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Loss Cost Components and Industrial Structure

Presented by

Frank Schmid

CAS Ratemaking and Product Management Seminar
Philadelphia, PA
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Overview

- The Research Question
- The Data
- The Model
- Empirical Findings
- Summary and Discussion

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Change in Industrial Structure

Construction, Manufacturing, and Health Care Employment

- Over the past several years, the composition of employment by industry has changed profoundly
  - Most notable are the job losses in construction and manufacturing, and the job growth in health care
- During the years leading up to the 2007-2009 recession, in many states, employment in the construction sector grew faster than employment overall
  - Then, the multi-year expansion of construction employment reversed—the contraction was swift and extensive
- It is not unusual that recessions serve as a catalyst for structural change in the economy
  - The job losses in manufacturing may be permanent to a high degree, and so may be the job gains in health care

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The Research Question

Loss Cost Components and Industrial Structure

- The objective is to quantify the effect of the change in industrial structure on frequency and the severities, as defined in NCCI ratemaking
- The NCCI ratemaking data is as used in the trend analysis during the 2011 NCCI ratemaking season
  - 36 states are analyzed
  - Data are on a Paid basis—where applicable, the State Fund is included
- Forecasts for employment by industry and state through 2016 have been obtained from a professional forecasting firm(1)

(1) Date of data pull: January 27, 2012. Historical observations run through Q3/2011. Forecasts start in Q4/2011

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Definitions

Loss Cost Components in Ratemaking

- Frequency is defined as the ratio of the lost-time claim count (developed to ultimate) to on-leveled and wage-adjusted premium
- Severity is defined as the ratio of (on-leveled, developed-to-ultimate, and wage-adjusted) losses to the number of lost-time claims (developed to ultimate)
- The loss ratio is the product of frequency and the respective severity

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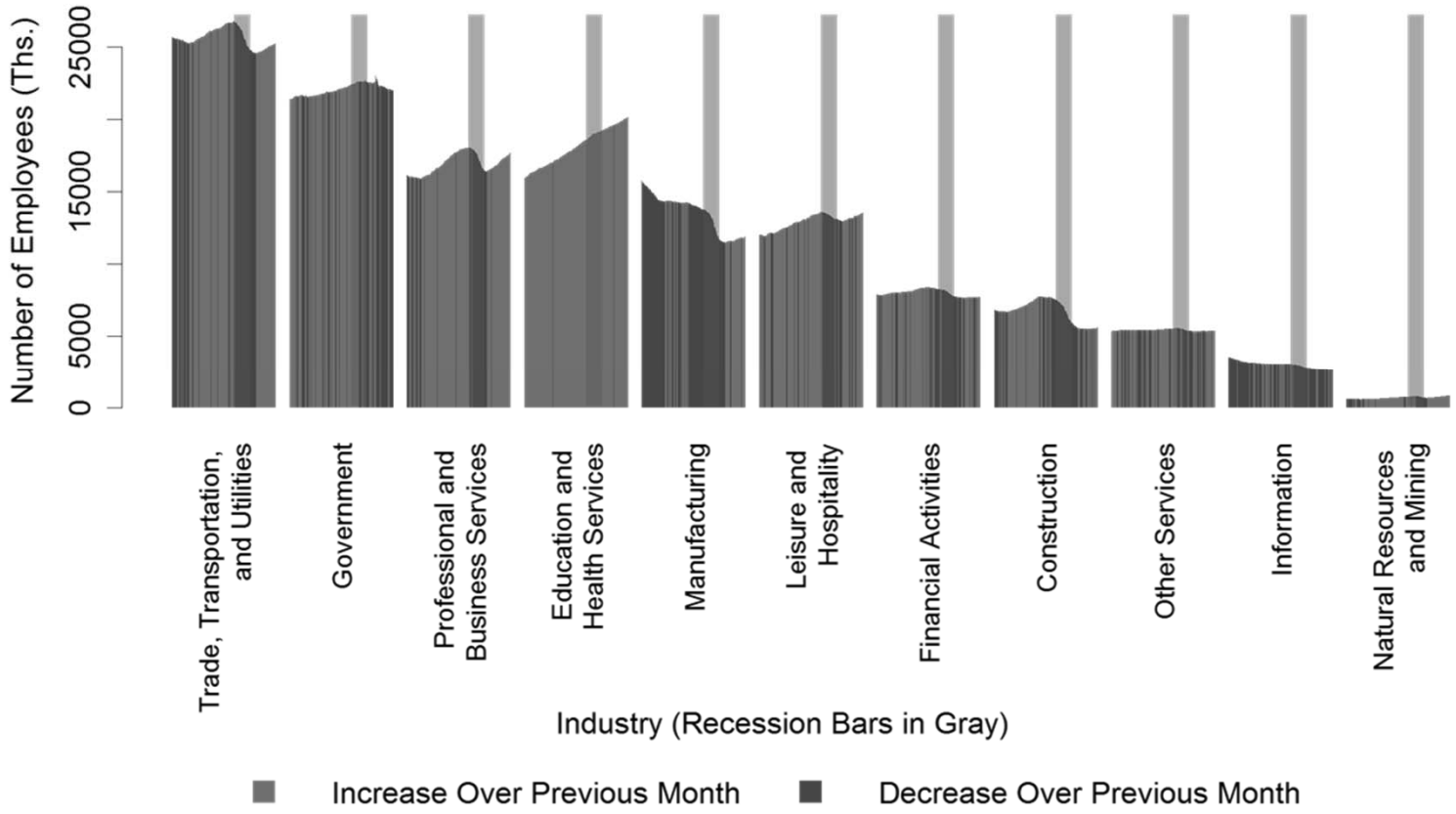
The Industrial Structure is Changing

The Recession as a Catalyst for Industrial Change



Note: Nonfarm Employment, seasonally adjusted, monthly observations, November 2001 through January 2012. Source: FRED, https://research.stlouisfed.org/fred2; U.S. Bureau of Labor Statistics (BLS), http://www.bls.gov.

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Industry Breakdown

Private Nonfarm

	BLS Sectors and Supersectors	Industry Breakdown
Service-providing	Trade, Transportation, and Utilities	**Trade, Transportation, and Utilities**
	Education and Health Services	**Education and Health Services**
	Financial Activities	**Services NEC (Not Elsewhere Classified)**
	Information	
	Leisure and Hospitality	
	Professional and Business Services	
	Other Services	
Goods-producing	Construction	**Construction**
	Manufacturing	**Manufacturing**
	Natural Resources and Mining	**Natural Resources and Mining**

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The Data

Time Frames for Policy-Year and Accident-Year States

- For policy year states, the rates of change for frequency and the severities range from 1992 through 2009 (with the exception of Colorado, Louisiana, Nevada, and Texas, where the rates of change start in 1996, 2000, 2001, and 1997, respectively)
  - For Florida, which is the only accident-year state, the rates of change run from 1993 through 2010
- Employment is based on the BLS Current Employment Statistics (nonfarm payroll employment)
  - The rate of employment growth is measured on a 12-month basis
    - For policy year states, growth is measured June over June (that is, June of the following calendar year over June of the current calendar year)
    - For accident year states, growth is measured December over December (that is, December of the current calendar year over December of the previous calendar year)

For Maine and Rhode Island, growth rates prior to 1997 were discarded due to the structural changes that occurred in these workers compensation markets in the first half of the 1990s
All growth rates in this study are logarithmic rates of growth, that is, first differences in natural logarithms

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The Statistical Model

Dependent Variable and Covariates

- Log growth rates of frequency and severity are modeled at the state level on…

  …log growth rates of employment by industry

  …the first difference in the log rate of employment growth

  - From the analysis of the link between BLS frequency and job flows it is known that frequency growth is related to the *change* in the rate of job creation

    - Here, employment growth refers to *net* job creation, which means that there is no breakdown into (gross) job creation and (gross) job destruction—this is because there are no forecasts readily available for job flows

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The Model

Interpretation of Effects of Covariates

- All covariates are centered
  - The centering implies that the intercept represents the (geometric) rate of frequency growth in the steady state
- The regression coefficients that capture the industrial structure measure the change of frequency growth in percentage points in response to a one-percentage point change in employment growth in the industry in question
  - All growth rates are on the logarithmic scale, which means that they correspond to geometric rates of growth (as required for the purpose of ratemaking)

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The Model

Likelihood and Estimation

- The likelihood is a discrete scale mixture of normal distributions
  - The variance of the normal is allowed to vary by state
- As a variation to this standard approach, ridge regression is applied
  - In ridge regression, the regression coefficients (of standardized covariates) share a common variance
  - Ridge regression imposes a penalty on large parameters—this is important where regression coefficients may comprise effects of correlated covariates
- All regression coefficients are common to all states
- The model is estimated by means of Markov-chain Monte Carlo simulation (MCMC)

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Construction

Effect of Employment Growth on Frequency: Construction

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Regression Coefficients

Frequency

Effect on Frequency Growth in Percentage Points in Response to a One-Percentage Point Change

Discrete Scale Mixture of Normal Distributions

	Standard Approach	Ridge Regression	Probability that Variable Has Explanatory Power (Percent)
	Estimated Coefficient	Estimated Coefficient	
Trade, Transportation, and Utilities	0.001	-0.008	58.3
Education and Health Services	-0.360	-0.312	97.5
Services NEC	0.100	0.037	21.9
Construction	-0.163	-0.120	74.5
Manufacturing	0.161	0.120	12.9
Natural Resources and Mining	-0.007	-0.007	8.5

Note that that public school system is part of Government, not Education and Health Services. The bulk of jobs in Education and Health Services fall into the category Health Care and Social Assistance. Evidence of explanatory power was established by means of Generalized Linear Spike-and-Slab Stochastic Search Variable Selection

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Regression Coefficients

Indemnity Severity

Effect on Indemnity Severity Growth in Percentage Points in Response to a One-Percentage Point Change

Discrete Scale Mixture of Normal Distributions

	Standard Approach	Ridge Regression	Probability that Variable Has Explanatory Power (Percent)
	Estimated Coefficient	Estimated Coefficient	
Trade, Transportation, and Utilities	-0.009	-0.004	4.19
Education and Health Services	-0.058	-0.009	3.87
Services NEC	-0.096	-0.007	4.80
Construction	0.065	0.001	3.65
Manufacturing	-0.105	-0.009	7.67
Natural Resources and Mining	-0.021	-0.002	4.26

Note that that public school system is part of Government, not Education and Health Services. The bulk of jobs in Education and Health Services fall into the category Health Care and Social Assistance. Evidence of explanatory power was established by means of Generalized Linear Spike-and-Slab Stochastic Search Variable Selection

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Regression Coefficients

Medical Severity

Effect on Medical Severity Growth in Percentage Points in Response to a One-Percentage Point Change

Discrete Scale Mixture of Normal Distributions

	Standard Approach	Ridge Regression	Probability that Variable Has Explanatory Power (Percent)
	Estimated Coefficient	Estimated Coefficient	
Trade, Transportation, and Utilities	0.288	0.079	10.74
Education and Health Services	0.061	0.016	4.37
Services NEC	-0.501	-0.208	24.44
Construction	0.128	0.059	17.26
Manufacturing	-0.206	-0.131	68.24
Natural Resources and Mining	-0.075	-0.054	18.95

Note that that public school system is part of Government, not Education and Health Services. The bulk of jobs in Education and Health Services fall into the category Health Care and Social Assistance. Evidence of explanatory power was established by means of Generalized Linear Spike-and-Slab Stochastic Search Variable Selection

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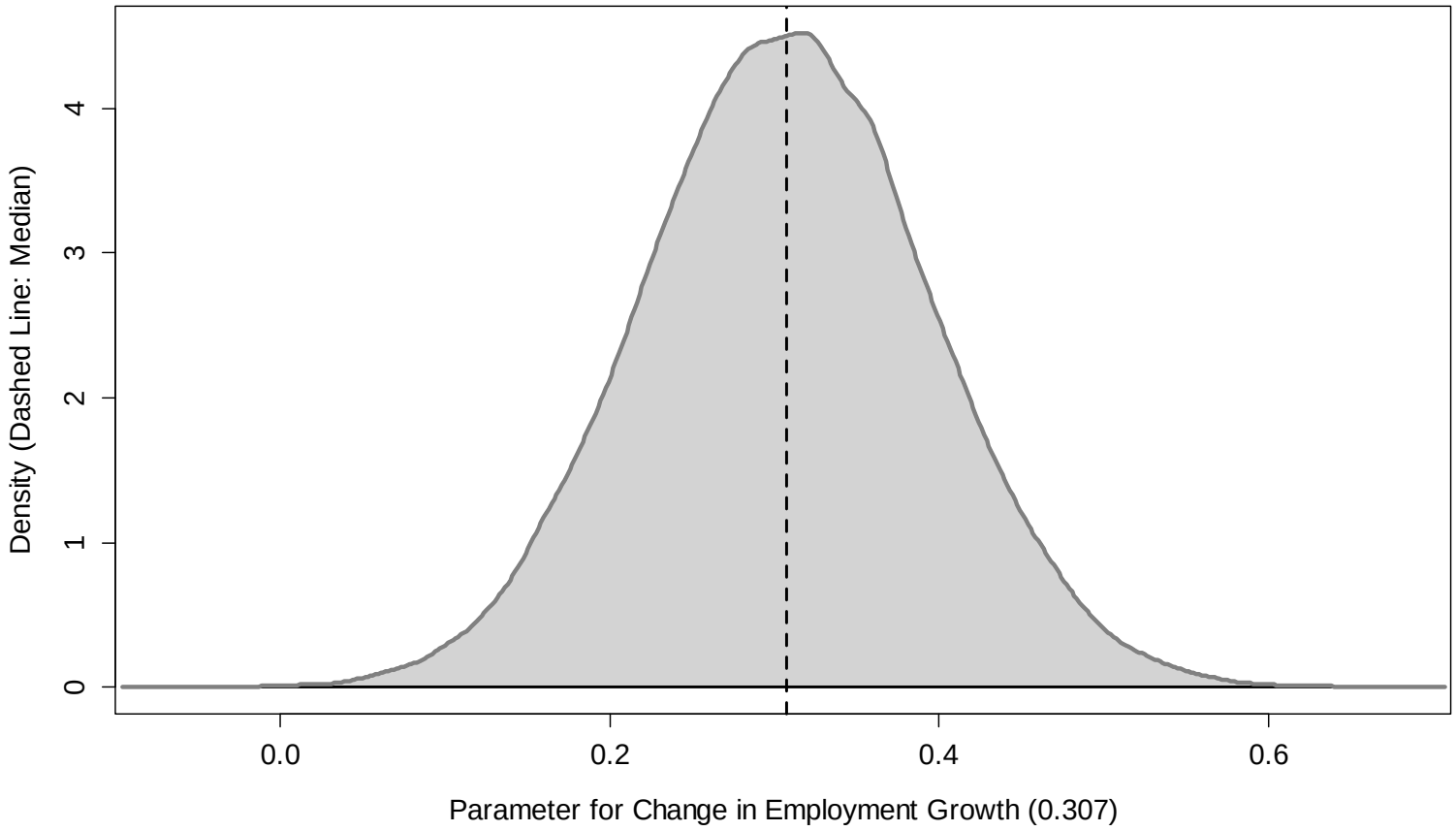
Private Nonfarm Employment Growth

Effect of Change in Net Job Creation on Frequency Growth



Probability that change in employment growth has statistical power to explain frequency growth: 90.5 percent.
Probabilities that change in employment growth has statistical power to explain indemnity and medical severity growth: 99.5 percent and 49.4 percent, respectively
Evidence of explanatory power was established by means of Generalized Linear Spike-and-Slab Stochastic Search Variable Selection

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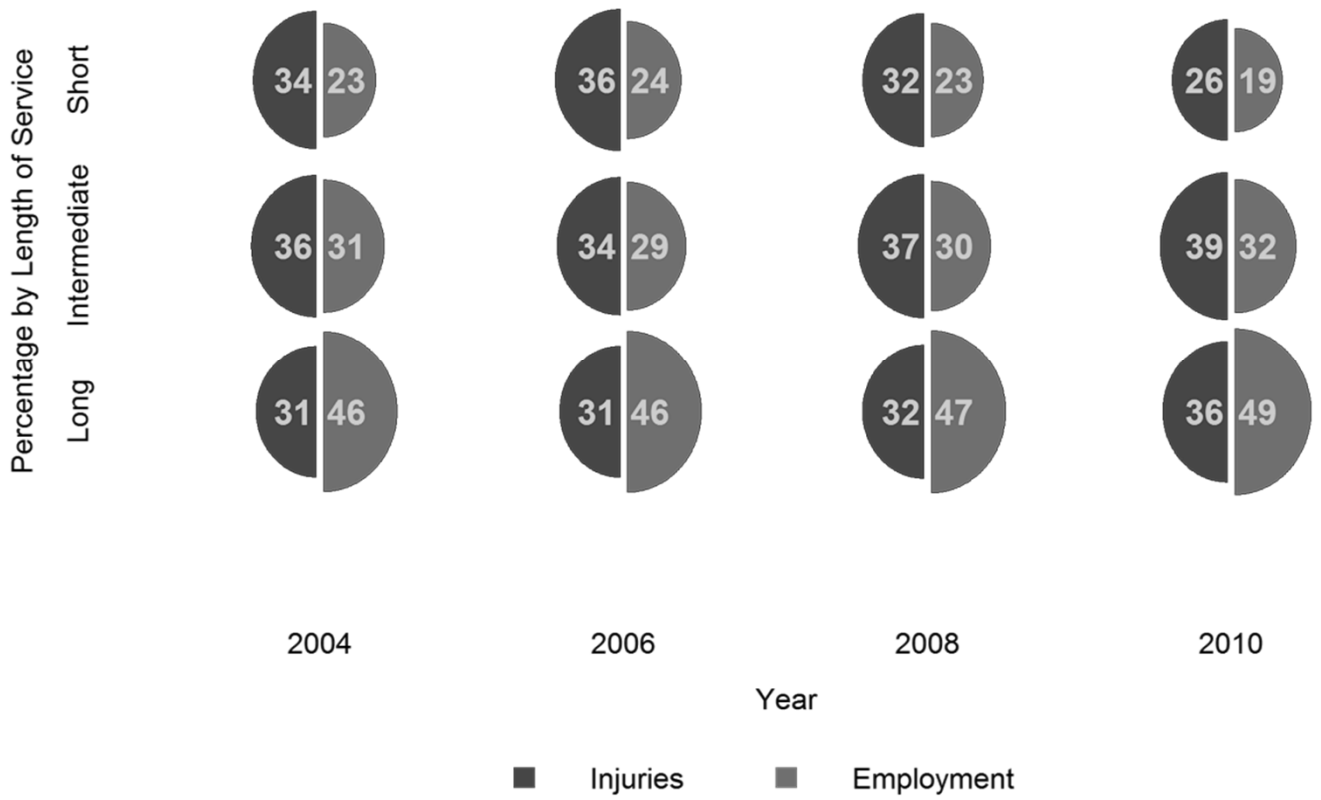
Workplace Injury Proportions by Job Tenure

Short-tenured Workers are Overrepresented Among the Injured



Note: Workplace injuries represent nonfatal injuries and illnesses involving days away from work. Short job tenure means 11 months or less (workplace injuries) or 12 months or less (employment). Intermediate length of service means 1 to 5 years and 13 months to 4 years, respectively. Long length of service means more than 5 years or 5 years or more, respectively. Percentages for workplace injuries do not account for a small "residual category." Job tenure information for employment is available bi-annually (for January only). Percentages may not add to 100 due to rounding. Source: U.S. Bureau of Labor Statistics (BLS), http://www.bls.gov

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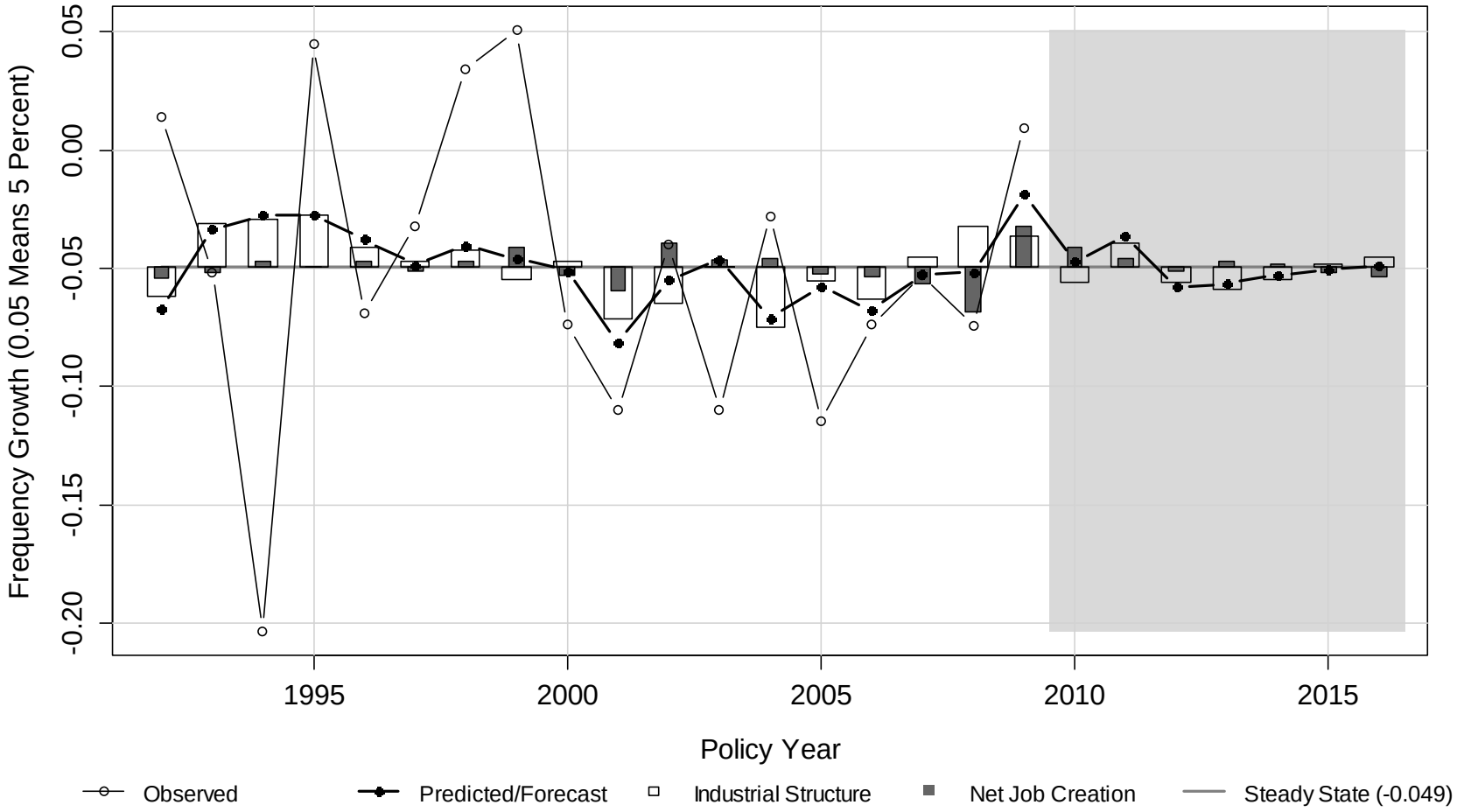
State #1

Job Losses in Construction Were Close to the National Average



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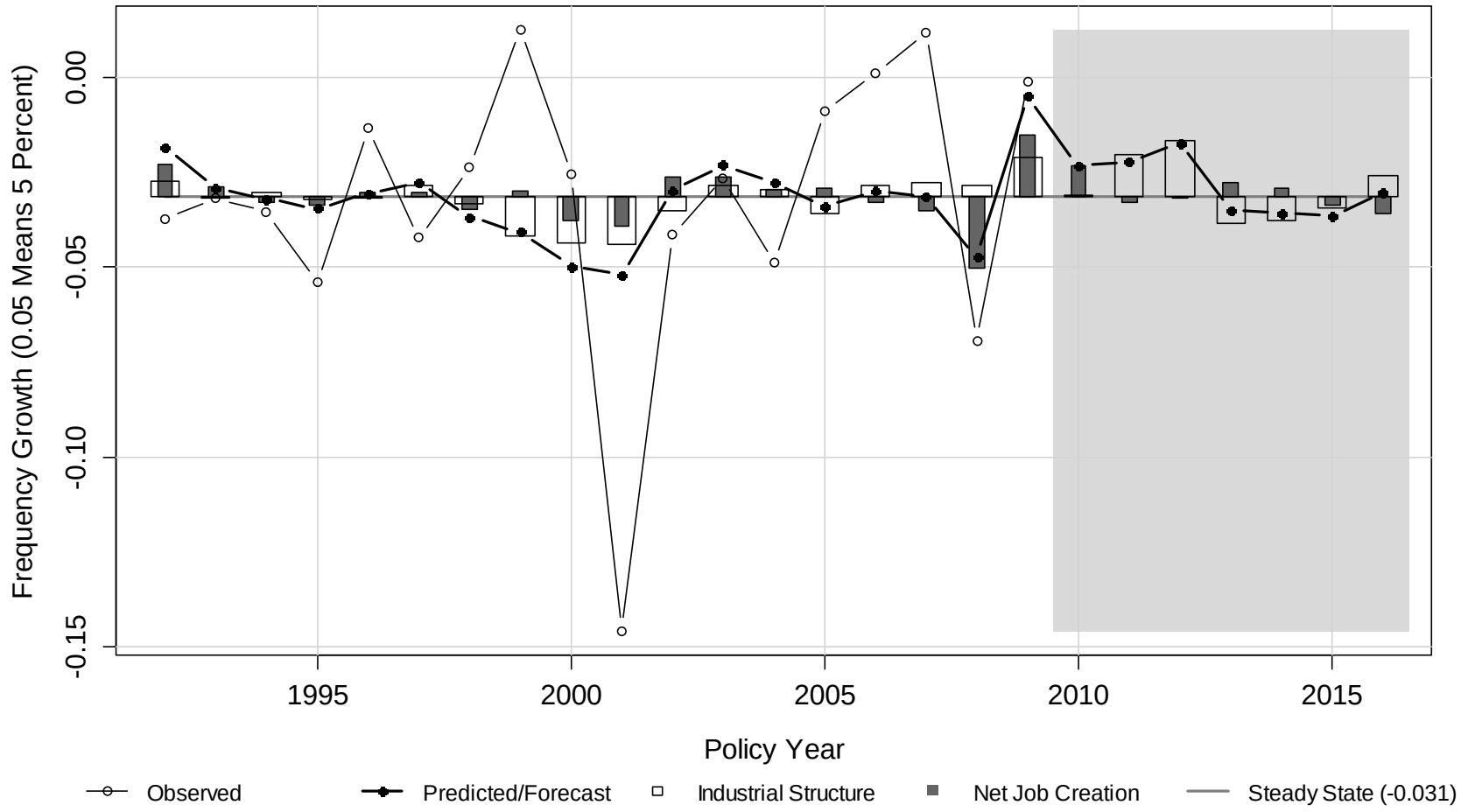
State #2

Job Losses in Construction Were Close to the National Average



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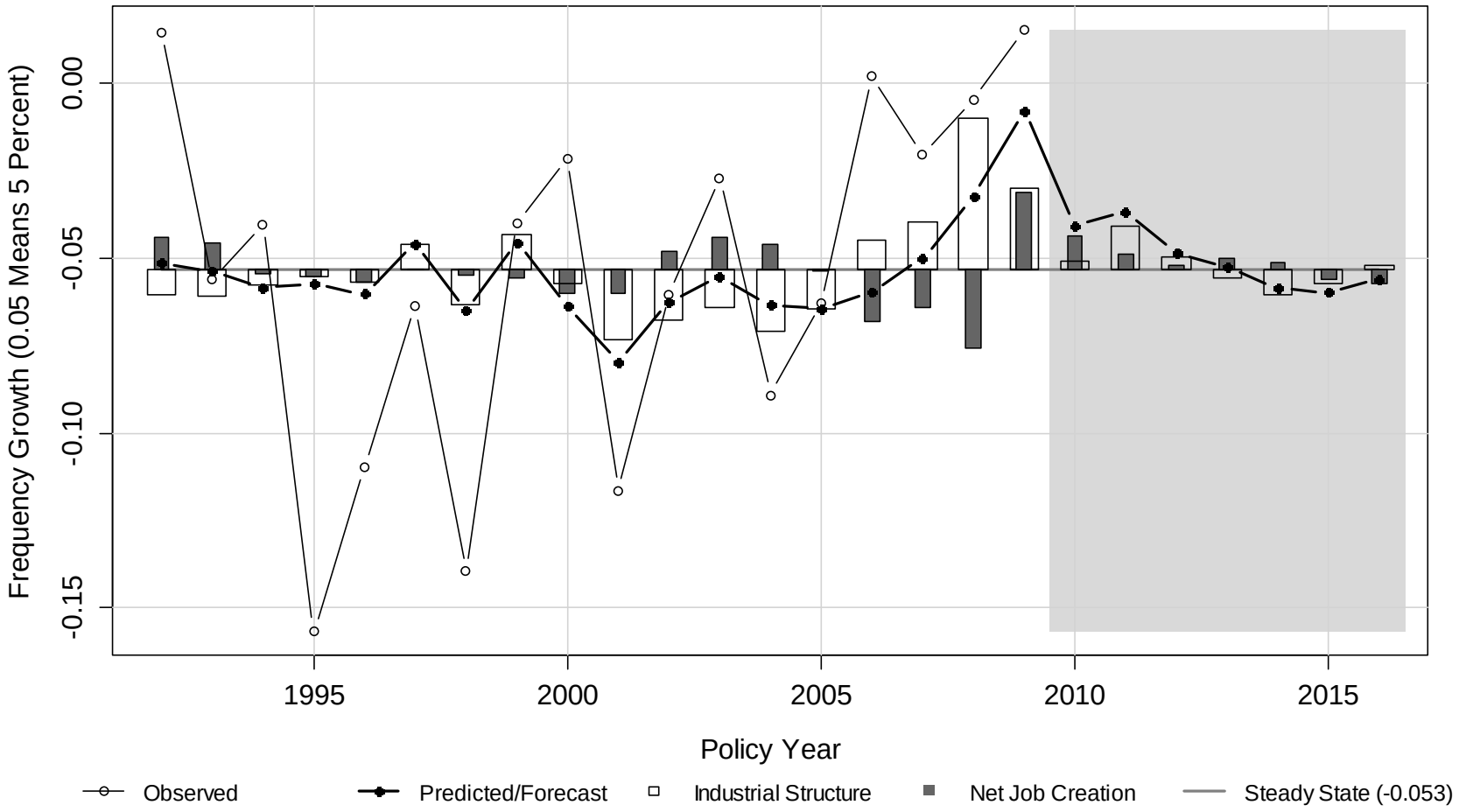
State #3

Job Losses in Construction Exceeded the National Average



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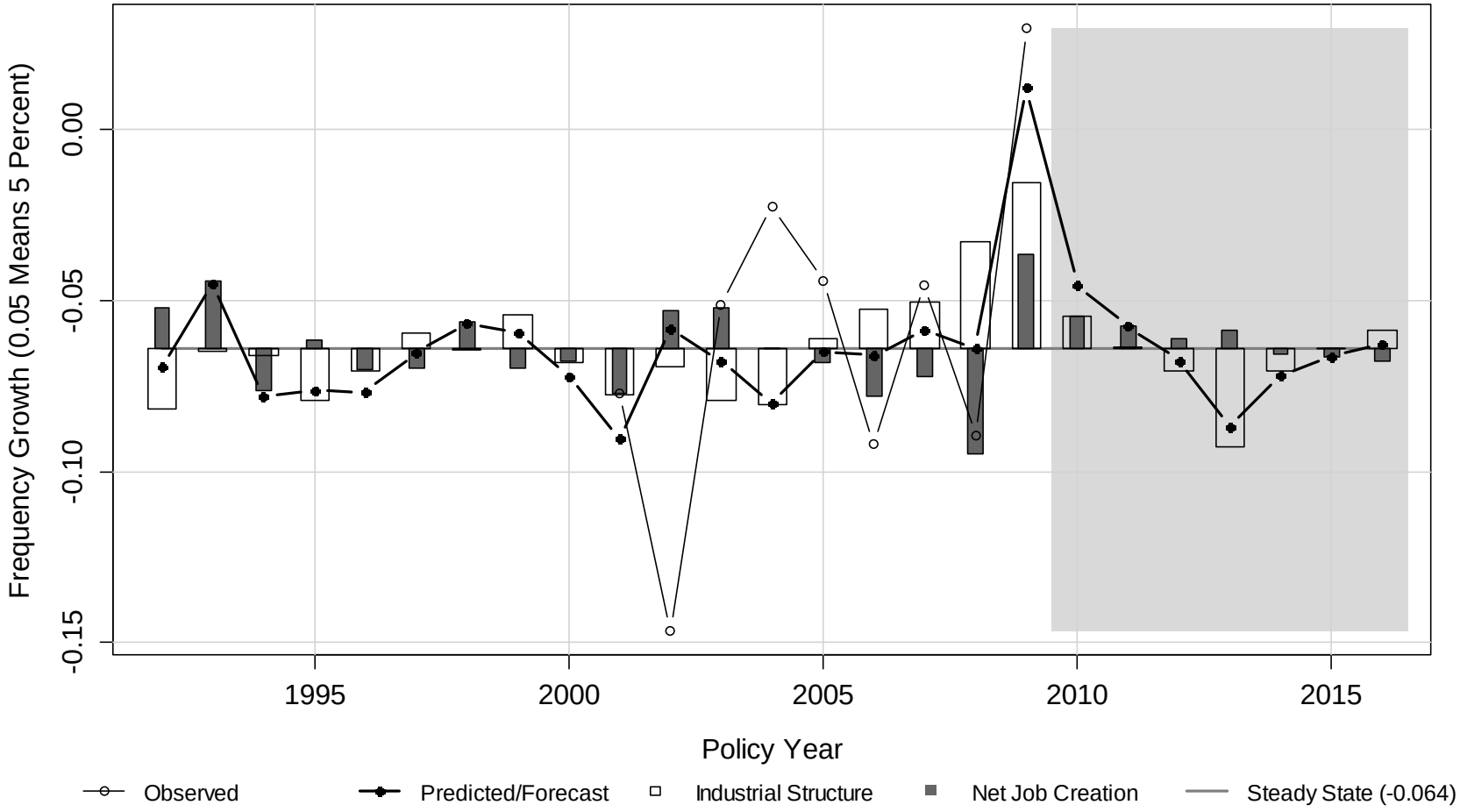
State #4

Job Losses in Construction Exceeded the National Average



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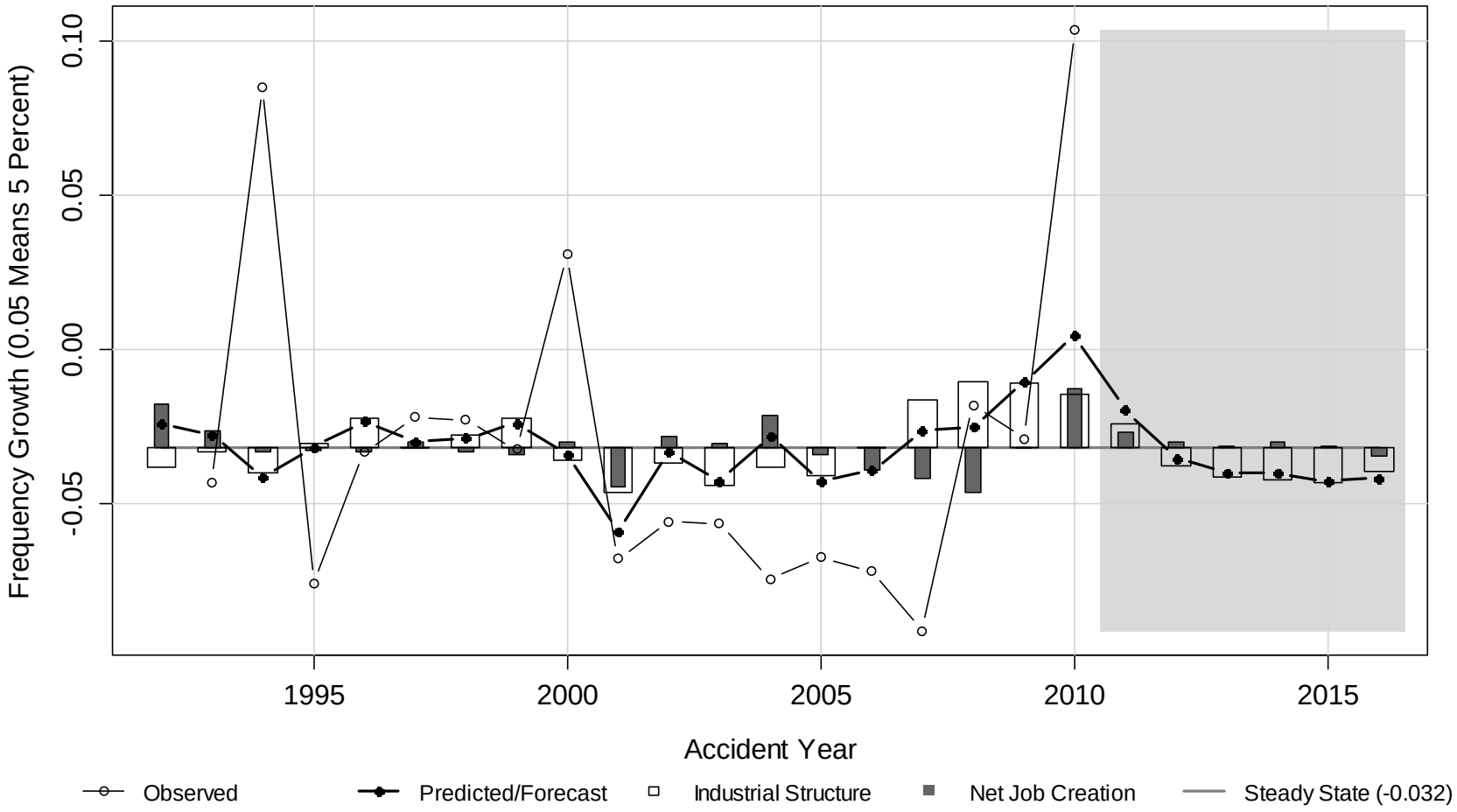
State #5

Job Losses in Construction Exceeded the National Average



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Summary of Findings

- The change in industrial structure concomitant with the 2007-2009 recession and its aftermath affects ratemaking loss cost components
  - The effect is largely due to the expansion and contraction of the construction sector
  - Thus, the effect is most pronounced in states that experienced a sharp downturn of the housing market
- There are offsetting effects on the part of the severities
  - Medical severity appears to be more responsive to a change in industrial structure than indemnity severity, although this finding should not be considered conclusive
- The effect is likely to be transitory
  - The rates of frequency and severity growth revert to their steady states as the economy returns to its trend rate of growth

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Model Validation

- The model has been validated through its performance during the 2011 ratemaking season
  - Equally weighted across the 36 states analyzed here, the frequency decline observed in the latest (policy or accident) year that was employed in the 2011 ratemaking season equaled 1.5 percent
  - The model had forecast a decline of around 1 percent—various model specifications had been estimated in sensitivity analyses
- Yet, contrary to the model assumption, the steady state of frequency growth may have shifted with the industrial structure
  - The equally weighted average of the rate of frequency decline for the analyzed set of states and the time interval covered in this study runs at around 4.5 percent

As mentioned, all growth rates in this study are logarithmic rates of growth, that is, first differences in natural logarithms

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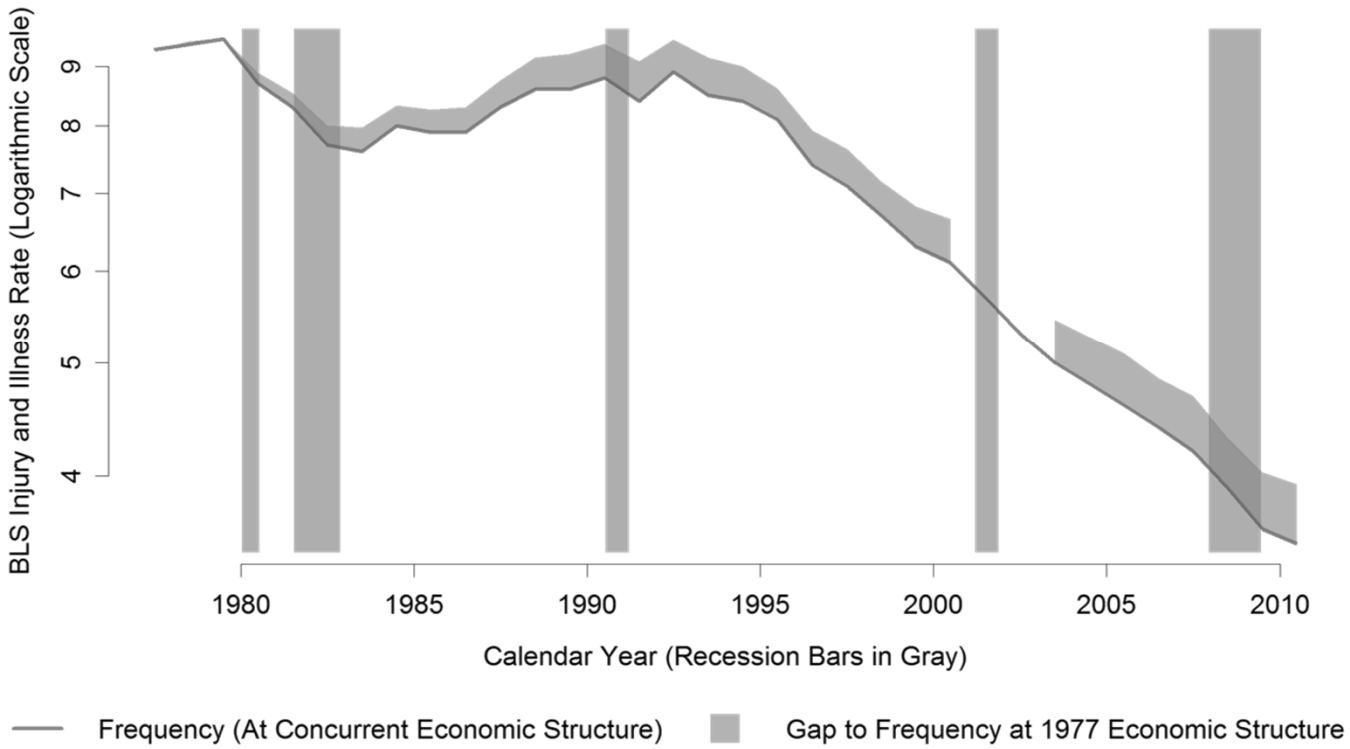
The Argument for a Stable Steady State

92.5 Percent of the Frequency Decline Since 1977 Occurred Within Industries



Note: Injury and Illnesses Cases per 100 Full-Time-Equivalent Workers, Total Recordable Cases, All Private Industry. Frequency of observation: annual; latest available data point: 2010. No data points are available for 2001 and 2002 due to changes in industry classification. Tick marks indicate beginning of year. Data points are mid-year. Sources: Bureau of Economic Analysis (BEA), http://www.bea.gov; U.S. Bureau of Labor Statistics (BLS), http://www.bls.gov/iif.

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