From Population Growth to Firm Demographics:
Implications for Concentration, Entrepreneurship and the Labor Share

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Motivation

- Puzzling aggregate trends in the US since 1980s
  - Decline in the **firm entry rate** (14% to 8%)
  - Decline in **firm exit rate** (9.7% to 7.7%)
  - Increase in **average firm size** (20 to 24 employees)
  - Increase in (employment) **concentration** (51% to 58%)
  - Decline in the (corporate) **labor share** (66% to 60%)

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  - Increase in (employment) **concentration** (51% to 58%)
  - Decline in the (corporate) **labor share** (66% to 60%)
- What explains this?
  - We look at population growth + firm demographics

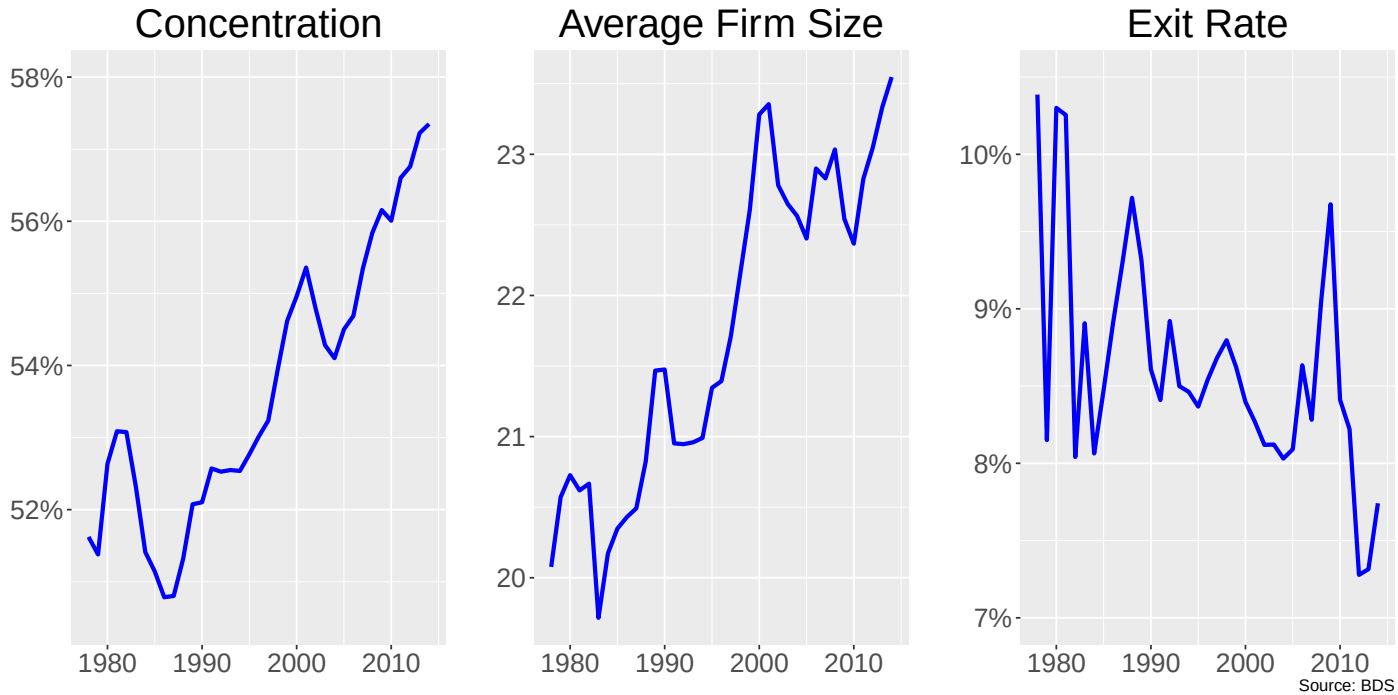
Outline

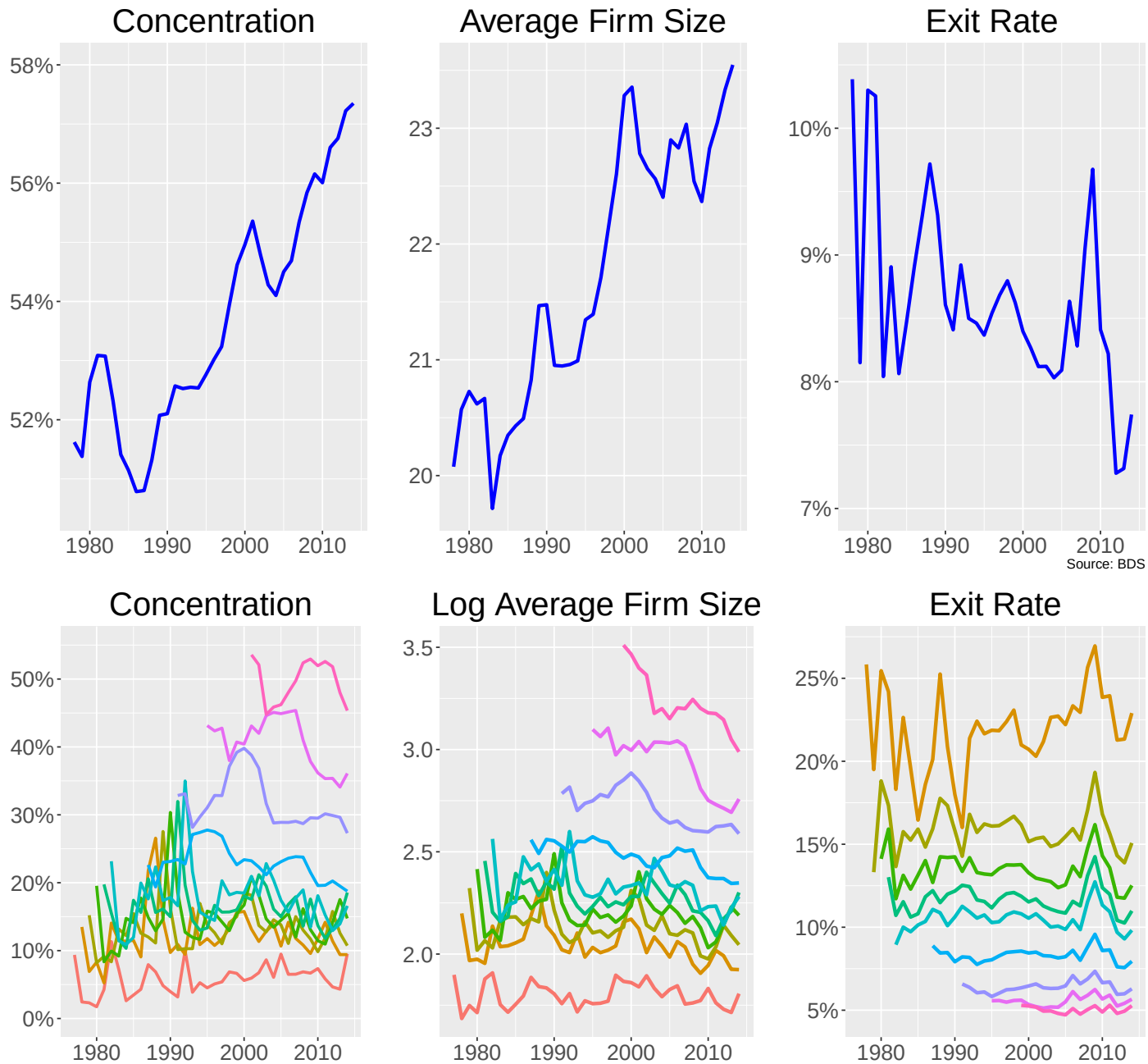
- Why population growth + firm demographics?
  - Document new facts
  - Feedback effects
- Theory
- Accounting
- Calibration
- Results

Overview of Results

- Reallocation across firm-age groups accounts for
  - Concentration
  - Average firm size
  - Exit rates
  - Labor share
- Declining entry rates generate the reallocation
- Declining population growth lowers entry rate
- Feedback from firm demographics to entry is 2/3 of the effect

Motivating Evidence


Concentration
58%
56%
54%
52%
1980
1990
2000
2010
Average Firm Size
23
22
21
20
1980
1990
2000
2010
Exit Rate
10%
9%
8%
7%
1980
1990
2000
2010
Source: BDS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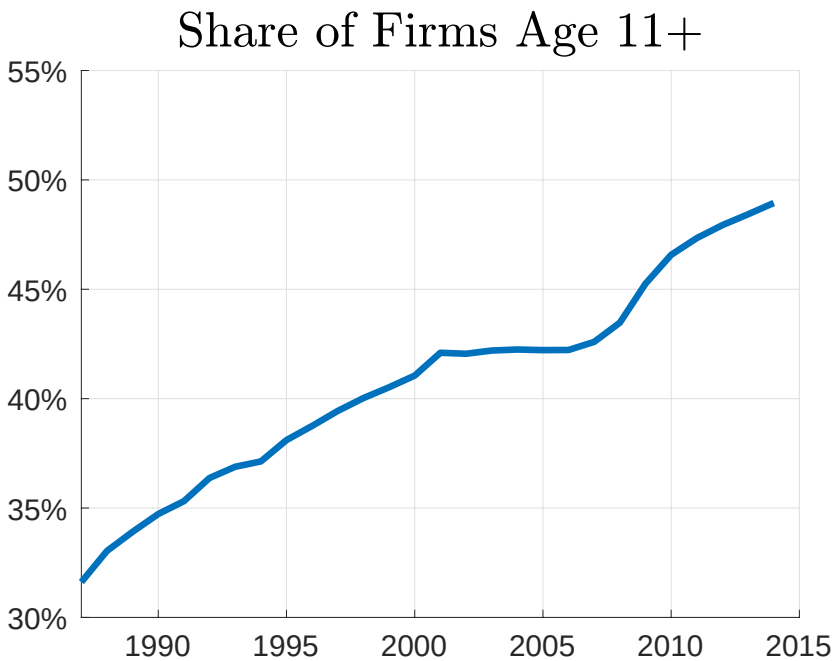
1990
2000
2010
Source: BDS
Concentration
50%
40%
30%
20%
10%
0%
1980
1990
2000
2010
Log Average Firm Size
3.5
3.0
2.5
2.0
1980
1990
2000
2010
Exit Rate
25%
20%
15%
10%
5%
1980
1990
2000
2010
Firm age
a) 0
b) 1
c) 2
d) 3
e) 4
f) 5
g) 6 to 10
h) 11 to 15
i) 16 to 20
j) 21 to 25

Firms are Aging



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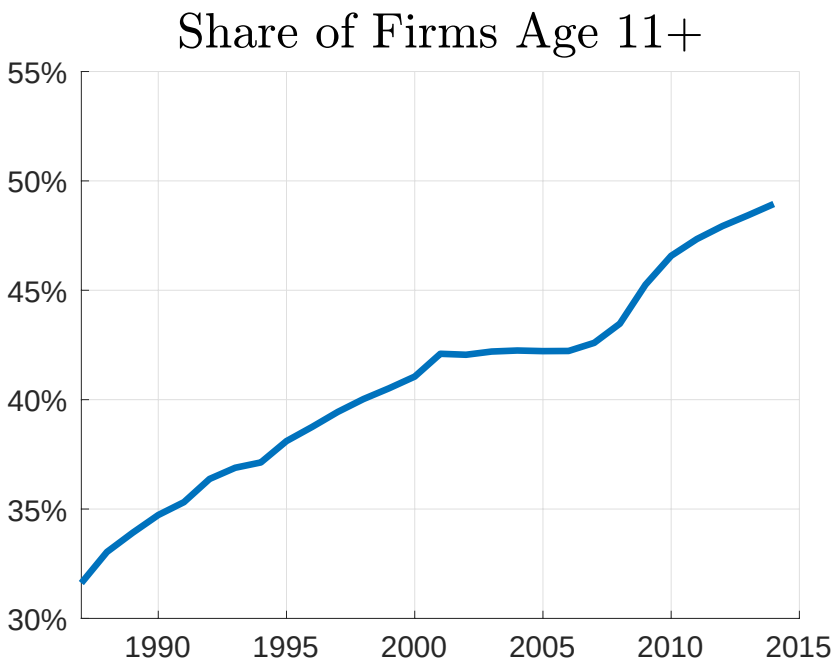

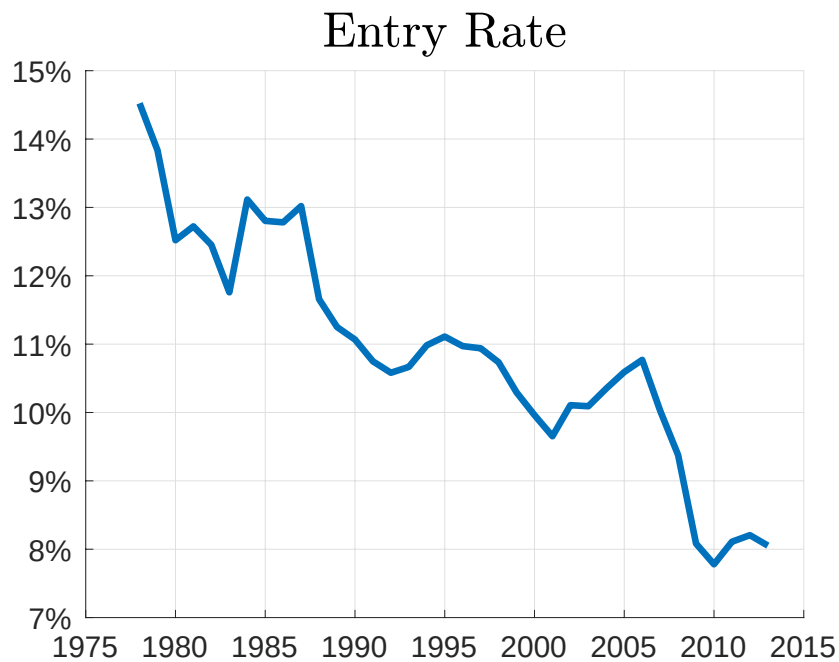

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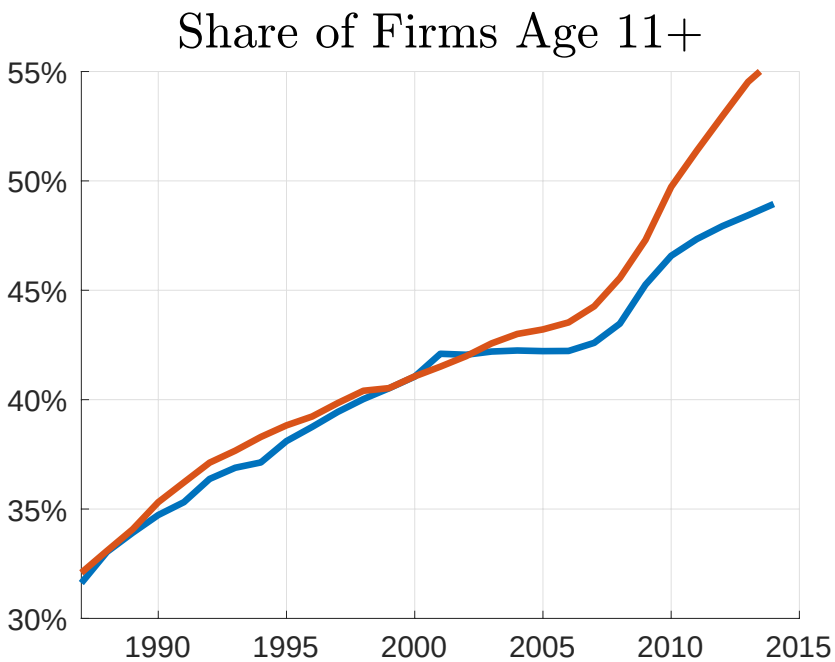

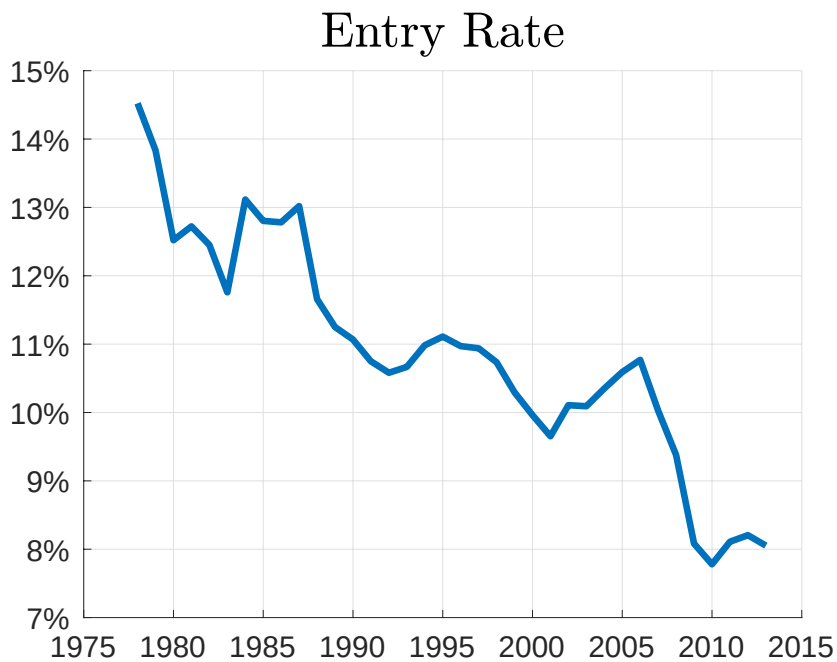

ΔPopulation Growth $\rightarrow$ ΔEntry Rates

- Average firm size:

$$e_t \equiv N_t / M_t$$

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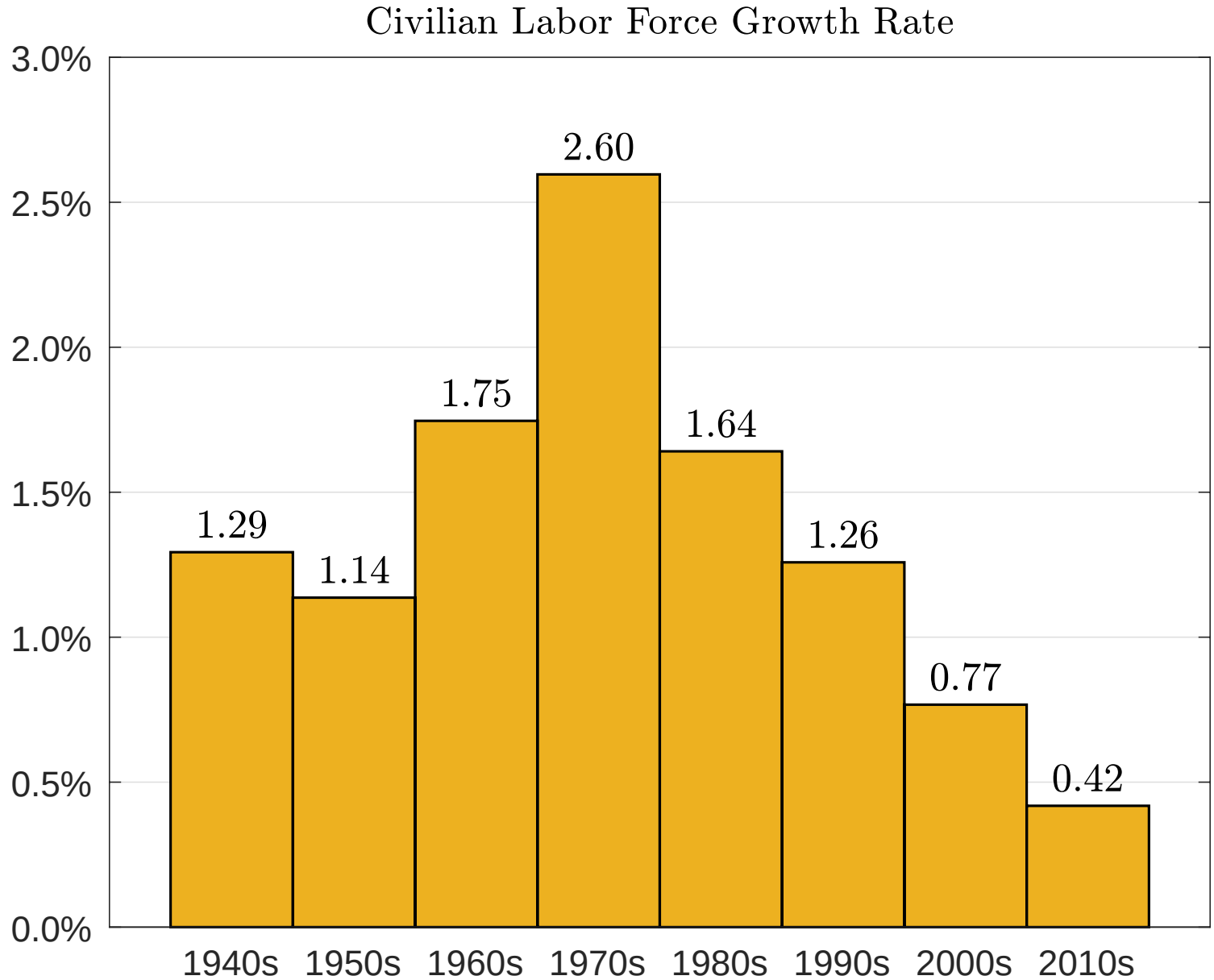
- Combining (1) and (2):

$$\lambda = \hat{N} - \hat{e} + \xi$$

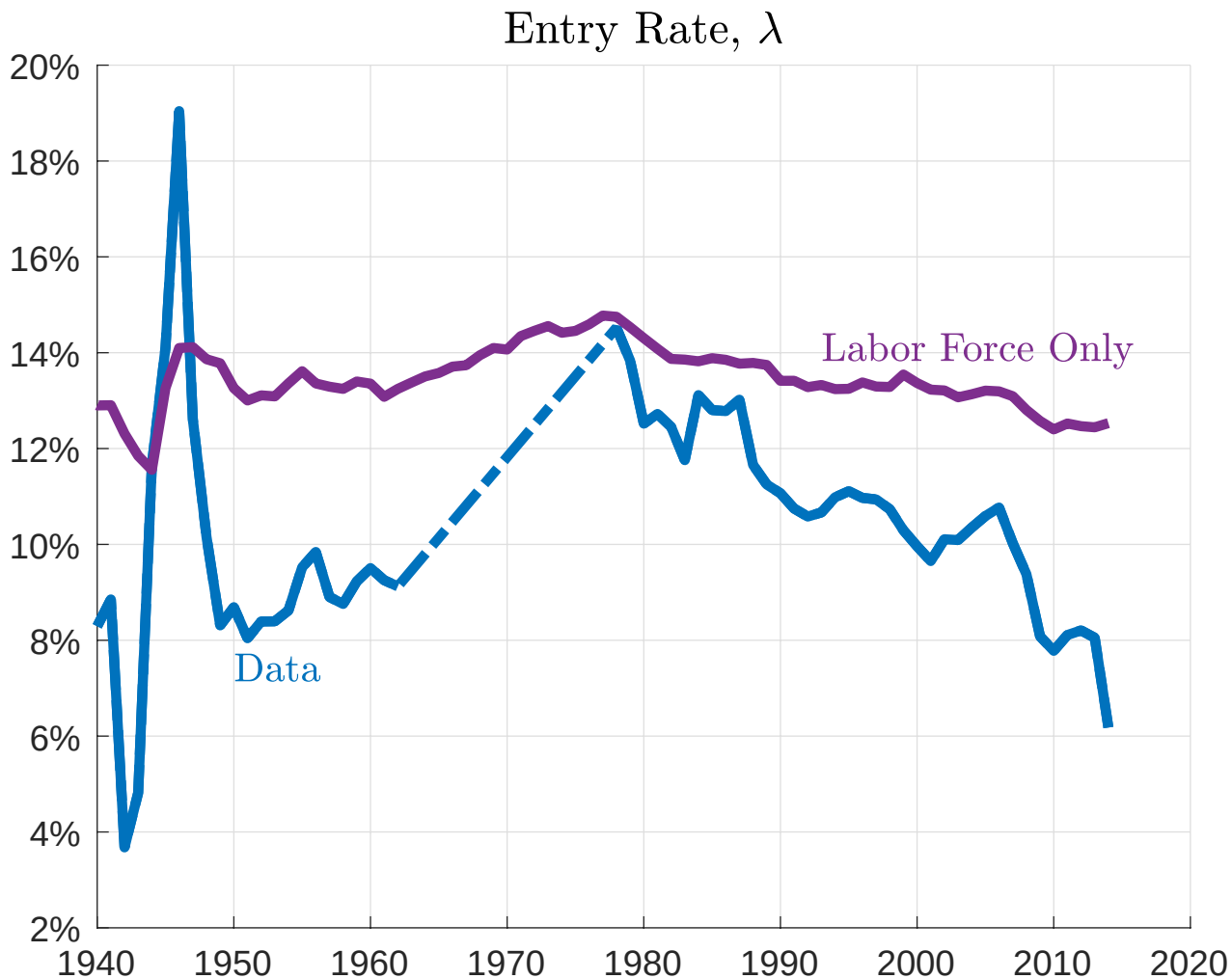
The Rise and Fall of Population Growth



Source: BLS Current Population Survey

Is This Driving Force Enough?

$$\lambda = \hat{N} - \underbrace{\hat{e}}_{0} + \underbrace{\xi}_{12\%}$$



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- In the data

$$\underbrace{\Delta\lambda}_{6\%} = \underbrace{\Delta\hat{N}}_{2\%} - \underbrace{\Delta\hat{e}}_{2\%} + \underbrace{\Delta\xi}_{2\%}$$

Firm Demographics

Age	Average firm size	Exit rate (%)
0	6.05	–
1	7.73	21.85
2	8.46	15.86
3	9.14	13.43
4	9.77	11.68
5	10.36	10.48
6-10	11.98	8.30
11-15	15.08	6.40
16-20	18.81	5.56
21-25	24.03	4.99

ΔPopulation Growth + Firm Demographics

- Need to account for firm demographics

- Important **feedback** effects

$$\lambda = \hat{N} - \hat{e} + \xi$$

  - Δ entry rates $\rightarrow$ Δ age distribution
  - This affects average firm size
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- Decrease in population growth implies:
  - Decline in entry rate
  - Aging of firms

Theory

Environment

- Common discount factor β
- Fixed endowment of a resource (labor) N_t inelastically supplied. Numeraire.
- Firm's idiosyncratic state s
- $s_t \sim F\left(s_{t+1}|s_t\right)$. Persistence.

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- Accomodates **perfect competition** and **variable markups**

Equilibrium: Definition

An equilibrium for a given sequence $\{N_t\}$ and given initial measure μ_0 are sequences $\{s_t^*, m_t, \mu_t, Z_t\}$

1. **Exit:** Optimal exit condition.
2. **Entry:** No rents for entrants
3. **Resource constraint** holds

Equilibrium: Analysis

- Guess $Z_t = Z^*$ for all t, where $v^e(Z^*) = 0$

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- Exit rates, average firm size, and size distributions by cohorts are time invariant.

Resource Constraint

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  - S_a : Probability an entrant survives at least a periods
  - e_a : Average size of cohort of age a

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$$N_t = m_t e_0 + E_t^I$$

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$$N_t = m_t e_0 + E_t^I$$

- Mass of entrants:

$$m_t = \frac{N_t - E_t^I}{e_0}$$

Dynamic Entry Equation

$$m_t = \frac{N_t - E_t^I}{e_0}$$

- Employment by incumbents depends on firm demographics

$$E_t^I = \sum_{a=1}^{\infty} m_{t-a} S_a e_a$$

- History dependence: Current entry depends on past entry

$$m_t = \frac{N_t - \sum_{a=1}^{\infty} m_{t-a} S_a e_a}{e_0}$$

- Feedback of firm demographics on entry

From Population Growth to Entry

1. Long run effects
   - $\hat{e} = 0$
   - Population growth g affects share of age cohorts:

     Lower growth implies lower exit rates

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2. Adjustment Path
   - Change in g implies changes in average size
   - $\hat{e} \neq 0$ in the transition

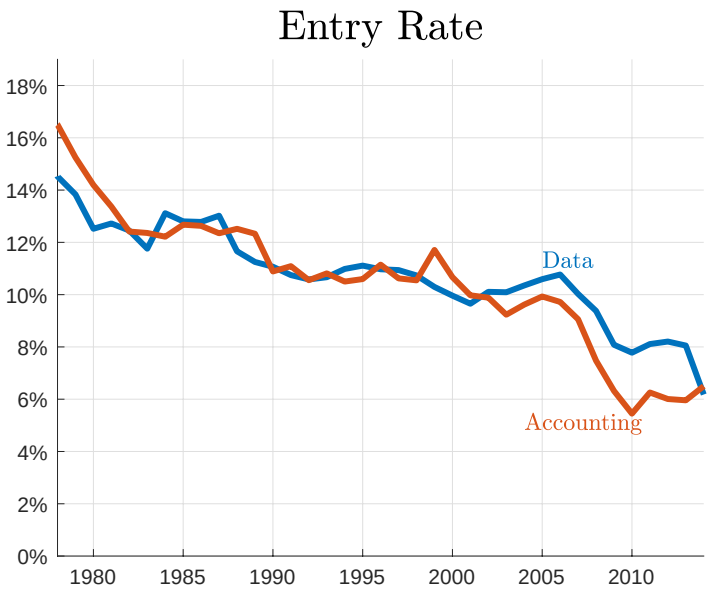
Accounting

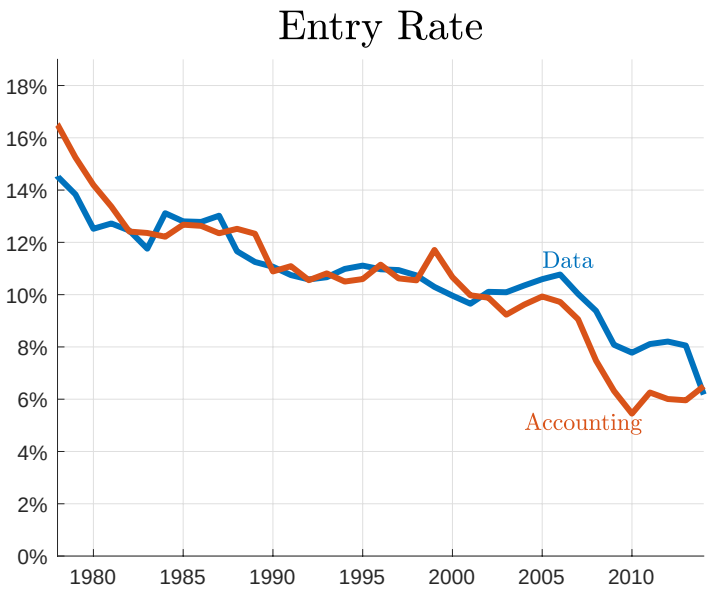
Accounting Exercise

- Composition effect due to changes in N_t
- Take firm demographics S_a and e_a from data
- Feed N_t into dynamic entry equation

$$m_t = \frac{N_t - \sum_{a=1}^{\infty} m_{t-a} S_a e_a}{e_0}$$

- Remain agnostic about the underlying model


Entry Rate
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
1980
1985
1990
1995
2000
2005
2010
Data
Accounting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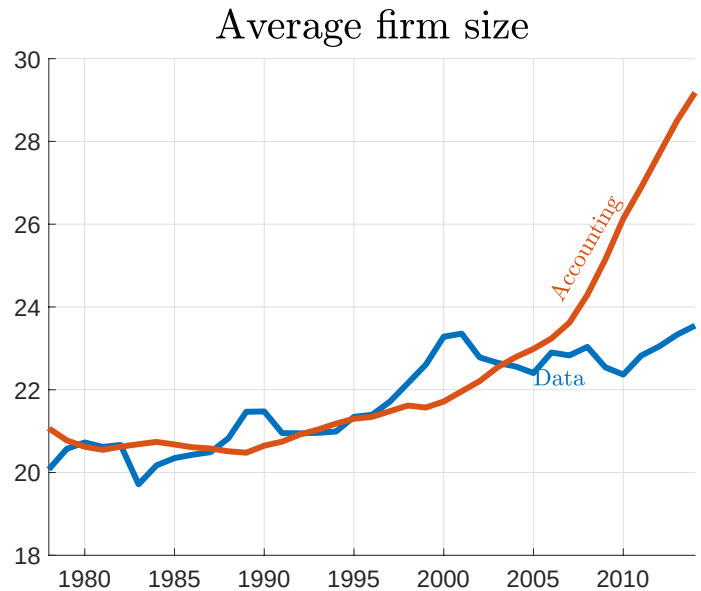
Average firm size
30
28
26
24
22
20
18
1980
1985
1990
1995
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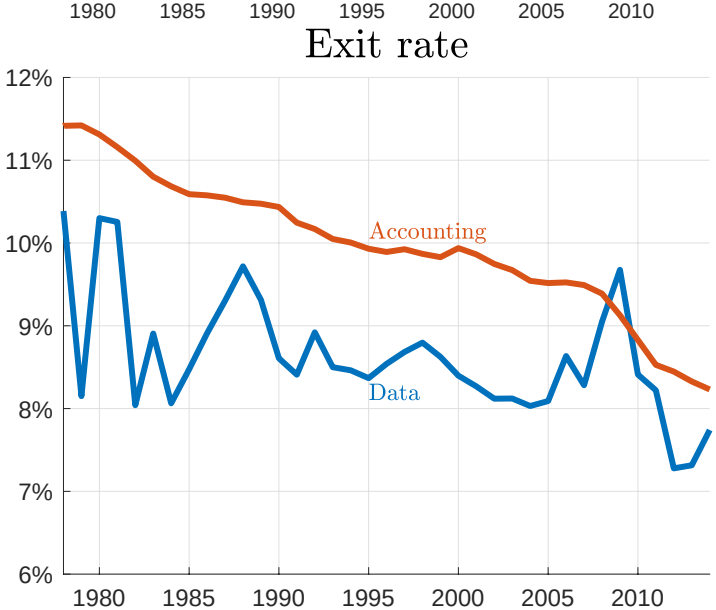
Accounting
Data


Exit rate
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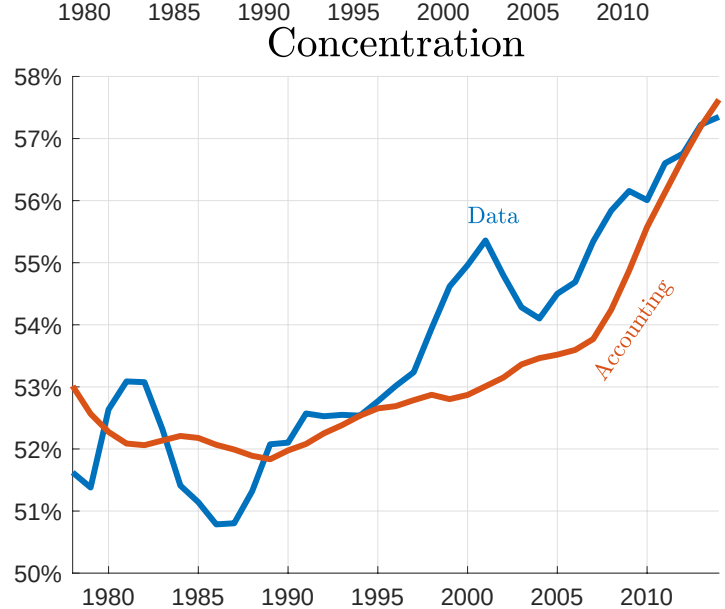
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Accounting

- Extrapolation necessary due to data limitations ▸ Extrapolation
  - Do not observe e_a and S_a for older firms (age > 25)
  - Do not observe μ_0 (age distribution in 1940)

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    - Match time-series of **employment weight** of left-censored firms ▸ Match

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- Alternative to extrapolation: calibrate a structural model

Calibration

Calibration strategy

- Pick a model: perfect competition
  - Homogeneous good
  - Aggregate state Z equals market price p
- Assume economy in balanced growth path in 1939
- Feed labor force growth rate from 1940 to 2014
- Calibrate to (mostly) 1978 moments
- Look at non-targeted moments

Functional Forms

- Production function

$$f(s, n) = sn^{\alpha}; \qquad \alpha < 1$$

- Log-productivity follows AR(1)

$$\log(s_{t+1}) = \mu_s + \rho \log(s_t) + \varepsilon_{t+1}; \qquad \varepsilon_{t+1} \sim \mathcal{N}(0, \sigma_{\varepsilon}^2)$$

- Startups draw productivity from

$$G \sim \log \mathcal{N}\left(s_0, \sigma_0^2\right)$$

- Overhead labor is increasing in firm size

$$c_f = c_{fa} + c_{fb} \times h(s)$$

Parameter Values

Assigned

	Value	Definition	Basis
β	0.96	Discount factor	Standard
α	0.64	Worker's share of output	Standard
g	0.01	Labor force growth rate (SS)	Standard

Jointly Calibrated

Parameters			Moments		
	Value	Definition		Data	Model
c_e	3e−7	Entry cost	$p^* = 1$	—	—
c_{fa}	3.760	Operating cost intercept	Avg. firm size 1978	20.08	20.08
c_{fb}	0.007	Operating cost slope	SD log-LP 1993-01	0.58	0.60
s_0	−11.189	Mean of G	Avg. entrant size 1978	5.40	5.36
σ_0^2	3.966	Variance of G	Avg. conc. of entrants	5.90%	5.87%
μ_s	−0.025	Drift in AR(1)	Entry rate 1978	14.75%	14.33%
ρ	0.973	Persistence of AR(1)	5-year growth rate	70.49%	73.82%
σ_ε^2	0.073	Variance of AR(1) shocks	5-year exit rate	48.42 %	45.83%

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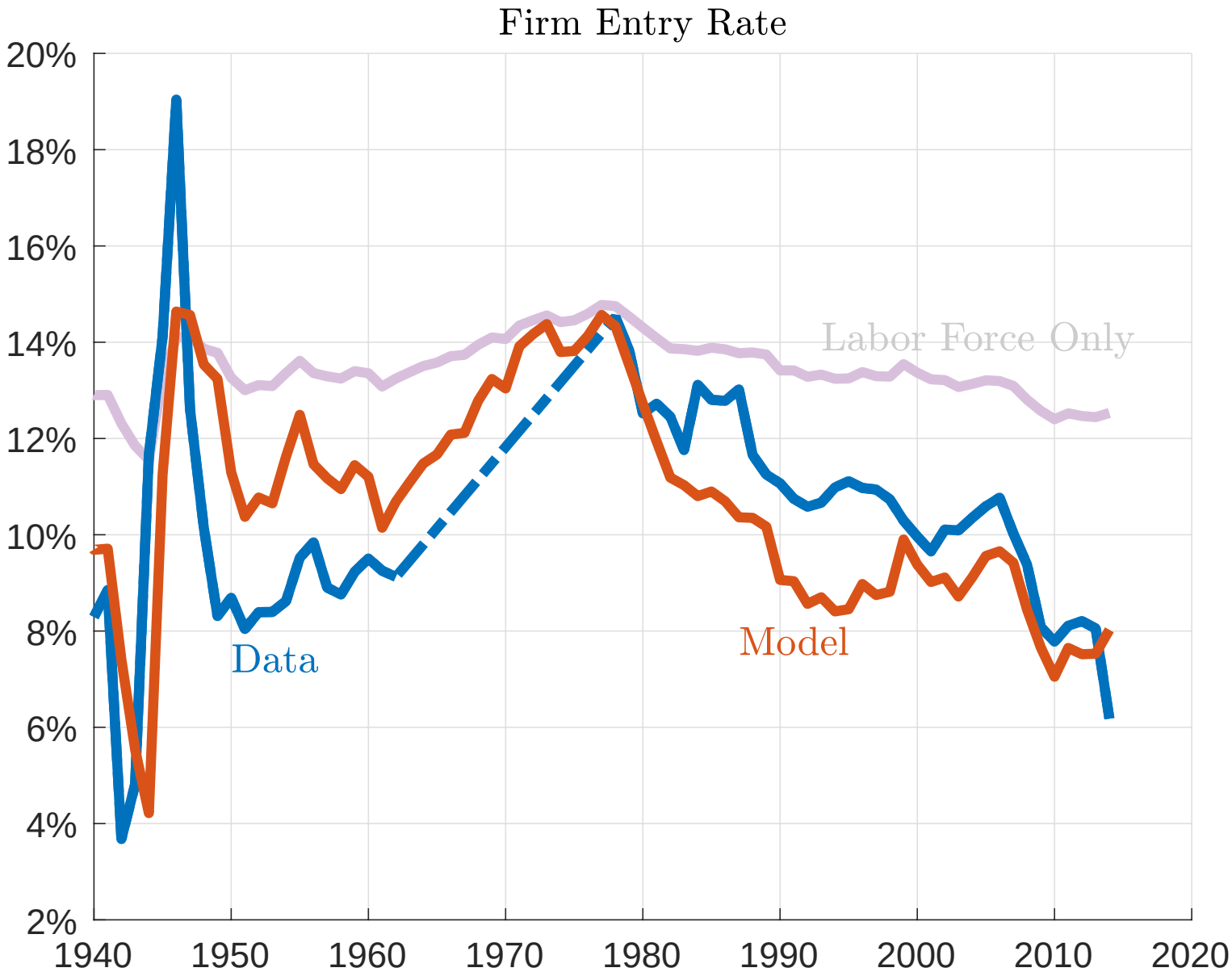
Non-targeted moments on Firm Dynamics?

Exit, Size, and Concentration by Firm Age

Age	**Exit rate**		**Average firm size**		**Concentration**	
	Data(%)	Model(%)	Data	Model	Data(%)	Model(%)
0	–	–	6.05	5.35	5.90	5.87
1	21.85	29.22	7.73	6.01	12.29	7.53
2	15.86	18.73	8.46	6.71	13.29	9.07
3	13.43	14.53	9.14	7.47	14.83	10.68
4	11.68	12.18	9.77	8.34	16.45	12.44
5	10.48	10.66	10.36	9.29	17.84	14.43
6-10	8.30	8.40	11.98	12.66	23.00	22.38
11-15	6.40	6.47	15.08	20.52	31.85	37.62
16-20	5.56	5.60	18.81	30.46	40.68	50.85
21-25	4.99	5.12	24.03	41.43	50.47	60.25
26+	4.29	4.53	81.59	72.70	78.91	73.90

Entry Rate


Firm Entry Rate
20%
18%
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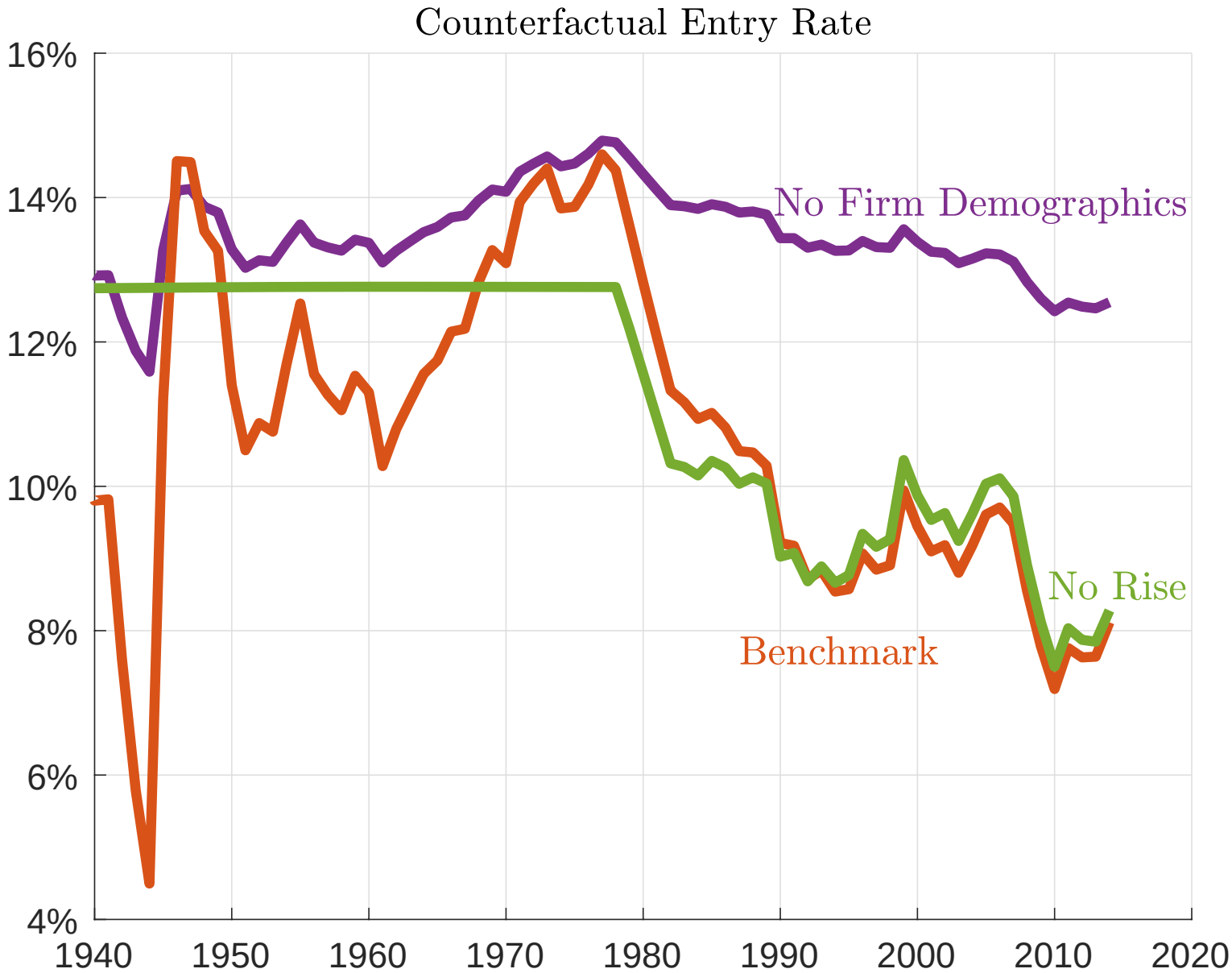
14%
12%
10%
8%
6%
4%
2%
1940
1950
1960
1970
1980
1990
2000
2010
2020
Labor Force Only
Data
Model

Non-targeted moments

Counterfactuals



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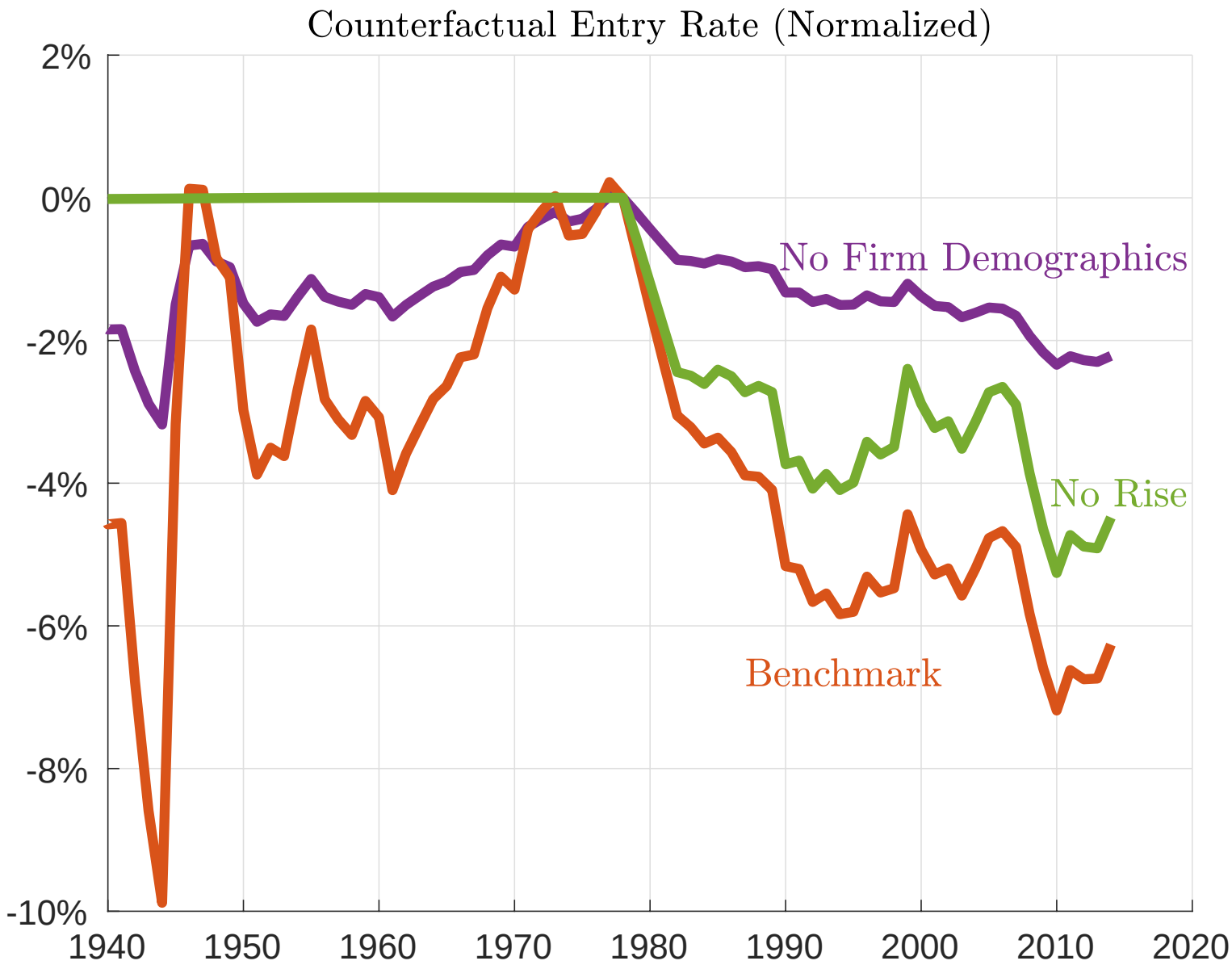
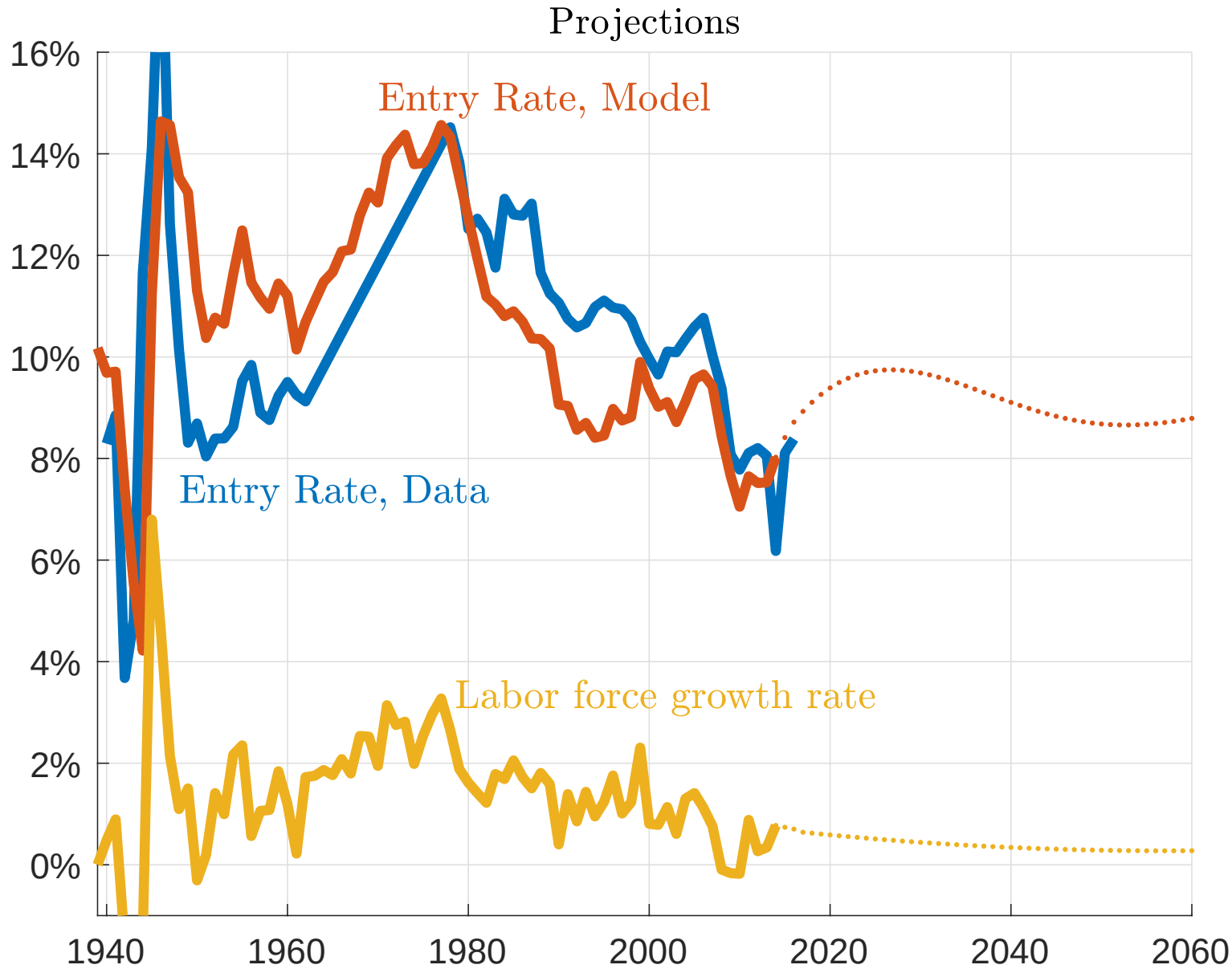


Projections



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$$\text{Labor share}_i = \frac{\text{Comp. to production labor}_i}{\text{Value added}_i} + \frac{\text{Comp. to overhead labor}_i}{\text{Value added}_i}$$

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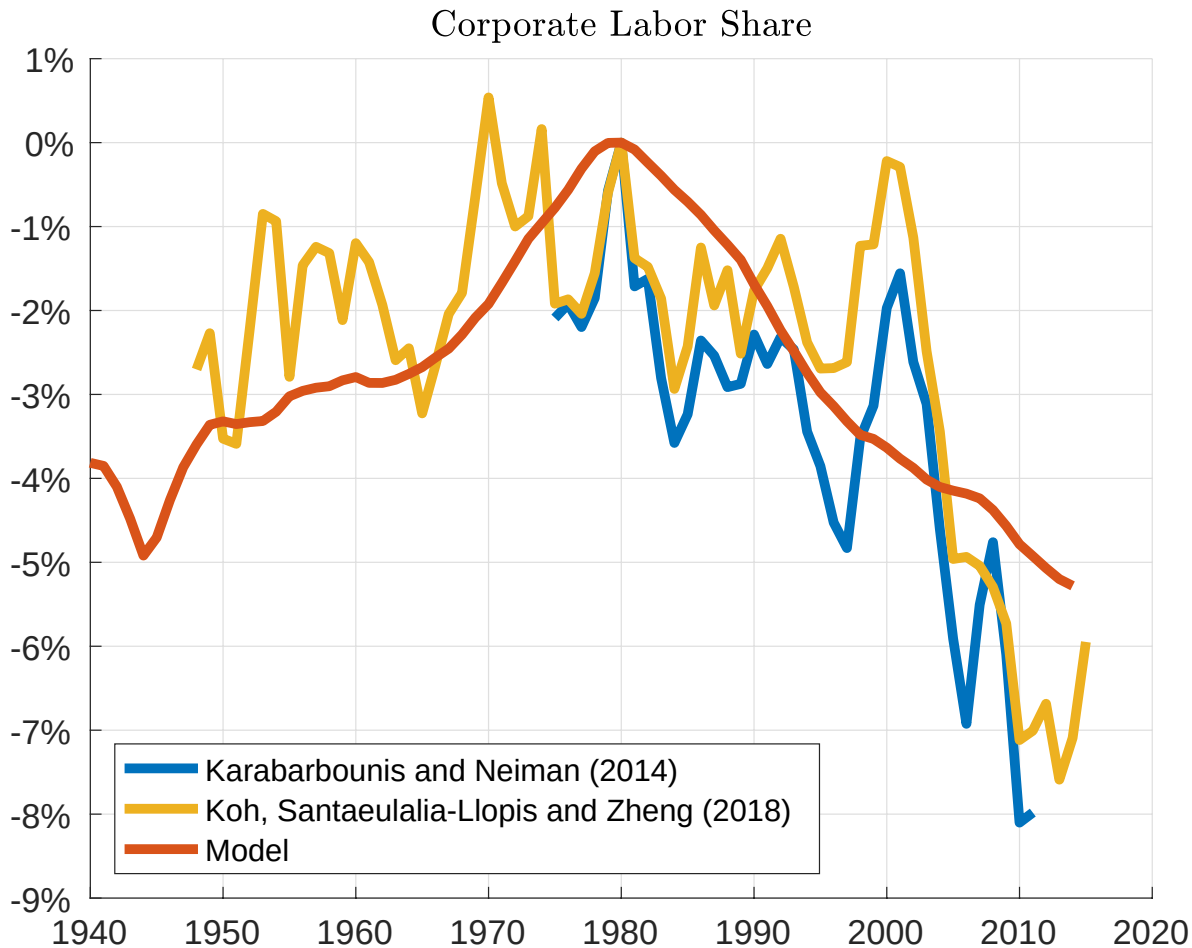

Discussion

- Labor force and labor supply
- Job Creation and Destruction
- TFP
- CONCLUSION

Alternative Measures of Labor Supply

Back

Labor Force Growth Decomposition

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$$\text{LF}_t = \text{Civilian Noninstitutional Population Age 16 And Over}_t \times \text{Participation Rate}_t$$

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Labor Force Growth Decomposition

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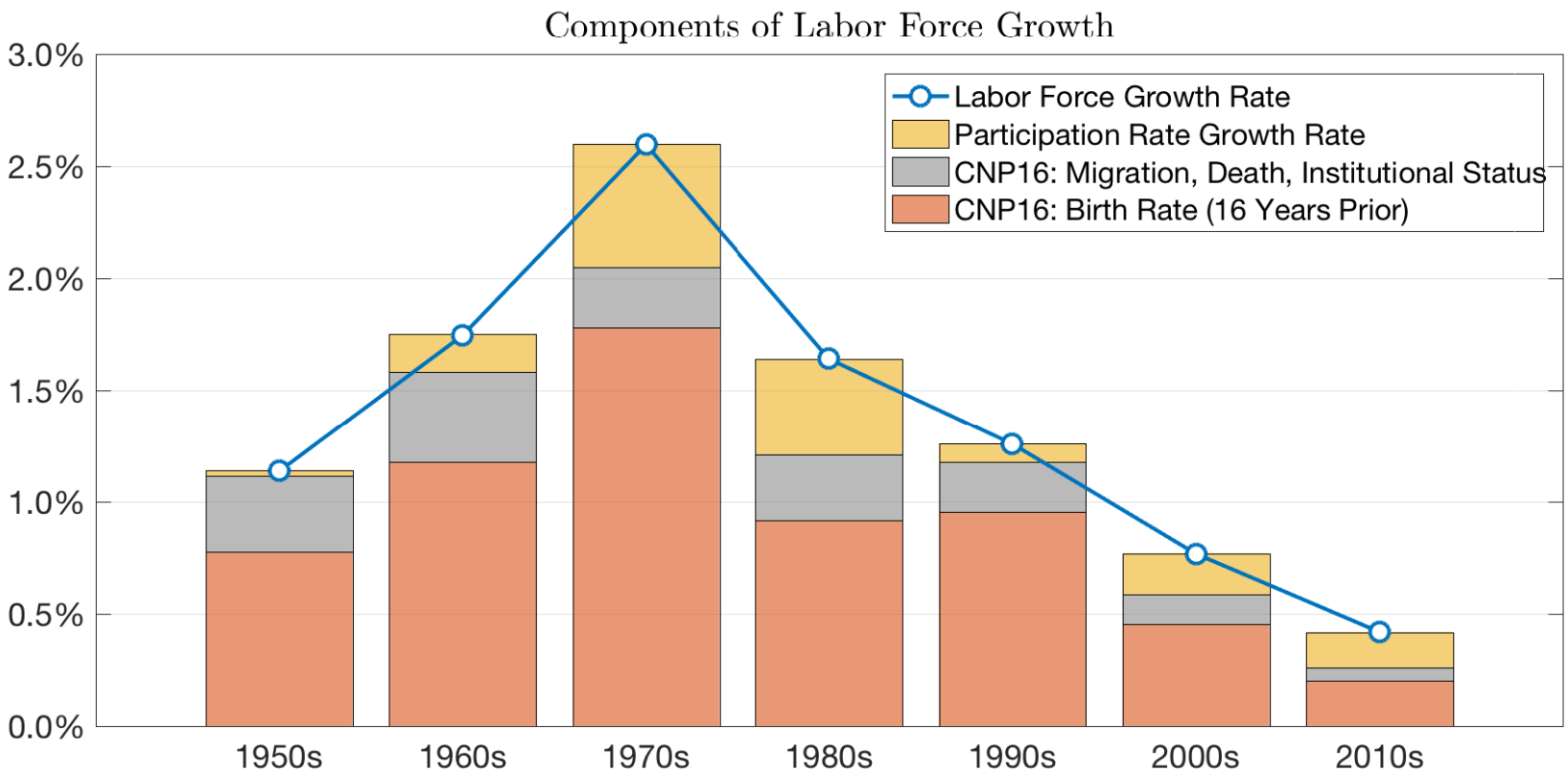
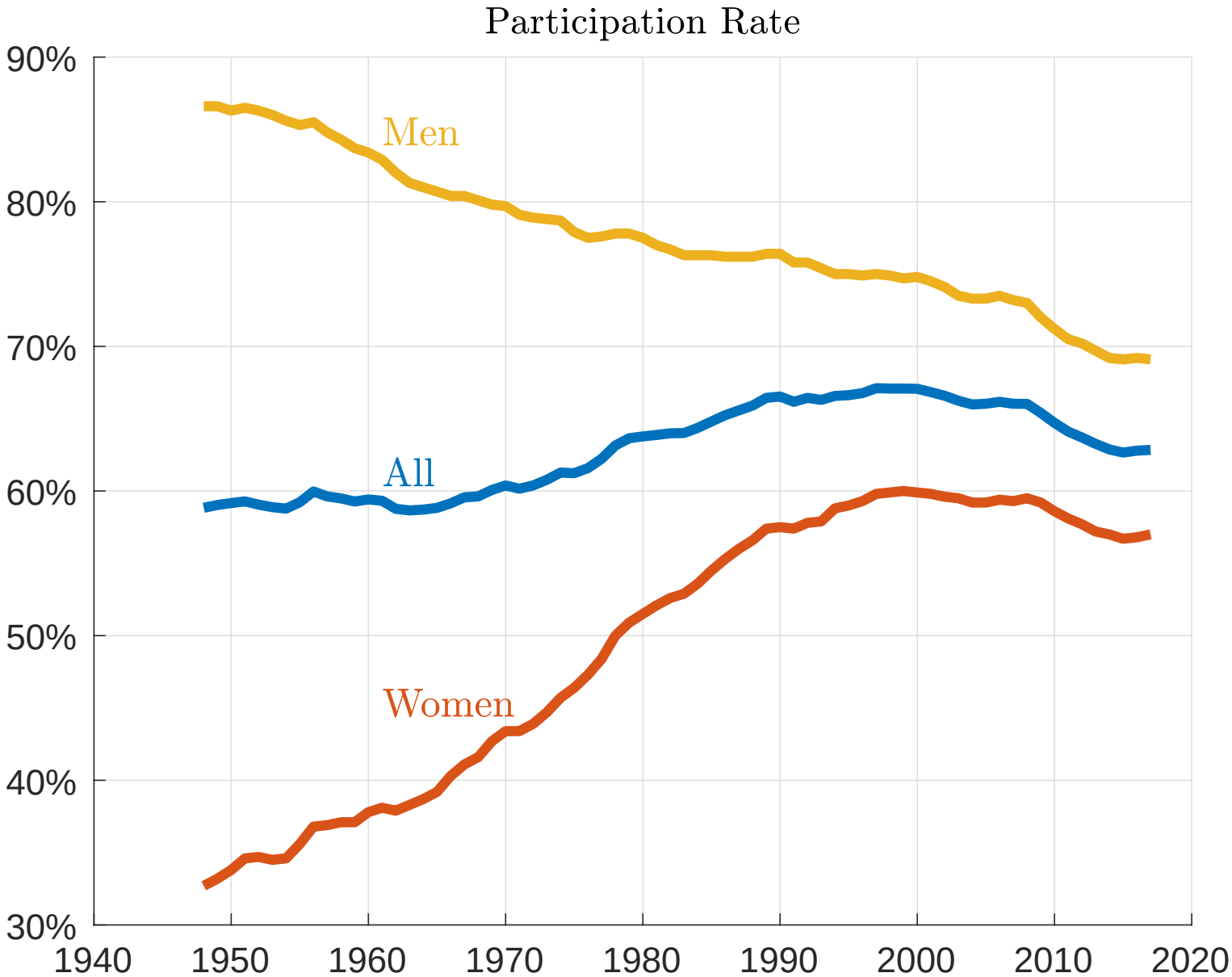
$$\text{LF Growth Rate}_t = \text{CNP16 Growth Rate}_t + \text{PR Growth Rate}_t$$

$$\text{CNP16 Growth Rate}_t = \text{Birth Rate}_{t-16} + \text{Other(Migration, Death, Instit)}_t$$



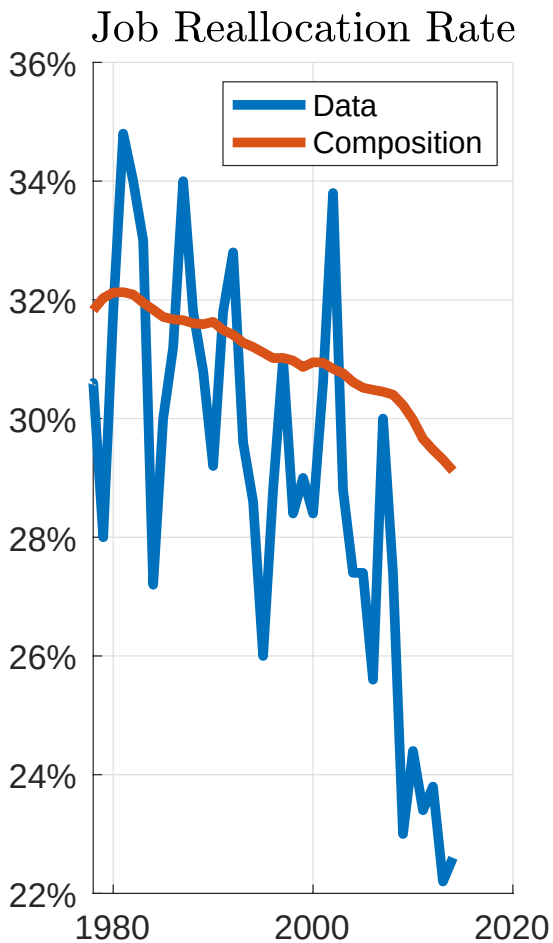
Participation Rate By Gender

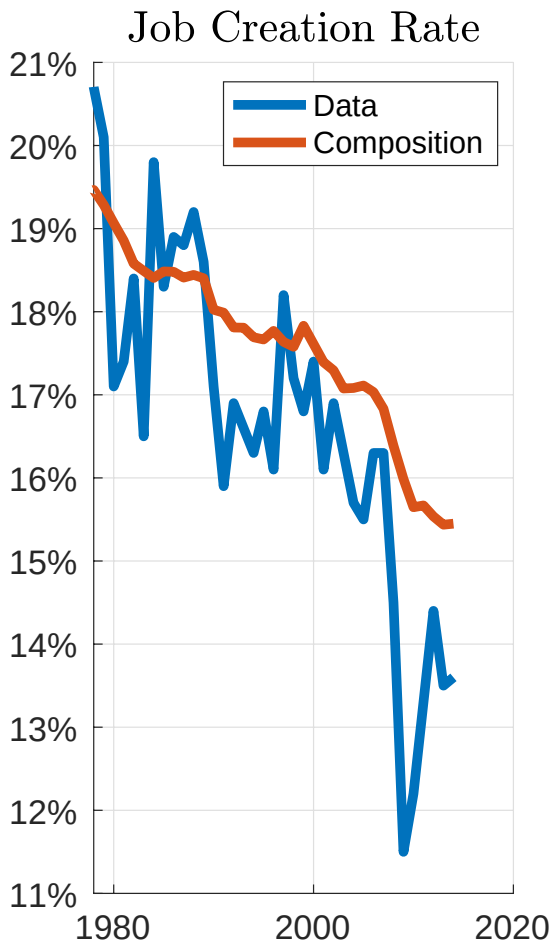
Back

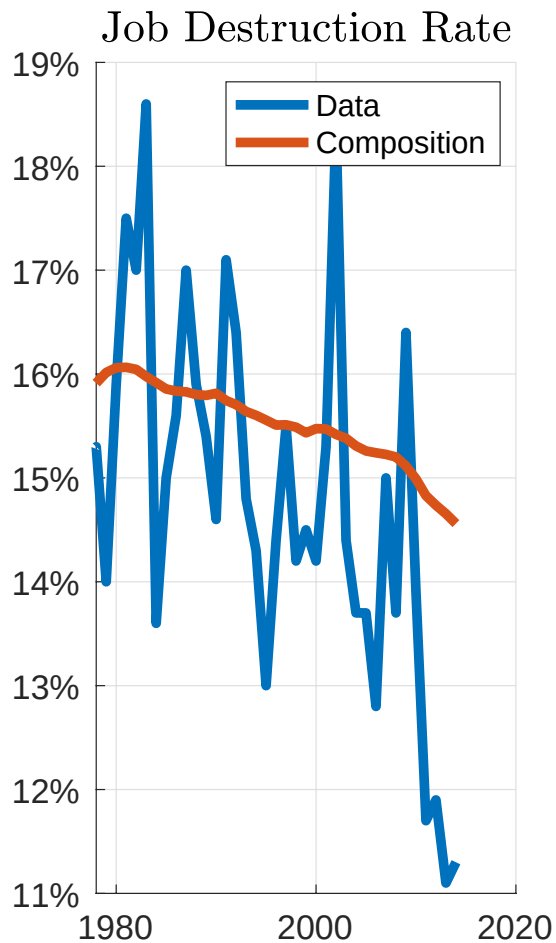


Job Reallocation: Accounting Approach

Back







TFP Growth by Decade

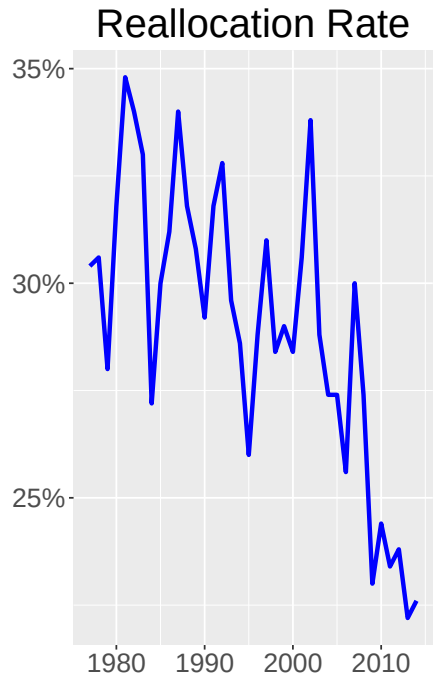
Back

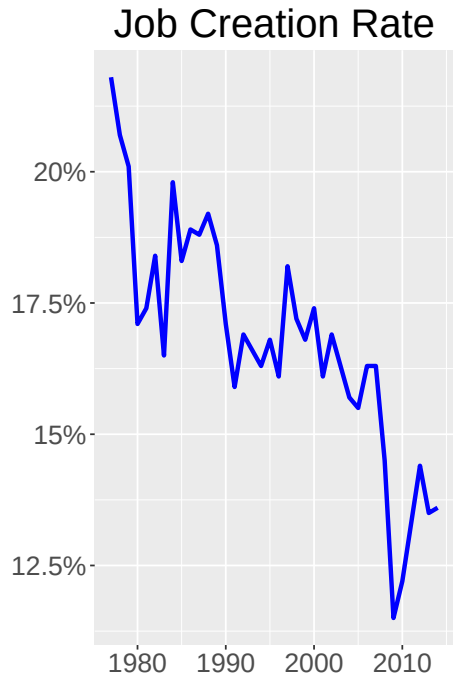
		Model	
	TFP data (%)	measured TFP(%)	TFP(%)
1950s	2.35	0.43	−0.16
1960s	2.05	0.53	−0.27
1970s	1.08	0.78	−0.51
1980s	0.51	0.79	0.46
1990s	1.03	0.59	0.59
2000s	0.77	0.39	0.40
2010s	1.11	0.23	0.47

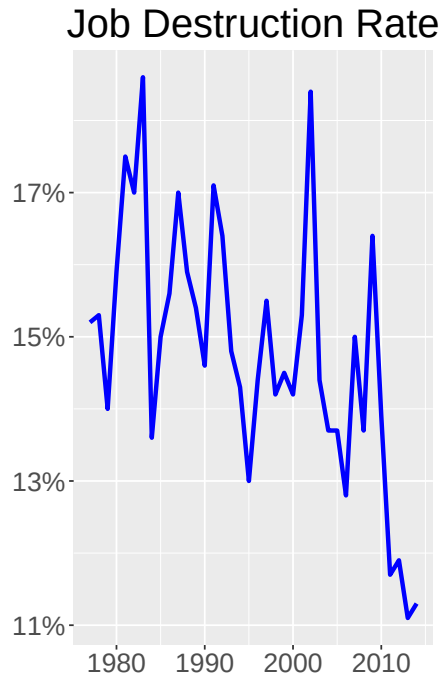
- Aggregate production function is $Y = AM^{1-\alpha}N^{\alpha}$.
- TFP is $A = \left[\int s^{1/(1-\alpha)} d\mu(s)\right]^{1-\alpha}$
- Measured TFP is $AM^{1-\alpha}$.

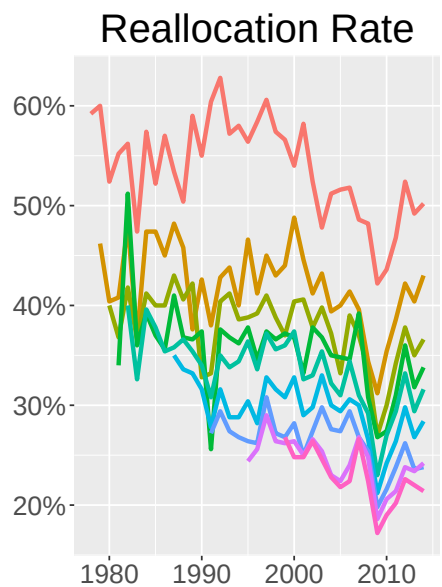
Conclusions

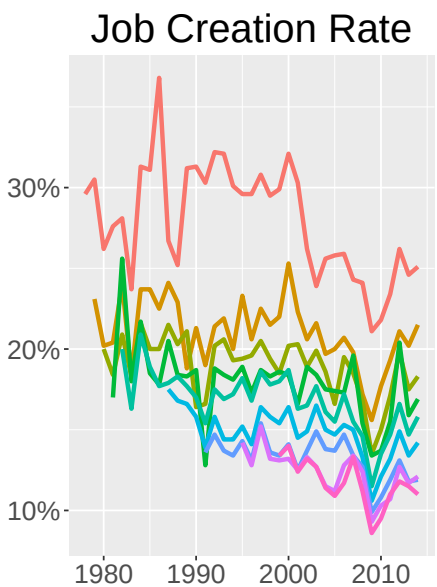
- Unified quantitative explanation for long-term changes in
  - Entry rate
  - Exit rates
  - Average firm size
  - Concentration
  - Labor Share
- Population growth as driving force
- Importance of firm demographics
- Interplay of population and firm demographics explains a large part of these facts

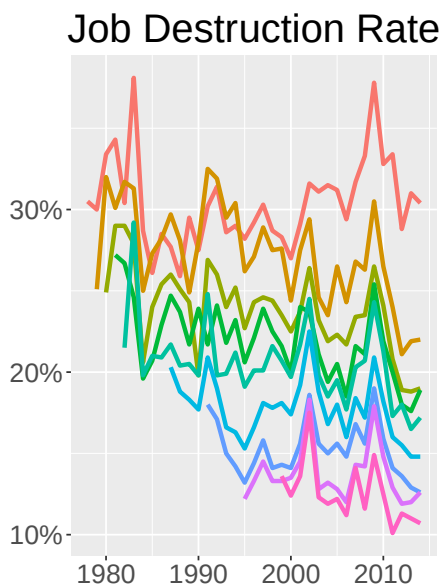












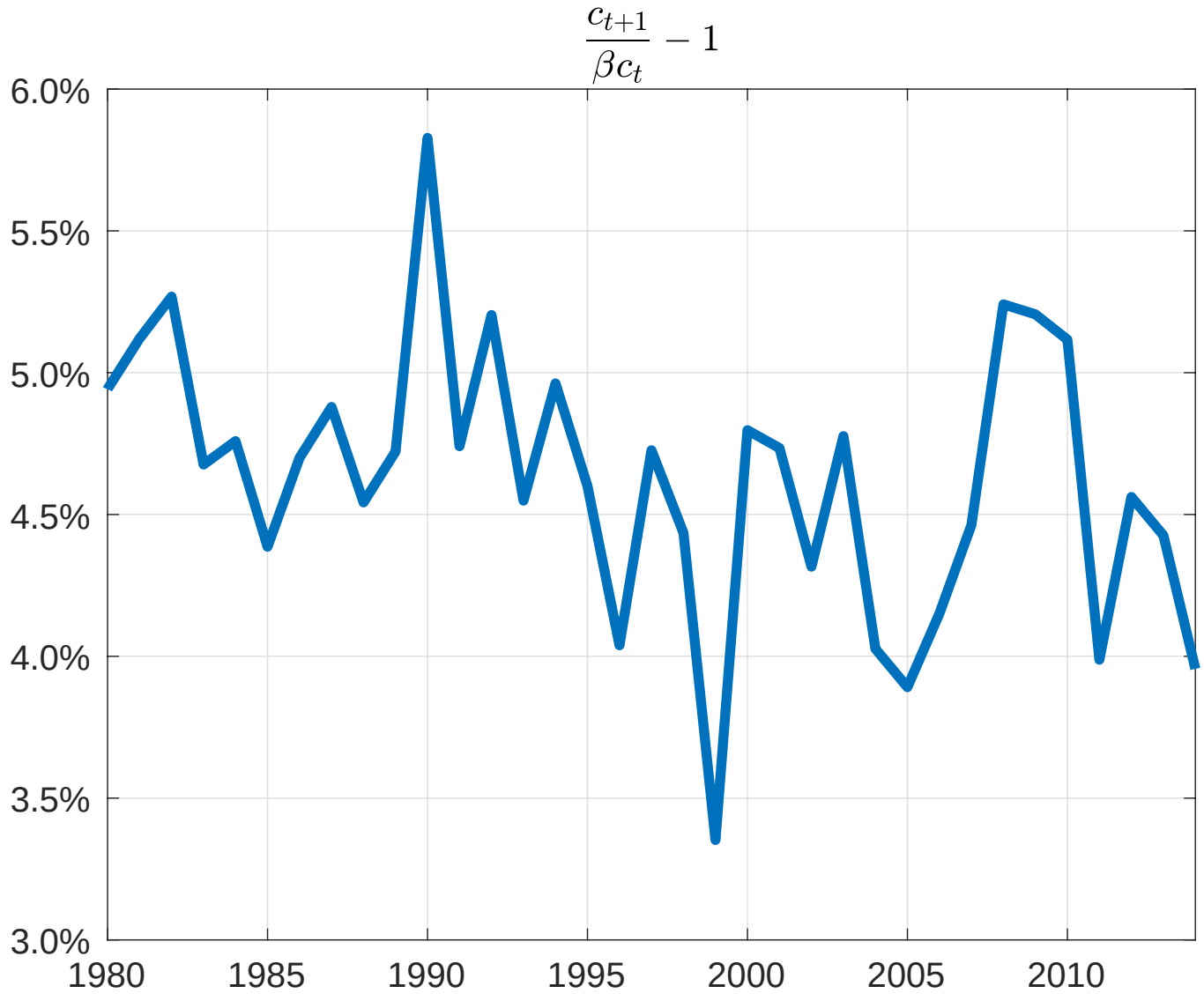
Back

Firm age

b) 1 c) 2 d) 3 e) 4 f) 5 g) 6 to 10 h) 11 to 15 i) 16 to 20 j) 21 to 25

Implied interest rate with log utility

Back



Regression of reallocation rate on firm age

Back

Variable	Specification			
	(1)	(2)	(3)	(4)
Year	-0.423***	-0.231***	-0.231***	-0.231***
	(0.020)	(0.014)	(0.011)	(0.011)
AGE:				
Age 1		57.421***	60.543***	60.992***
		(0.422)	(0.450)	(0.811)
Age 2		47.321***	50.443***	52.719***
		(0.429)	(0.455)	(0.823)
Age 3		43.351***	46.473***	48.006***
		(0.437)	(0.460)	(0.836)
Age 4		40.915***	44.037***	45.051***
		(0.446)	(0.465)	(0.848)
Age 5		38.974***	42.097***	42.327***
		(0.454)	(0.470)	(0.862)
Age 6 to 10		35.972***	39.095***	38.718***
		(0.499)	(0.500)	(0.937)
Age 11 to 15		32.761***	35.883***	33.679***
		(0.540)	(0.528)	(1.013)
Age 16 to 20		30.965***	34.087***	30.609***
		(0.588)	(0.561)	(1.108)
Age 21 to 25		30.030***	33.153***	29.323***
		(0.646)	(0.602)	(1.236)
SECTOR CONTROLS	No	No	Yes	Yes
SECTOR×AGE CONTROLS	No	No	No	Yes
Observations	2,817	2,367	2,367	2,367
R^2	0.141	0.975	0.983	0.985

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Regression of job creation rate on firm age

Back

Variable	Specification			
	(1)	(2)	(3)	(4)
Year	-0.221***	-0.117***	-0.117***	-0.117***
	(0.012)	(0.010)	(0.009)	(0.009)
AGE:				
Age 1		31.795***	33.409***	33.507***
		(0.303)	(0.351)	(0.644)
Age 2		24.325***	25.939***	28.023***
		(0.309)	(0.355)	(0.653)
Age 3		22.323***	23.936***	24.811***
		(0.315)	(0.359)	(0.663)
Age 4		21.174***	22.788***	23.092***
		(0.321)	(0.363)	(0.673)
Age 5		20.206***	21.820***	21.702***
		(0.327)	(0.367)	(0.683)
Age 6 to 10		18.476***	20.090***	19.810***
		(0.359)	(0.390)	(0.743)
Age 11 to 15		16.853***	18.467***	17.117***
		(0.389)	(0.412)	(0.803)
Age 16 to 20		16.324***	17.938***	16.088***
		(0.423)	(0.438)	(0.879)
Age 21 to 25		15.908***	17.522***	15.116***
		(0.465)	(0.470)	(0.980)
SECTOR CONTROLS	No	No	Yes	Yes
SECTOR×AGE CONTROLS	No	No	No	Yes
Observations	2,817	2,367	2,367	2,367
R^2	0.105	0.954	0.964	0.967

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Regression of job destruction rate on firm age

Back

Variable	Specification			
	(1)	(2)	(3)	(4)
Year	-0.259***	-0.125***	-0.125***	-0.125***
	(0.014)	(0.011)	(0.010)	(0.010)
AGE:				
Age 1		34.426***	35.072***	36.933***
		(0.354)	(0.399)	(0.743)
Age 2		31.192***	31.838***	32.027***
		(0.361)	(0.403)	(0.753)
Age 3		27.792***	28.439***	29.024***
		(0.367)	(0.408)	(0.765)
Age 4		25.842***	26.488***	25.858***
		(0.374)	(0.413)	(0.776)
Age 5		24.119***	24.766***	24.353***
		(0.381)	(0.417)	(0.789)
Age 6 to 10		21.868***	22.514***	21.879***
		(0.419)	(0.444)	(0.858)
Age 11 to 15		19.477***	20.124***	19.707***
		(0.453)	(0.468)	(0.927)
Age 16 to 20		17.825***	18.472***	17.317***
		(0.493)	(0.498)	(1.014)
Age 21 to 25		17.459***	18.106***	17.470***
		(0.543)	(0.535)	(1.131)
SECTOR CONTROLS	No	No	Yes	Yes
SECTOR×AGE CONTROLS	No	No	No	Yes
Observations	2,817	2,367	2,367	2,367
R^2	0.103	0.956	0.967	0.969

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Regression of log average firm size on firm age

Back

Variable	Specification			
	(1)	(2)	(3)	(4)
Year	0.006***	-0.005***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.000)	(0.000)
AGE:				
Age 0		1.839***	1.435***	1.441***
		(0.023)	(0.015)	(0.026)
Age 1		2.080***	1.676***	1.717***
		(0.023)	(0.015)	(0.026)
Age 2		2.171***	1.767***	1.806***
		(0.023)	(0.015)	(0.026)
Age 3		2.247***	1.843***	1.868***
		(0.024)	(0.015)	(0.026)
Age 4		2.319***	1.915***	1.941***
		(0.024)	(0.015)	(0.026)
Age 5		2.378***	1.974***	2.002***
		(0.024)	(0.015)	(0.027)
Age 6 to 10		2.526***	2.122***	2.159***
		(0.027)	(0.016)	(0.029)
Age 11 to 15		2.748***	2.344***	2.323***
		(0.029)	(0.017)	(0.032)
Age 16 to 20		2.977***	2.573***	2.472***
		(0.032)	(0.018)	(0.035)
Age 21 to 25		3.251***	2.847***	2.579***
		(0.035)	(0.019)	(0.039)
SECTOR CONTROLS	No	No	Yes	Yes
SECTOR×AGE CONTROLS	No	No	No	Yes
R^2	0.015	0.978	0.995	0.996
Observations	2,682	2,682	2,682	2,682

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Regression of exit rate on firm age

Back

Variable	Specification			
	(1)	(2)	(3)	(4)
Year	-0.151***	-0.011*	-0.011**	-0.011**
	(0.012)	(0.006)	(0.005)	(0.005)
AGE:				
Age 1		21.780***	19.381***	19.036***
		(0.178)	(0.188)	(0.342)
Age 2		16.143***	13.744***	12.702***
		(0.178)	(0.188)	(0.342)
Age 3		13.673***	11.274***	10.765***
		(0.181)	(0.190)	(0.347)
Age 4		12.029***	9.629***	9.380***
		(0.185)	(0.192)	(0.352)
Age 5		10.753***	8.354***	8.331***
		(0.189)	(0.194)	(0.358)
Age 6 to 10		8.647***	6.247***	6.695***
		(0.208)	(0.206)	(0.390)
Age 11 to 15		6.711***	4.312***	5.160***
		(0.225)	(0.218)	(0.421)
Age 16 to 20		5.901***	3.501***	4.582***
		(0.246)	(0.232)	(0.461)
Age 21 to 25		5.416***	3.017***	4.420***
		(0.271)	(0.250)	(0.514)
SECTOR CONTROLS	No	No	Yes	Yes
SECTOR×AGE CONTROLS	No	No	No	Yes
R^2	0.065	0.962	0.976	0.978
Observations	2,358	2,358	2,358	2,358

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Regression of concentration on firm age

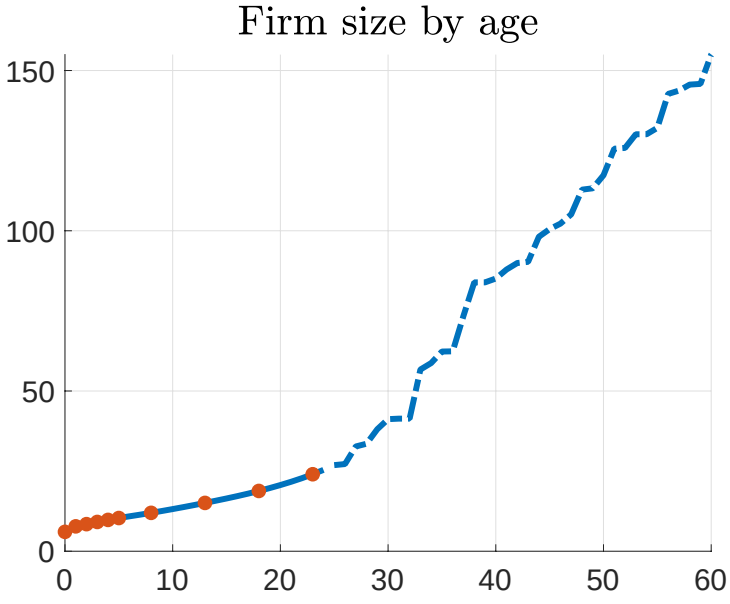
Back

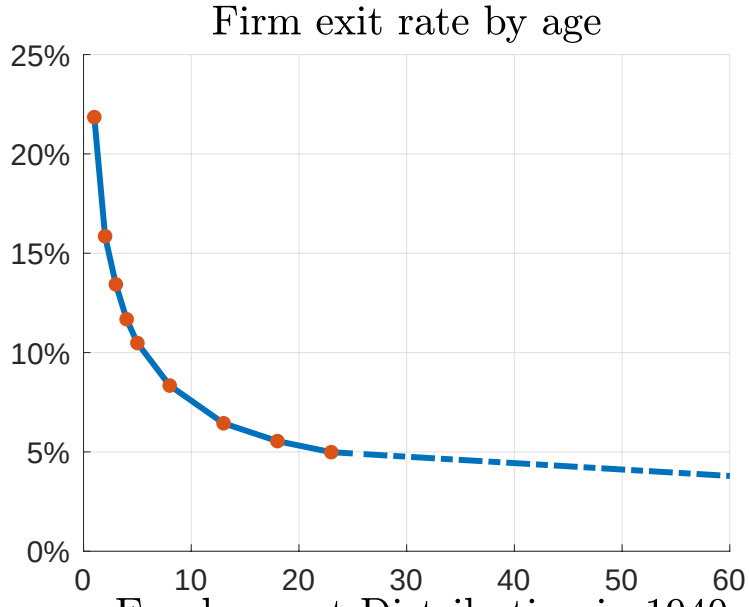
Variable	Specification (1)	(2)
Year	0.003***	-0.000
	(0.001)	(0.000)
AGE:		
Age 0		0.666
		(0.439)
Age 1		0.730*
		(0.439)
Age 2		0.740*
		(0.440)
Age 3		0.756*
		(0.440)
Age 4		0.772*
		(0.440)
Age 5		0.786*
		(0.440)
Age 6 to 10		0.839*
		(0.440)
Age 11 to 15		0.928**
		(0.441)
Age 16 to 20		1.017**
		(0.441)
Age 21 to 25		1.115**
		(0.442)
R^2	0.080	0.976
Observations	301	301

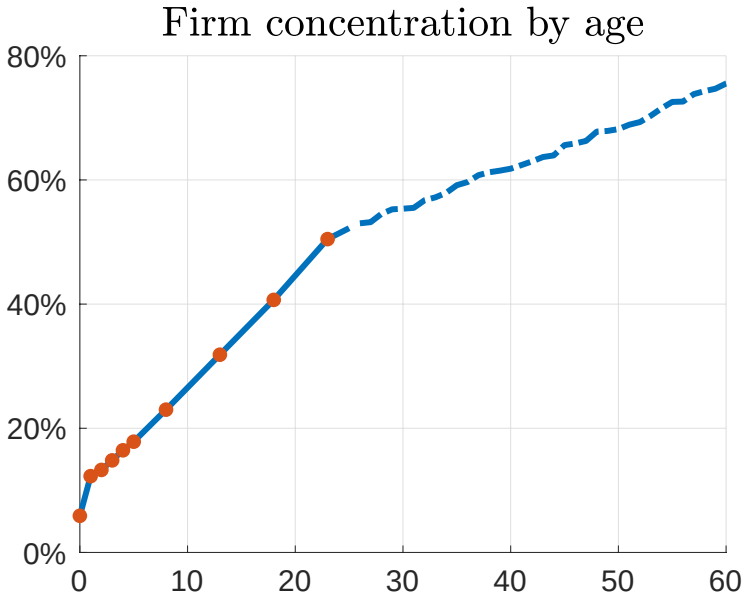
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

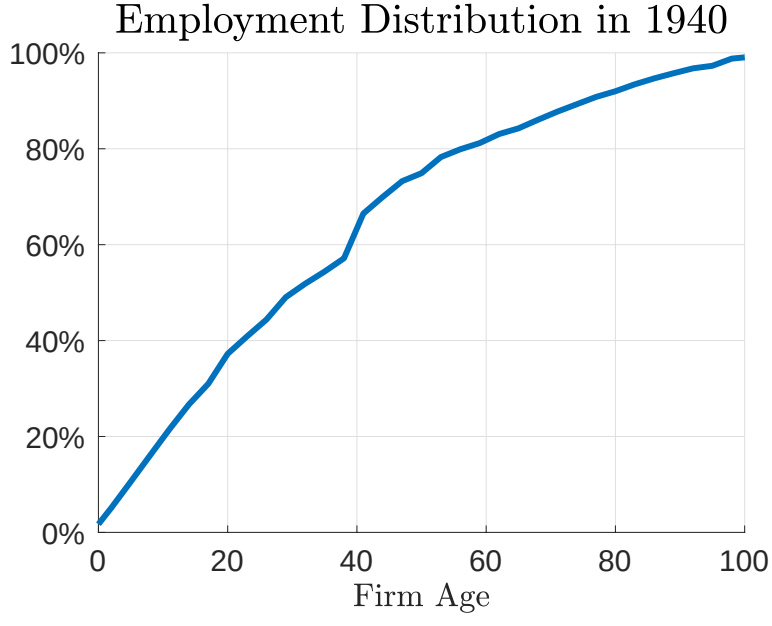
Extrapolation

Back





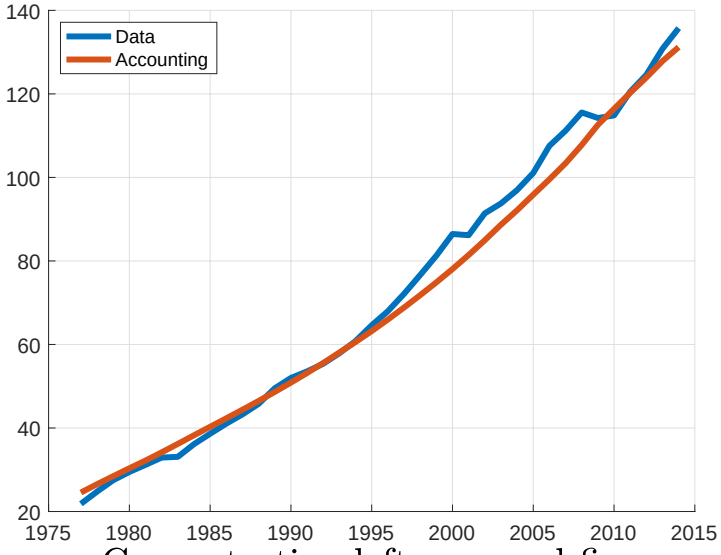




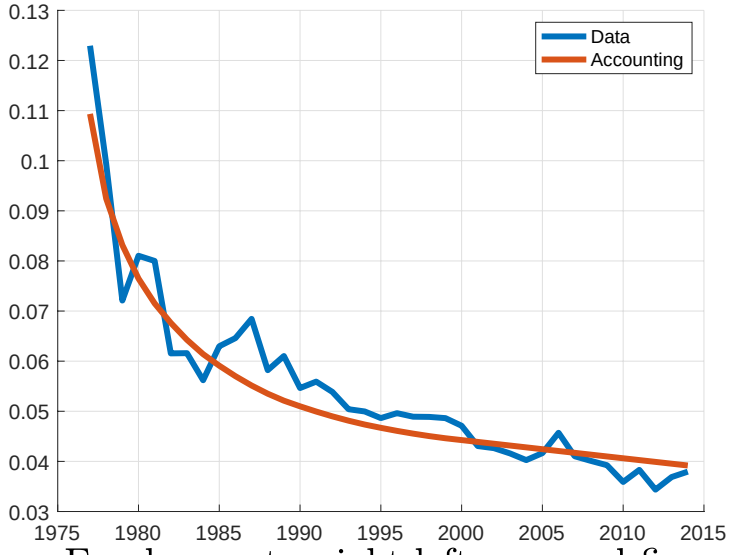
Accounting Exercise: Left-Censored Match

Back

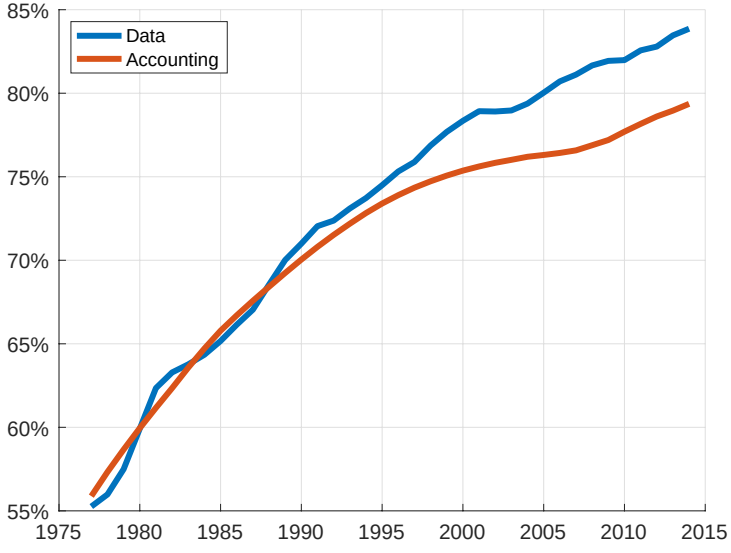
Average firm size left censored firms



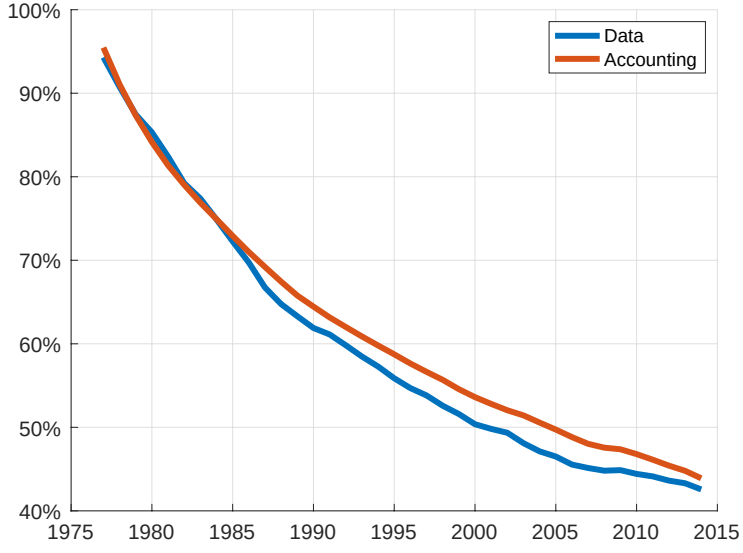
Exit rate left censored firms



Concentration left censored firms

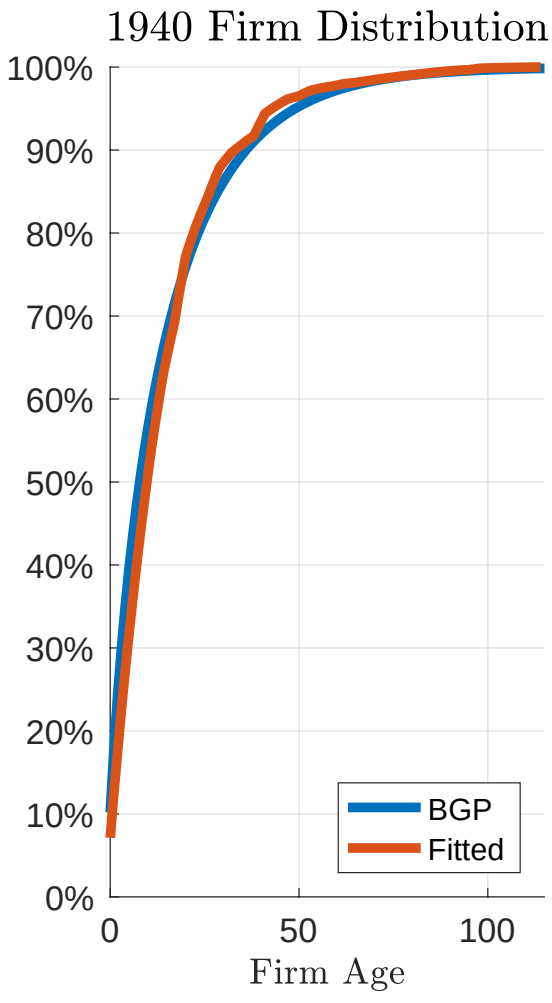


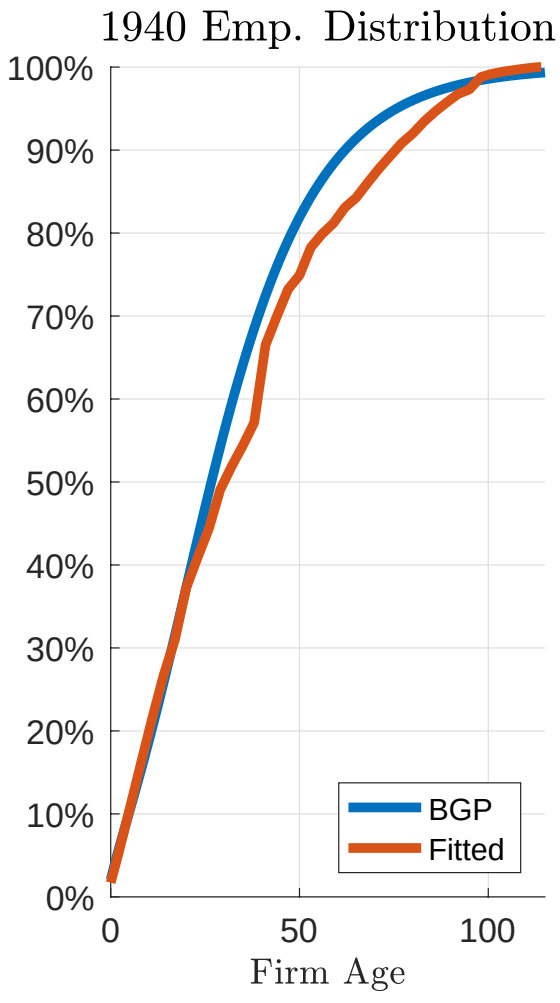
Employment weight left censored firms

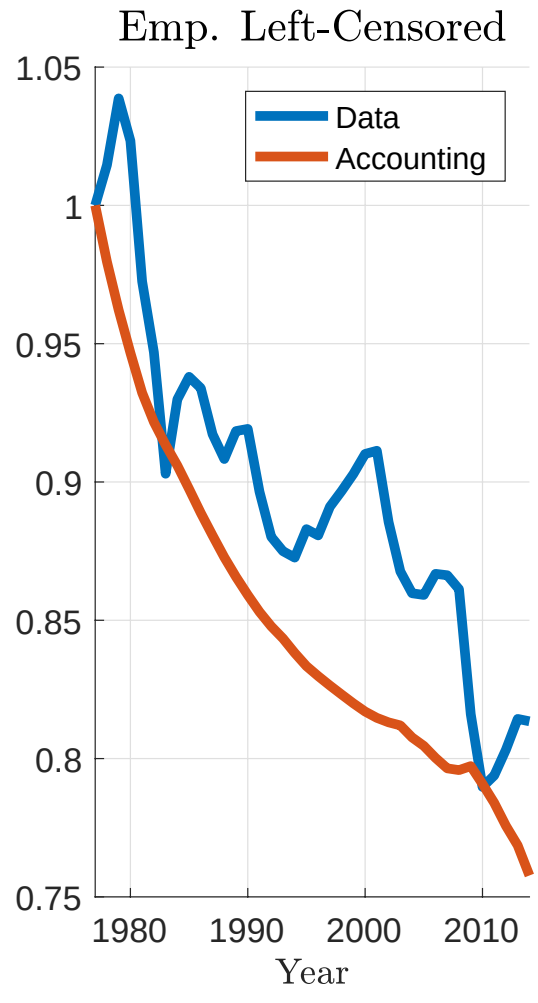


Accounting Exercise: Robustness checks

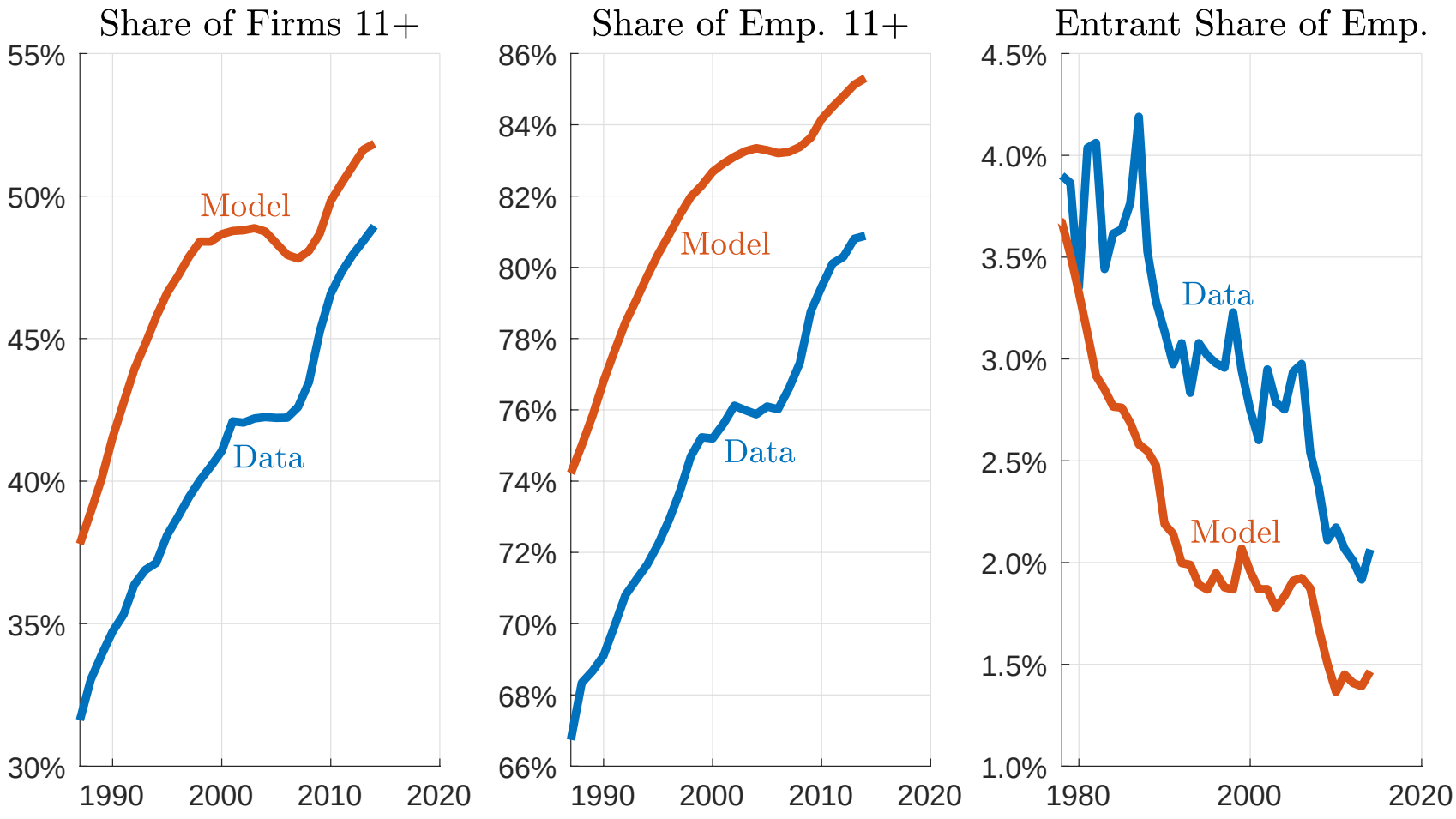
Back



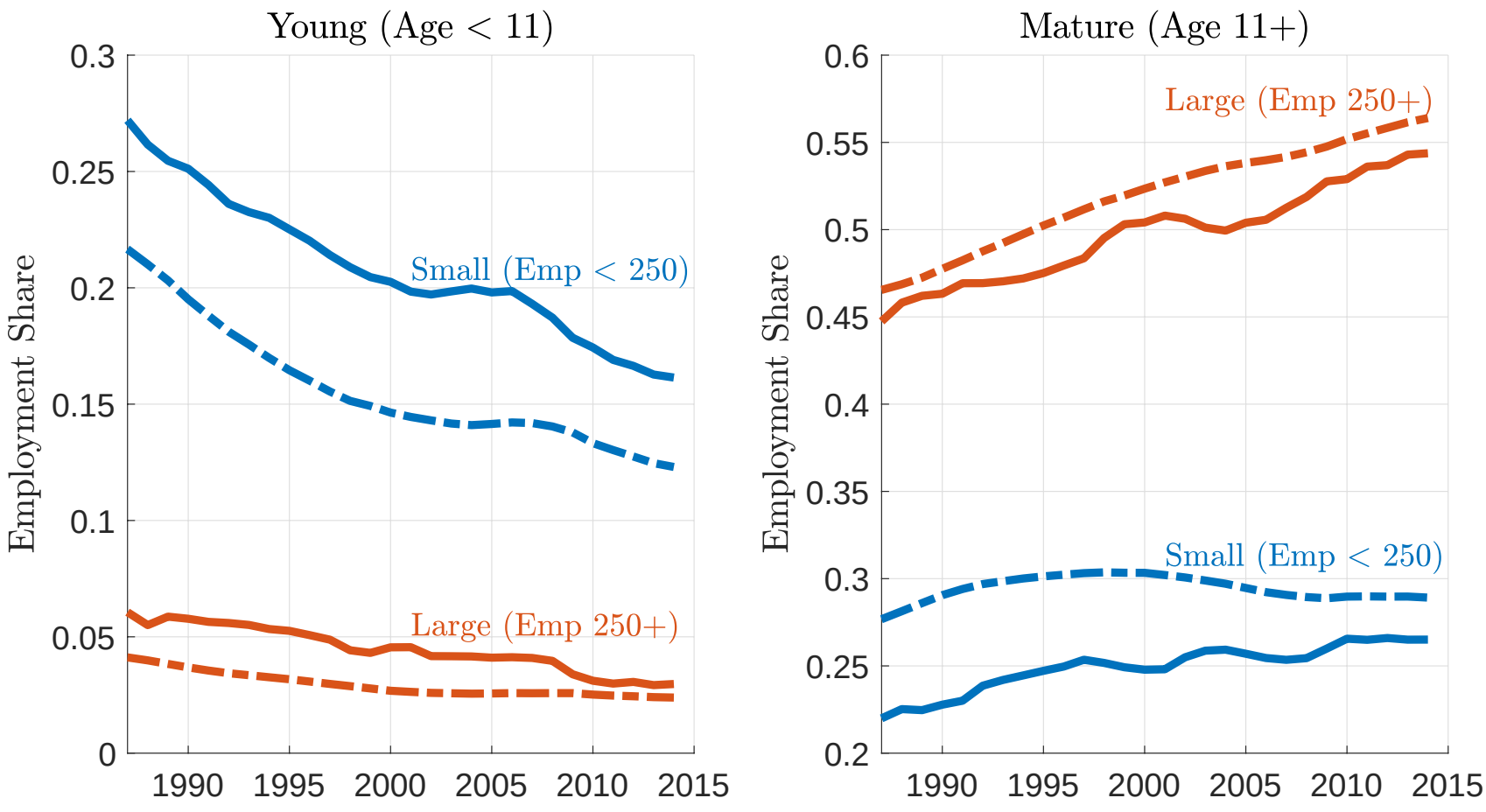




Distributional Moments Match: Competitive Model

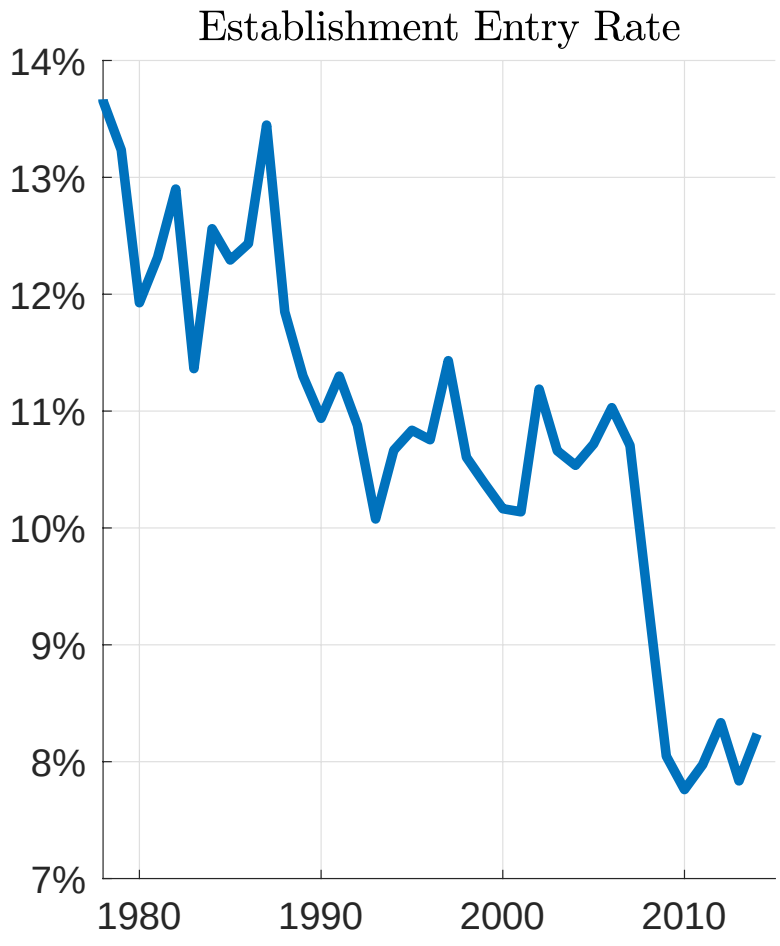


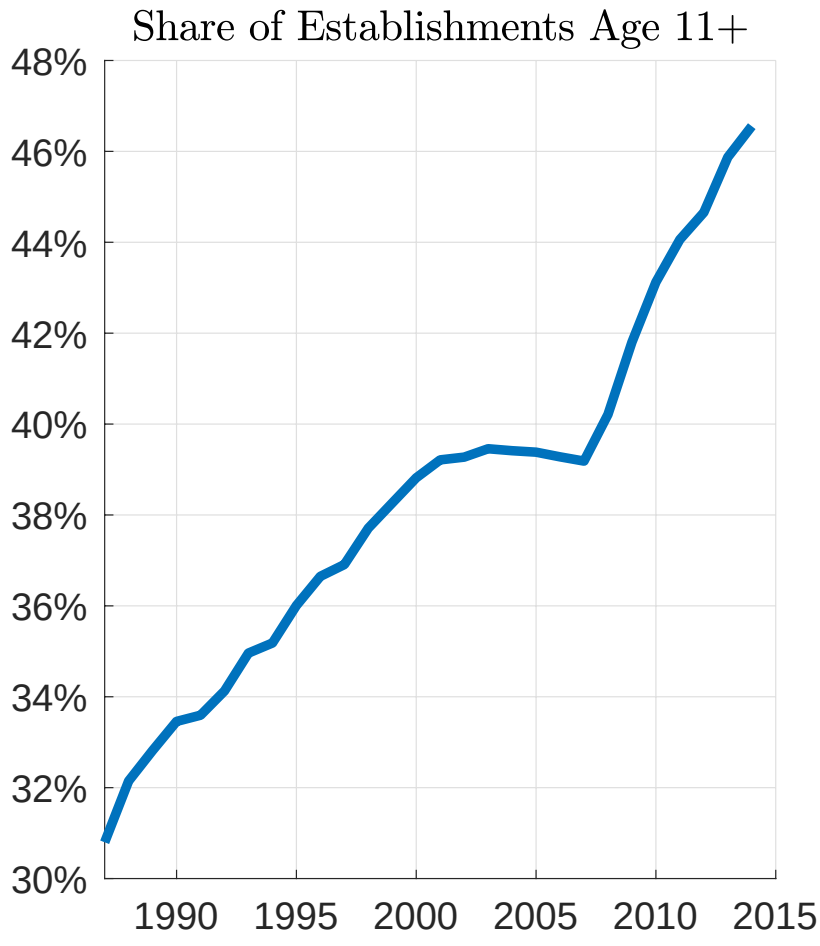
Age-Size Distribution Match: Competitive Model



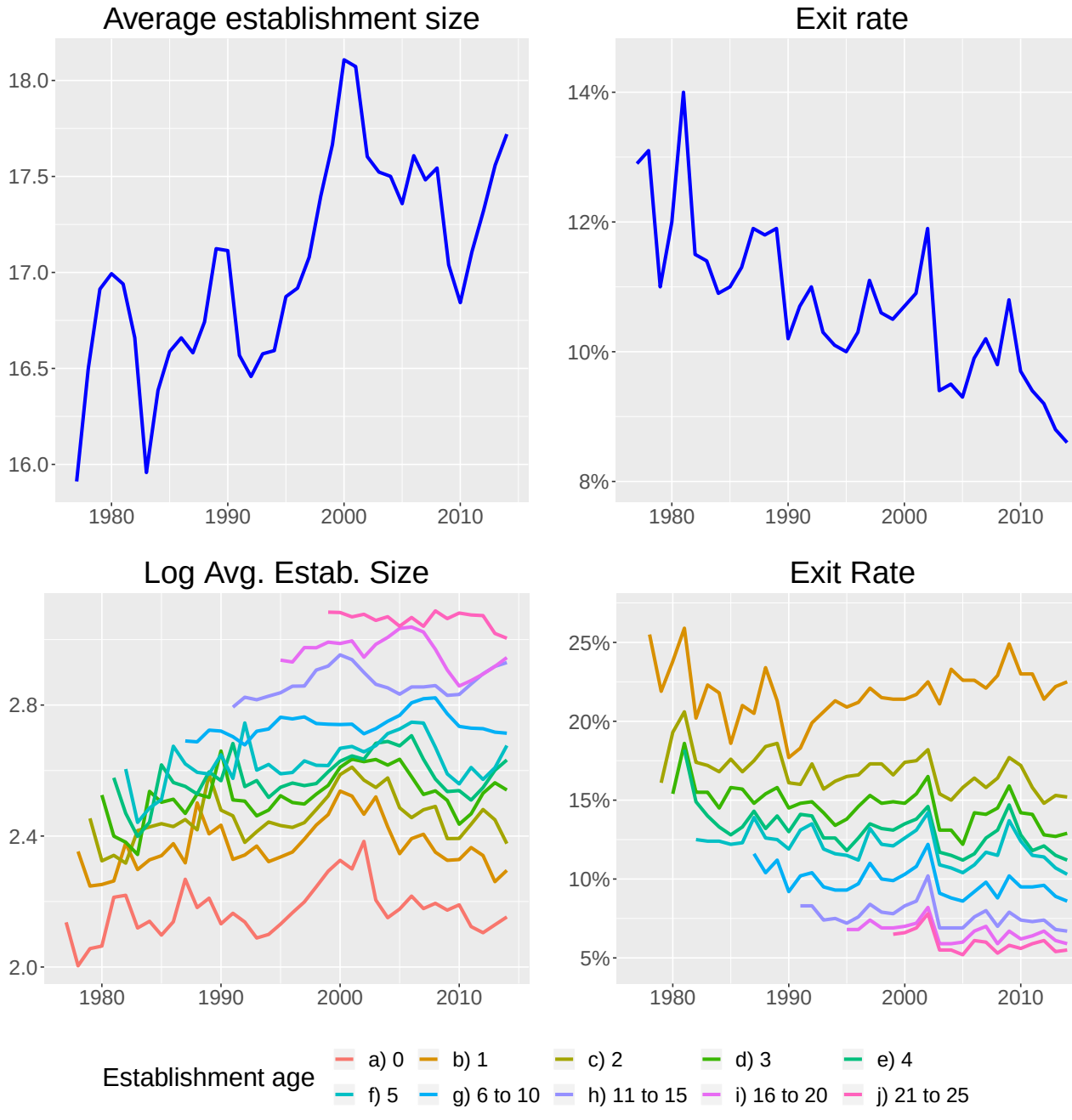
- Model: Dashed Line
- Data: Solid Line

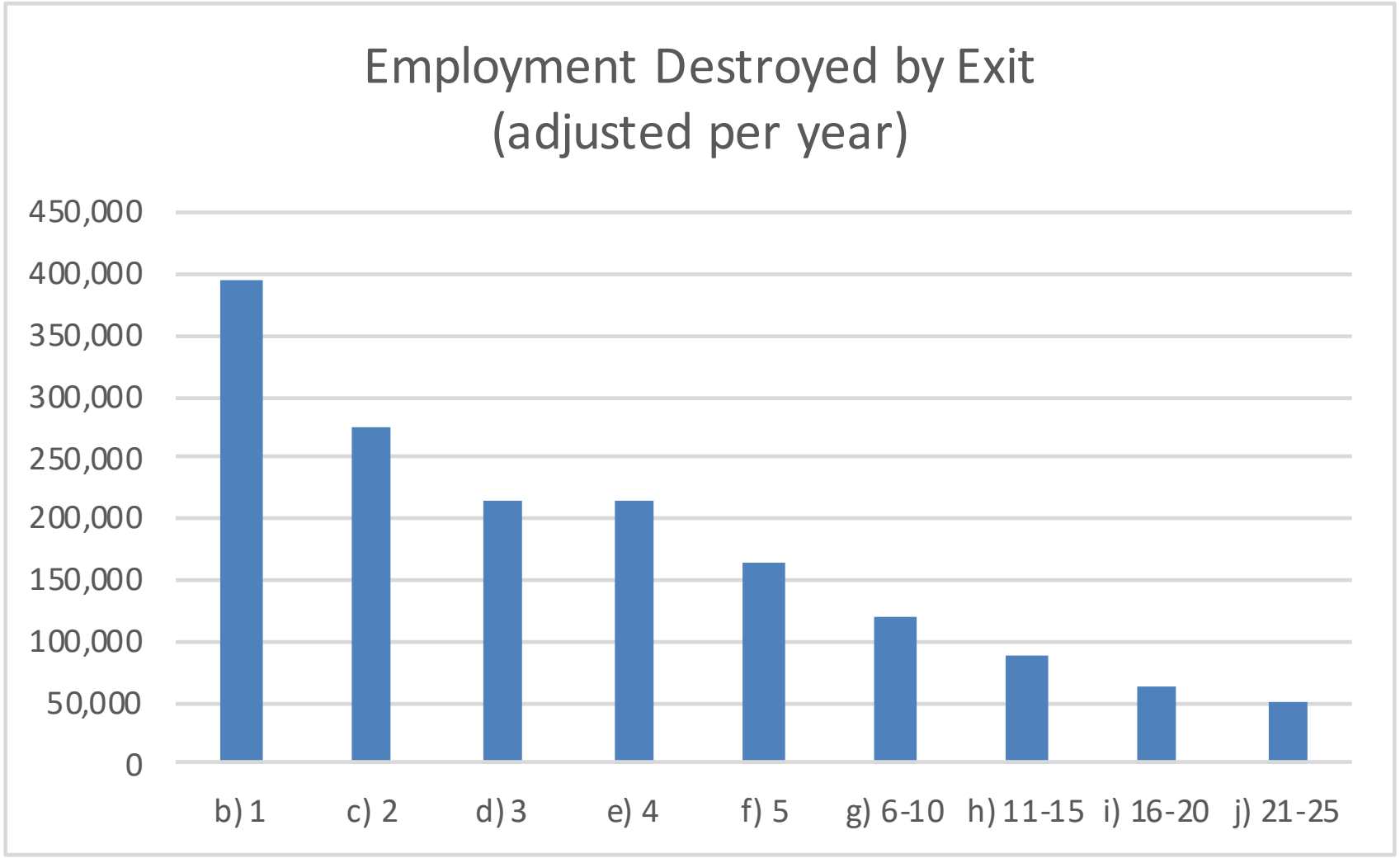
Establishments





Establishments




Employment Destroyed by Exit
(adjusted per year)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
b) 1
c) 2
d) 3
e) 4
f) 5
g) 6-10
h) 11-15
i) 16-20
j) 21-25

Statistics including firms age > 25