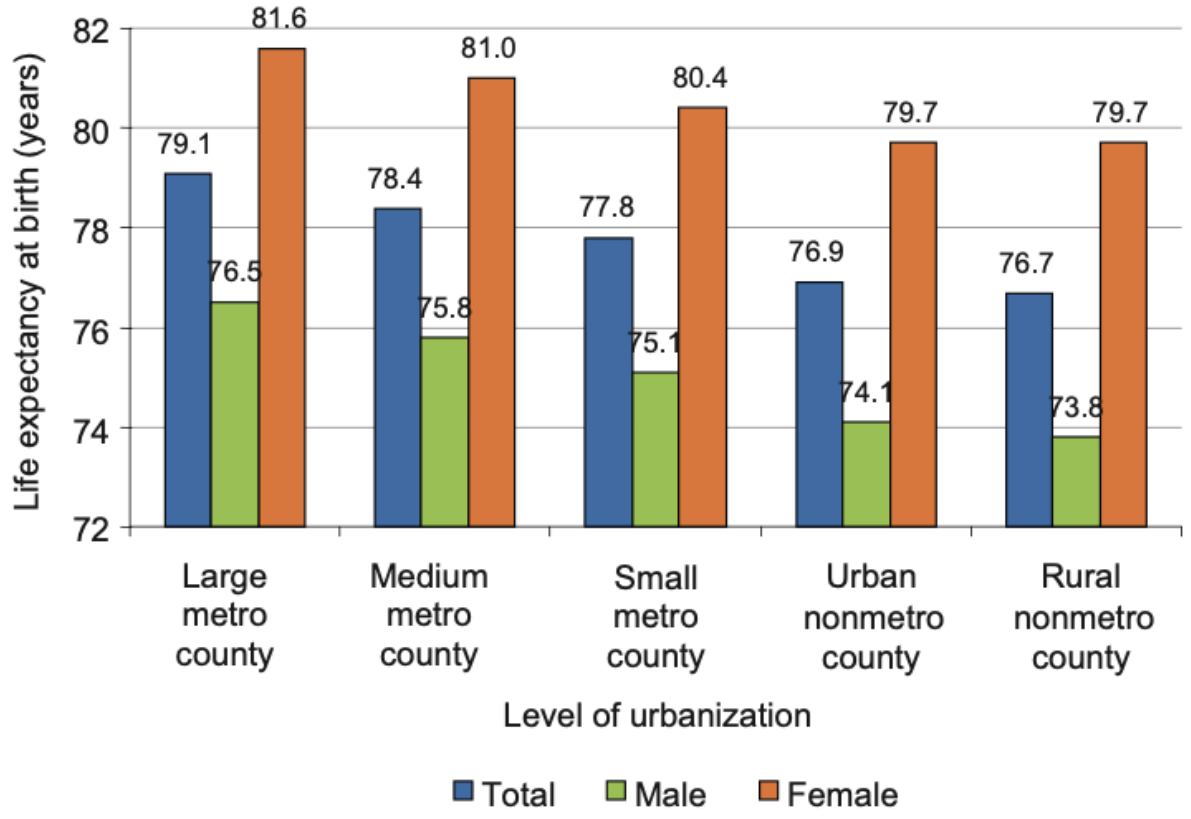
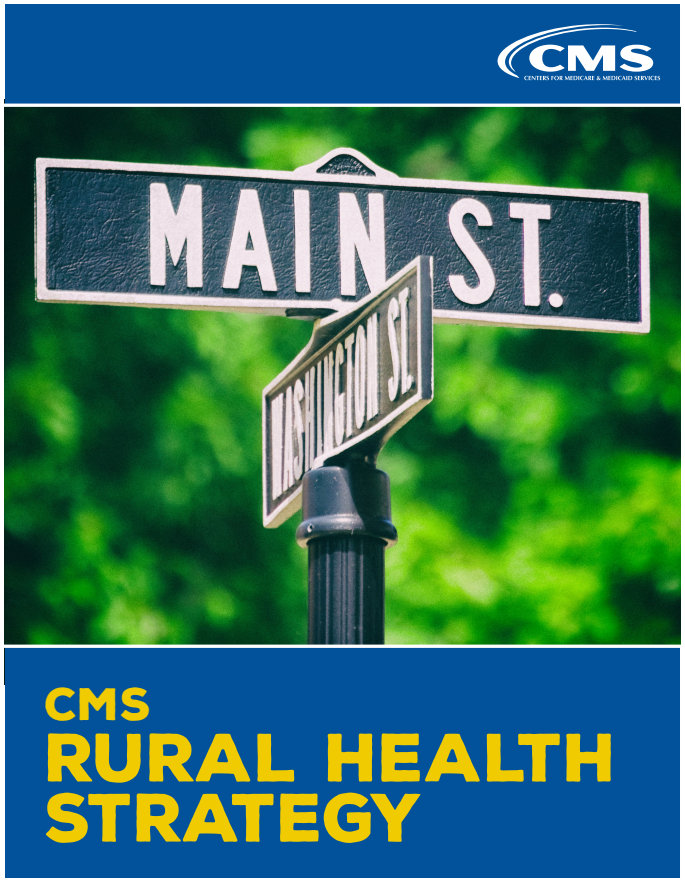


Figure 1. Life expectancy at birth (years) by levels of urbanization, U.S., 2005–2009

Source: Singh *et al.* 2014

Rural Health



Source: CMS, 2020

Goals of the Paper

Goals of this Paper: Understand *why* smoking is increasingly a rural phenomenon.

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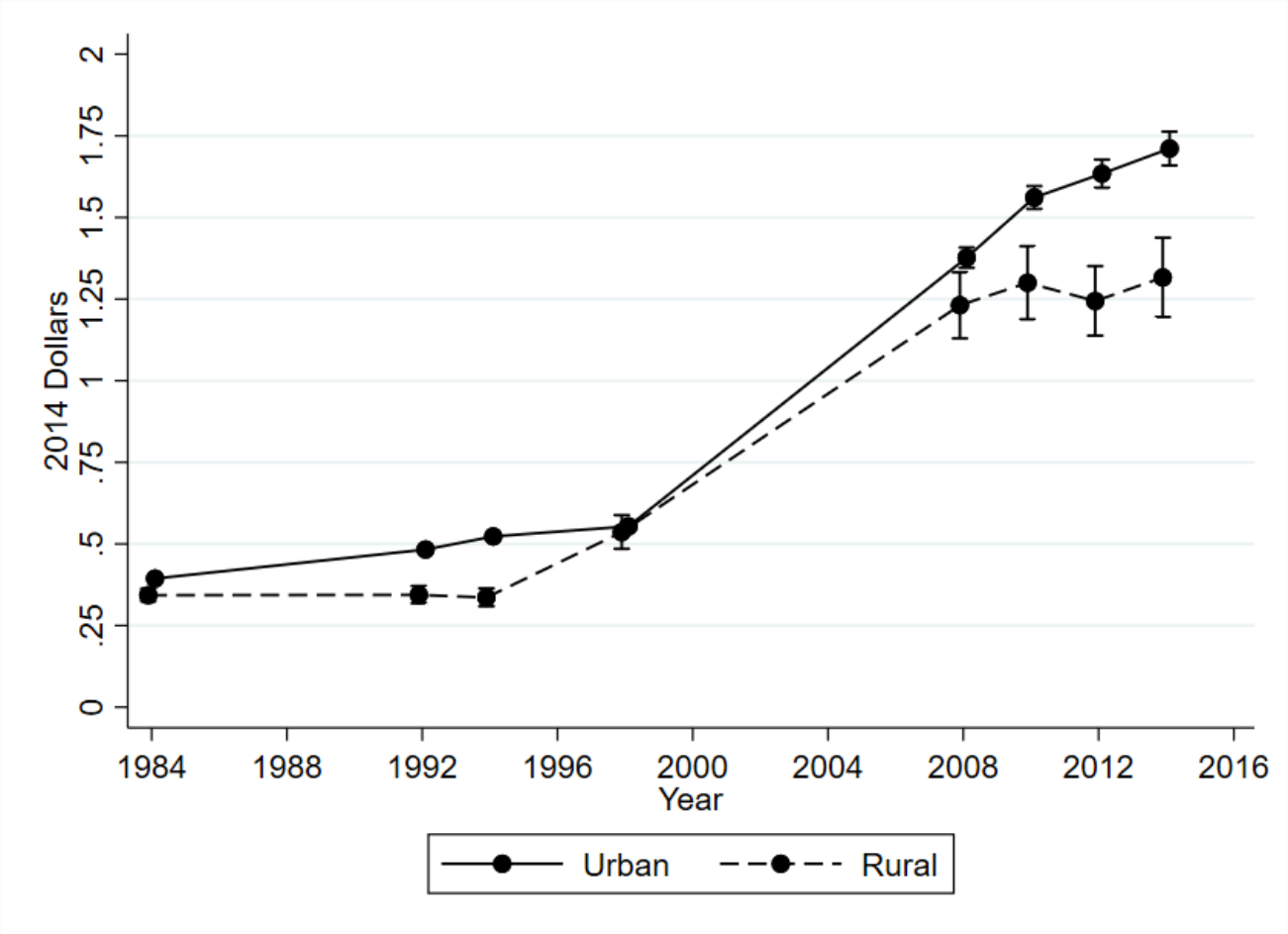
Possible Explanations:

1. Differential Tobacco Control Laws

Real State + Local Cigarette Taxes



Source: Author's Calculations from NLSY 1979, Orzechowski and Walker (2017), and The American Nonsmokers Rights Foundation

Public Health View

Doogan *et al.* 2017:

> "*uniform federal policies may be important to expanding effective tobacco control and regulatory efforts into areas that lack the resources or political will to implement and enforce local policies that decrease initiation and increase cessation.*"

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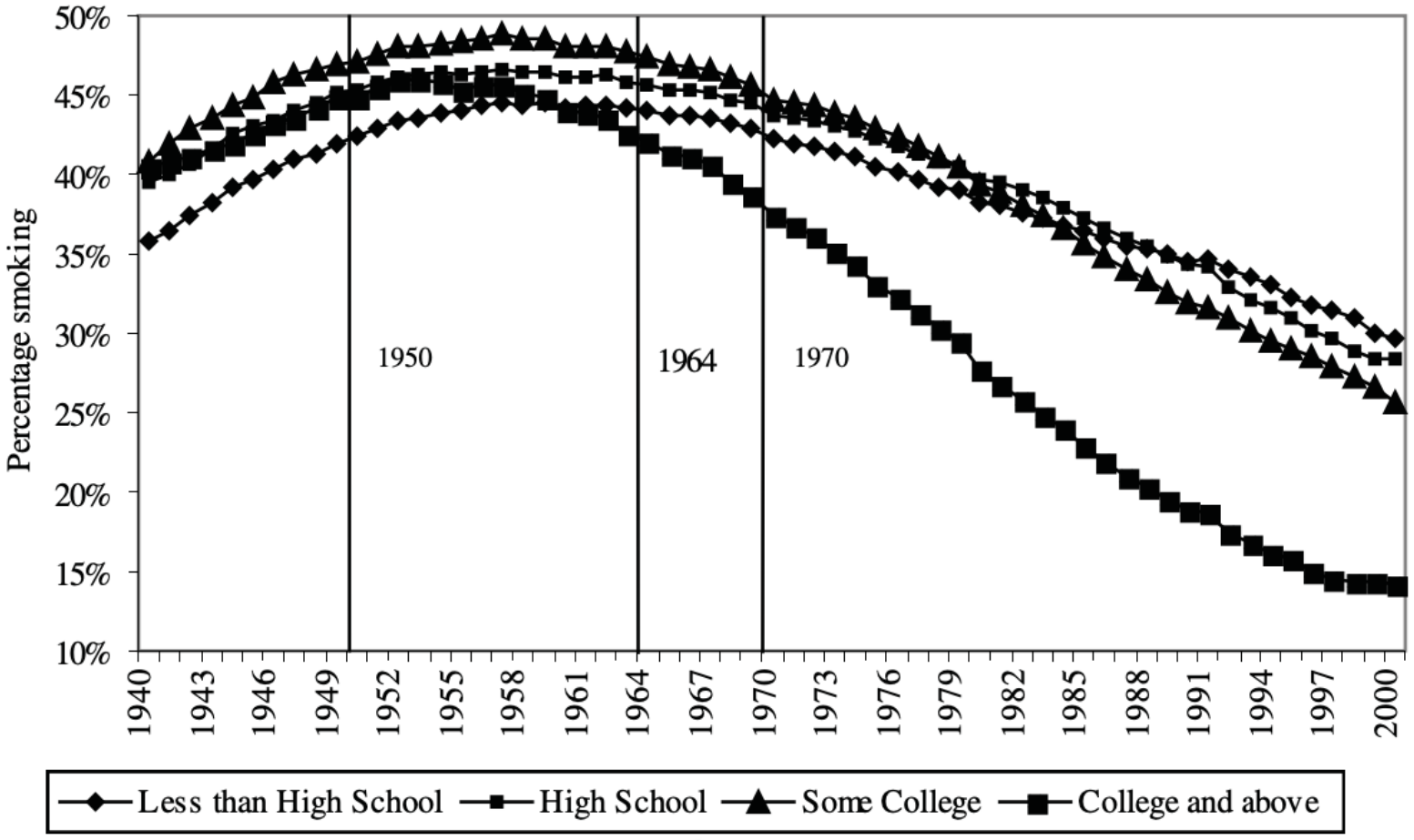
Possible Explanations:

1. Differential Tobacco Control Laws
2. Composition Changes
    a. Education

Education



Source: de Walque (2010): More educated smokers responded to public health information campaigns 1960s-1990s.

Goals of the Paper

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Possible Explanations:

1. Differential Tobacco Control Laws
2. Composition Differences
    a. Education
    b. Skill/Ability

Ways that Composition Matters

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1. Innate, unobserved differences between urban and rural populations.
2. Selected internal migration over time.
   - **Significant Urbanization:**. Between 1950 and 2010, the share of the United States population living in an urban area increased from roughly 60% to 80% (Boustan *et al.* (2013))
   - **Historically, urban areas were defined by high returns to skill.**
   - **Corr(Smoking, Education)<0**.

Composition differences/changes are difficult to capture using standard program evaluation methods.

This Paper

1. Estimate an empirical model of smoking, education, and location decisions
   - 30-years of longitudinal, geocoded data from the NLSY 1997.
   - Rich, local area tobacco control laws from the American Nonsmokers Rights Foundation.
   - Local area economic variables.
2. Simulate the model to isolate mechanisms.

Preview of Results

By 2014, the smoking prevalence gap between urban and rural areas was 7.9 percentage points

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1. Differential tobacco control laws explain only 9.6% of this gap.
   - Divergence in smoking behavior occurred 10 years before divergence in cigarette taxes.
   - Divergence in smoking behavior occurred 10-15 years before large-scale adoption of indoor smoking bans in urban area.

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   - Divergence in smoking behavior occurred 10 years before divergence in cigarette taxes.
   - Divergence in smoking behavior occurred 10-15 years before large-scale adoption of indoor smoking bans in urban area.
2. Instead, sorting on unobserved characteristics that predict smoking, education, and urban residence explain 70% of the gap.

Outline

Simple Model to Exemplify Migration as a Mechanism

- The basic model is of young individuals in two locations, U and R, where the only input in firms' production functions in both locations is labor.
- Workers are paid their marginal product, which is a function of a uni-dimensional measure of skill, S.
- Workers are differentiated by S and their preference for cigarettes Z.
- Let ρ denote the correlation between S and Z.
- S and Z are drawn from a population distribution, independent of location.

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Simple Roy Model Predicts Divergent Trends:

- High skill individuals sort into urban areas; low skill individuals sort out of urban areas
- Correlation between smoking and skill is negative.
- Urban/rural smoking gap is a long-term phenomenon.

Outline

Brain Drain

- Skill-selected migration causes composition changes in local areas. Kwok & Leland (1982) and Miyagiwa (1991)
- Anything correlated with skill could also see composition changes.
- Young (2013) shows that differential skill prices are not needed to generate skill composition shifts if workers select on unobserved individual characteristics that are correlated with education.

Urban workers (in the 1990s) earned 33% higher wages than non-urban workers. Why?

1. Is the urban wage premium selection into cities of more able workers?
2. Is the urban wage premium a wage growth effect or a wage level effect?
   - Wage level effect: migrants to cities immediately enjoy an increase in wages; those leaving cities see immediate decline.
   - Wage growth effect: wages grow faster in cities, and those leaving cities do not see a drop.
   - Evidence says the growth effect is real: longer term migrants enjoy a larger wage premium.

Does this translate to smoking? How may urban areas may *cause* less smoking:

1. Tobacco Control Laws
2. Information externalities
3. Space
4. Social norms

Outline

NLSY 1979

Data from:

1. **National Longitudinal Survey of Youth, 1979 Cohort (NLSY)**
   - Longitudinal information on a single cohort is important for the study of cross-sectional, long-run disparities because a panel allows me to hold the sample of study fixed.
2. **United States Department of Agriculture Economic Research Service**
3. **Carneiro *et al.* 2012**
4. **American Nonsmokers' Rights Foundation**
5. **Orzechowski and Walker**

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National Longitudinal Survey of Youth, 1979 Cohort (NLSY)

- Panel of young men and women between 15 and 22 years of age in 1979.
- Annual surveys from 1979 to 1994, then every two years.
- Geocoded sample includes county of residence and county at age 14.
- Rich information on sociodemographic, economic, and environmental characteristics.
- Smoking behavior information in waves corresponding to years: 1984, 1992, 1994, 1998, 2008, 2010, 2012, and 2014.
  - Focus on extensive margin of current smoking.

Table: Sample Construction

Unique Individuals	Person/Years	Description
12,484	71,026	Baseline Sample
10,534	58,371	- those with non-missing smoking waves.
9,163	51,375	- those with non-missing smoking or education.
5,260	42,080	- those not leaving through attrition .
4,626	37,008	- those without missing geocodes

Urban/Rural Classification

There is no consensus on how to define rural. Usual variables include:

- County population
- Commuting flows
- Proximity to major urban centers.

Unit of analysis is almost always a county.

Metro vs. Nonmetro

United States Office of Management and Budget (OMB):

- **Metropolitan County** a dense urban area of 50,000 residents or more and which has outlying counties that are economically dependent.
- **Non-metropolitan County** all other counties and are the traditional definition of rural counties in most economic and public health research

USDA ERS Continuum Codes

2013 Rural-Urban Continuum Codes, AKA Beale Codes

Code	Description
Metropolitan Counties	
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of 50,000-250,000 population
Nonmetropolitan Counties	
4	Urban population of 20,000-49,999, adjacent to a metro area
5	Urban population of 20,000-49,999, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

Provides more granular definition with metro/nonmetro.

Two Problems . . .

1. **Little consensus on classification/grouping using Beale Codes**
2. **Beale Codes are only updated every 10 years, and they are generally not comparable over time.**

This lack of uniformity makes comparisons of “rural” disparities across behaviors and outcomes difficult.

1. Define rural based on “remoteness”, following Winkler (2016)
   - **Metro**: Beale Codes 1, 2, and 3
   - **Adjacent**: Non-metro counties adjacent to a metro county. Beale Codes 4, 6, and 8.
   - **Remote**: Non-metro counties not adjacent to a metro county. Beale Codes 5, 7, and 9.
2. Focus on the 2013 Beale Code:
   - Updates in 2003 and 2013 are not compatible with 1983 and 1993.
   - Time varying definitions complicate empirical modeling.
   - No measurement error in years with largest smoking gap.

My Solutions

1. Define rural based on “remoteness”, following Winkler (2016)
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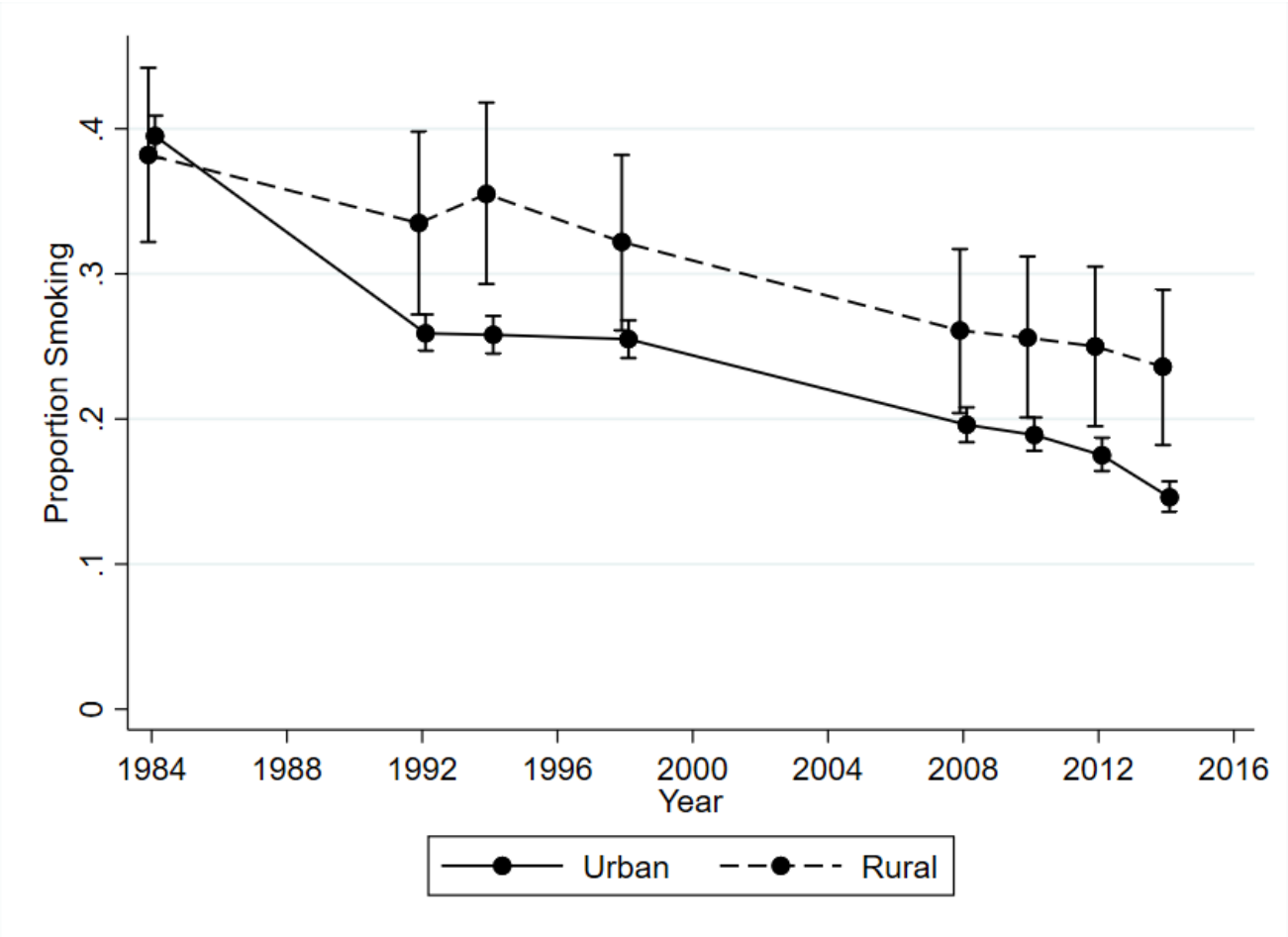
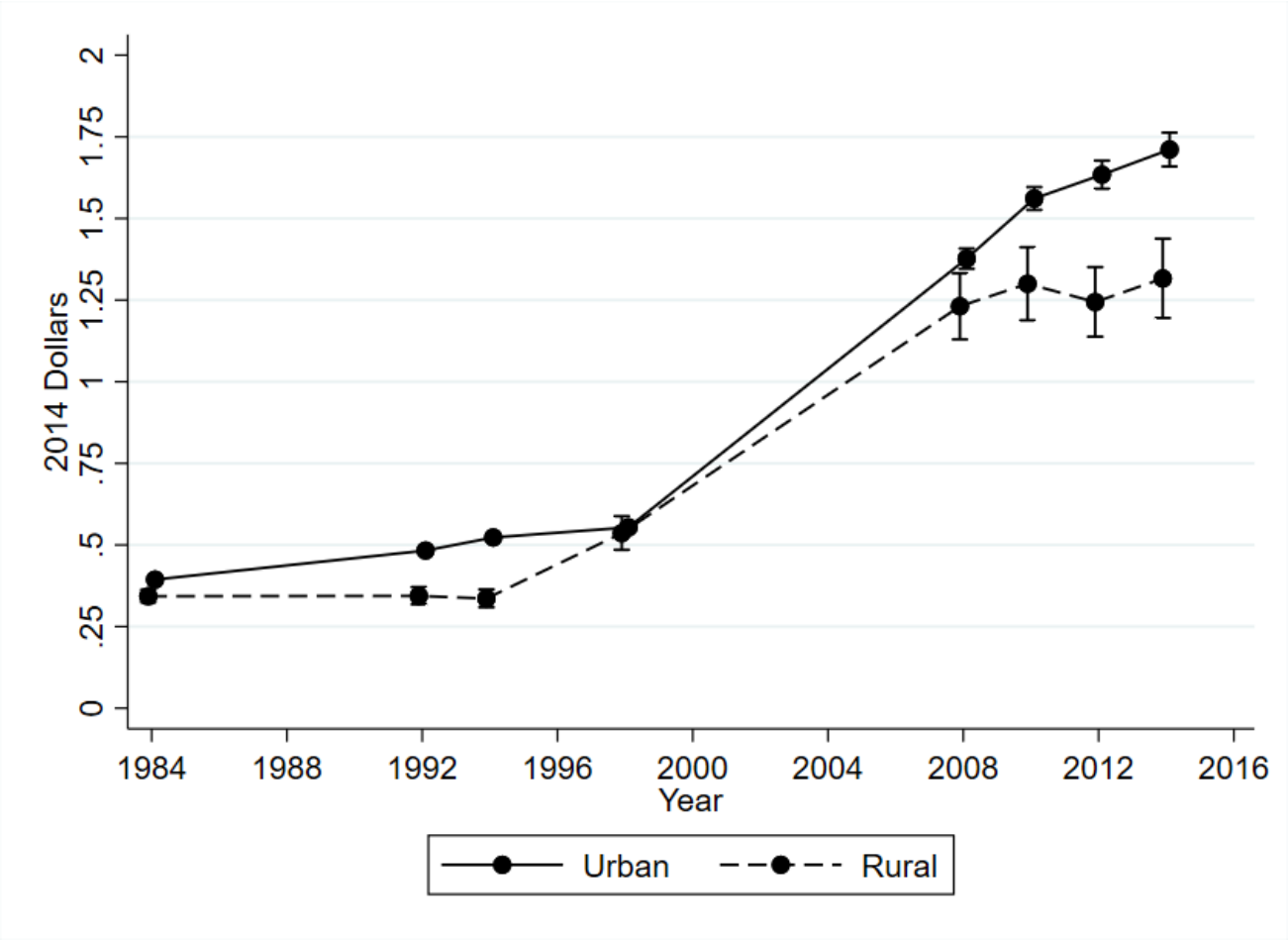
2. Focus on the 2013 Beale Code:
   - Updates in 2003 and 2013 are not compatible with 1983 and 1993.
   - Time varying definitions complicate empirical modeling.
   - No measurement error in years with largest smoking gap.
3. For this paper:
   - **Urban**= Metro + Adjacent
   - **Rural**= Remote

Smoking Prevalence



State and Local Cigarette Taxes



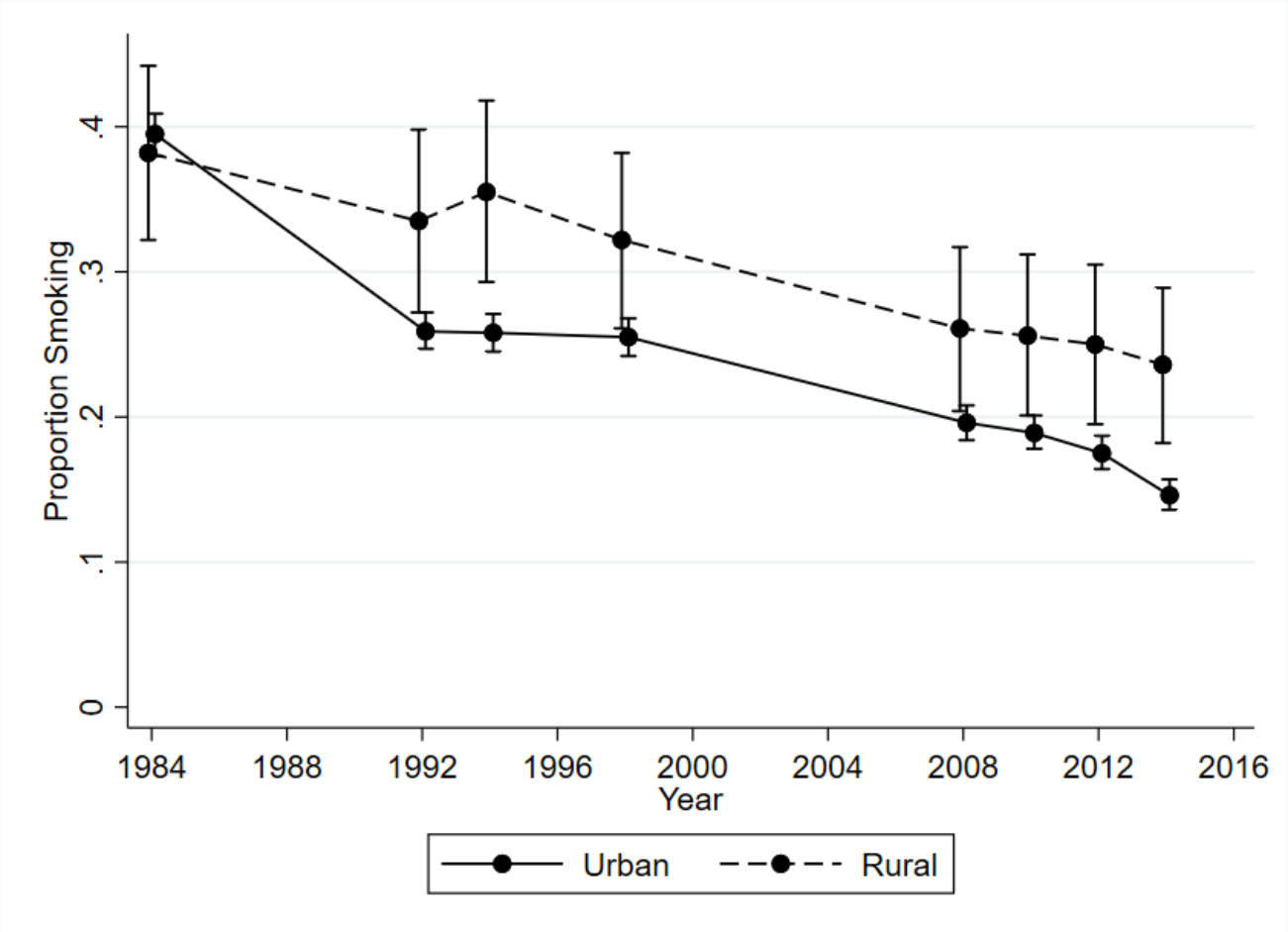
Outline

Preliminary Attempt to Explain Disparity:

$$Smoke_{it} = \alpha_0 + \sum_{t=2}^{8} \alpha_{1t} 1[Wave = t] + \sum_{t=1}^{8} \alpha_{2t} 1[Wave = t] 1[Rural_{it} = 1] + x_{it}\beta + \epsilon_{it} \quad (1)$$

- Waves 1-8 correspond to smoking waves: 1984, 1992, 1994, 1998, 2008, 2010, 2012, and 2014.
- Smoking is binary based on DS-7, which asks about daily smoking.

Plot Coefficients without Controls

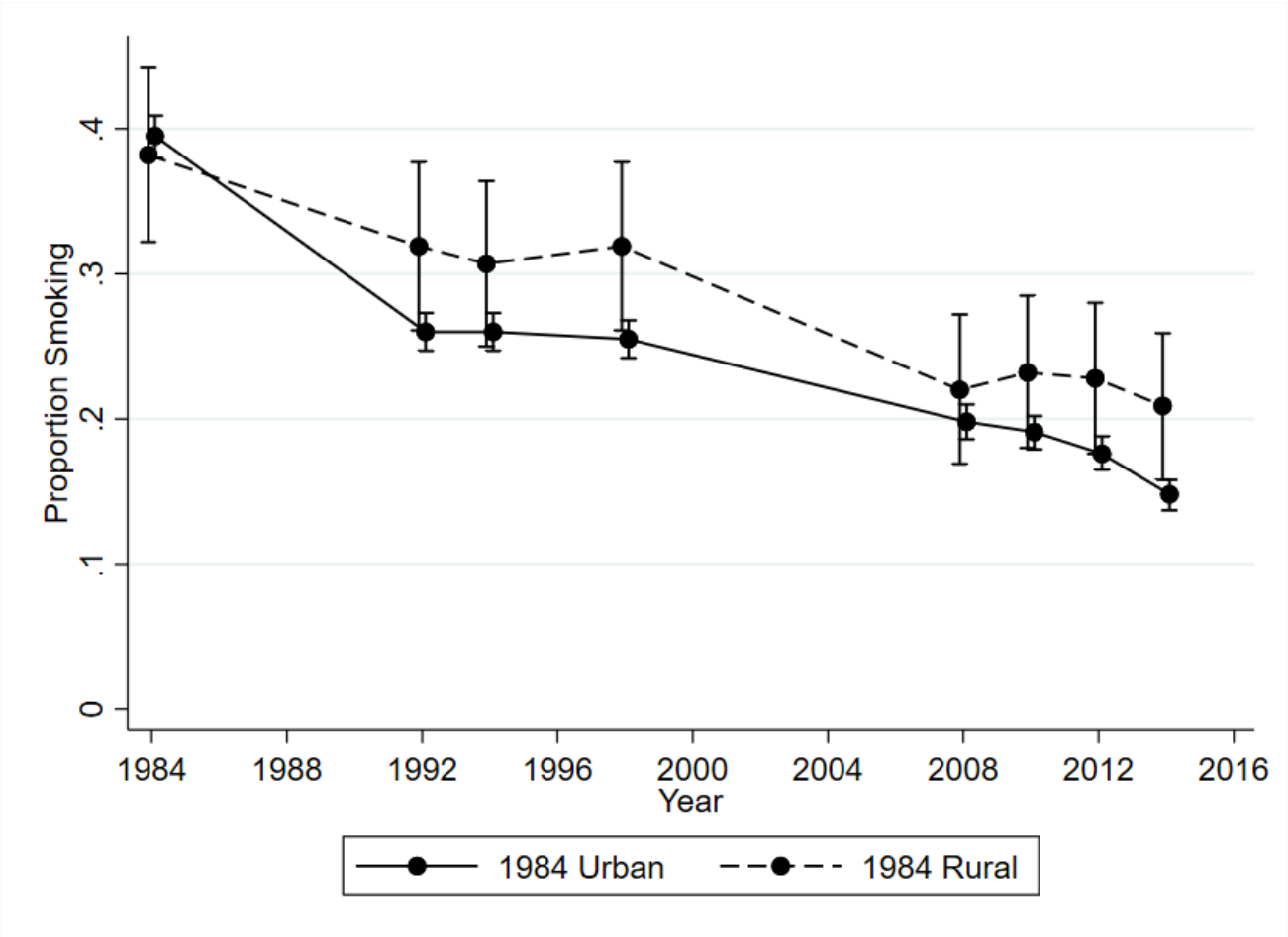


Source: Author's Calculations from NLSY 1979

Smoking Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Mean of Urban Smoking in 1984 = 0.395					
$\alpha_{2,1984}$	-0.013	-0.014	-0.019	-0.034	-0.034	-0.055
	(0.031)	(0.031)	(0.032)	(0.031)	(0.031)	(0.027)
$\alpha_{2,1992}$	0.075**	0.075**	0.070**	0.045	0.045	0.063**
	(0.032)	(0.032)	(0.033)	(0.032)	(0.032)	(0.029)
$\alpha_{2,1994}$	0.097***	0.098***	0.091***	0.069**	0.069**	0.083***
	(0.032)	(0.032)	(0.033)	(0.032)	(0.032)	(0.027)
$\alpha_{2,1998}$	0.067**	0.067**	0.061*	0.041	0.042	0.071***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.028)
$\alpha_{2,2008}$	0.065**	0.065**	0.058**	0.038	0.039	0.061**
	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)	(0.030)
$\alpha_{2,2010}$	0.067**	0.067**	0.060**	0.039	0.039	0.049*
	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)	(0.029)
$\alpha_{2,2012}$	0.075***	0.074***	0.068**	0.046*	0.047*	0.062**
	(0.028)	(0.028)	(0.028)	(0.027)	(0.027)	(0.028)
$\alpha_{2,2014}$	0.090***	0.089***	0.083***	0.065**	0.067**	0.074**
	(0.028)	(0.028)	(0.028)	(0.027)	(0.027)	(0.031)
Controls	None	Age Gender	Age Gender Race	Age Gender Race Education	Age Gender Race Education AFQT TCP	Age TCP
Ind. FE	No	No	No	No	No	Yes

Suggestive Evidence of Composition Changes



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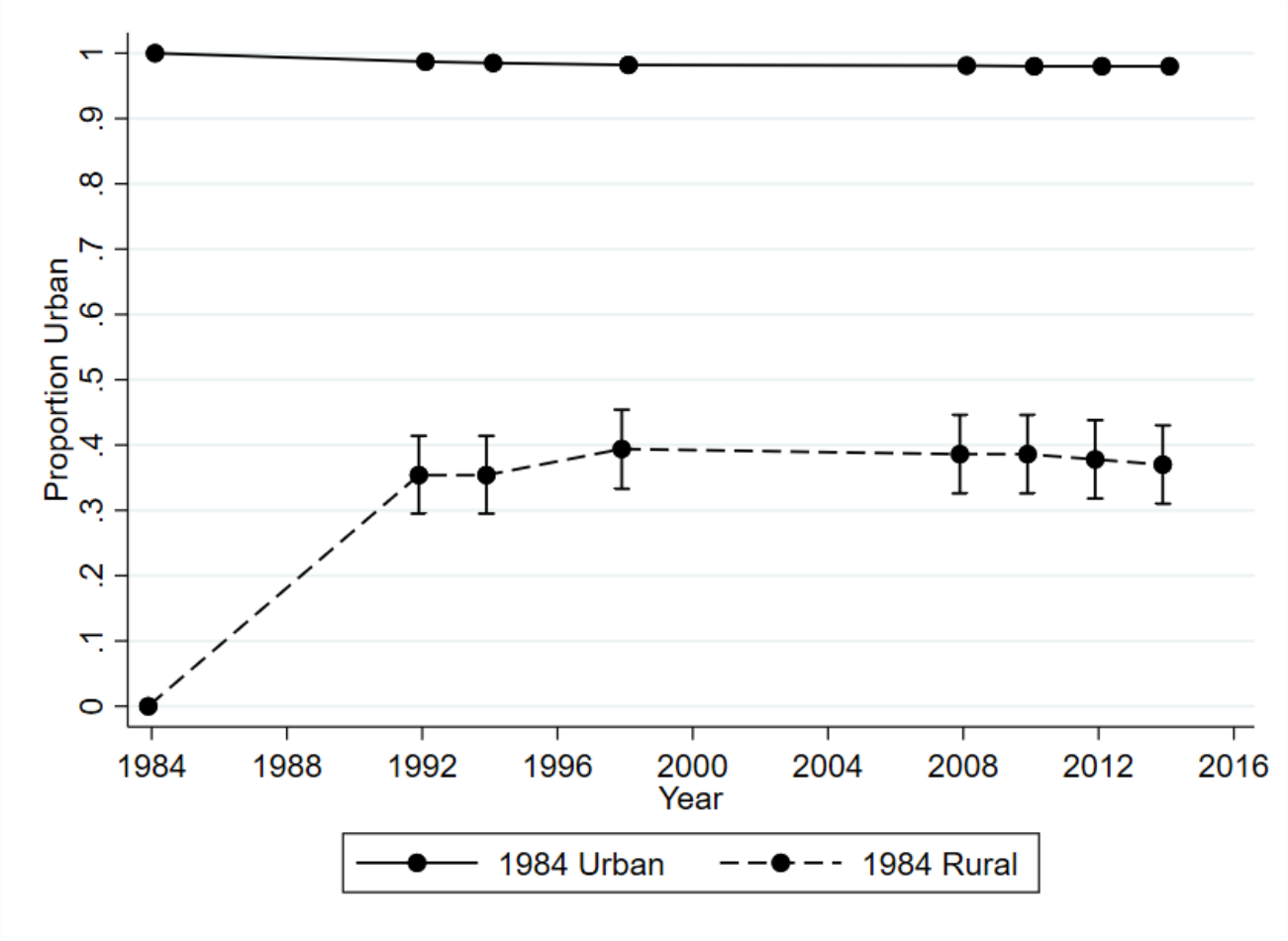
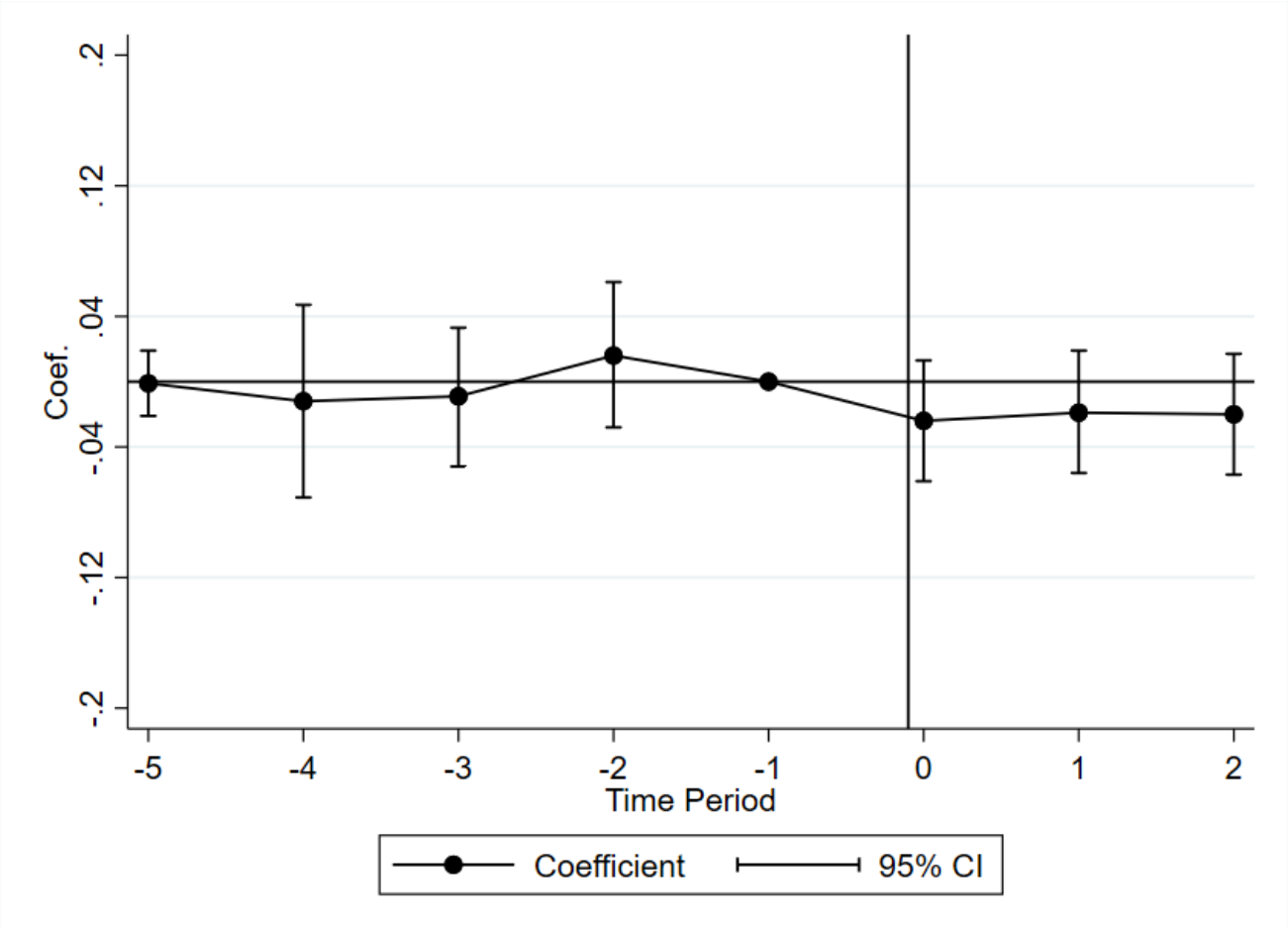


Does moving to a new area cause a change in smoking behavior?

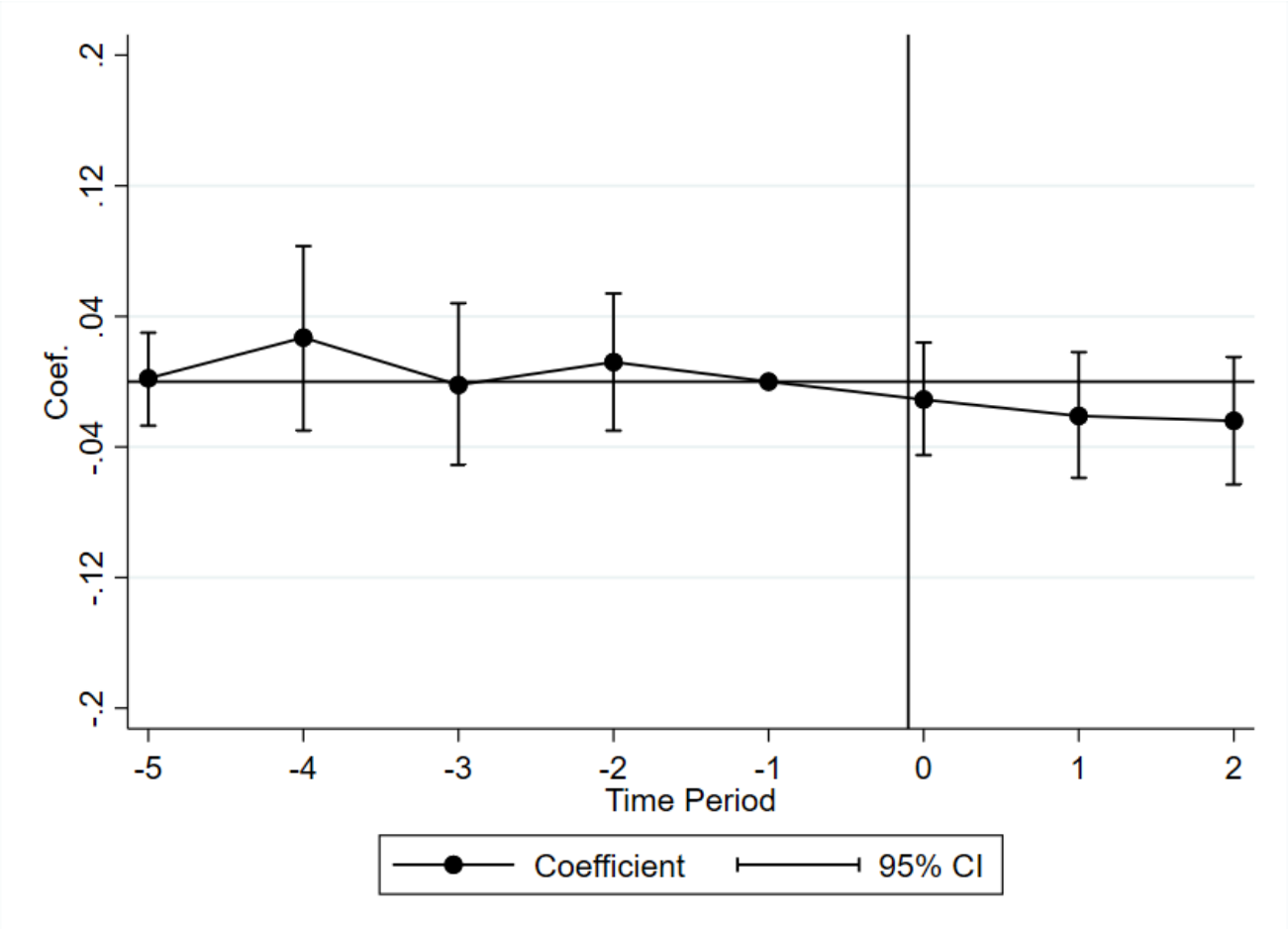
- Estimate event study regressions around different types of migration.
- Omit the NLSY wave just prior to migration.

$$Smoke_{it} = \sum_{t=2}^{8} \alpha_{0t} 1[Wave = t] + \phi_1 1[\text{Moved in wave t+5}] + \ldots + \phi_5 1[\text{Moved in wave t+1}] + \\ + \phi_6 1[\text{Moved in wave t}] + \phi_7 1[\text{Moved in wave t-1}] + \phi_8 1[\text{Moved 2 or waves prior to t}] + x_{it}\beta + \mu_i + \epsilon_{it} \quad (2)$$

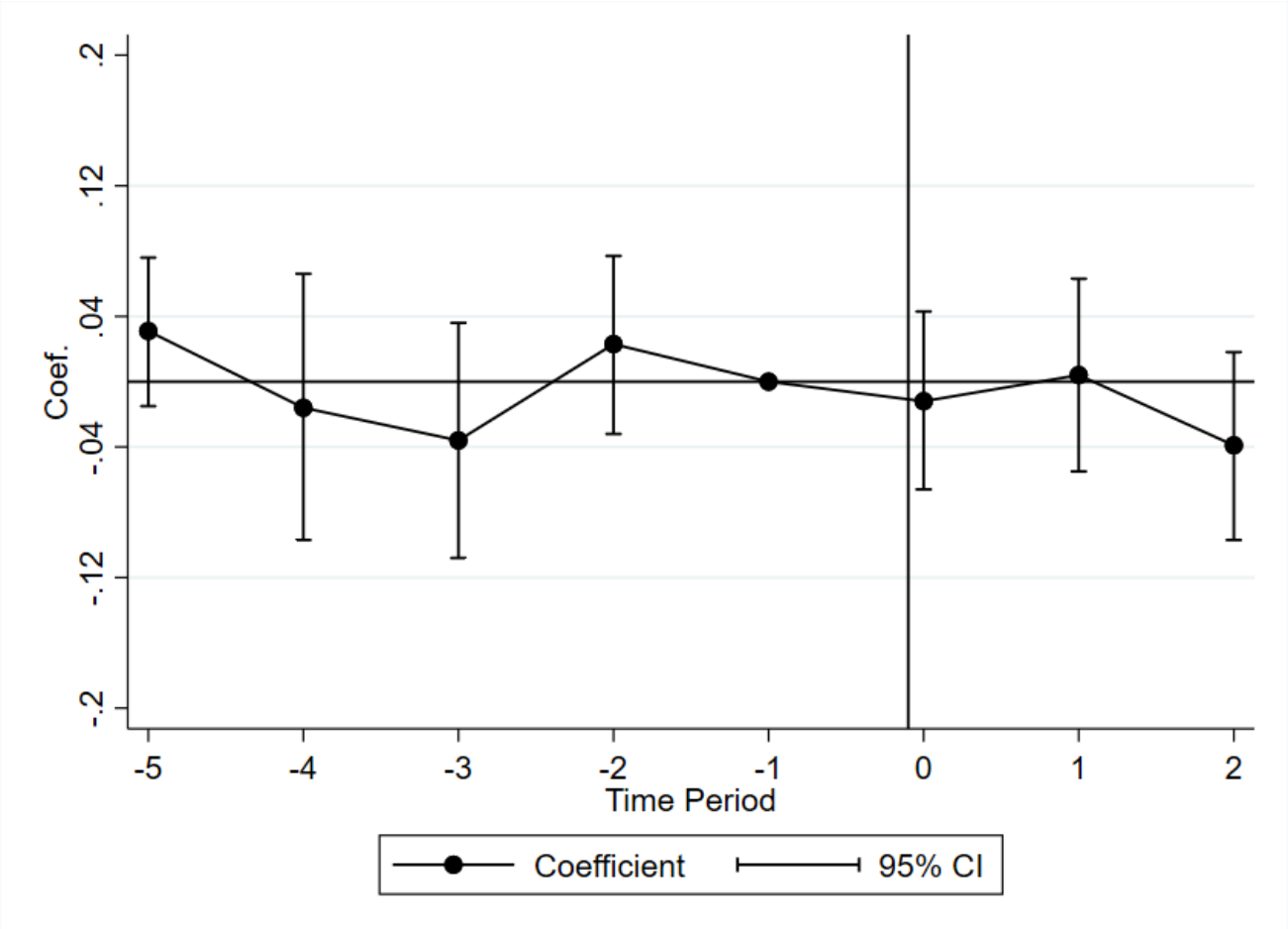
Event Study: State Migration



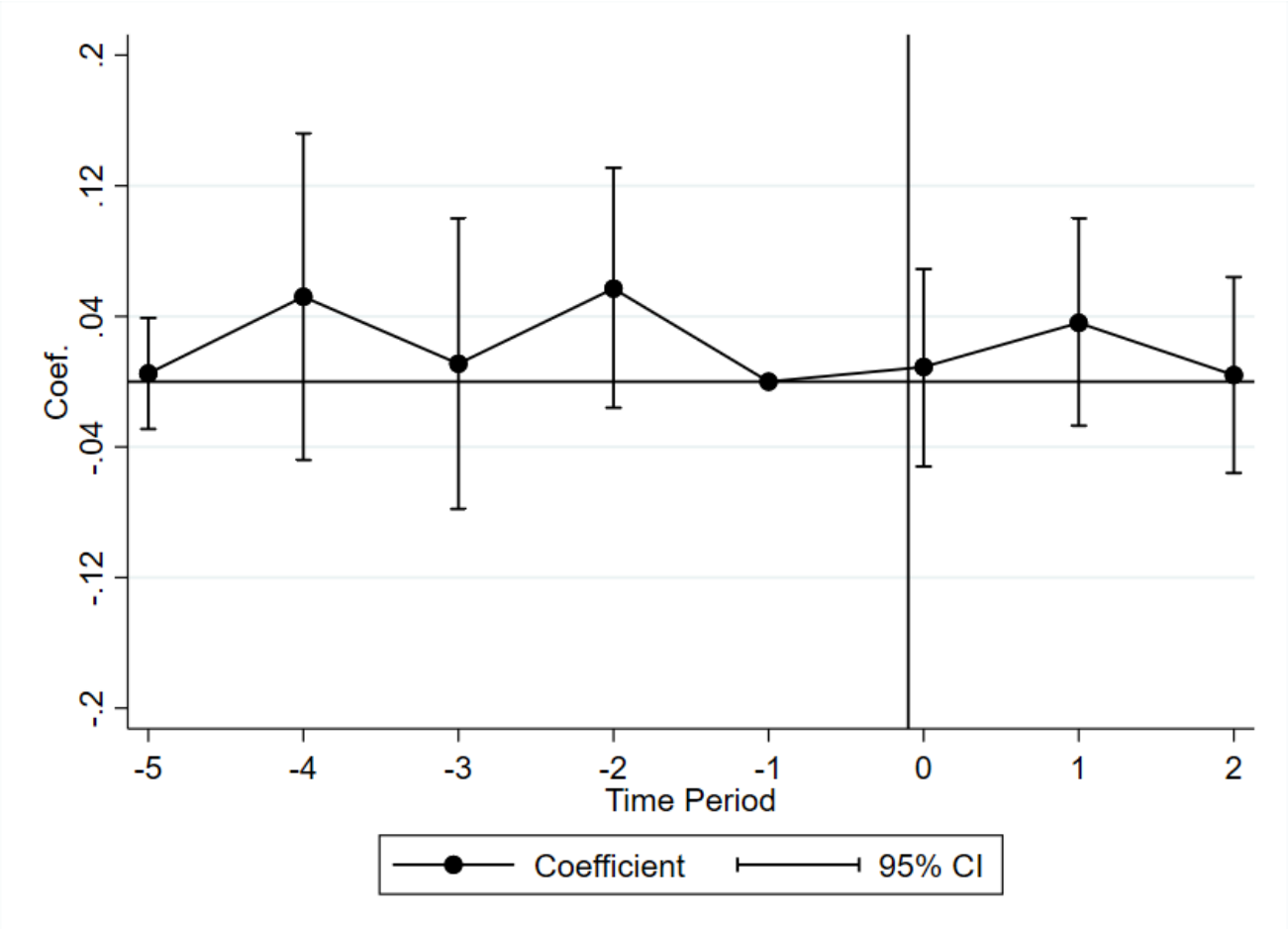
Event Study: County Migration



Event Study: Urban to Rural Migration



Event Study: Rural to Urban Migration

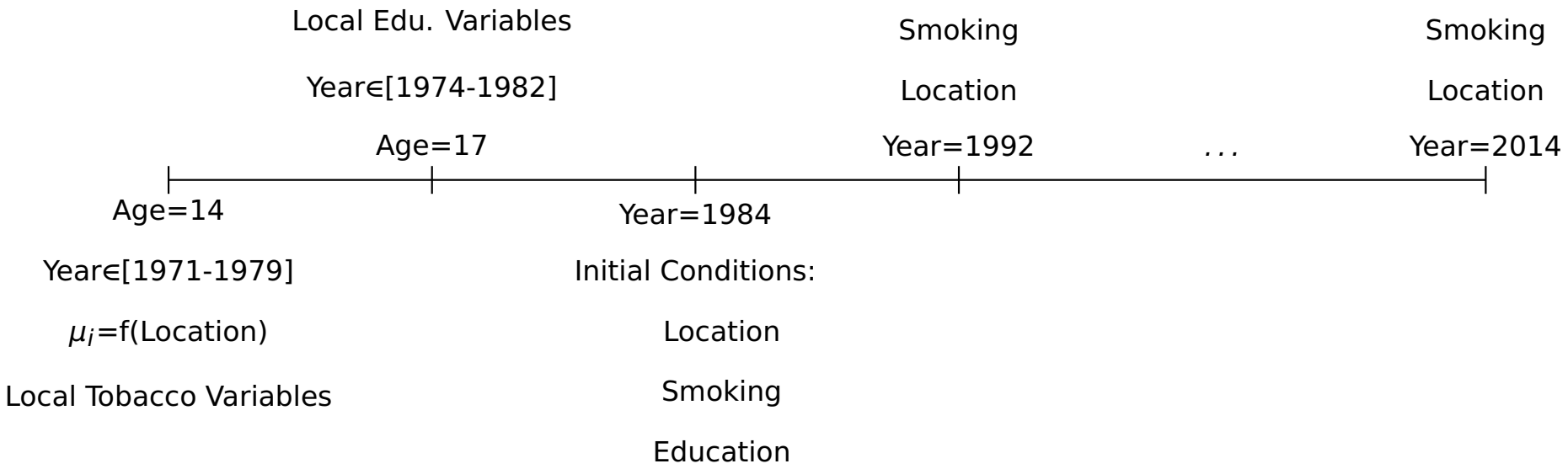


Outline

Overview

- Estimate a system of equations that captures:
  - Dynamics of Smoking
  - Education
  - Location Decisions
- Simulate the model under counterfactuals that isolate mechanisms (e.g., equalize tobacco control policies across space)

Timeline


Local Edu. Variables
Year∈[1974-1982]
Age=17
Smoking
Location
Year=1992
. . .
Smoking
Location
Year=2014
Age=14
Year∈[1971-1979]
μ_i=f(Location)
Local Tobacco Variables
Year=1984
Initial Conditions:
Location
Smoking
Education

Initial Condition: Age 14

- All individuals are in school
- No individuals smoke

Yet location is endogenous. I allow residence at age 14 to affect a permanent and discrete unobserved factor μ_i (Keane and Wolpin (1997)):

$$\tau_j = P(\mu = \mu_j) = \frac{exp(\psi_{0j} + \psi_{1j} 1[Rural_{age=14} = 1])}{\sum_{k=1}^{3} exp(\psi_{0k} + \psi_{1k} 1[\psi_{1k} 1[Rural_{age=14} = 1])} \quad (3)$$

Estimation:

- Estimate a step function:
  - μ_i takes 3 points: $(\mu_1, \ldots, \mu_3)$.
- Subject to normalizations, I estimate how μ affects each subsequent behavior or outcome as well as the associated probabilities of each type.

1984: Initial Conditions

Model the smoking behavior, location choice, and education outcomes as of 1984:

$$ln\Big[\frac{p(e_i = e)}{p(e_i = 0)}\Big] = f^E(X_{i,1984}, M_{i,age=17}) + \mu_i^e \tag{4}$$

$$ln\Big[\frac{p(m'_{t=1984} = 1)}{p(m'_{t=1984} = 0)}\Big] = f^{m'}(X_{i,1984}, e_i) + \mu_i^{m'} \tag{5}$$

$$ln\Big[\frac{p(s_i = 1)}{p(s_i = 0)}\Big] = f^S(X_{i,1984}, e_i, P_{age=14}) + \mu_i^s \tag{6}$$

- $e \in \{1, 2, 3, 4\}$
- M includes county level education supply factors.
- $m' \in \{Urban, Rural\}$
- $P_{age=14}$ tobacco control laws in a person's county at age 14.

Dynamic Equations: Location then Smoking

Dynamic Location Equation: $m \in \{Urban, Rural\}$

$$ln\Big[\frac{p(m_{it}=1)}{p(m_{it}=0)}\Big] = f^M(X_{it}, E_i, m_{it-1}, S_{it-1}, L_{it-1}) + \mu_i^m \quad (7)$$

Dynamic Smoking Equation: $s \in \{0, 1\}$

$$ln\Big[\frac{p(s_{it}=1)}{p(s_{it}=0)}\Big] = f^S(S_{it-1}, X_{it}, E_i, m_{it}, P_{it}) + \mu_i^s \quad (8)$$

Estimated on waves corresponding to years 1992, 1994, 1998, 2008, 2010, 2012, and 2014.

Smoking Equation Error Structure

The error structure for the smoking equation:

$$\mu_i^s + \epsilon_{it}^s$$

Smoking Equation Error Structure

The error structure for the smoking equation:

$$\mu_i^s + \epsilon_{it}^s$$

Assume that ϵ_{it}^s follows an extreme value type 1 distribution $\rightarrow$

$$P(s_{it} = 1) = \frac{exp(\text{observable heterogeneity} + \mu_i^s)}{1 + exp(\text{observable heterogeneity} + \mu_i^s)}$$

Likelihood Function

Individual $i's$ contribution to the likelihood function is:

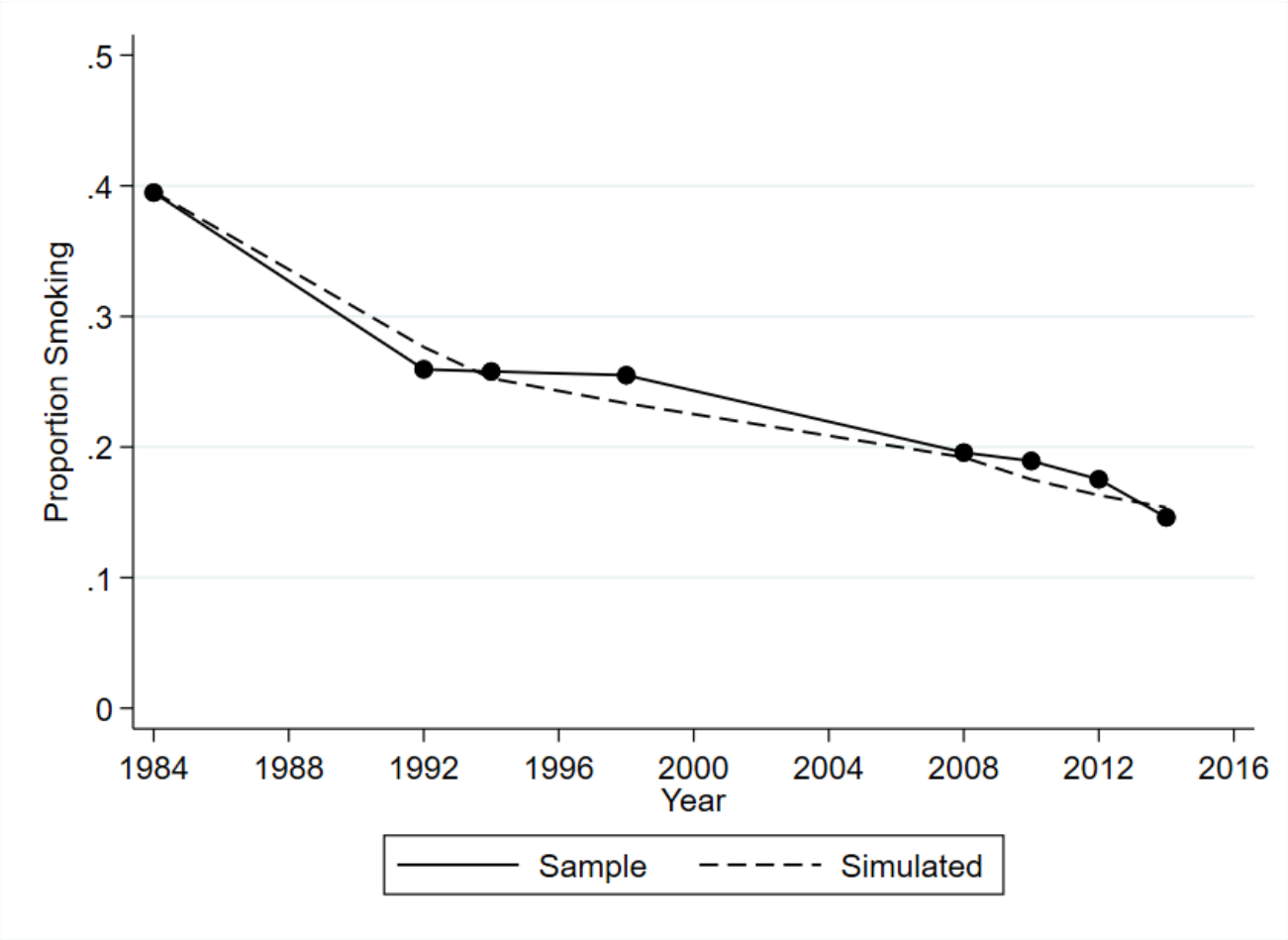
$$L_i(\Delta) = \sum_{k=1}^{3} \tau_k \left\{ \prod_{e=0}^{3} P(e_i = e|\mu_k)^{1[e_i=e]} \prod_{m'=0}^{2} P(m'_i = m|\mu_k)^{1[m_i=m]} \prod_{s=0}^{1} P(s' = s|\mu_k)^{1[s'_i=s]} \times \right.$$
$$\left. \times \prod_{t=2}^{8} \left\{ \prod_{m=0}^{2} P(m_{it} = m|\mu_k)^{1[m_{it}=m]} \prod_{s=0}^{1} P(s_{it} = s|\mu_k)^{1[s_{it}=s]} \right\} \right\} \tag{9}$$

Outline

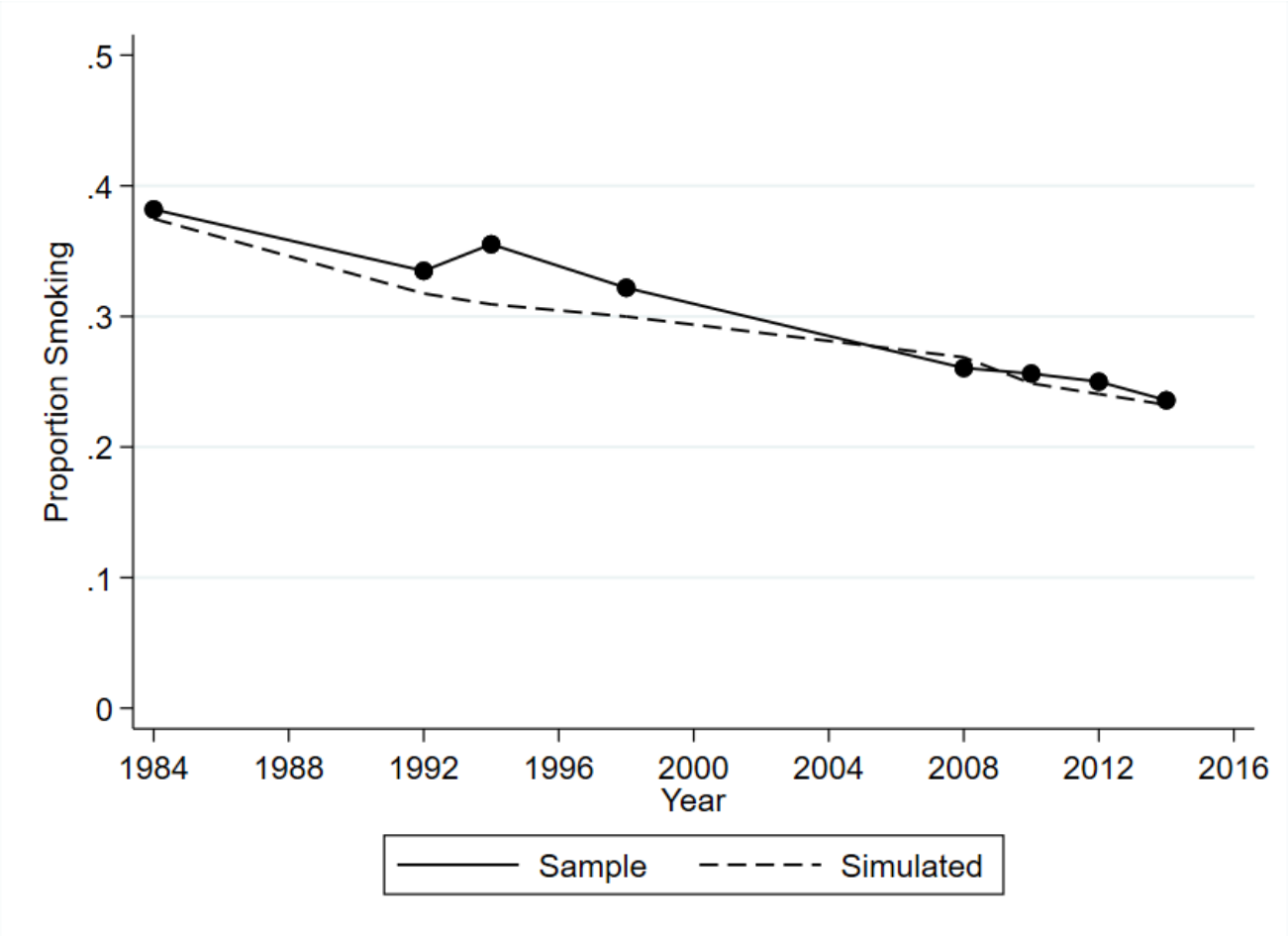
To simulate the model I:

1. Expand each person's observation by 50 → 231,300 person/draw observations
2. Endow each with random draws from all error terms. μ draws are based on the actual location at age 14.
3. Simulate Behavior *while updating state vector*.
4. Collapse results by person, draw, and time.

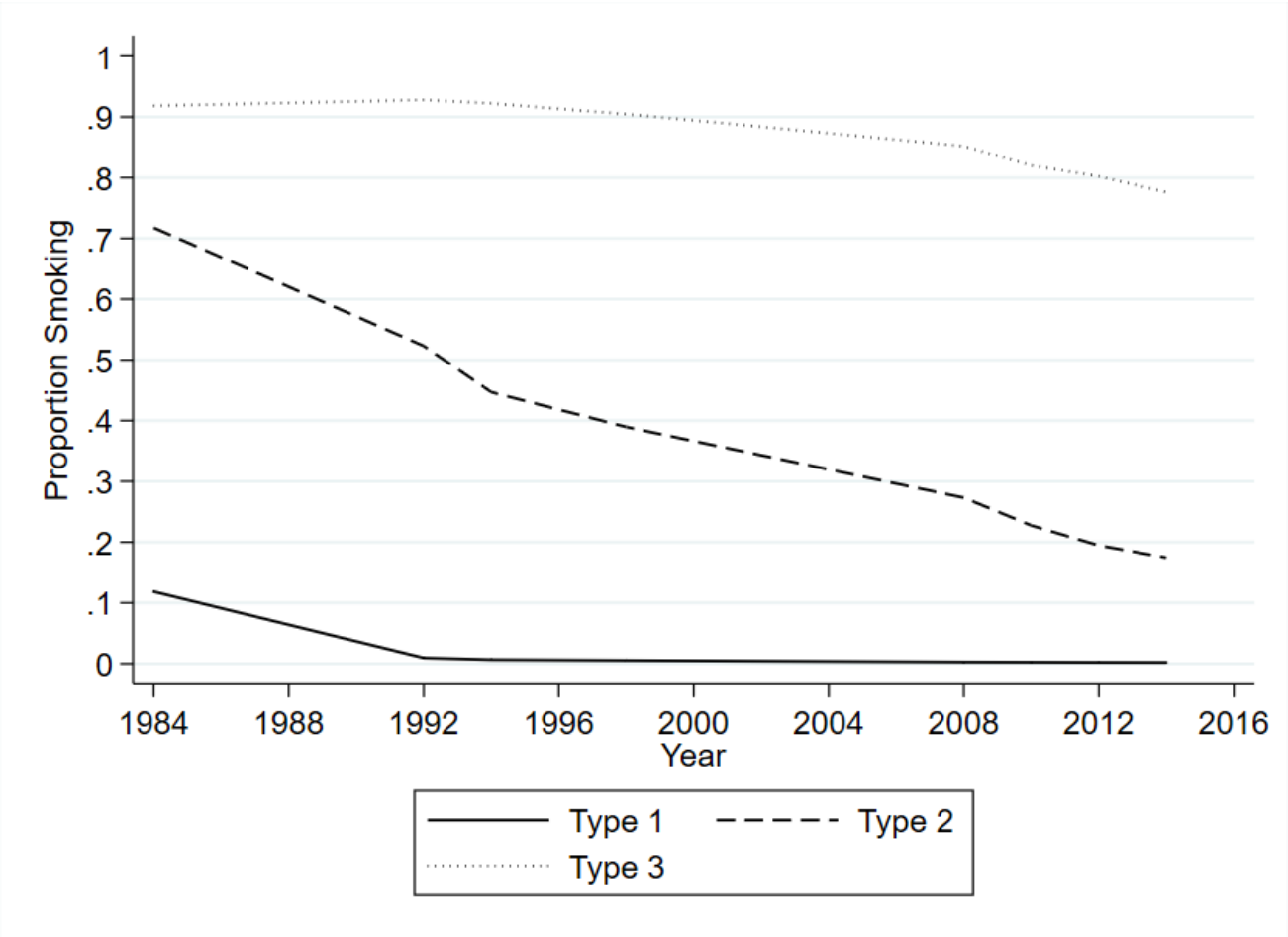
Model Fit: Urban Smoking



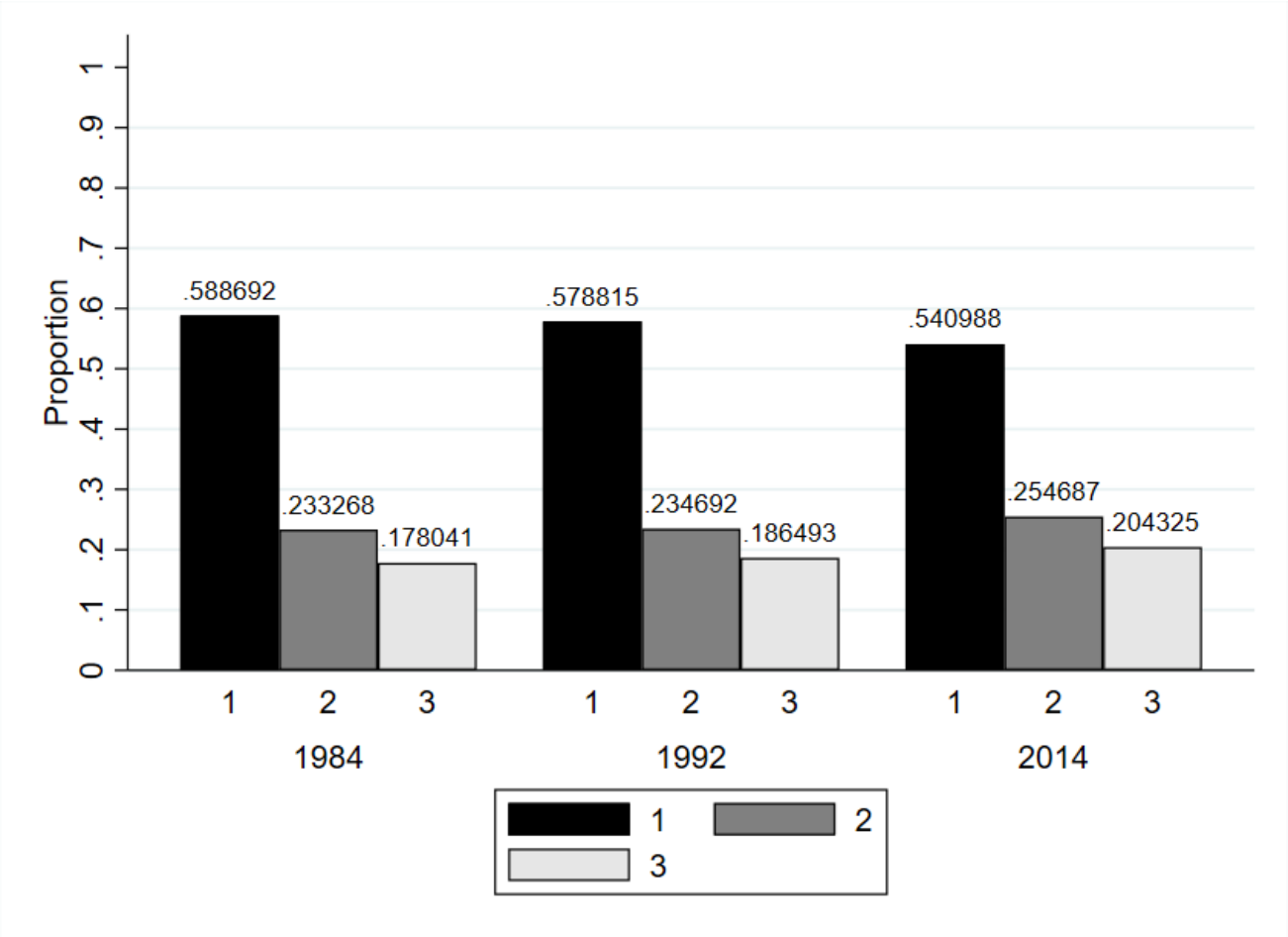
Model Fit: Rural Smoking



Smoking by Type



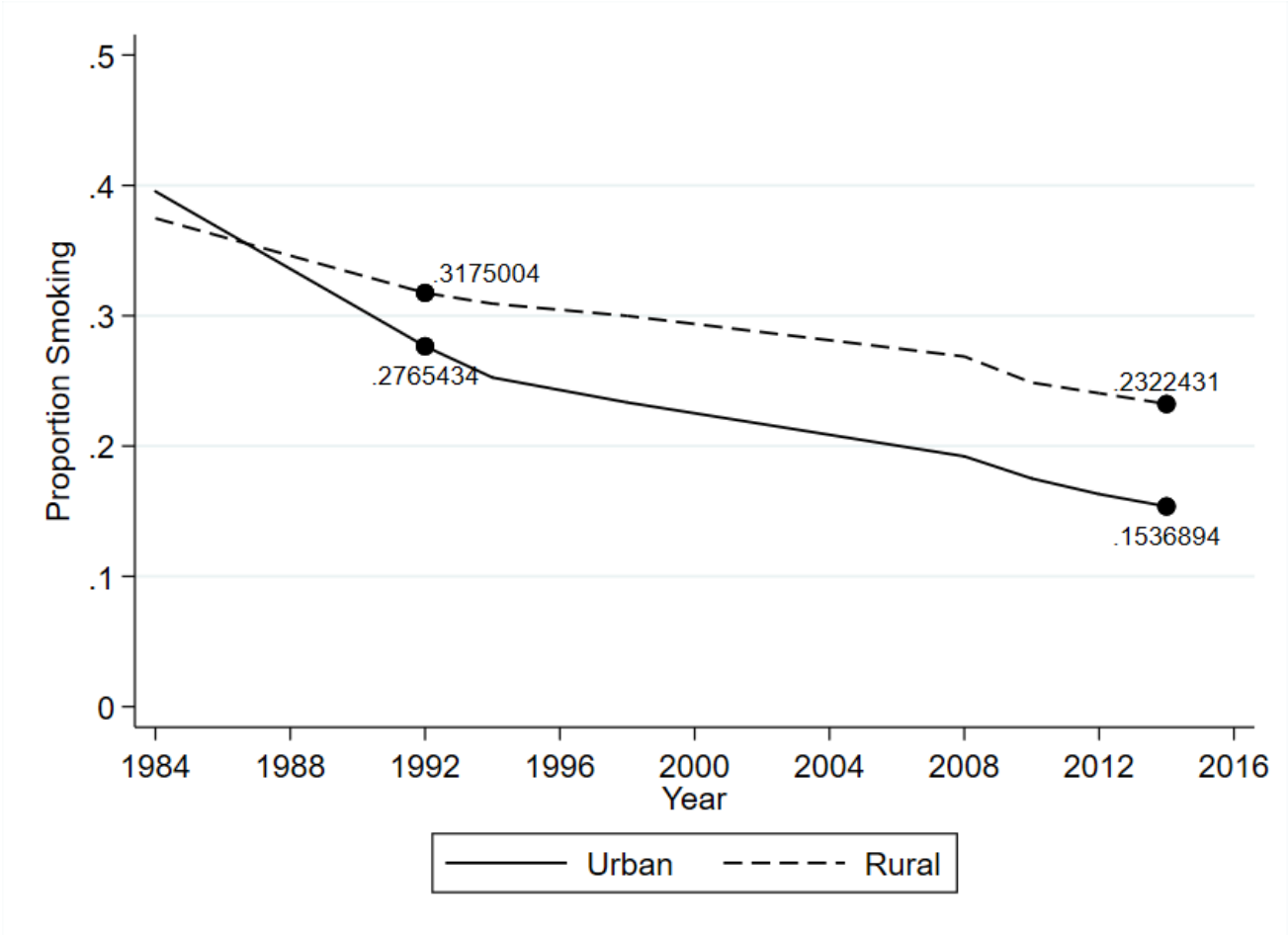
Distribution of Unobserved Heterogeneity over Time In Rural Counties



Overview

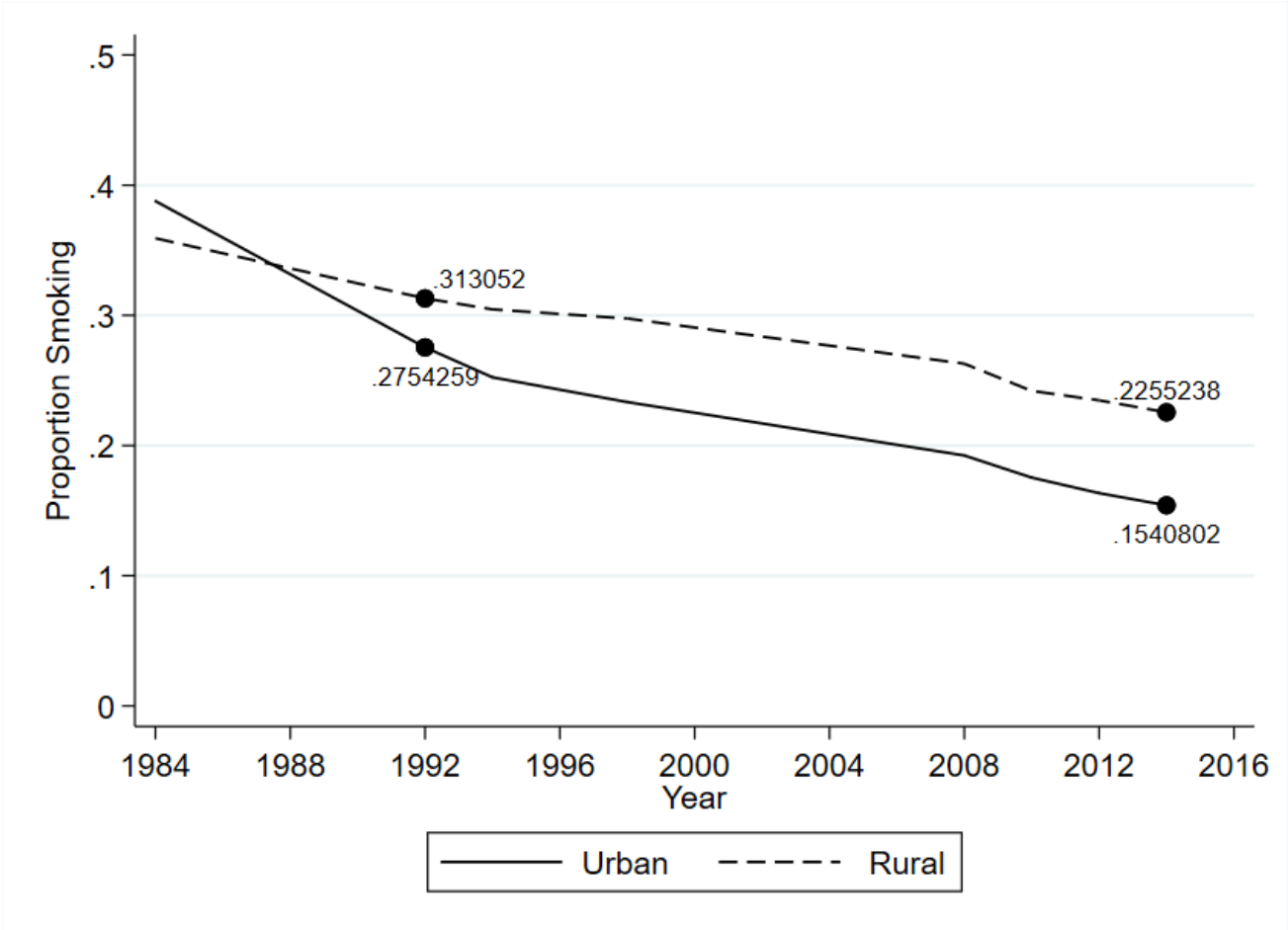
1. Baseline Simulation to Establish the Model Adjusted Smoking Gap
2. Equalized Type Distribution
3. No Migration
4. Equalized Type Distribution + No Migration
5. Urban Tobacco Control Policies.

Simulation: Baseline

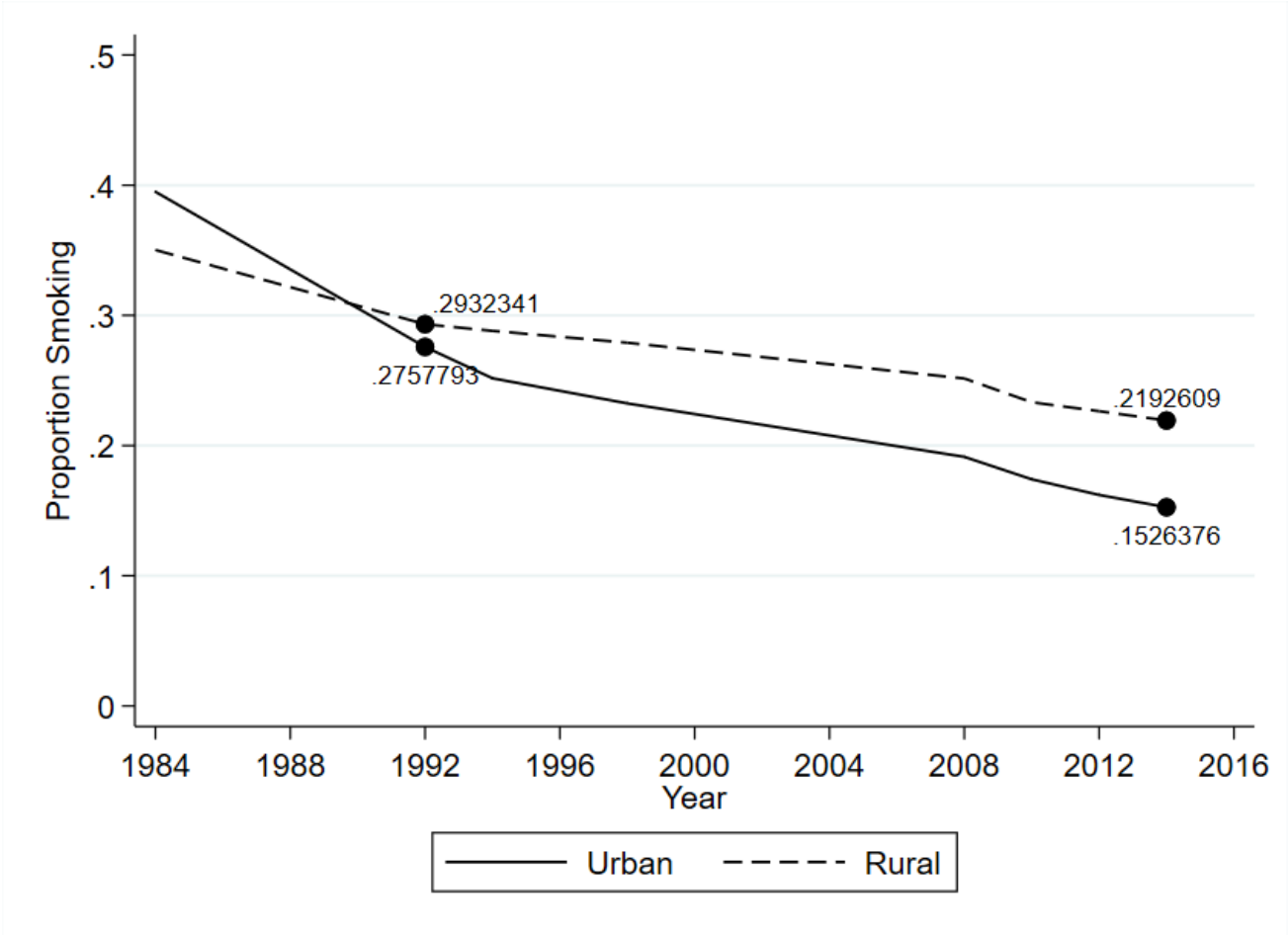


Simulated Smoking Gap in 2014: 7.9 percentage points.

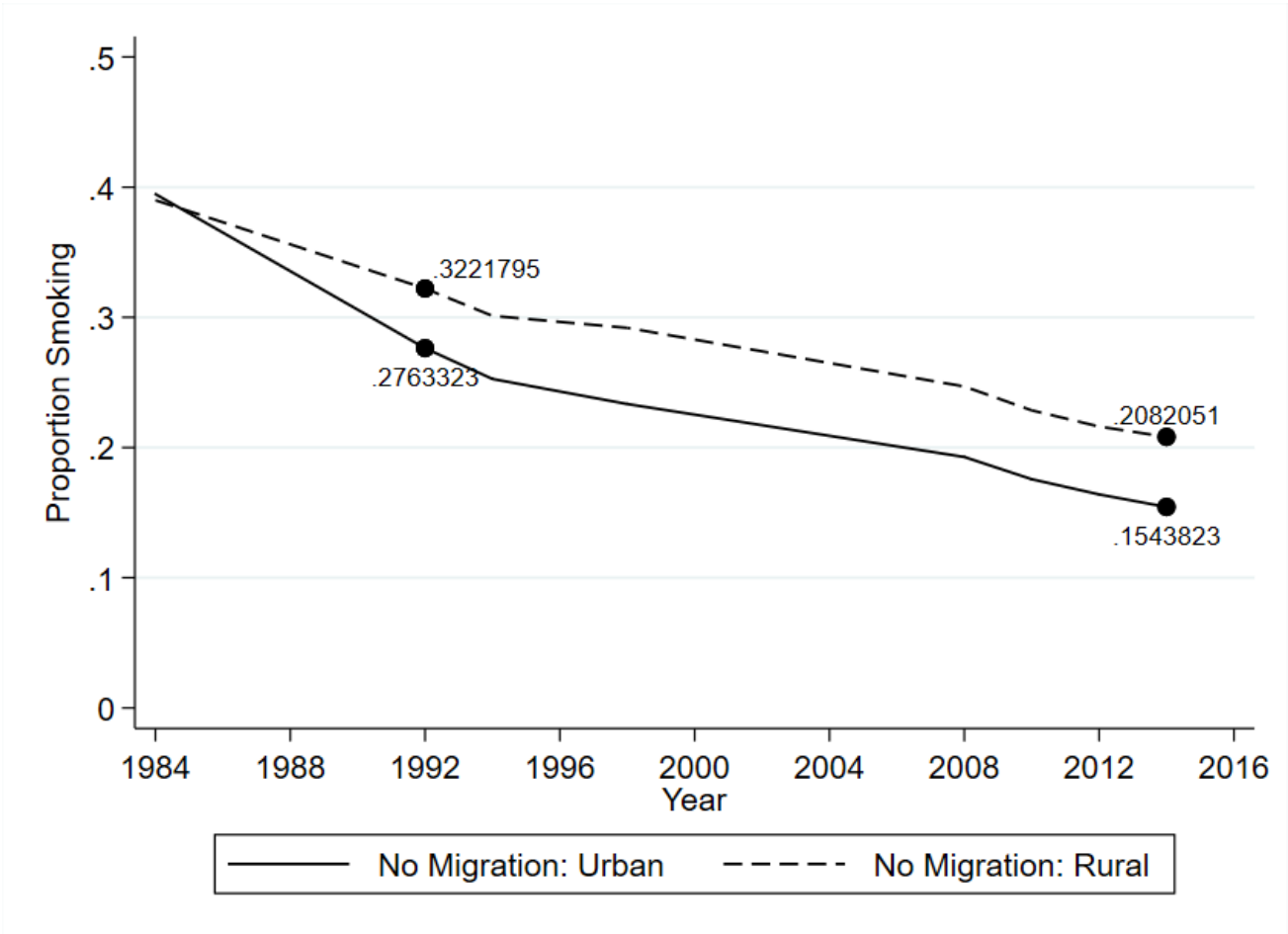
Simulation: Urban Taxes



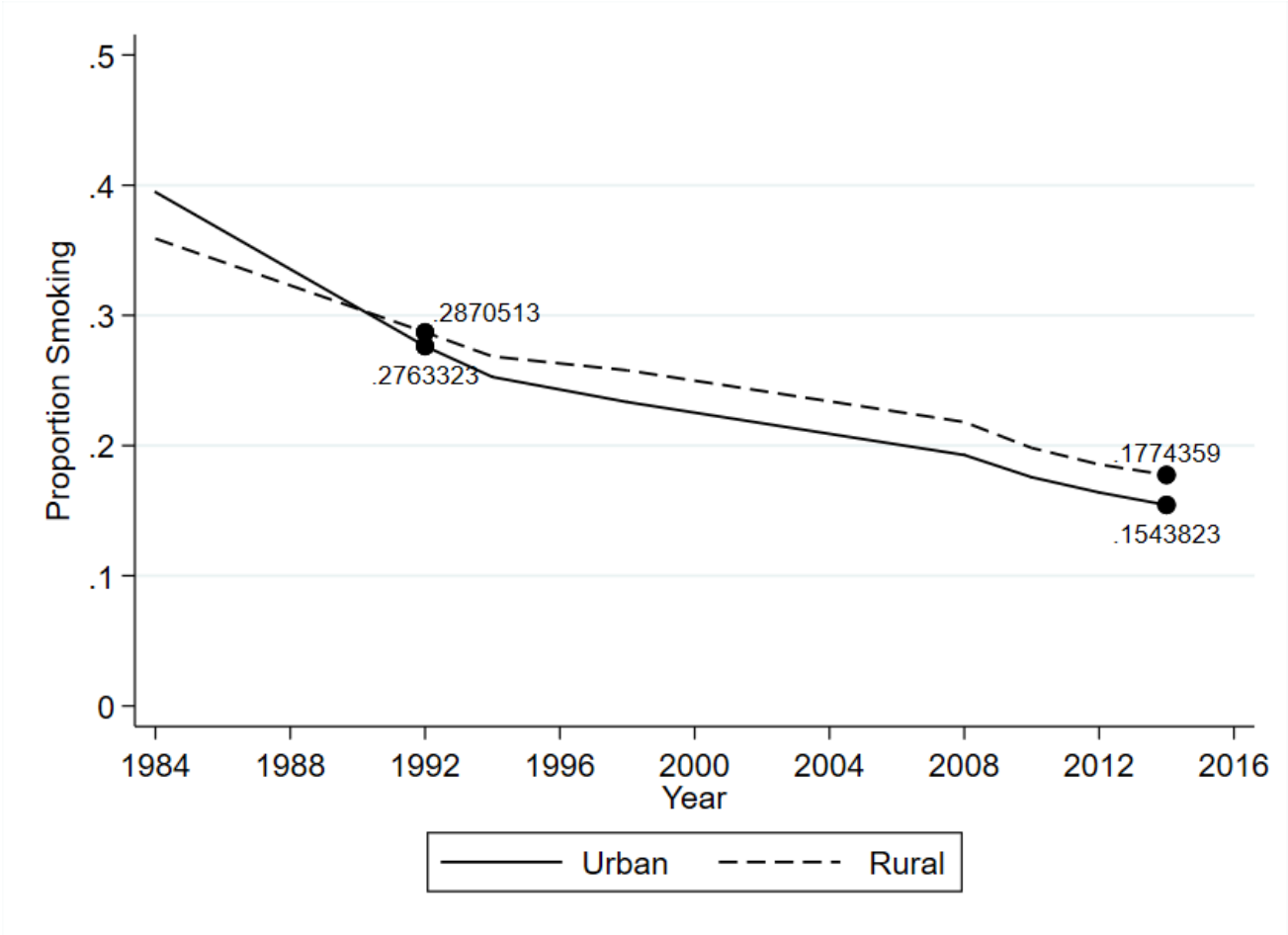
Simulation: Equalized Type Distribution



Simulation: No Migration



Simulation: Equalized Types + No Migration



Takeaways

I simulate a dynamic empirical model of smoking, education, and location to understand the smoking gap between urban and rural individuals. I find:

- Differential Tobacco Control Policies explain only 9.6%
- Selection on unobserved heterogeneity and migration are much more important.
- Little evidence that migration causes changes in smoking behavior.

Thanks!

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