



NCCI Holdings, Inc.

Workplace Injuries and Job Flows

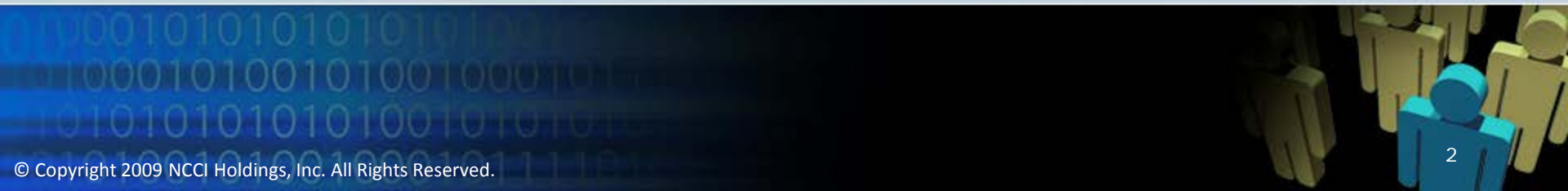


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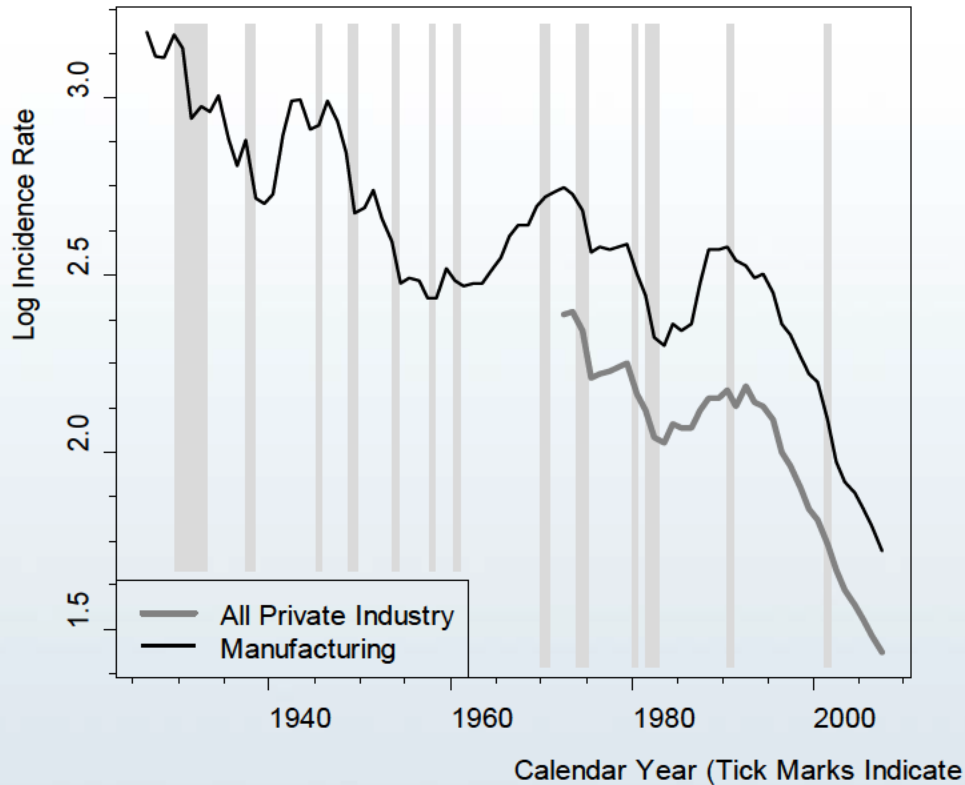
Travelers Actuarial Forum
Hartford, Connecticut
November 5, 2009

Summary

- Q: What is the most important driver of frequency in workers' compensation?**
- A: Frequency is primarily driven by job flows, that is *job creation* and *job destruction*
- Q: Does frequency drop during recessions even more than it would drop otherwise?**
- A: Yes, frequency accelerates its decline during recessions due to the decline in the rate of job creation
- Q: Is there indication that layoffs give rise to workers' compensation claims that would not be observed otherwise?**
- A: Yes, there is statistical evidence that elevated job destruction during recessions slows the decline in frequency, but the magnitude of this effect is smaller than the opposing effect of depressed job creation



BLS Frequency



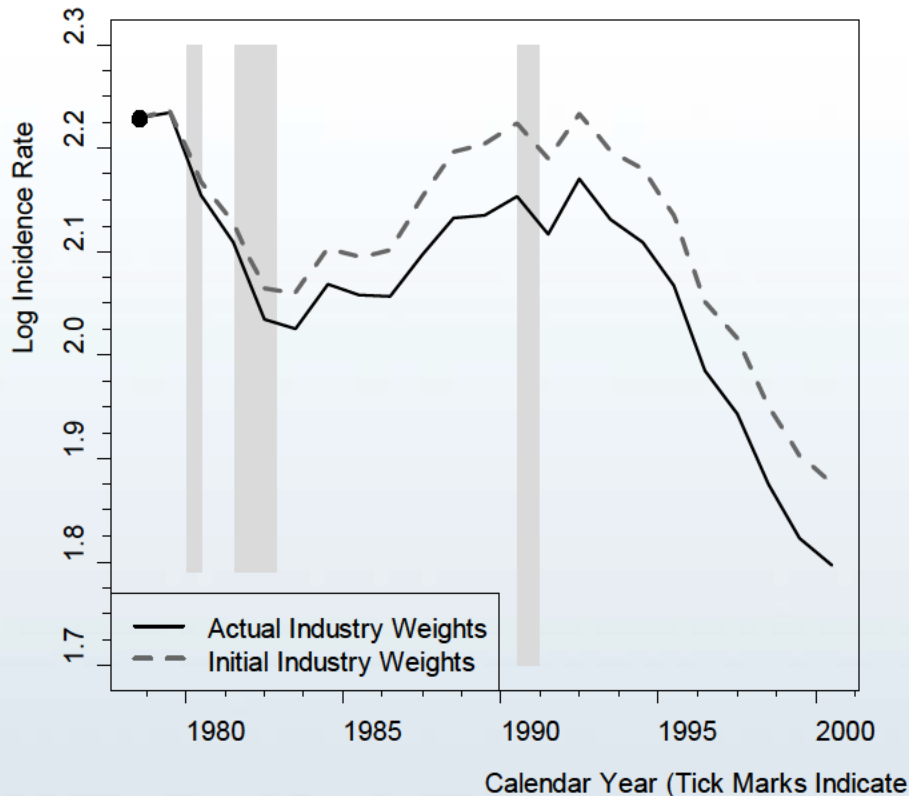
- Frequency is defined as number of cases per 100 full-time equivalent employees
- Frequency exhibits a long-term decline, both in All Private Industry and in Manufacturing
- There are highly persistent deviations from trend, during which the decline slows or temporarily reverses
- The gray bars indicate economic recessions, as defined by the NBER Recession Dating Committee

All Private Industry: 1972-2007; Manufacturing: 1926-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

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BLS Frequency and Structural Change

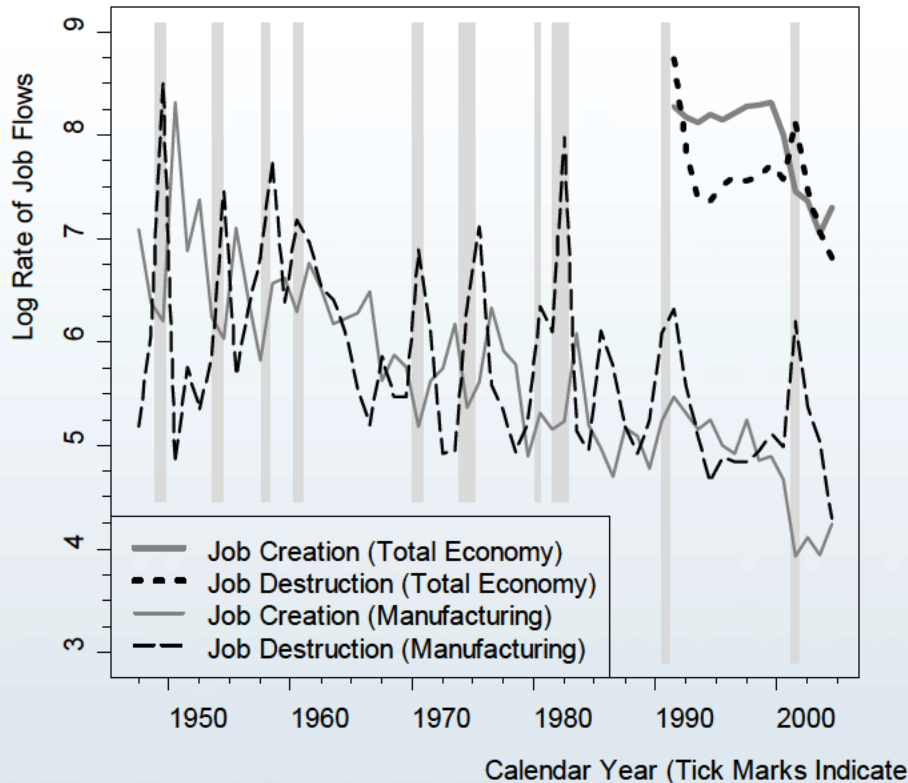


- Actual frequency (“actual industry weights”) is plotted alongside the level of frequency that would have been observed had the structure of the economy not changed over time (“initial industry weights”)
- Only about 15 percent of the frequency decline is due to structural change in the economy

All Private Industry: 1977-2000; Frequency is calculated as employment-weighted average across industries: Agriculture, Forestry and Fishing, Mining, Construction, Manufacturing, Transport and Public Utilities, Wholesale Trade, Retail Trade, Finance, Insurance and Real Estate, and Services; these industries add up to the private sector. The industry classification rests on SIC (Standard Industrial Classification), which confines the data set to the pre-2002 time window

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

Job Flows

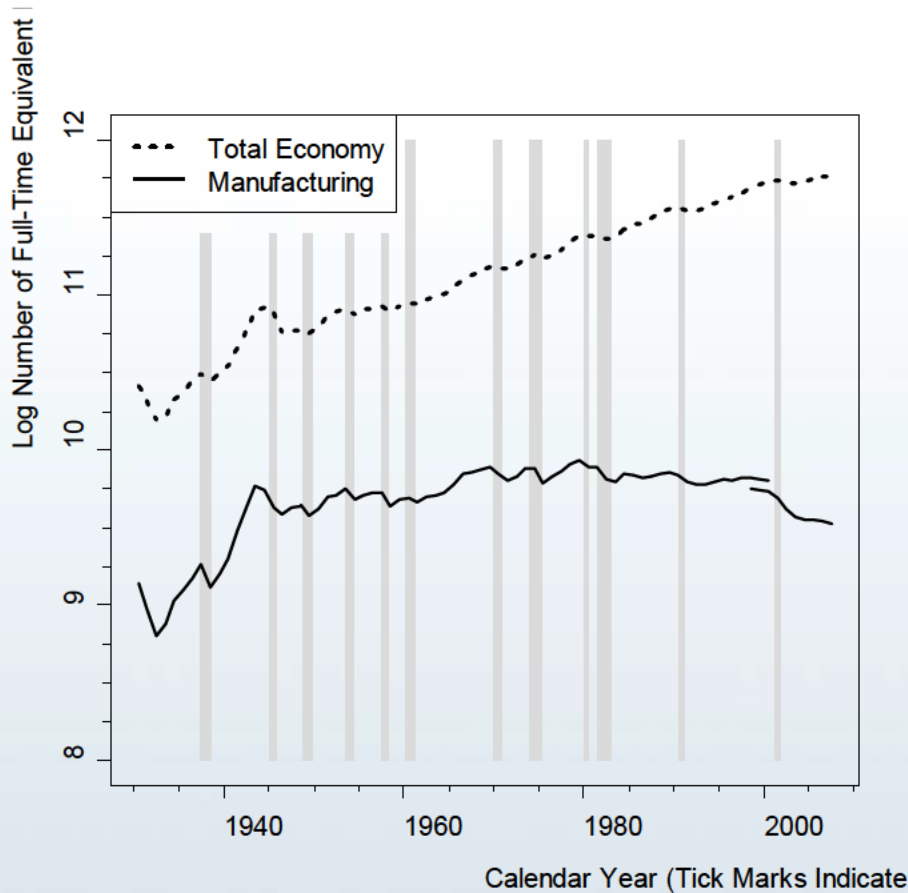


- The job flow concepts of job creation and job destruction measure the number of jobs created or destroyed per number of existing jobs
- Measurement is *gross* at the establishment (e.g., plant) level
- The concept of establishment typically refers to the physical location of production

Total Economy: 1991-2004; Manufacturing: 1947-2004; geometric mean of Q1 through Q4

Data source: Davis, S.J., R.J. Faberman, and J. Haltiwanger (2006) "The Flow Approach to Labor Markets: New Data Sources and Micro-Macro Links," *Journal of Economic Perspectives* 20(3), pp. 3-26; recession information: NBER (National Bureau of Economic Research), www.nber.org

Employment



- On net, the rate of job creation in the total economy shows a nearly time-invariant, positive trend
- In manufacturing, the rate of net job creation slowed over time and, most recently, turned negative
 - Starting with the 1980s recessions, employment in manufacturing failed to regain its pre-recession level
 - Following the 2001 recession, employment in manufacturing continued to decline during the economic recovery

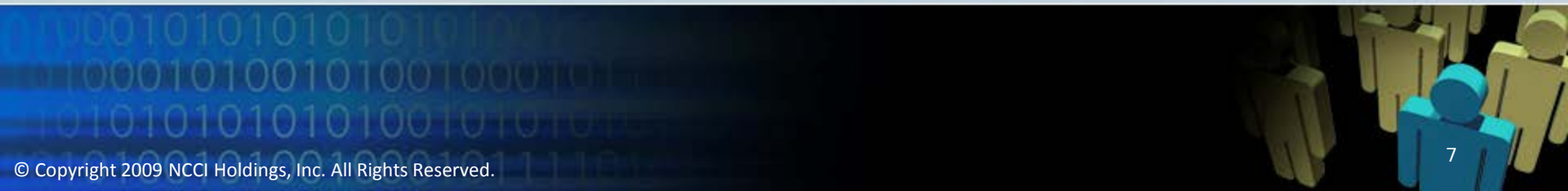
Total Economy: 1929-2007; Manufacturing: 1929-1948, 1948-1987, 1987-2000, 1998-2007; number of full-time equivalent employees

Data source: NIPA (National Income and Product Accounts) Table 6.5(A-D), BEA (Bureau of Economic Analysis), www.bea.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

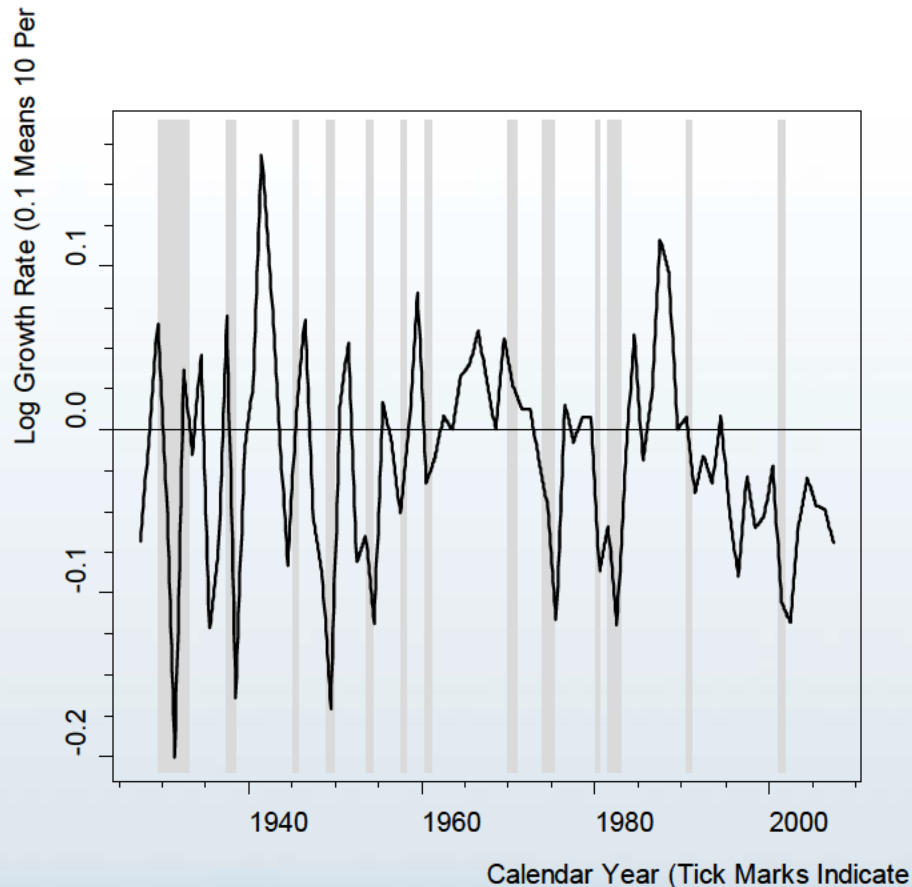
Hypothesis

FREQUENCY GROWTH IS DRIVEN BY THE GROWTH RATES OF JOB CREATION AND JOB DESTRUCTION

- First, using a statistical model, the time series properties of the frequency growth rate are analyzed
- Second, the statistical model is expanded to a structural time series model in order to quantify the influence of changes in job flows on changes in frequency over the business cycle



Frequency Log Rate of Change



- As shown here for manufacturing, the frequency growth rate drops during recessions and rises during economic recoveries
- Since the early 1960s, there is a decline in variance and an increase in persistence of deviations from (a potentially time-varying) trend

Manufacturing: 1927-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

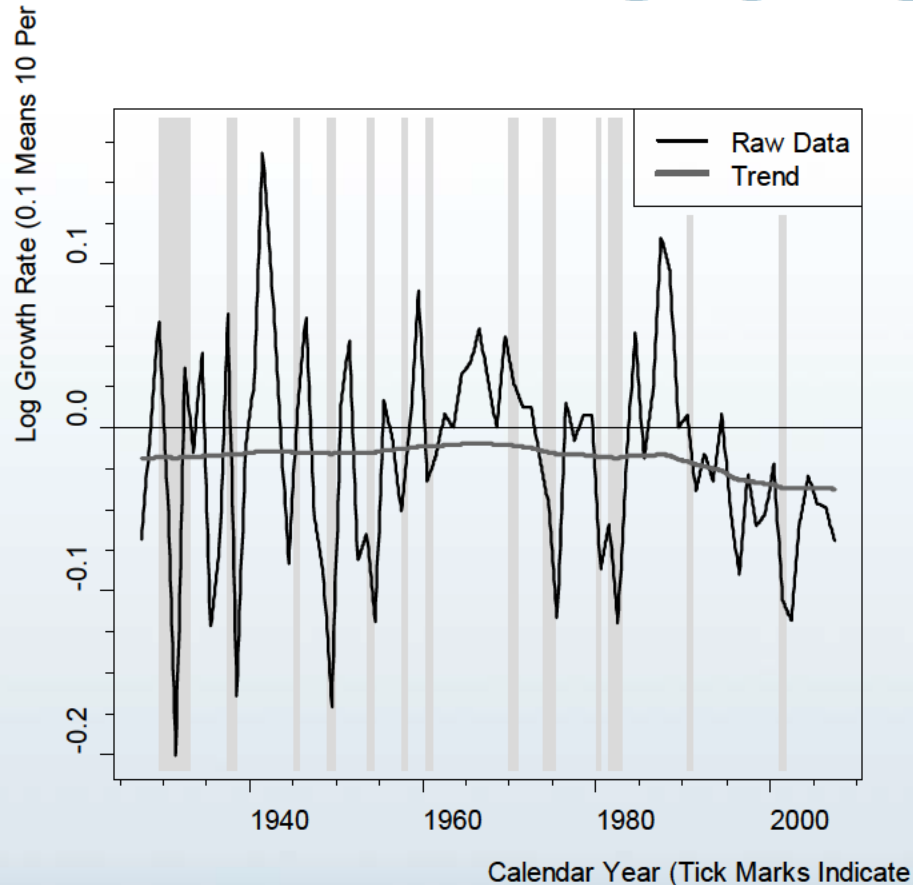
State-Space Time Series Model

- The model is Bayesian and estimated by means of MCMC (Markov-chain Monte Carlo simulation)
- The model breaks down the observed growth rate of the BLS incidence rate into three components
 - The level (i.e., mean rate of growth)
 - The level is allowed to vary over time (i.e., may change states)
 - An AR(1) (first-order autoregressive) process
 - The variance of the AR(1) process may change states
 - The AR(1) coefficient (ρ) may have a (*one*) change-point
 - White noise in measurement

Manufacturing: 1927-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

Trend Rate of Frequency Growth

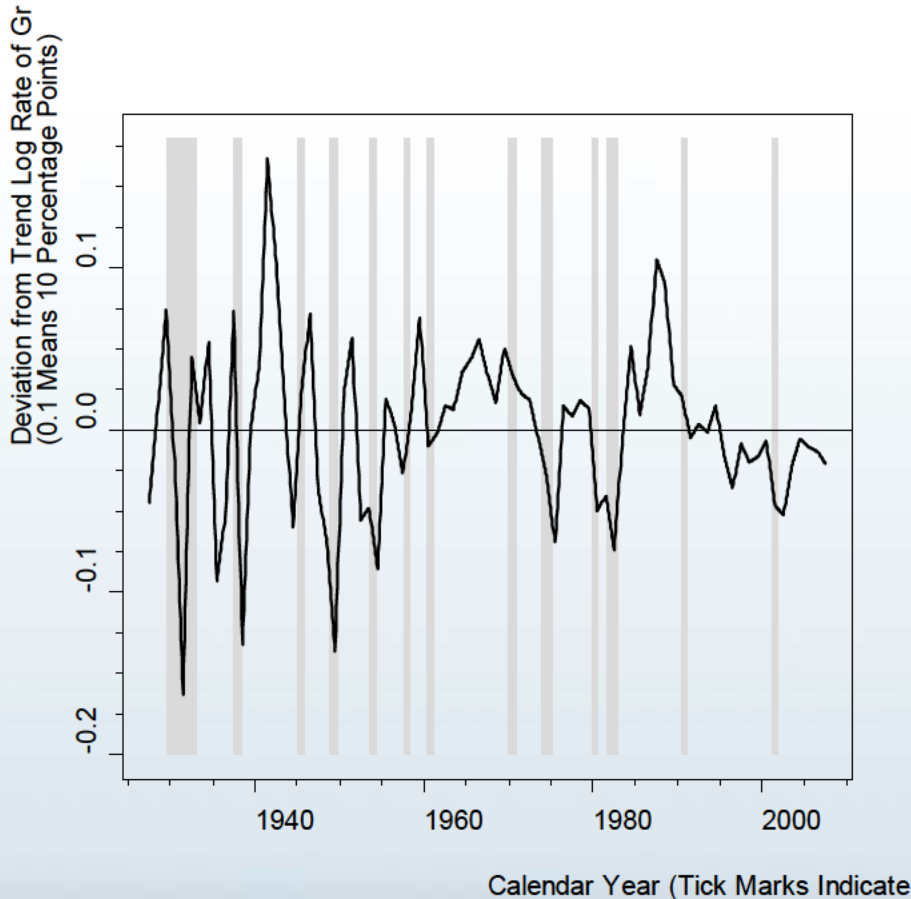


- The trend rate of growth has been negative since the 1920s
- During the 1990s, this (negative) trend rate of growth has drifted down, but has since stabilized at a new level
- L.I. Boden and J.W. Ruser (2003, "Workers' Compensation 'Reforms,' Choice of Medical Care Provider, and Reported Workplace Injuries," *Review of Economics and Statistics* **85**, 923-929) attribute this decline to cost containment reforms in the early 1990s

Manufacturing: 1927-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

Autoregressive Process

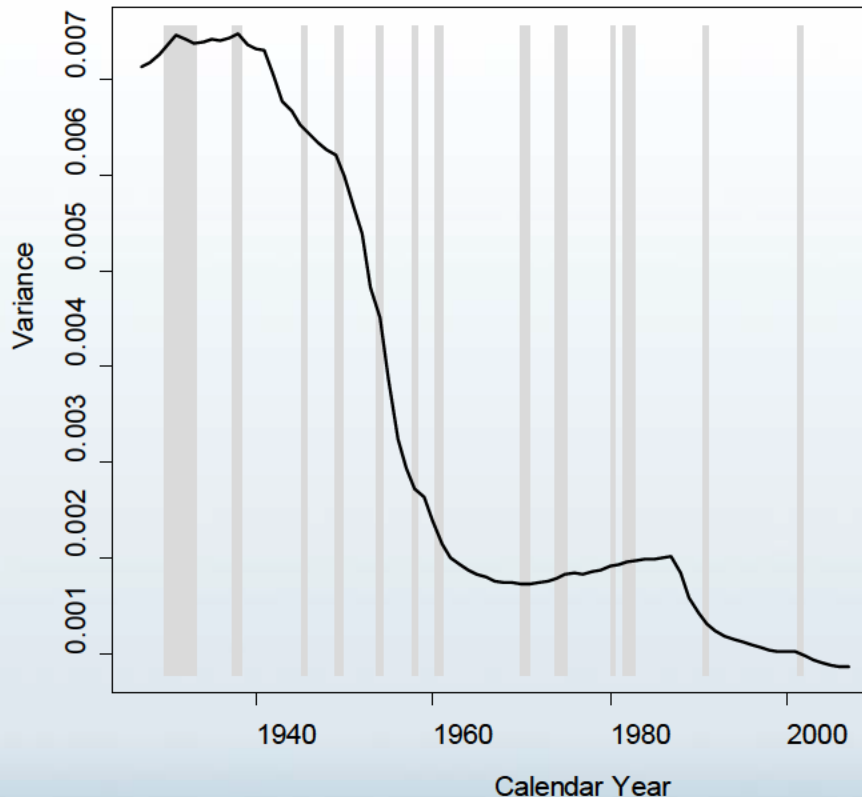


- The business cycle (i.e., fluctuations in economic activity) manifests itself in the autoregressive process
- Such autoregressive process is net of trend and (white) noise in measurement
- By definition, the autoregressive process is centered on zero

Manufacturing: 1927-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

Variance of Autoregressive Process

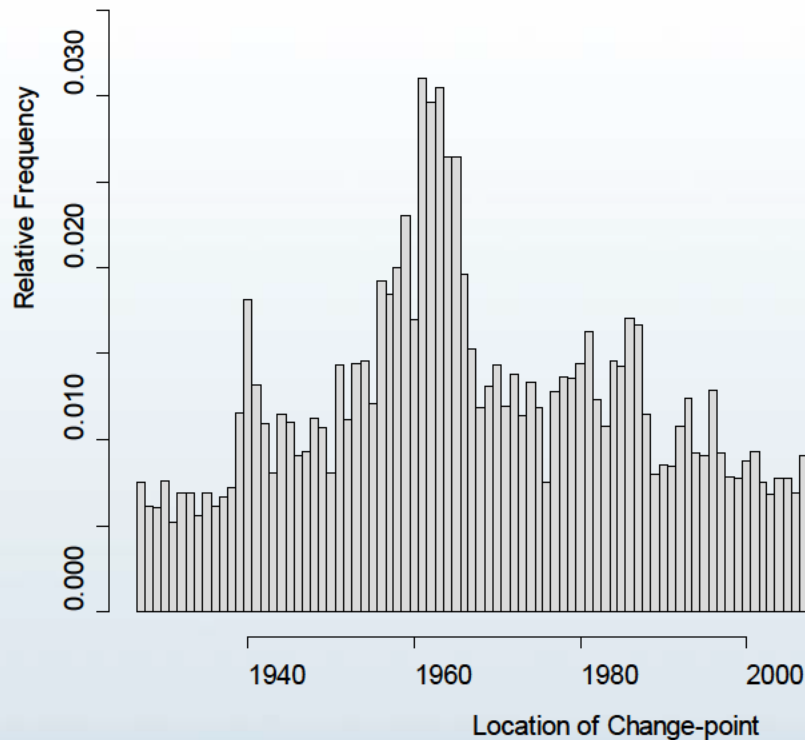


- The variance of the autoregressive process has decreased sharply over time, thus indicating that deviations from trend have become smaller

Manufacturing: 1927-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

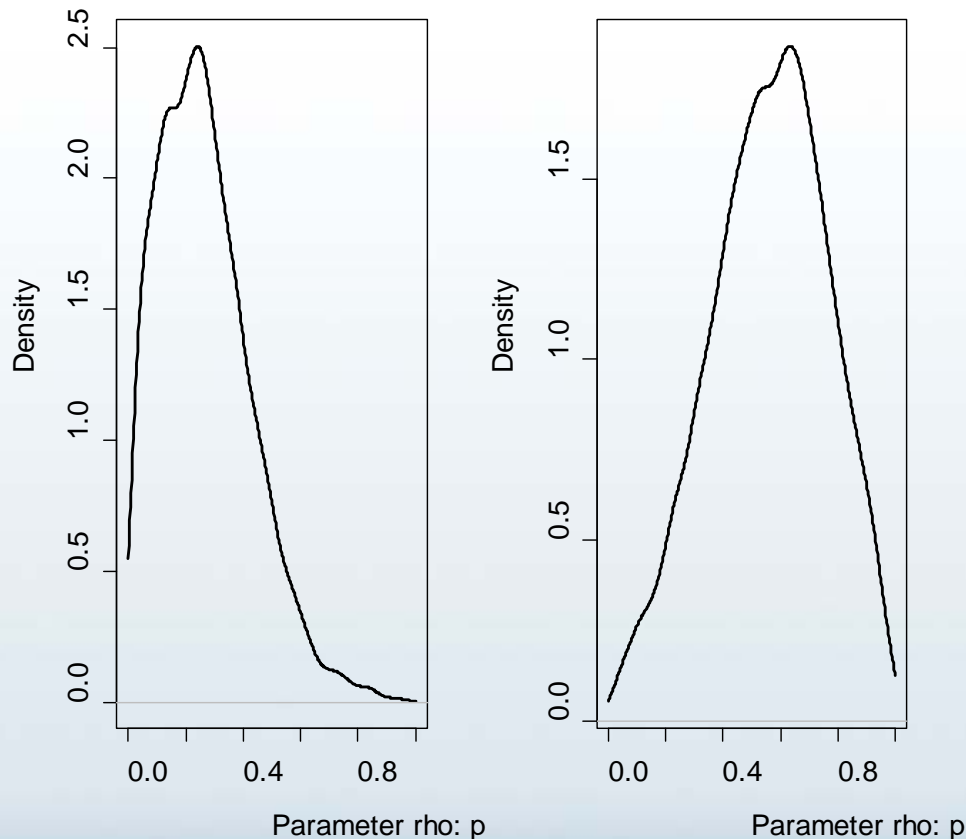
Posterior Distribution of Change-point of Autoregressive Coefficient (ρ)



- The posterior distribution of the autoregressive coefficient (ρ), which gauges the degree of persistence of deviations from trend, indicates a change-point in the early 1960s

Manufacturing: 1927-2007
Prior distribution: Beta(1.3,1.3) on the interval (1927,2007); mode: 1961
Data source: BLS (Bureau of Labor Statistics), www.bls.gov

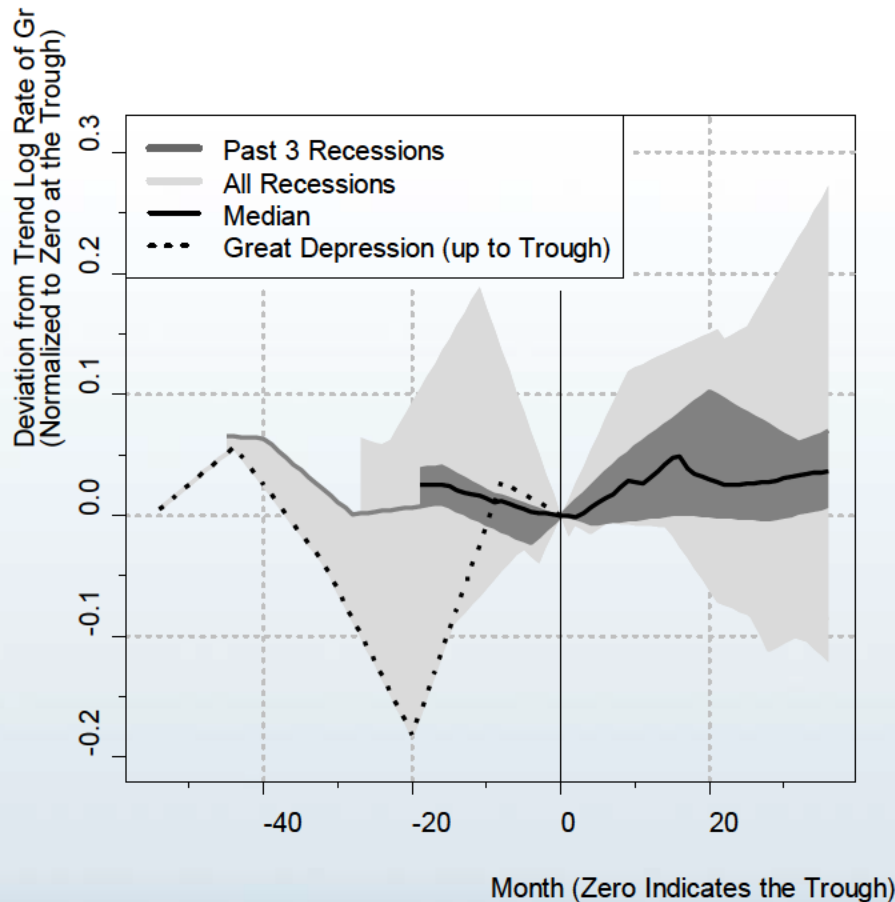
Autoregressive Coefficient (rho)



- The degree of persistence of deviations from trend, as measured by the autoregressive coefficient (ρ), has increased over time
- At the same time, such deviations from trend tend to be smaller, as argued above

Pre-change-point AR(1) coefficient to the left (mode: 0.24);
post-change-point AR(1) coefficient to the right (mode: 0.63);
prior: Beta(1.3,1.3)

Frequency Growth Rate over the Business Cycle

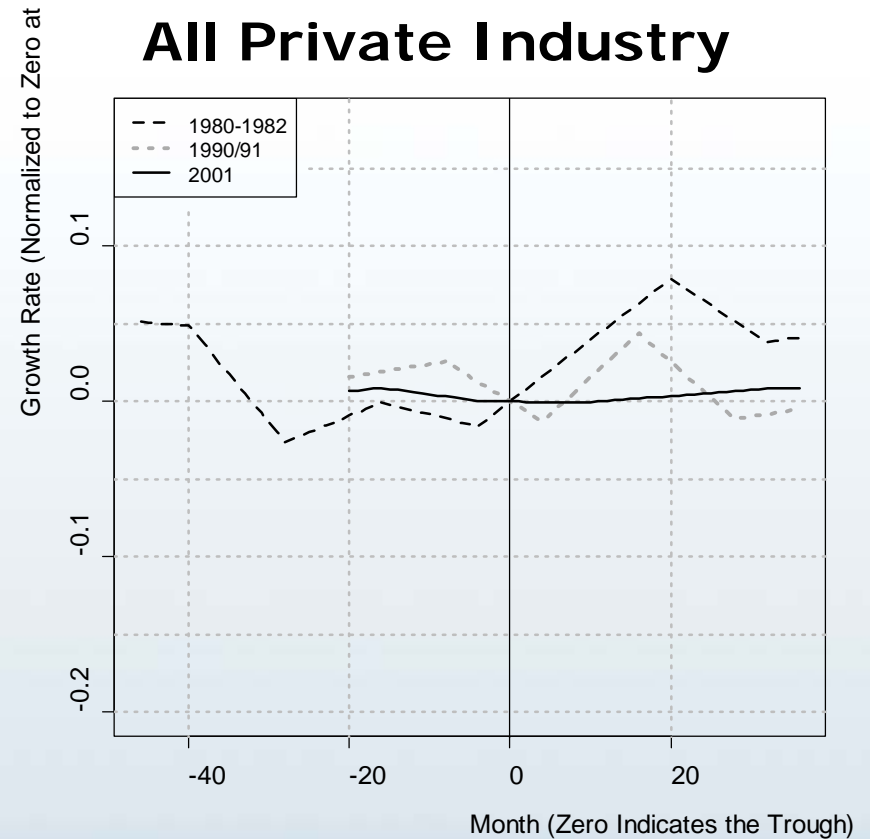
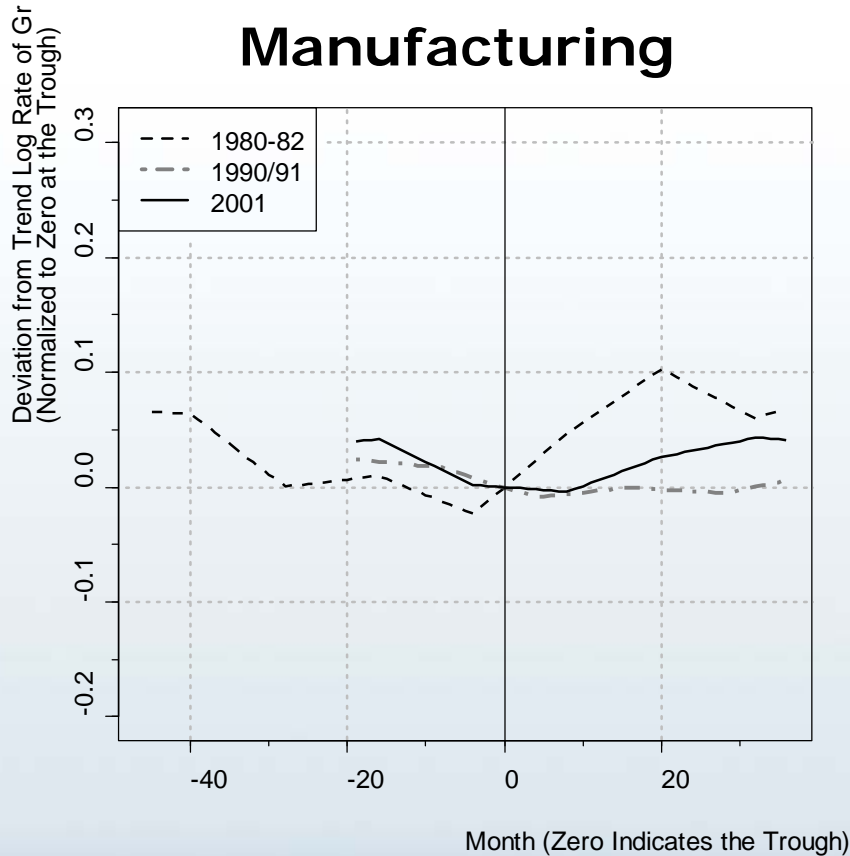


- The chart summarizes all recessions since (and inclusive of) the Great Depression
- During the course of a recession, the frequency growth rate tends to drop by 2.5 percentage points
- During the economic recovery, this growth rate rises sharply; it overshoots its pre-recession level by about 2.5 percentage points, before settling back down—this process ends 24 months into the recovery

Manufacturing: 1927-2007

The chart rests on the estimated autoregressive process. The gray areas are envelopes of chart lines that start 12 months prior to the onset of the recession and end 36 months after the trough (i.e., end of the recession). There are 12 recessions, treating the 1980 and 1981/82 recessions as a single event

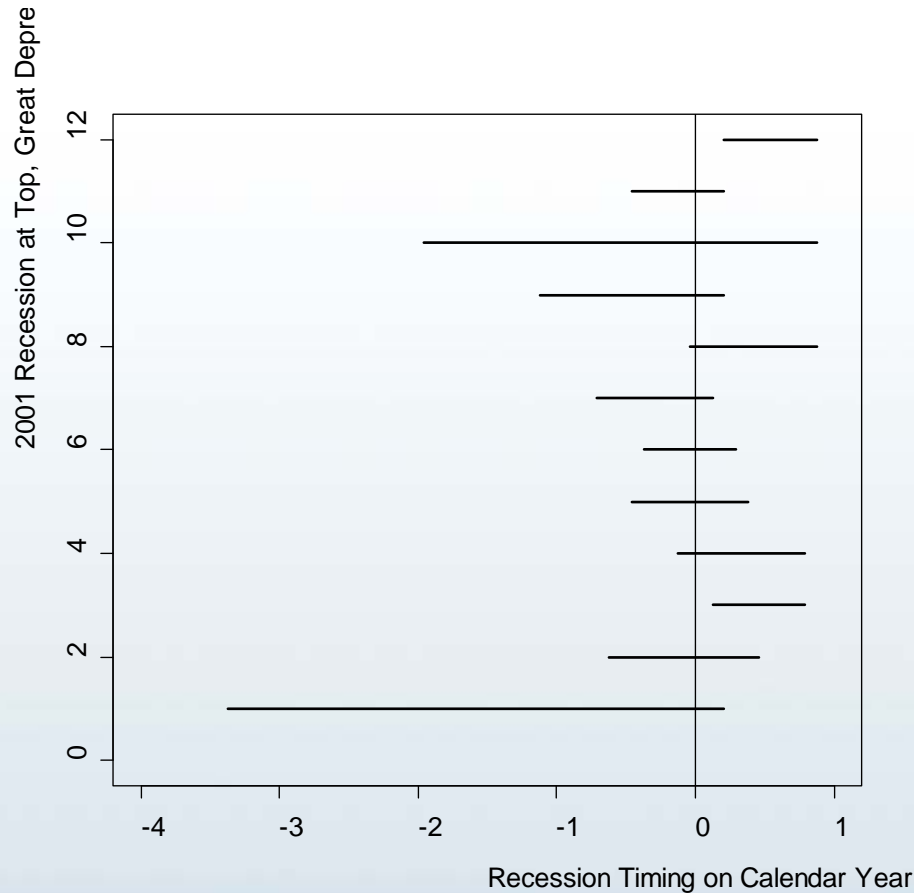
Manufacturing and All Private Industry in Comparison: Past 3 Recessions



Manufacturing: 1927-2007
 All Private Industry: 1973-2007

The chart rests on the estimated autoregressive process. The lines start 12 months prior to the onset of the recession and end 36 months after the trough (i.e., end of the recession). Displayed are the past three recessions, treating the 1980 and 1981/82 recessions as a single event

Caveat: Imperfect Time Match



- Recessions do not all line up the same way on the calendar year axis
- This timing mismatch introduces noise into the analysis

Recession ends in calendar year to the right of the vertical line at zero; 1980/1981 recessions are treated as one recession; final recession (#12): 2001

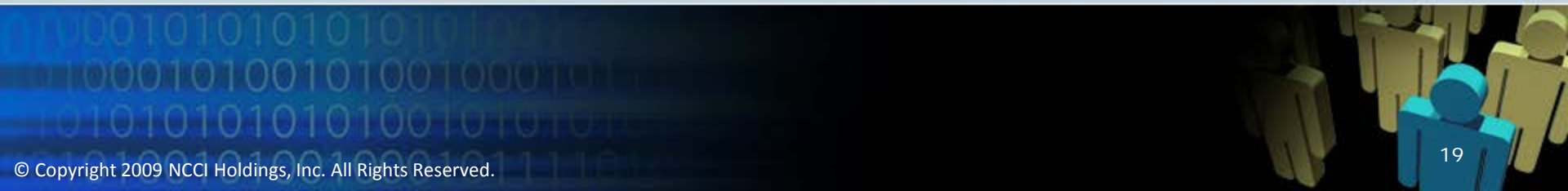
Data source: NBER (National Bureau of Economic Research), www.nber.org

Structural Time Series Model

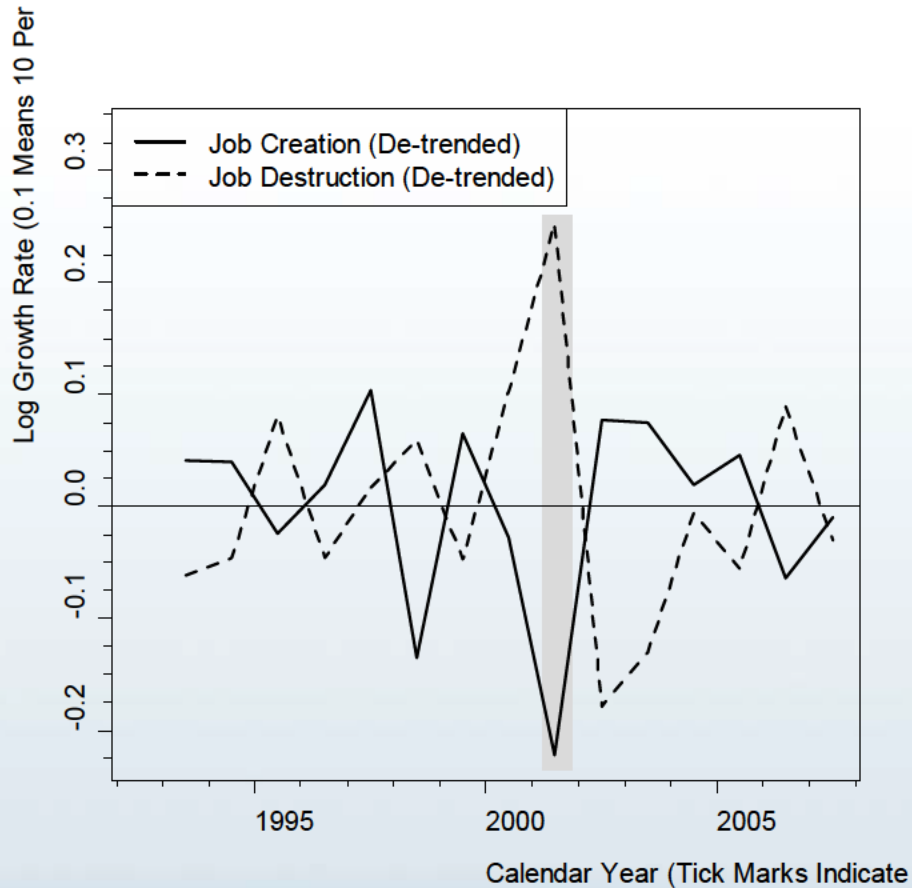
- The time series model for frequency growth is expanded to a structural model
 - Structural time series models allow for covariates (explanatory variables)
 - Two alternative sets of covariate are employed, both of which range from 1993 through 2007
 - (A) Growth rates of (1) job creation and (2) job destruction
 - (B) Growth rates of job creation at...
 - (1) existing establishments (“expansions”) and at
 - (2) opening establishments (“openings”)
 - Growth rates of job destruction at...
 - (3) continuing establishments (“contractions”) and at
 - (4) closing establishments (“closings”)

Explaining the Autoregressive Process in Frequency Growth

- It will be shown that the business cycle behavior of frequency growth (as it manifests itself in the autoregressive process) is driven by changes in job creation and destruction
 - For the time period for which there are covariates available, these covariates substitute for the autoregressive process
 - The covariates are de-trended (by means of centering on zero)—this way, the covariates do not bear on the estimated trend rate of growth
 - Covariates are available for 1993-2007
 - BLS data, manufacturing



The Covariates (A)

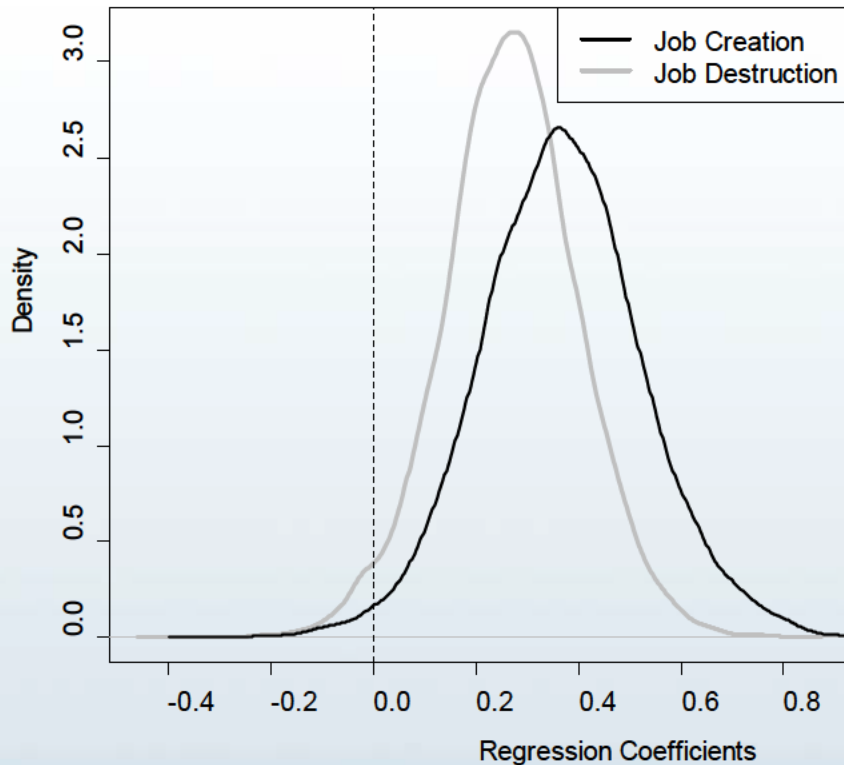


- At the onset of a recession, job creation slows and job destruction quickens

Manufacturing: 1993-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

The Evidence (A)



- Faster job creation is associated with an increase in the growth rate of the workplace injury and illness incidence rate
 - There is evidence of a positive relation between the likelihood of sustaining a workplace injury and job tenure (see next slide)
- Faster job destruction also increases the growth rate of the workplace injury and illness incidence rate
 - This finding is indicative of *moral hazard* (opportunistic behavior)

Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.367 (creation); 0.268 (destruction). The growth rates of job flows are calculated from Q4 numbers, thus affording newly created and destroyed jobs an average of six months to generate reported workplace injuries
Data source: BLS (Bureau of Labor Statistics), www.bls.gov

The Evidence (A)

Workplace Injuries and Job Tenure

Panel A: Manufacturing

Length of Service	Proportion of Injuries and Illnesses				
	2003	2004	2005	2006	2007
Less than 1 Year	0.237	0.290	0.307	0.311	0.300
1 to 5 Years	0.325	0.311	0.287	0.297	0.311
5 Years or More	0.435	0.396	0.402	0.386	0.382
Not Reported	0.003	0.003	0.004	0.006	0.007

- There is a strong link between the likelihood of sustaining a work-related injury or illness and the length of service with the current employer

Panel B: All Private Industry

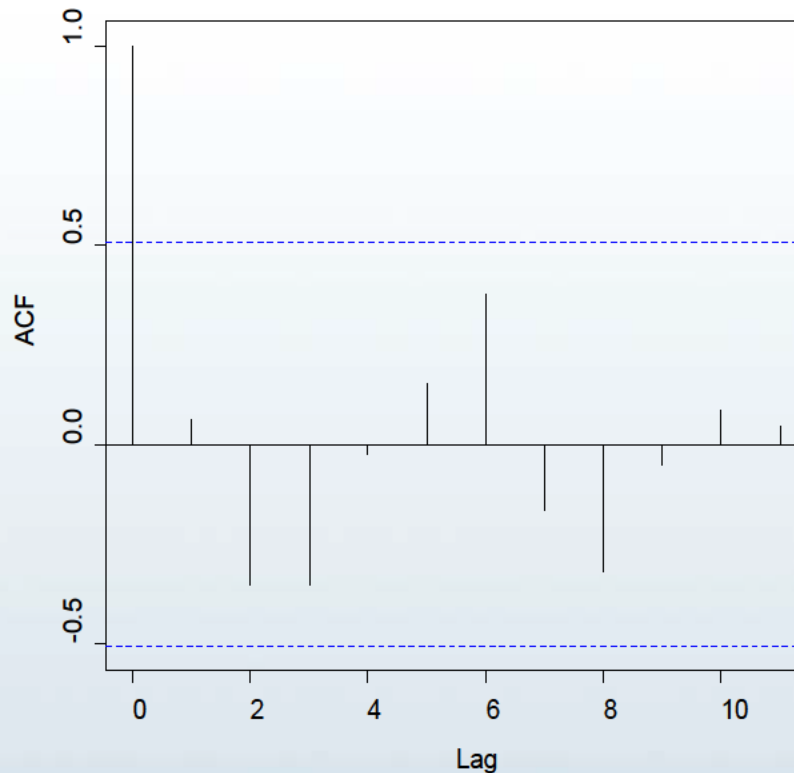
Length of Service	Proportion of Injuries and Illnesses					Proportion of Employment	
	2003	2004	2005	2006	2007	2006	2008
Less than 1 Year	0.321	0.334	0.347	0.352	0.338	0.244	0.229
1 to 5 Years	0.366	0.355	0.338	0.334	0.348	0.291	0.299
5 Years or More	0.306	0.304	0.306	0.305	0.302	0.465	0.472
Not Reported	0.007	0.007	0.008	0.009	0.012	---	---

Distribution of nonfatal injury and illnesses by length of service with the current employer. Manufacturing employment is not available by length of service. Proportions may not add up to 1 due to rounding

Data source: BLS (Bureau of Labor Statistics), www.bls.gov

The Evidence (A)

Explaining the Autoregressive Process



- The chart displays (for various lag lengths, measured in years) autocorrelation functions for the residuals for the time period where the covariates substitute for the autoregressive process
- The autocorrelations functions do not indicate that the covariates insufficiently account for the deviations around trend of frequency growth

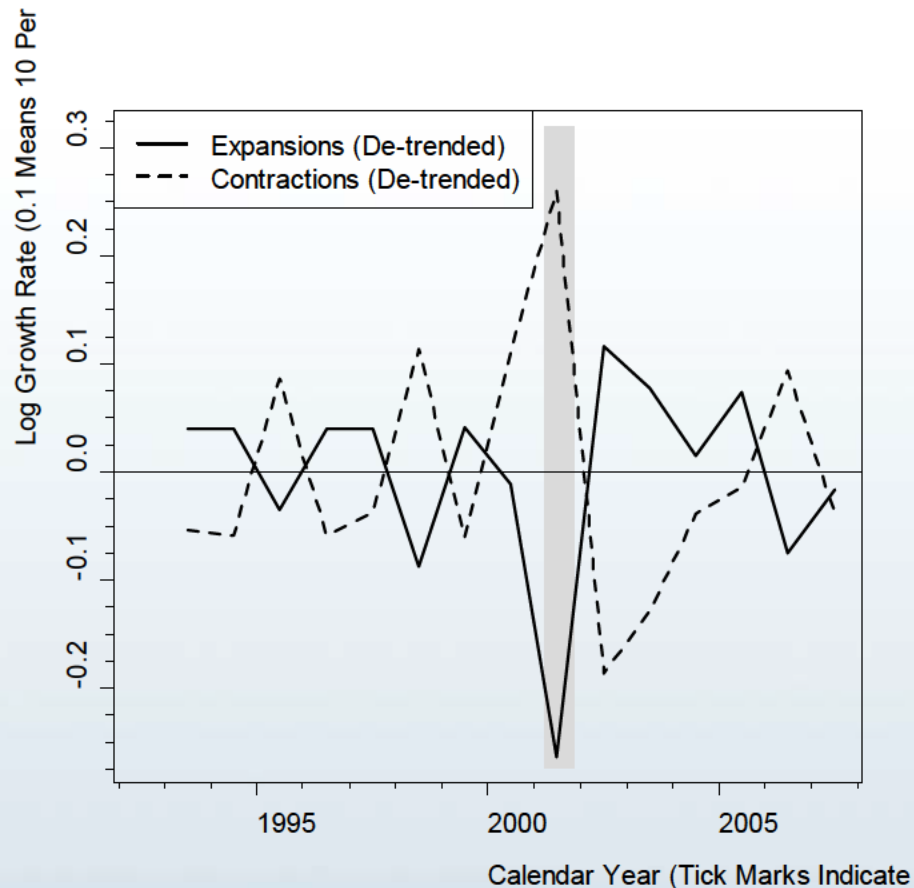
Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows)

Data source: BLS (Bureau of Labor Statistics), www.bls.gov

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The Covariates (B)

Expansions and Contractions



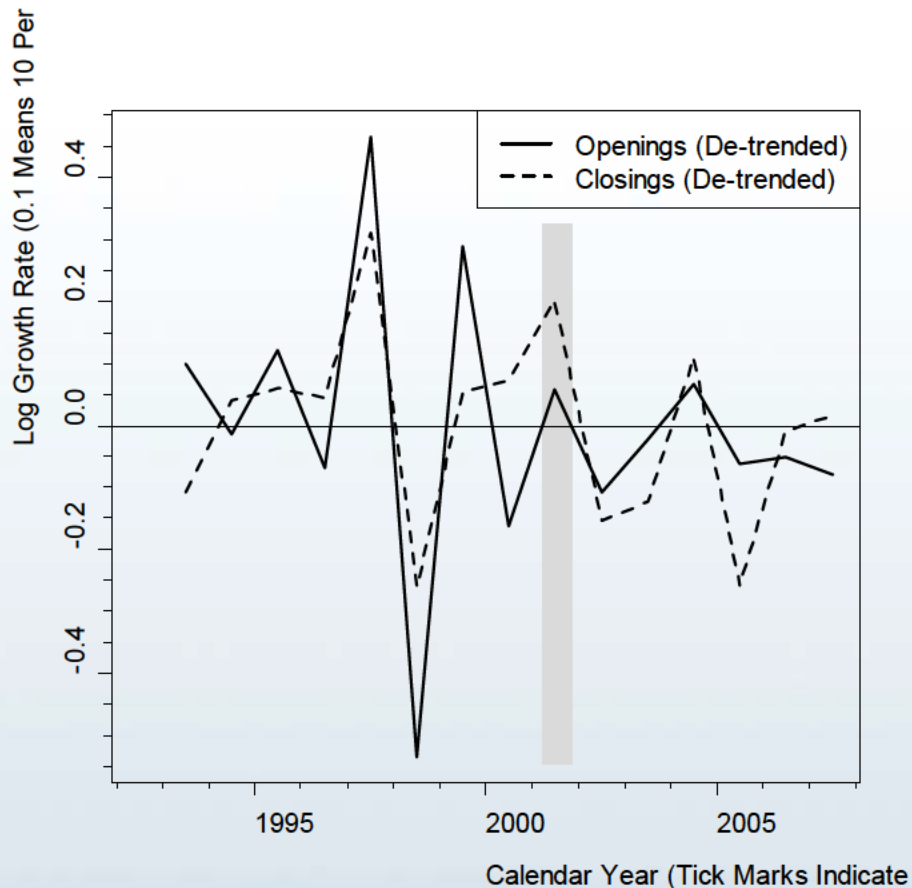
- Job creation by means of expansions at existing establishments and job destruction by means of contractions at continuing establishments make up the bulk of total job creation and destruction
- Hence, this chart resembles the one for total job creation and destruction shown above

Manufacturing: 1993-2007

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

The Covariates (B)

Openings and Closings



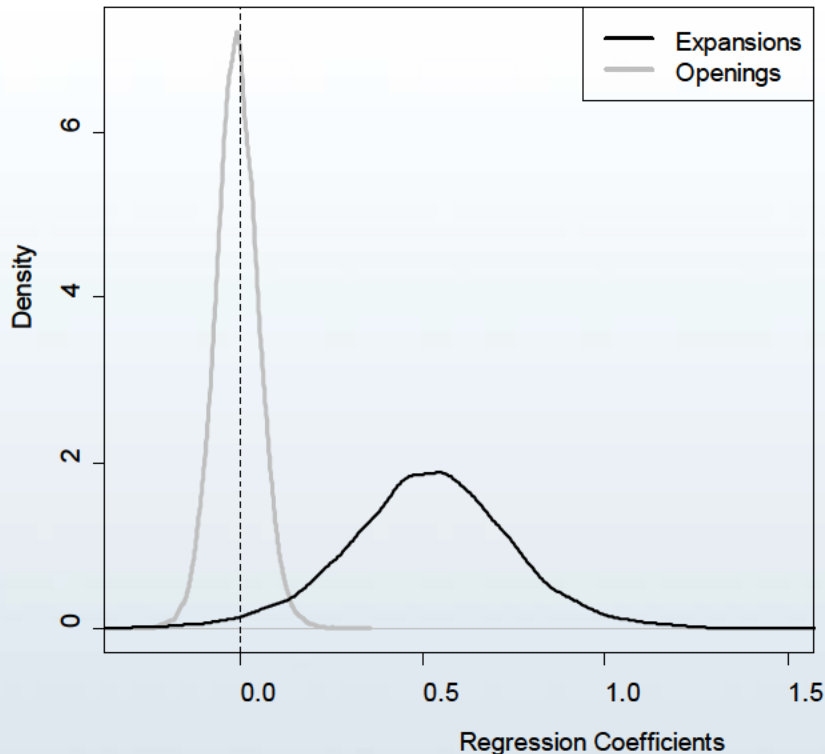
- Openings and closings responded more strongly to the 1997/1998 Asian Crisis than to the 2001 recession
- Unlike expansions and contractions, which are negatively correlated, openings and closings are positively correlated

Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows)

Data source: BLS (Bureau of Labor Statistics), www.bls.gov; recession information: NBER (National Bureau of Economic Research), www.nber.org

The Evidence (B)

Expansions and Openings



- Faster job creation due to expansions at existing establishments leads to an increase in the growth rate of the workplace injury and illness incidence rate
 - As discussed, there is a positive relation between high incidence rates and short job tenure
- Faster job creation that arises from the opening of new establishments leaves the growth rate of the workplace injury and illness incidence rate unaffected
 - Possibly, new establishments provide for safer workplaces by design

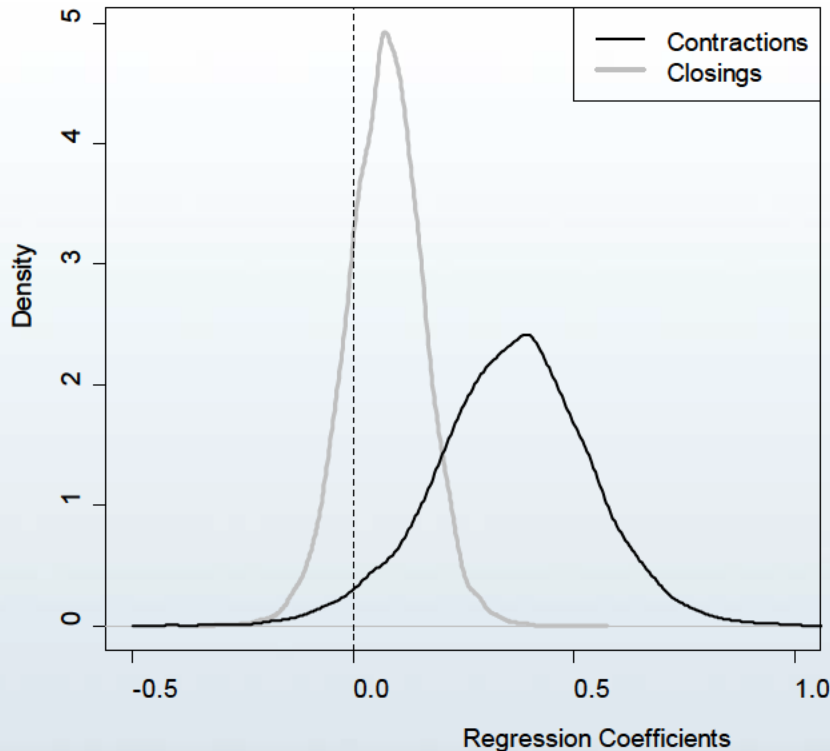
Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.517 (expansions); -0.010 (openings). The job creation and destruction growth rates are calculated from Q4 numbers, thus affording newly created and destroyed jobs an average of six months to generate reported workplace injuries

Data source: BLS (Bureau of Labor Statistics), www.bls.gov

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The Evidence (B)

Contractions and Closings



- Faster job destruction due to contractions of continuing establishments leads to an increase in the growth rate of the workplace injury and illness incidence rate
- Faster job destruction as caused by closings of establishments also increases the growth rate of the workplace injury and illness incidence rate
- Again, these two findings are indicative of *moral hazard* (opportunistic behavior)

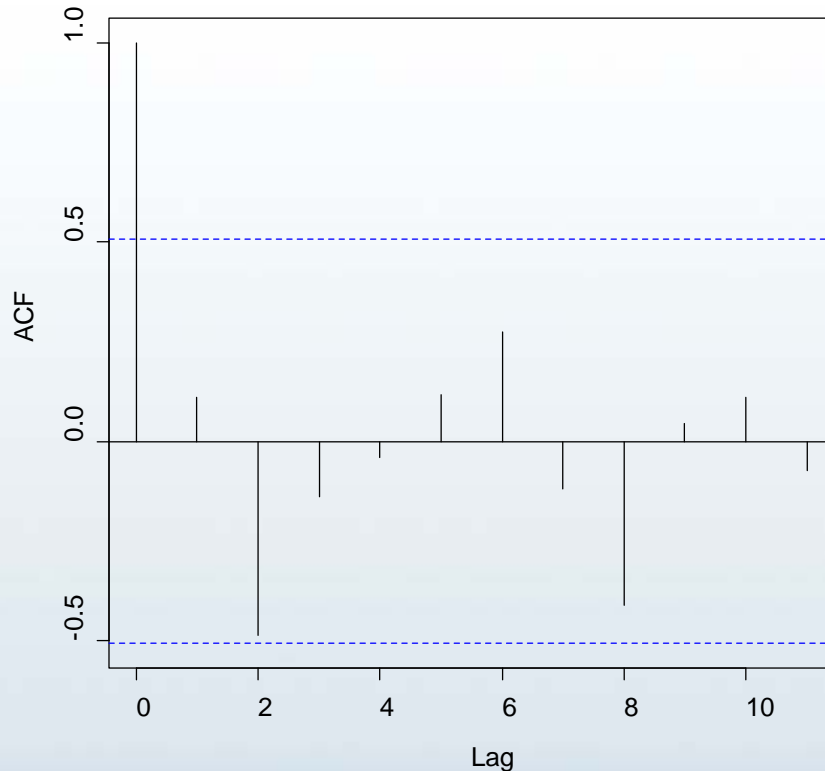
Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.361 (contractions); 0.074 (closings). The growth rates of job flows are calculated from Q4 numbers, thus affording newly created and destroyed jobs an average of six months to generate reported workplace injuries

Data source: BLS (Bureau of Labor Statistics), www.bls.gov

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The Evidence (B)

Explaining the Autoregressive Process



- Again, the chart displays autocorrelation functions for the residuals for the time period where the covariates substitute for the autoregressive process
- Here too, the autocorrelations functions do not indicate that the covariates insufficiently account for the deviations around trend of frequency growth

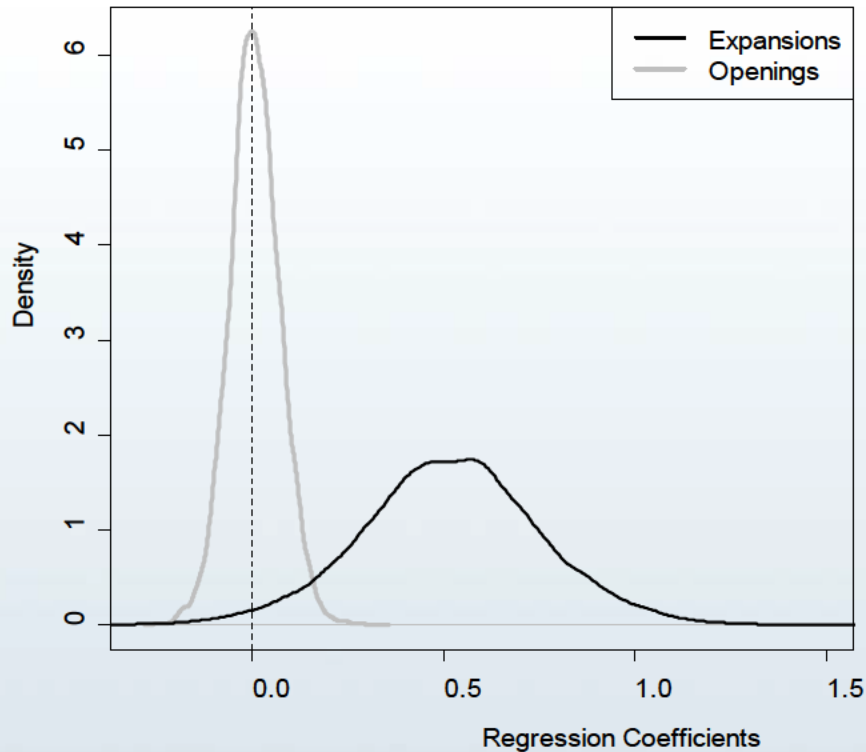
Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows)

Data source: BLS (Bureau of Labor Statistics), www.bls.gov

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The Evidence (B)

Openings with Six-month Lag

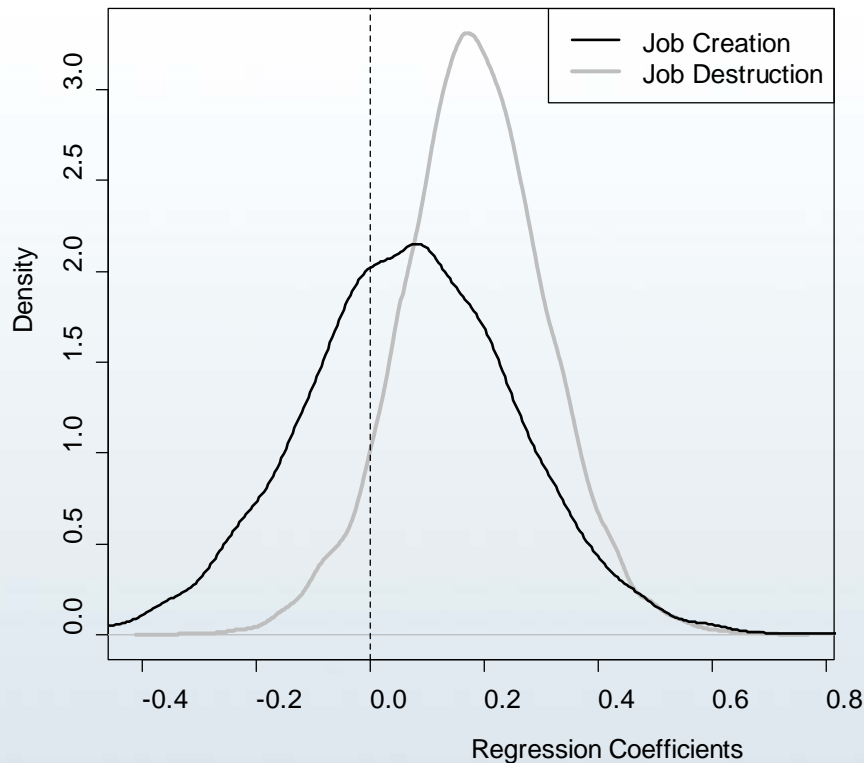


- It may be argued that the lack of evidence for openings having an effect on frequency is due to the yet short lifespan of these establishments
 - The average age of a job created at a new establishments is the same as at an expanding establishment: half a year
- As a sensitivity analysis, the model is re-estimated with the growth rate of job creation at openings calculated from Q2 (instead of Q4) numbers, and with the other three covariates unaltered
 - The introduction of a six-month lag for job creation at openings does not alter the regression results

Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.519 (creation); 0.005 (destruction). Due to switching to Q2 numbers for openings, the time window for the covariates shortens by one year (BLS job flow numbers are not available before Q3/1992)

Data source: BLS (Bureau of Labor Statistics), www.bls.gov

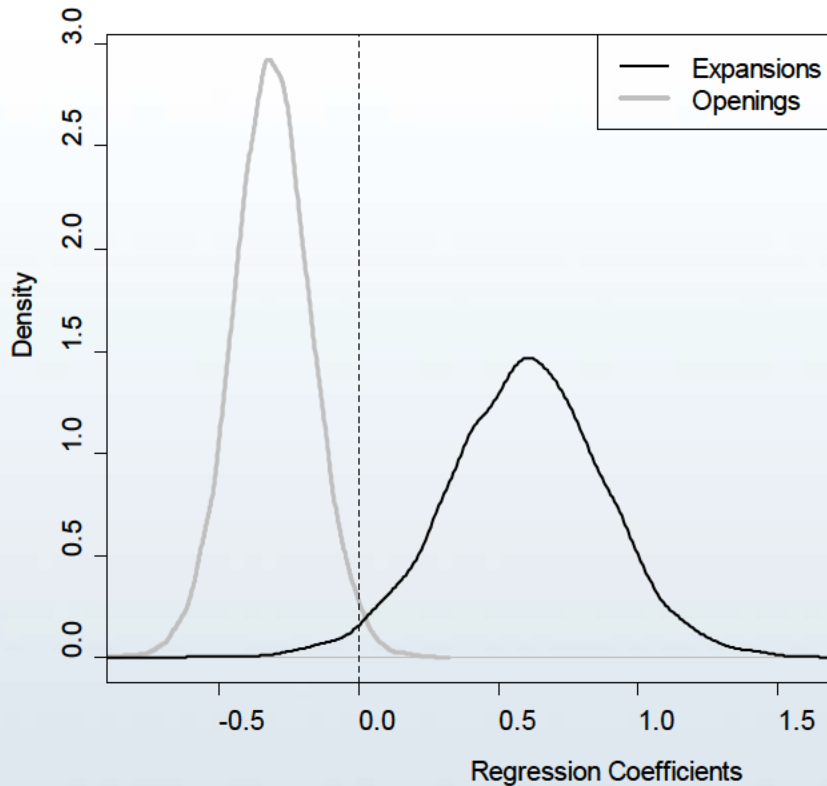
All Private Industry: The Evidence (A)



- Similar to manufacturing, there is strong evidence in support of a positive relation between the growth rates of frequency and of job destruction
- On the other hand, contrary to manufacturing, there is only mild evidence for a positive relation between frequency growth and job creation
- The reason for the weak impact of job creation becomes apparent when studying the posterior distributions of the second set of covariates (next slide)

All private industry: 1973-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.068 (creation); 0.183 (destruction). The growth rates of job flows are calculated from Q4 numbers, thus affording newly created and destroyed jobs an average of six months to generate reported workplace injuries
Data source: BLS (Bureau of Labor Statistics), www.bls.gov

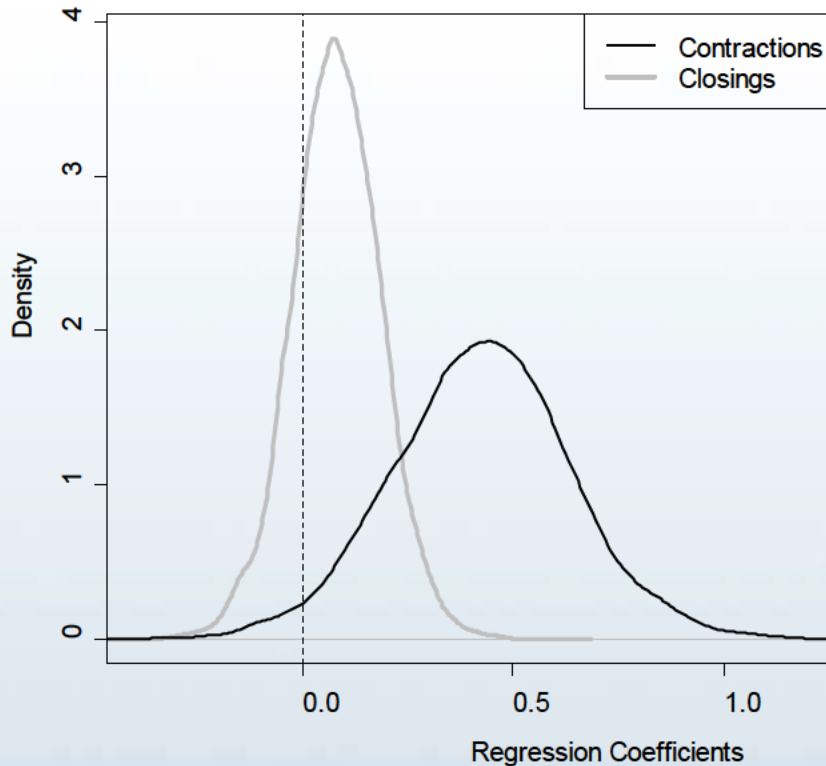
All Private Industry: The Evidence (B) Expansions and Openings



- The effect of expansions on frequency is similar to what has been established for manufacturing, but the impact of openings is very different
- Whereas for manufacturing, the posterior distribution for openings was centered on zero, there is strong evidence that for all private industry, the relation between the growth rates of frequency and job creation at openings is negative

All private industry: 1973-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.598 (expansions); -0.307 (openings). The growth rates of job flows are calculated from Q4 numbers, thus affording newly created and destroyed jobs an average of six months to generate reported workplace injuries
Data source: BLS (Bureau of Labor Statistics), www.bls.gov

All Private Industry: The Evidence (B) Contractions and Closings

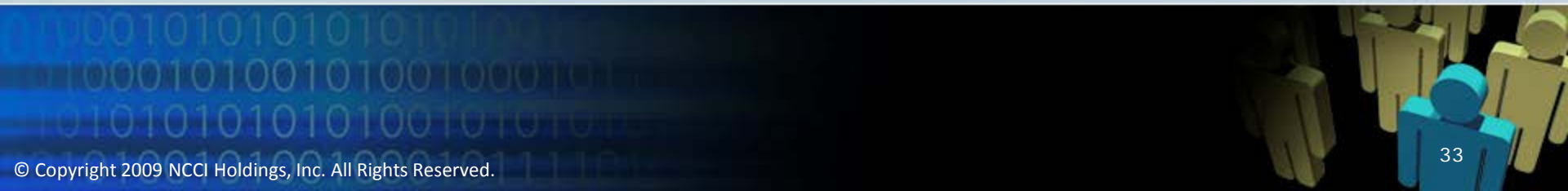


- For contractions and closings, the posterior distributions are similar to those in manufacturing, thus indicating the presence of moral hazard

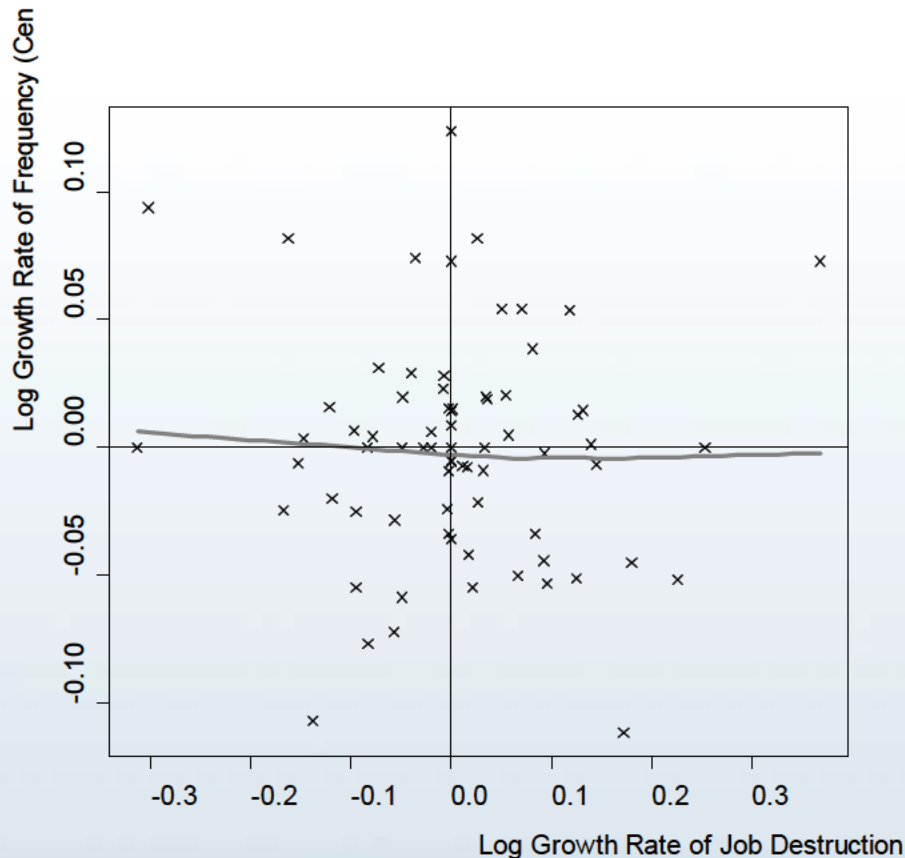
Manufacturing: 1927-2007 (frequency growth), 1993-2007 (growth of job flows). Means: 0.425 (contractions); 0.080 (closings). The growth rates of job flows are calculated from Q4 numbers, thus affording newly created and destroyed jobs an average of six months to generate reported workplace injuries
Data source: BLS (Bureau of Labor Statistics), www.bls.gov

Checking on Observational Equivalence: Moral Hazard (1)

- Is there an alternative explanation for the positive relation between the growth rates of frequency and job destruction?
 - If the growth of job destruction occurs primarily in industries with below-average frequency growth, then the relation between the two variables is positive, thus generating data that is equivalent to what is observed in the presence of moral hazard



Checking on Observational Equivalence: Moral Hazard (2)



- The scatterplot provides no compelling evidence for the growth of job destruction disproportionately affecting industries of low frequency growth
- This finding supports the hypothesis that the established empirical evidence originates in moral hazard

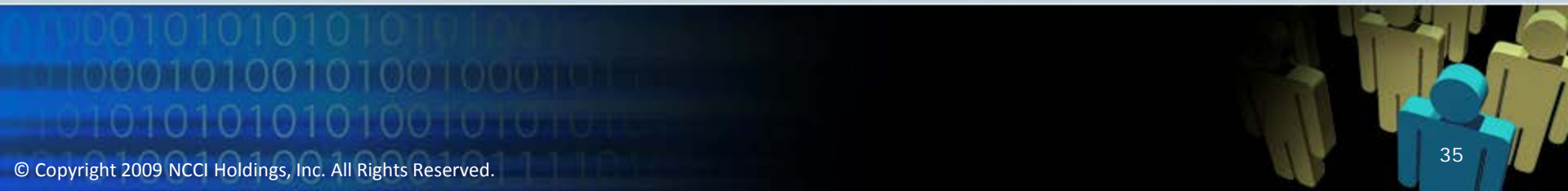
All private industry: 1993-2002. Frequency and job destruction are by industry: Agriculture, Forestry and Fishing, Mining, Construction, Manufacturing, Transport and Public Utilities, Wholesale Trade, Retail Trade, Finance, Insurance and Real Estate, and Services; these industries add up to the private sector. The industry classification rests on SIC (Standard Industrial Classification). All values are centered on the calendar year median across industries. Job flows are as of March 12. The scatterplot smoother (gray line) is LOESS with a unit smoothing parameter

Data source: Bureau of Labor Statistics (frequency; www.bls.gov) and Census Bureau (job flows; www.census.gov)

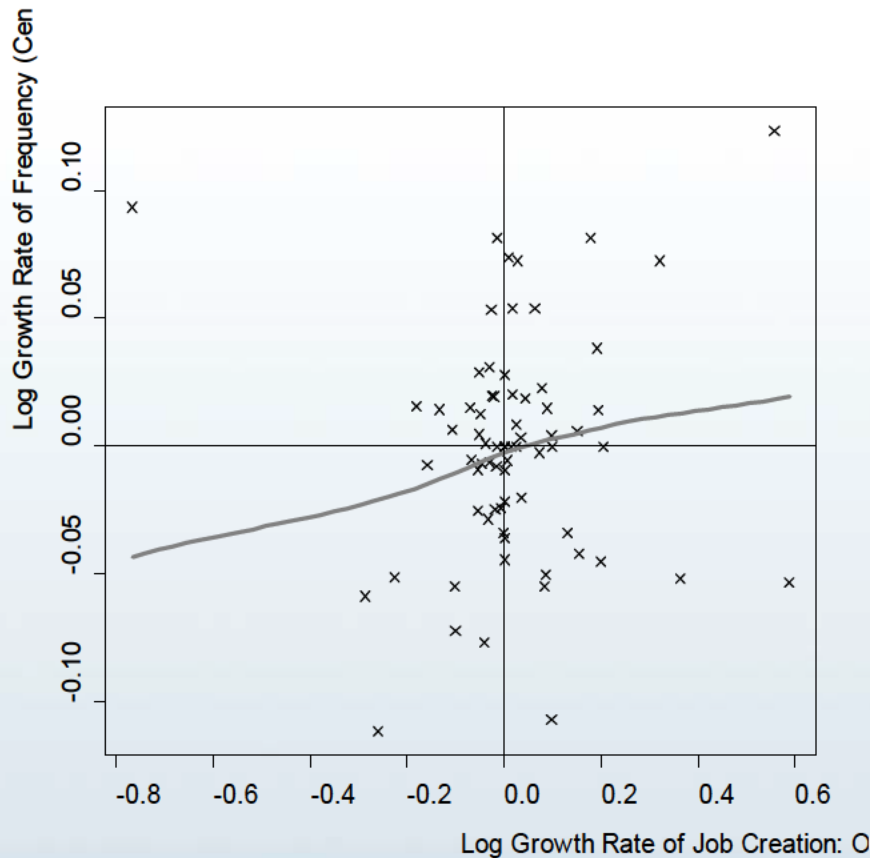
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Checking on Observational Equivalence: Workplaces at Openings are Safer (1)

- Is there an alternative explanation for the negative relation between the growth rates of frequency and job creation at openings?
 - If the growth of job creation at openings occurs primarily in industries with below-average frequency growth, then the relation between the two variables is negative, thus generating data that is equivalent to what is observed when workplaces at openings are safer than existing workplaces



Checking on Observational Equivalence: Workplaces at Openings are Safer (1)

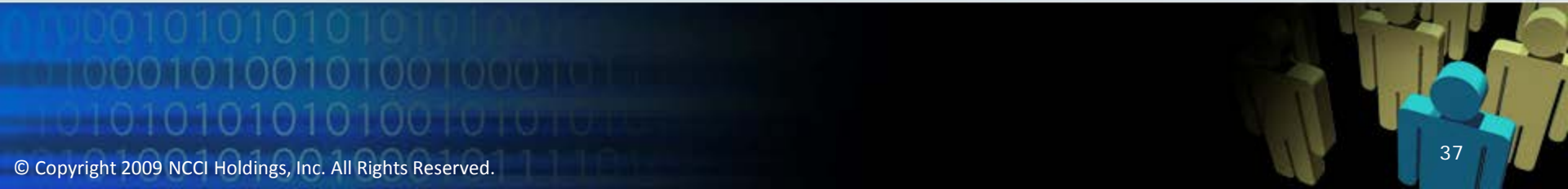


- The scatterplot provides no evidence for the growth of job creation at openings disproportionately affecting industries of low frequency growth
- This finding agrees with the hypothesis that new workplaces at openings are safer by design

All private industry: 1993-2002. Frequency and job creation are by industry: Agriculture, Forestry and Fishing, Mining, Construction, Manufacturing, Transport and Public Utilities, Wholesale Trade, Retail Trade, Finance, Insurance and Real Estate, and Services; these industries add up to the private sector. The industry classification rests on SIC (Standard Industrial Classification). All values are centered on the calendar year median across industries. Job flows are as of March 12. The scatterplot smoother (gray line) is LOESS with a unit smoothing parameter
Data source: Bureau of Labor Statistics (frequency; www.bls.gov) and Census Bureau (job flows; www.census.gov)

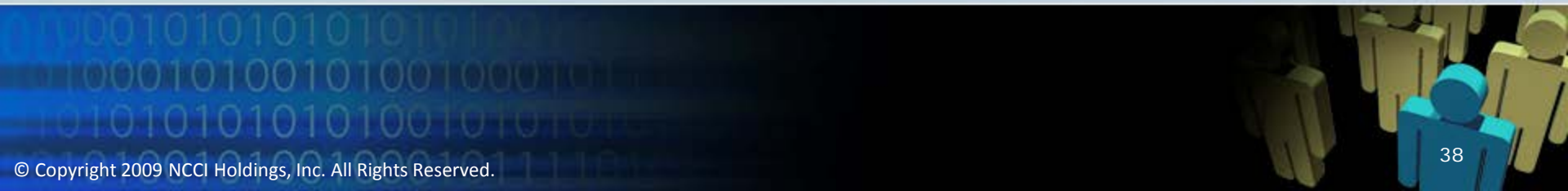
Conclusions: Explaining the Trend

- The nonfatal workplace injury and illness incidence rates in manufacturing and the private sector have experienced steep declines over their respective recorded histories
- By 2007, the incidence rate for the private sector had dropped to 40 percent of its 1972 value (which is the first value on record)
- It was shown (for the period 1977-2000) that only 15 percent of this decline is due to structural change in the economy; the remaining 85 percent are due to workplaces being safer by design



Conclusions: Business Cycle Sensitivity

- There is a “the dog that did not bark” issue to the behavior of the growth rate of the injury and illness incidence rate during recessions
- This growth rate does not drop because of the jobs that are destroyed (which lengthens the average job tenure if short-tenured workers are overrepresented in layoffs), but because of the jobs that are not created



Conclusions:

Safer Workplaces through Openings

- There is an important difference between jobs created at existing establishments (expansions) and jobs created at openings
 - Whereas an acceleration of job creation through expansions increases frequency growth, a quickening of job creation through openings has the opposite effect for the private sector and no effect for manufacturing
 - This finding suggests that workplaces at openings are safer than the average existing workplace, thus pointing to new establishments as an important avenue toward safer workplaces

Appendix: Caveat

- “BLS occupational injury and illness numbers come from the BLS annual Survey of Occupational Injuries and Illnesses,” which “captures data from Occupational Safety and Health Administration (OSHA) logs of workplace injuries and illnesses maintained by employers” (www.bls.gov/iif)
- A 2006 study published in the Journal of Environmental Medicine documented “missing cases in individual firms, as determined by comparisons between BLS and state workers compensation data” (www.bls.gov/iif)