Recession Scars and the Growth Potential of Newborn Firms in General Equilibrium

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Motivation

Weak firm entry during Great Recession

- job creation of entrants in 2006: 3.5 million jobs
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Does this have (persistent) macroeconomic effects?

This paper: 1. Empirical Analysis

US Business Dynamics Statistics (BDS) data, 1979-2010

- follow job creation by cohorts of entrants as they age
  - extensive margin (number of firms)
  - intensive margin (average firm size)
- document cyclical patterns
- quick & dirty counterfactuals for potential macro impact

This paper: 2. General Equilibrium Model

- build heterogeneous firm model with aggregate shocks
  - heterogeneity in technology types
  - endogenous entry
  - aggregate shocks
  - general equilibrium
- fit model to data
- redo counterfactuals, now accounting for GE effects

Empirical evidence

Data and methodology

- BDS data, 1979-2010
  - 98% of all US private employment
  - annual information: number of firms, net job creation
  - broken down according to age, size, sectors

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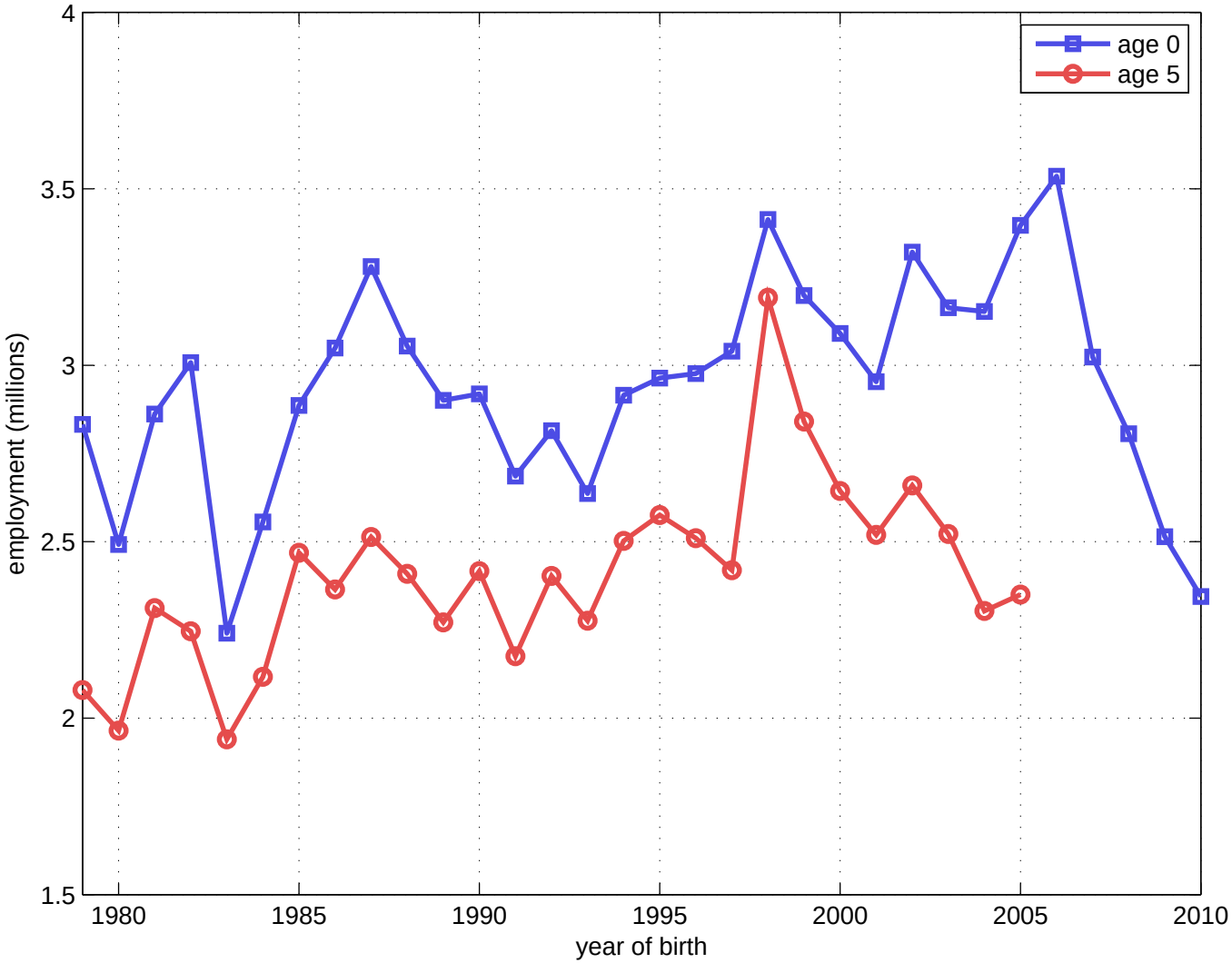
- BDS data, 1979-2010
  - 98% of all US private employment
  - annual information: number of firms, net job creation
  - broken down according to age, size, sectors
- employment and average firm size of entrants
- age breakdown $\rightarrow$ track them until 5 years old
- inspect patterns within and across cohorts

Three stylized facts

- 1. **cohort-level employment is largely determined in year of birth**
- 2. *variation in cohort-level employment is mainly driven by intensive margin*
- 3. *cohorts of small firms are born in times of low economic activity*

Stylized facts - 1. *cohort employment highly persistent*

Cohort employment at t and $t+5$



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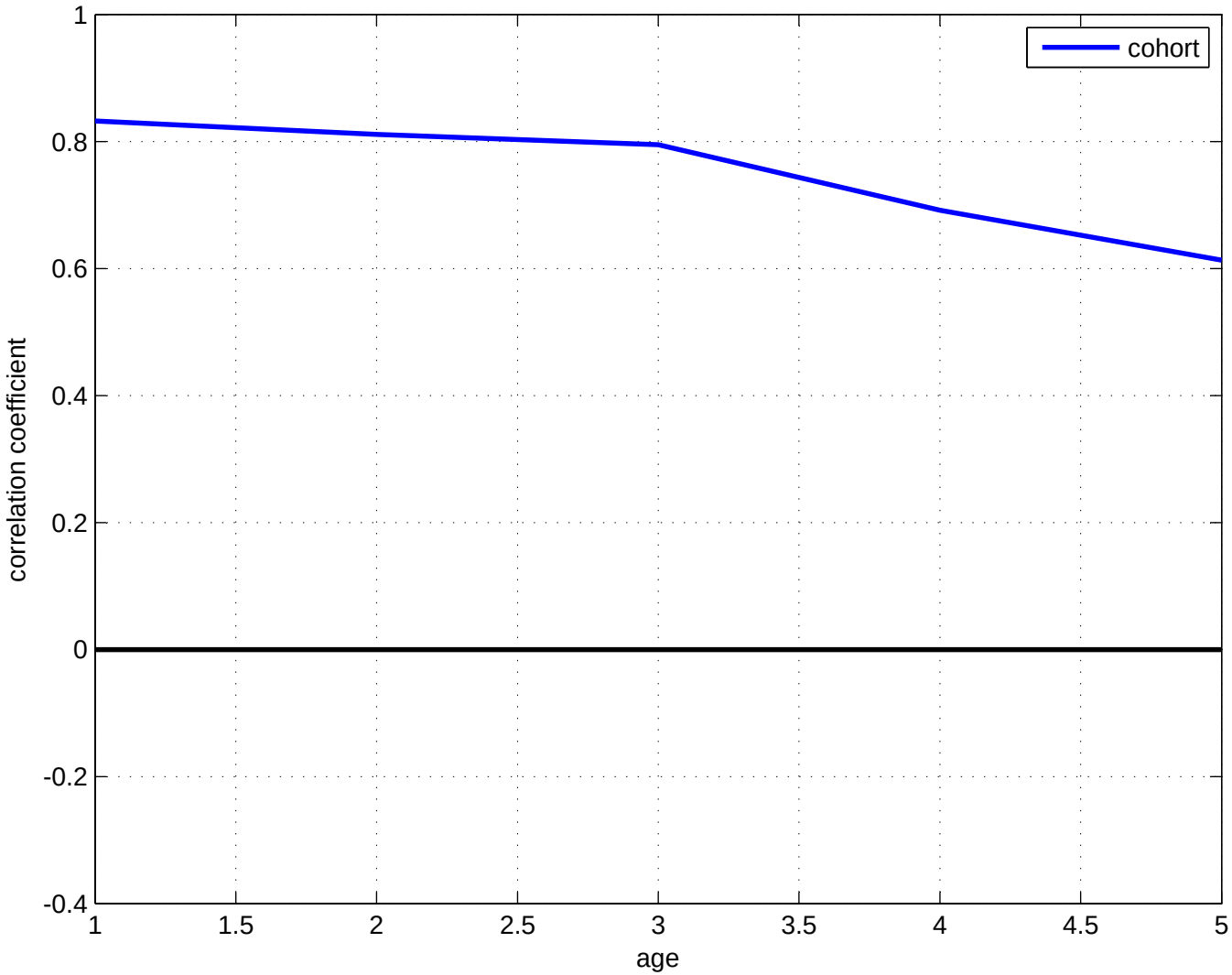

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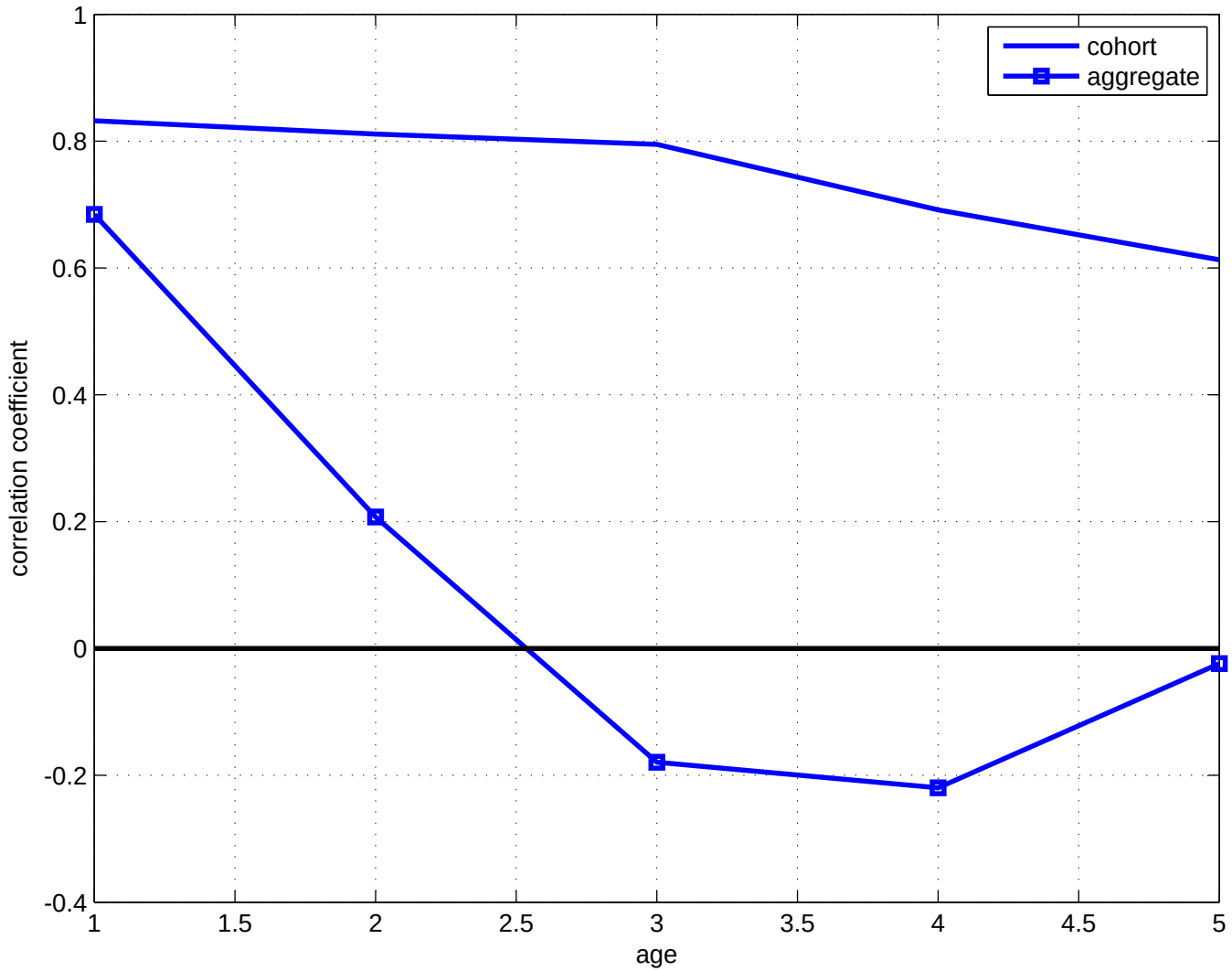

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$$\ln E_{a,t} = \ln S_{0,t-a} + \ln N_{0,t-a} + \sum_{j=1}^{a} \ln \gamma_{j,t-a+j} + \sum_{j=1}^{a} \delta_{j,t-a+j}$$

- $\gamma_{a,t} = \frac{S_{a,t}}{S_{a-1,t-1}}$
- $\delta_{a,t} = \frac{N_{a,t}}{N_{a-1,t-1}}$

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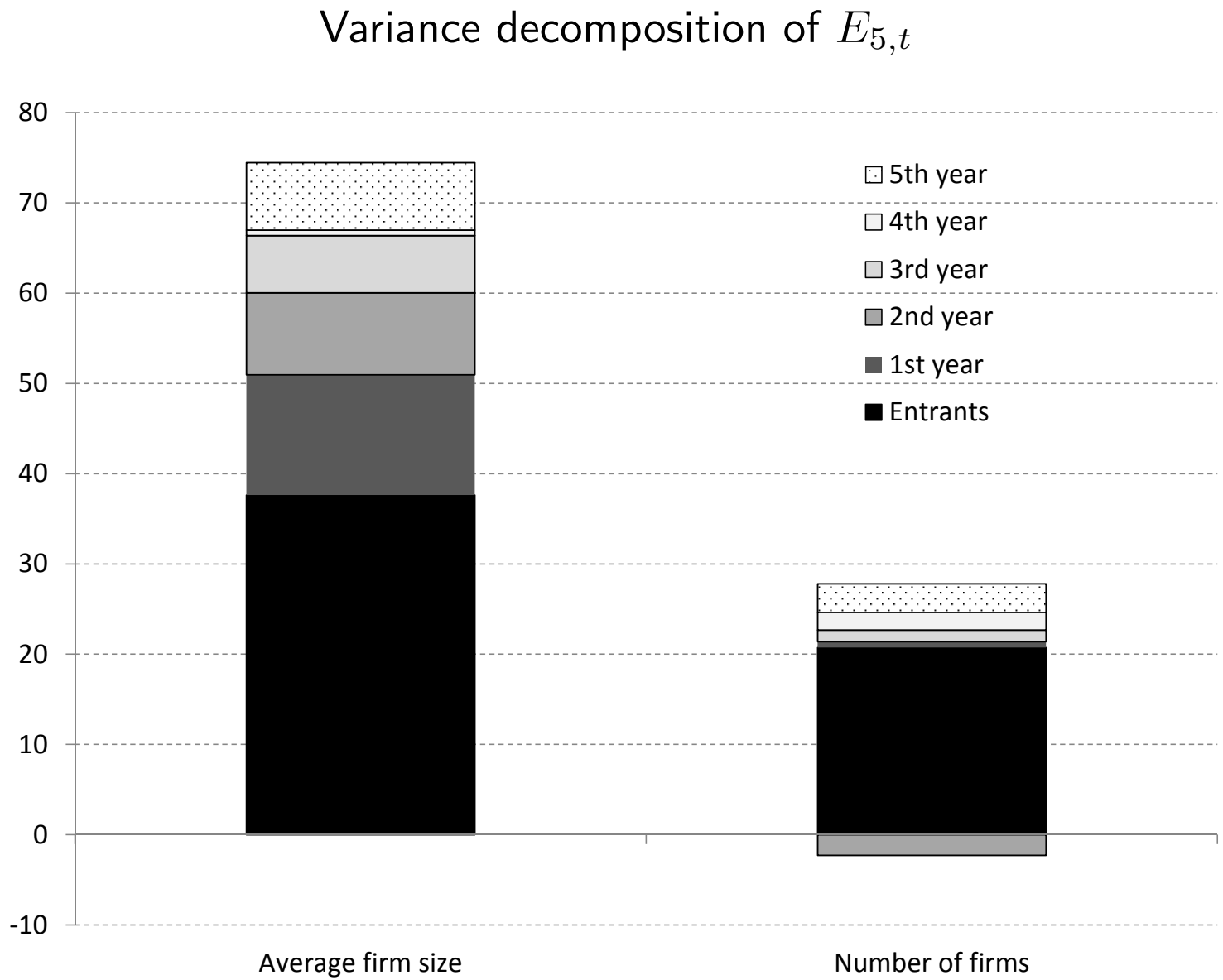

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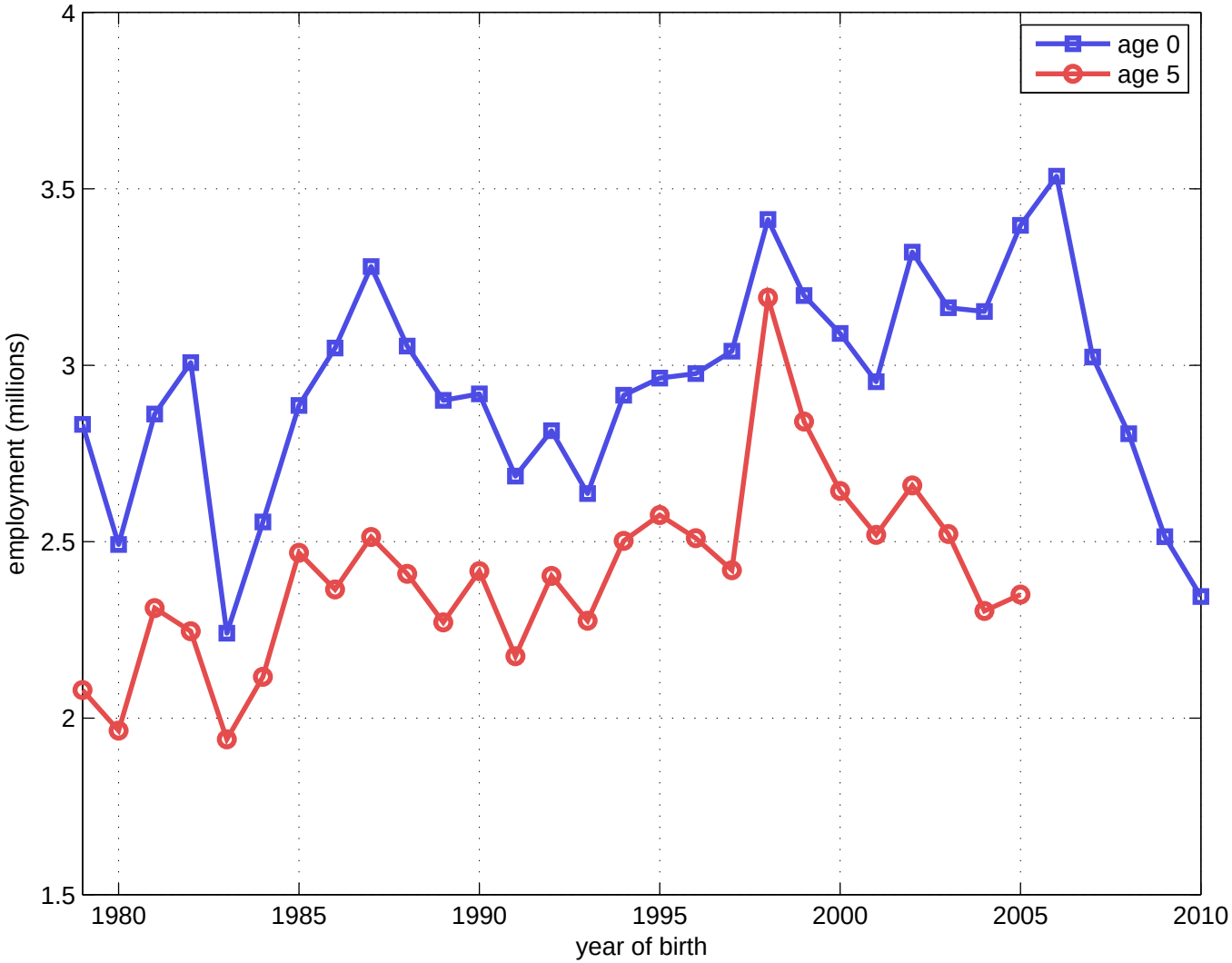

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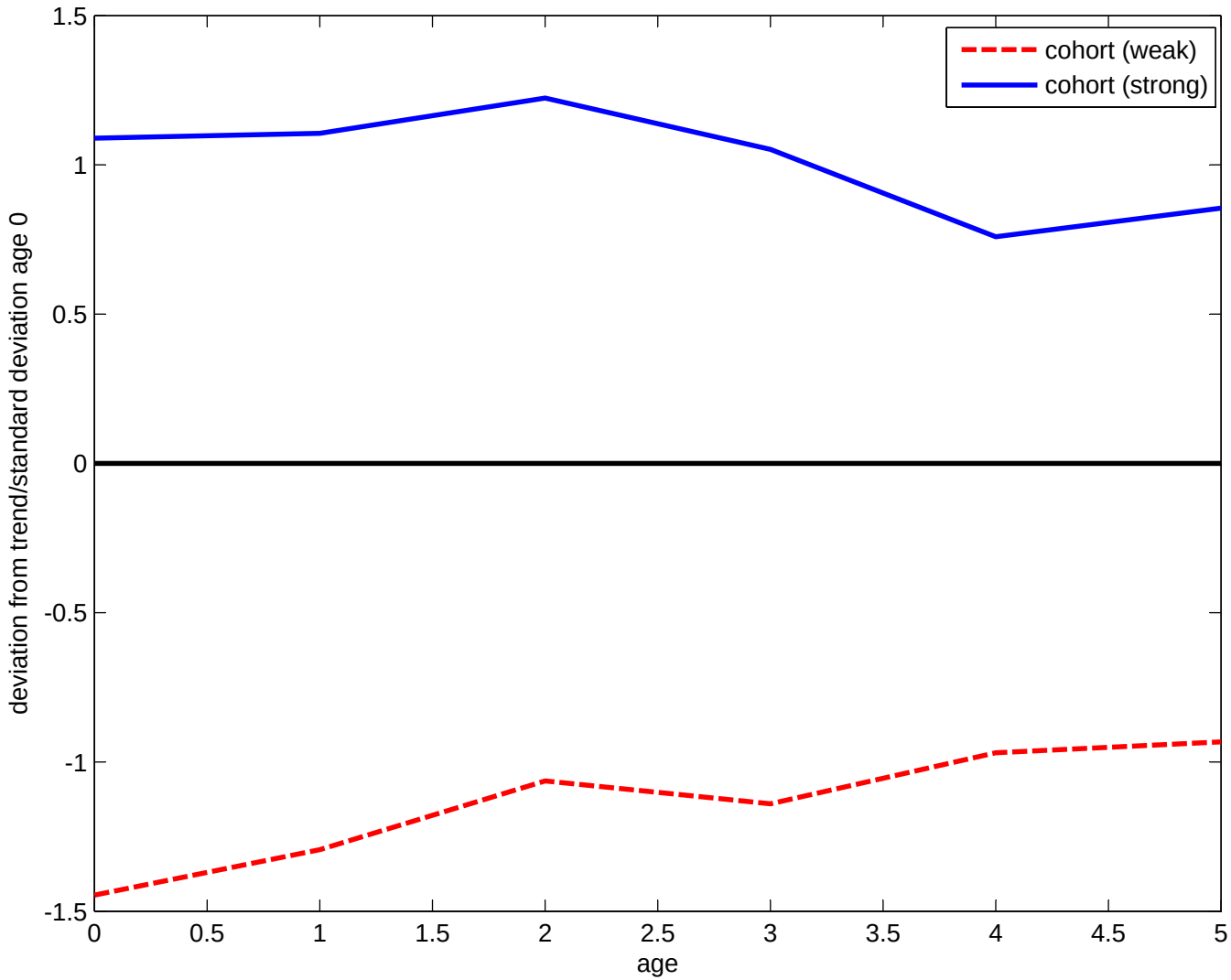
Cohort-level average size; weak and strong cohorts



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Cohort-level and aggregate average size; weak and strong cohorts

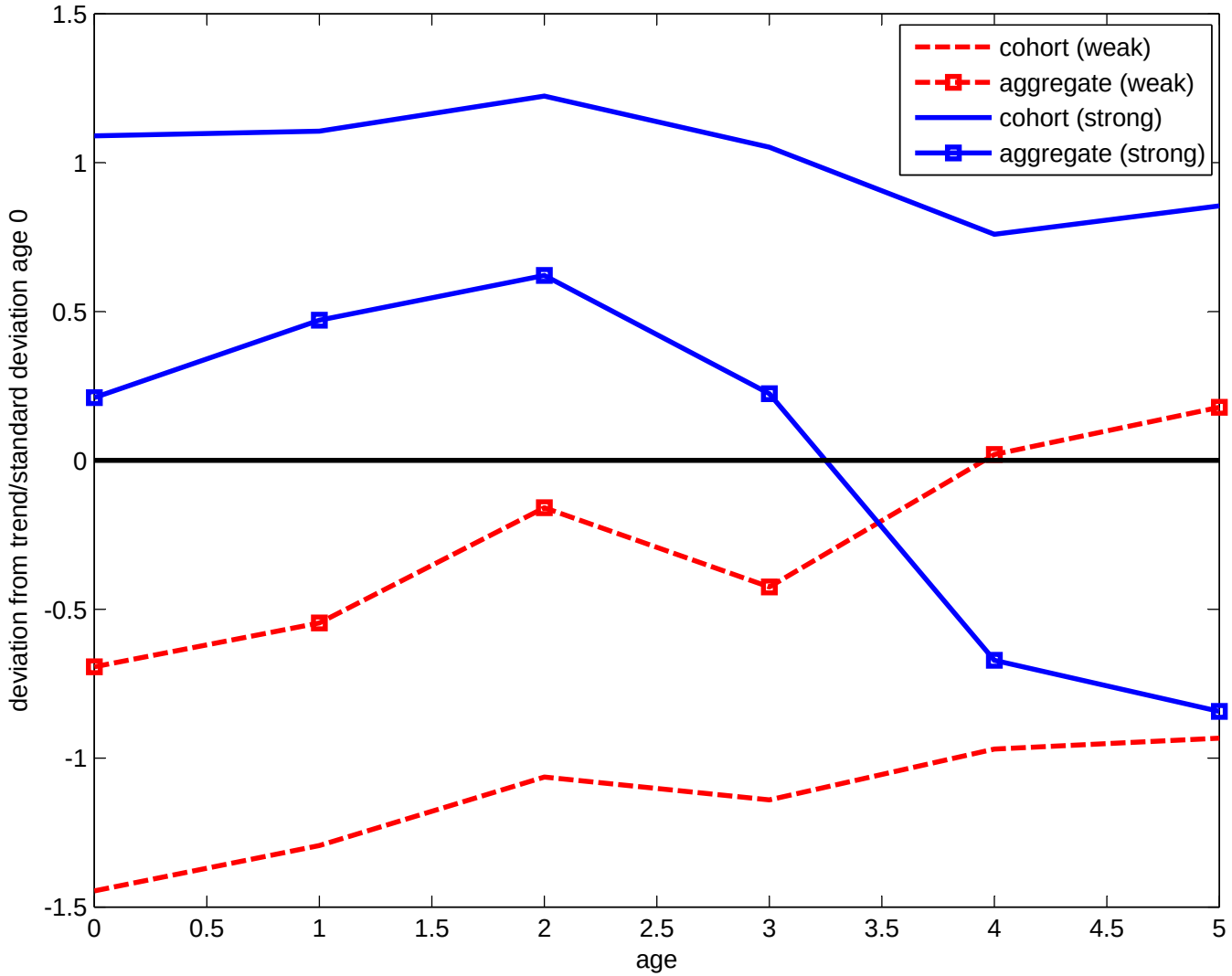

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Table: Correlations of average size with BC indicators in year t

age	Levels	linear trend		CF filter(6,12)	
	E/L	E/L	GDP	E/L	GDP
cohort-level					
$a = 0$	0.50	0.36	0.33	0.74	0.61
$a = 5$	0.44	0.28	0.10	0.74	0.74

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aggregate-level					
$a = 0$		0.75	0.74	0.76	0.72
$a = 5$		−0.17	−0.37	−0.73	−0.65

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$a = 5$	0.59	0.35	0.23	0.84	0.88
aggregate-level					
$a = 0$		0.91	0.88	0.96	0.98
$a = 5$		−0.07	−0.26	−0.67	−0.55

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- plot the differential from aggregate employment

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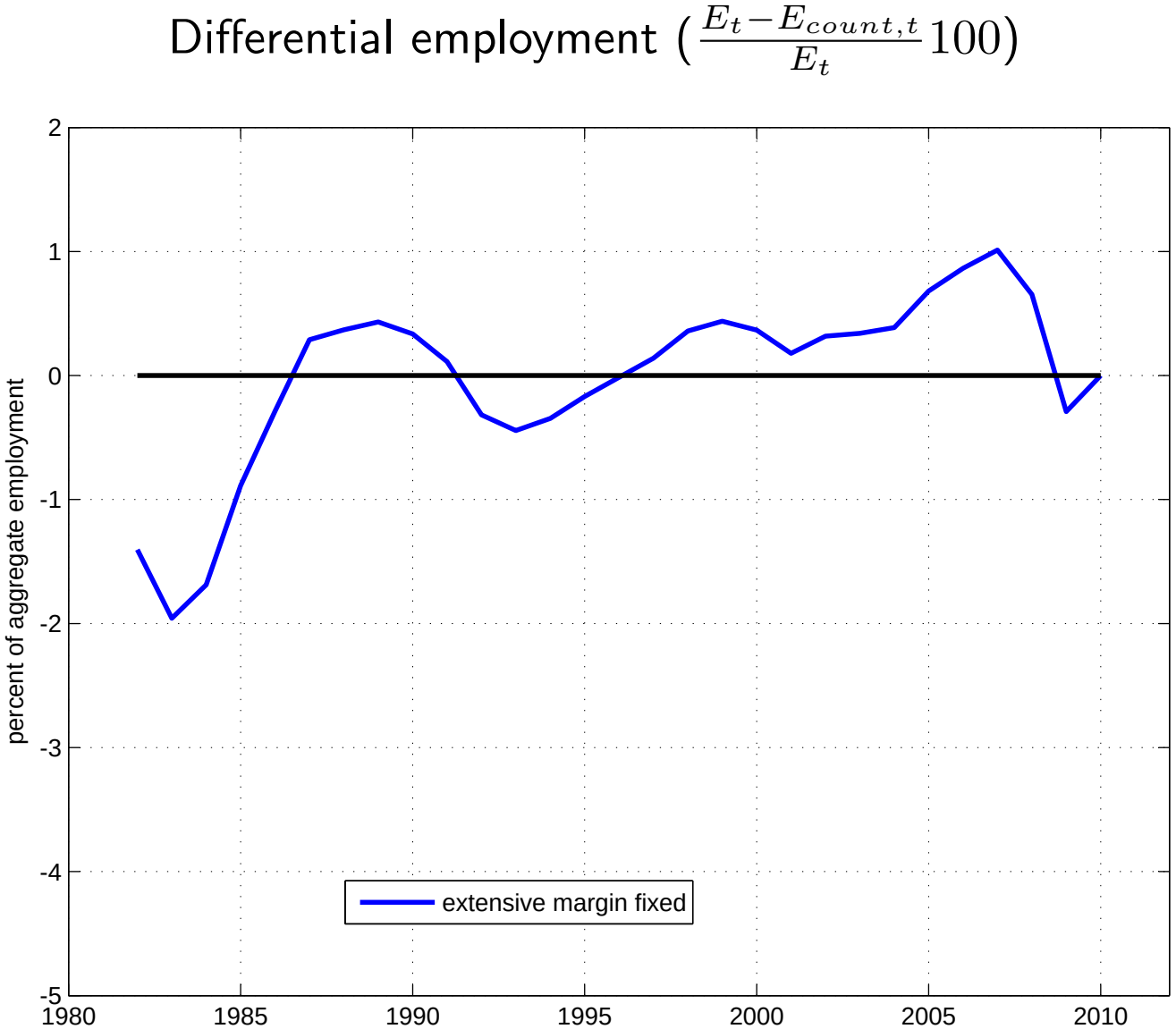

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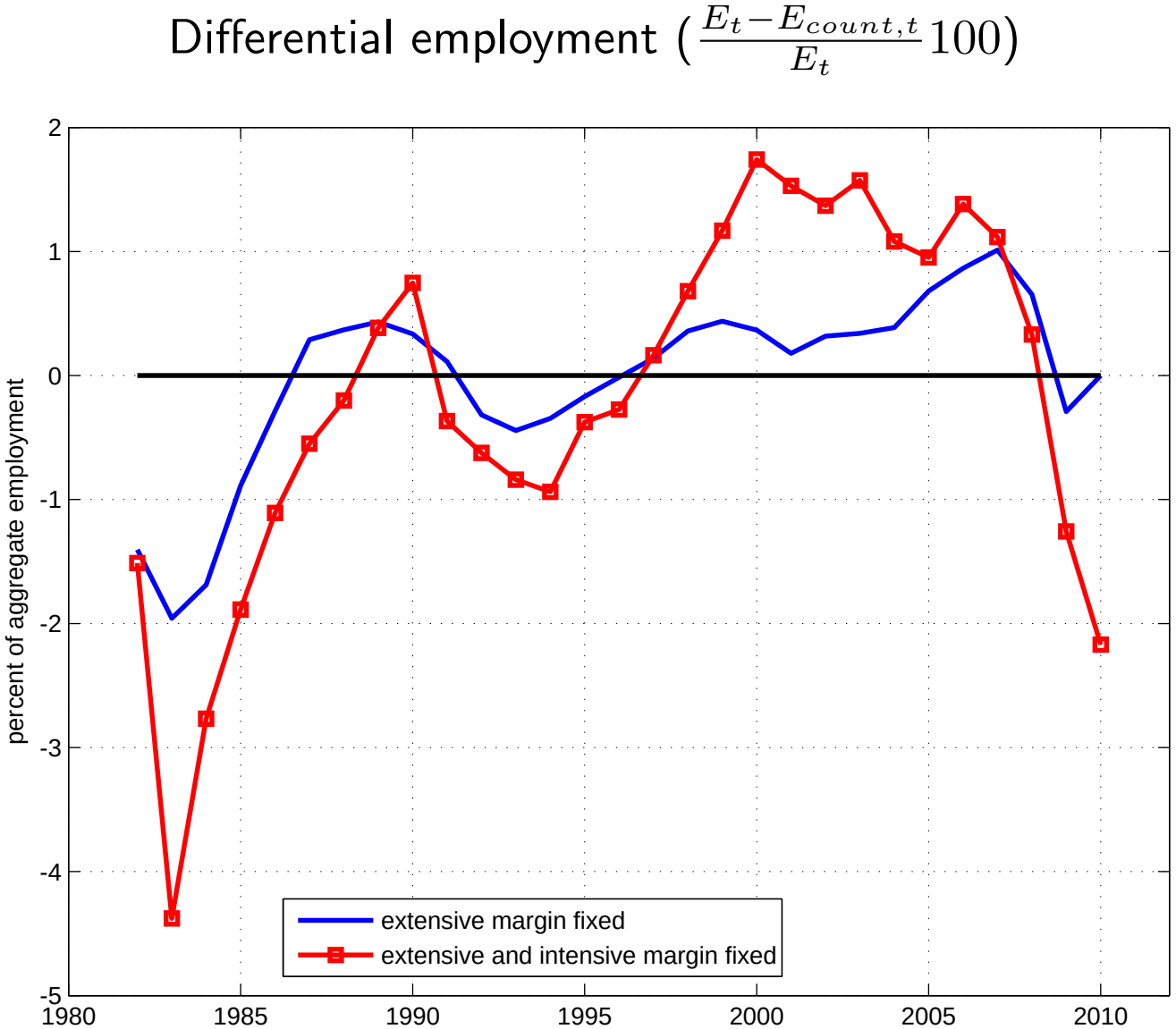

What next?

- we observe 3 new stylized facts explanations
- ultimately interested in macroeconomic implications
- counterfactuals cannot account for GE effects!
- $\rightarrow$ build a GE model that can explain the above facts
- investigate scarring effects of recessions in model

General equilibrium model

Related literature

- Hopenhayn (1992), Hopenhayn and Rogerson (1993), Cooley and Quadrini (2001), Melitz (2005)
- Lee and Mukoyama (2012), Clementi and Palazzo (2010), Siemer (2012)
- Kaas and Kircher (2011), Schaal (2012), Sedláček (2012)

Model features

Neoclassical general equilibrium model with heterogeneous firms

- heterogeneity in returns to scale
  - BDS data, many old small firms
  - many startups do not want to grow: Campbell and de Nardi (2009), Hurst and Pugsley (2012)
  - direct evidence: Basu and Fernald (1997), Holmes and Stevens (2012)

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  - many startups do not want to grow: Campbell and de Nardi (2009), Hurst and Pugsley (2012)
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- costly labor adjustment
  - firms grow gradually as they age

Model features

- endogenous entry
  - number and *composition* of entrants endogenous
- aggregate uncertainty
- estimated on BDS data

Heterogeneous firms

Existing firms

- endogenous measure, owned by household
- produce a homogeneous good using only labor
- finite number of technology types $i = 1, ..., I$.
- production function

$$y(n_t, A_t; i) = y_{i,t} = z_i A_t n_t^{\alpha_i}$$

Existing firms

Firms maximize expected discounted profits:

$$V_{i,a}(n_{i,a-1,t-1}, \mathcal{S}_t) = \max_{n_{i,a,t}} \left[\begin{array}{c} z_i A_t n_{i,a,t}^{\alpha_i} - W_t n_{i,a,t} - Q_t \zeta_a(n_{i,a,t}, n_{i,a-1,t-1}) \\ + (1-\rho_a)\, \mathbb{E}_t \Lambda_{t,t+1} V_{i,a+1}\left(n_{i,a,t}, \mathcal{S}_{t+1}\right) \end{array} \right]$$

Firm entry

- free entry
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- there is a time-invariant mass of opportunities per type: $\Psi = \sum_i \psi_i$
- some startup attempts fail due to a coordination friction
  - matching function

Firm entry

mass of entrants in technology type i

$$m_{i,0,t} = x_{i,t}^{\phi} \psi_i^{1-\phi}, \text{ for } i = 1, 2, .., I,$$

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free entry condition

$$\chi = P_{i,t} V_{i,0,t} \left(0, \mathcal{S}_t\right), \text{ for } i = 1, 2, .., I,$$

Firm entry decisions

- technology type is a *choice*
- more attractive technologies are tougher to startup
- entry happens in all technology types

Representative household, market clearing and shocks

Households

representative household with continuum of members. Choose consumption and labor:

$$\max_{\{C_t,N_t\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} + \frac{Z_t N_t^{1+\kappa}}{1+\kappa} \right)$$

$$s.t.$$

$$C_t = W_t N_t + \Pi_t$$

Market clearing

We impose maximum age K ($\rho_K = 1$). Aggregate resource constraint:

$$\sum_{i=1}^{I}\sum_{a=0}^{K} m_{i,j,t}\left(y_{i,a,t} - Q_t\zeta_{i,a,t}\right) - \sum_{i=1}^{I} x_{i,t}\chi = C_t$$

Labor market clearing:

$$\sum_{i=1}^{I}\sum_{a=0}^{K} m_{i,a,t}n_{i,a,t} = N_t$$

Aggregate state:

$$\mathcal{S}_t = \{m_{i,a,t}, n_{i,a,t-1}, A_t, Q_t, Z_t\}_{i=1,\ldots,I}^{a=0,\ldots,K}$$

$\Rightarrow$ large but finite-dimensional object

Aggregate shocks

$$
\begin{aligned}
y_{i,t} &= z_i A_t n_t^{\alpha_i} \\
W_t C_t^{-\sigma} &= Z_t N_t^{\kappa} \\
W_t &= \alpha_i z_i A_t n_{i,a,t}^{\alpha_i - 1} \left(1 - Q_t \zeta'_{i,a,t}\right) + (1 - \rho_a) \beta \mathbb{E}_t \Lambda_{t,t+1} Q_{t+1} \zeta'_{i,a,t+1}\Big)
\end{aligned}
$$

- stationary processes with continuous support
- *estimated* and used for counterfactuals

Quantitative implementation

Parametrization

Parameter values obtained using hybrid of:

- matching long-run targets
  - average size age 0
  - average size age 1
  - size distribution of firms aged 16-20 (use BDS size brackets)
- matching key moments
  - volatility number of entrants
  - volatility avg. size age 5 / volatility avg. size age 0
- maximum likelihood estimation (aggregate shock processes)
  - time series used: output, employment rate, average entrant size
  - obtain estimated shocks as by-product

Parametrization

Adjustment cost assumed to be quadratic:

$$\zeta_a(n_{i,a,t}, n_{i,a-1,t-1}) = \frac{\zeta_a}{2}(n_{i,a,t} - n_{i,a-1,t-1})^2$$

- $\zeta_0 \geq \zeta_1 = \zeta_2 = ... = \zeta_K$.
- ζ_1 calibrated to match growth rate of average size young cohorts
- ζ_0 calibrated to match relative volatility of avg. size at age 5
- initial level $n_{i,-1}$ calibrated

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Exit rates

- age-dependent $\rho_a = \xi_0 + \xi_1/a$, $\xi_0, \xi_1 > 0$
- parameters ξ_0 and ξ_1 fitted to exit rates observed in BDS

Parameter values

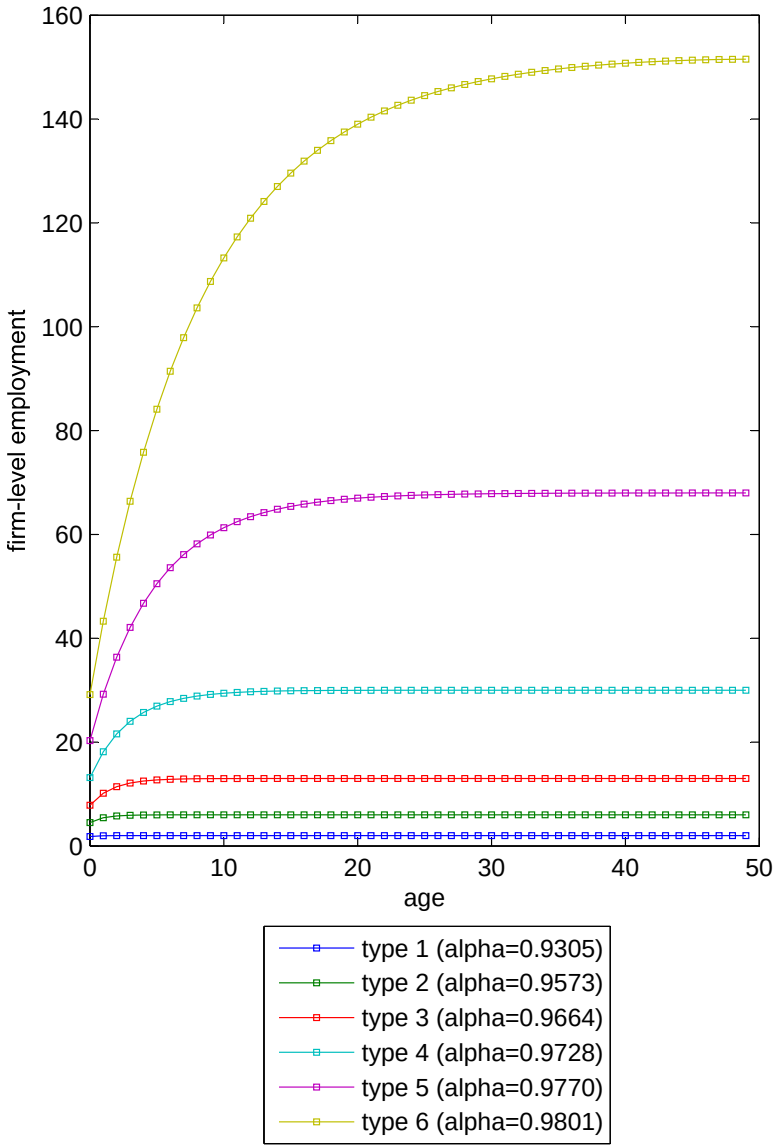
Table 4: Calibrated parameters

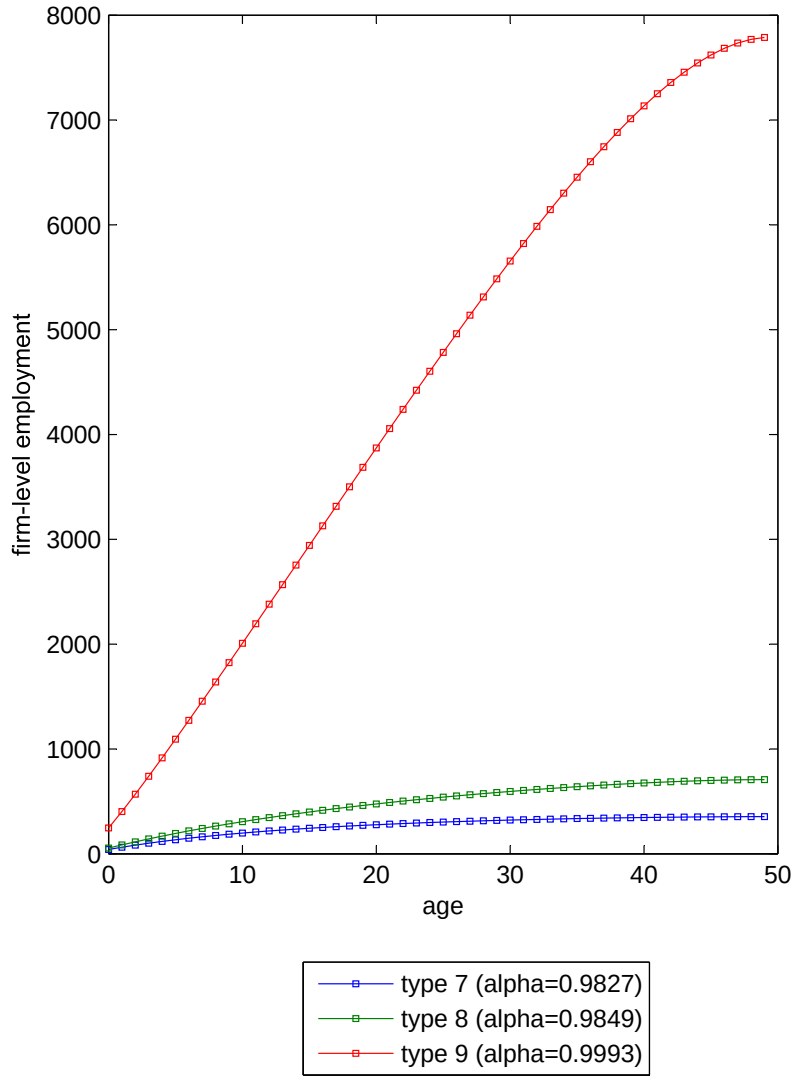
	parameter	value	target/estimate
β	discount factor	0.96	annual interest rate 4%
σ	relative risk aversion coefficient	1	log-utility
κ	utility of leisure parameter	1	unit Frisch elastiicty
ζ	adjustment cost, age 1-50	0.007	size of 1 year old firms
ζ_0	adjustment cost, entrants	0.041	size of entrants
ξ_0	exit rate coefficient	0.050	exit rates by age, BDS data
ξ_1	exit rate coefficient	0.170	exit rates by age, BDS data
χ	entry cost	0.930	entry costs = 0.073 GDP
Ψ	measure of business opportunities	0.090	$M = 1$, normalization
ϕ	elasticity in entry function	0.500	std(entry)/std(y)
ρ_A	TFP wedge, persistence	0.815	
σ_A	TFP wedge, standard deviation	0.011	
ρ_Q	adjustment cost wedge, persistence	0.533	
σ_Q	adjustment cost wedge, standard deviation	1.088	
ρ_Z	labor wedge, persistence	0.595	
σ_Z	labor wedge, standard deviation	0.022	

α_i	returns to scale								average size in BDS size classes
	0.916	0.948	0.959	0.967	0.972	0.976	0.979	0.982	0.999
$P_i = \left(\frac{\psi_i}{x_i}\right)^{1-\phi}$	probability of starting up a type i firm								firm shares in BDS size classes
	0.799	0.451	0.272	0.153	0.087	0.051	0.030	0.018	0.001

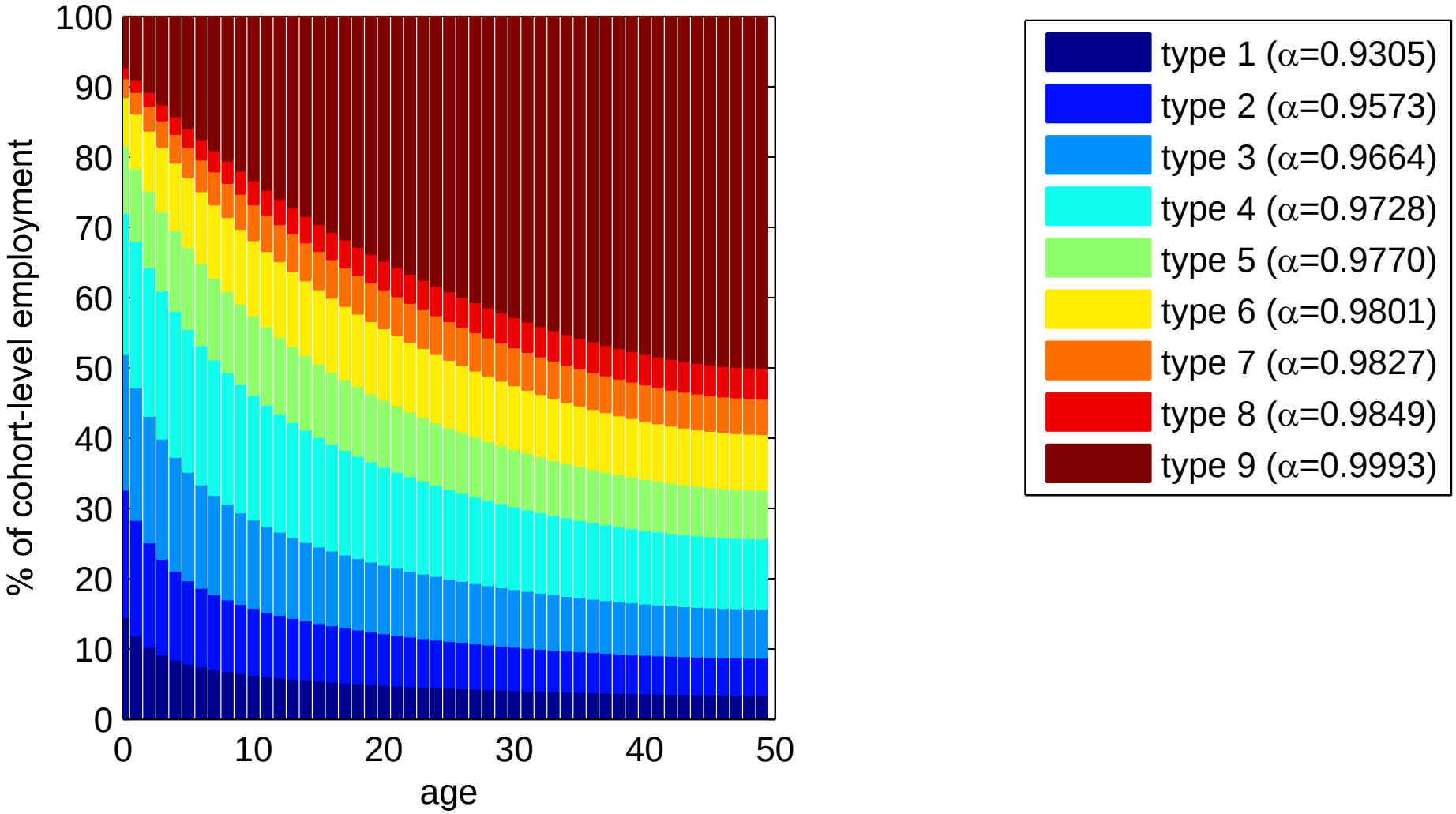
Results

Steady state: Firm size by type and age

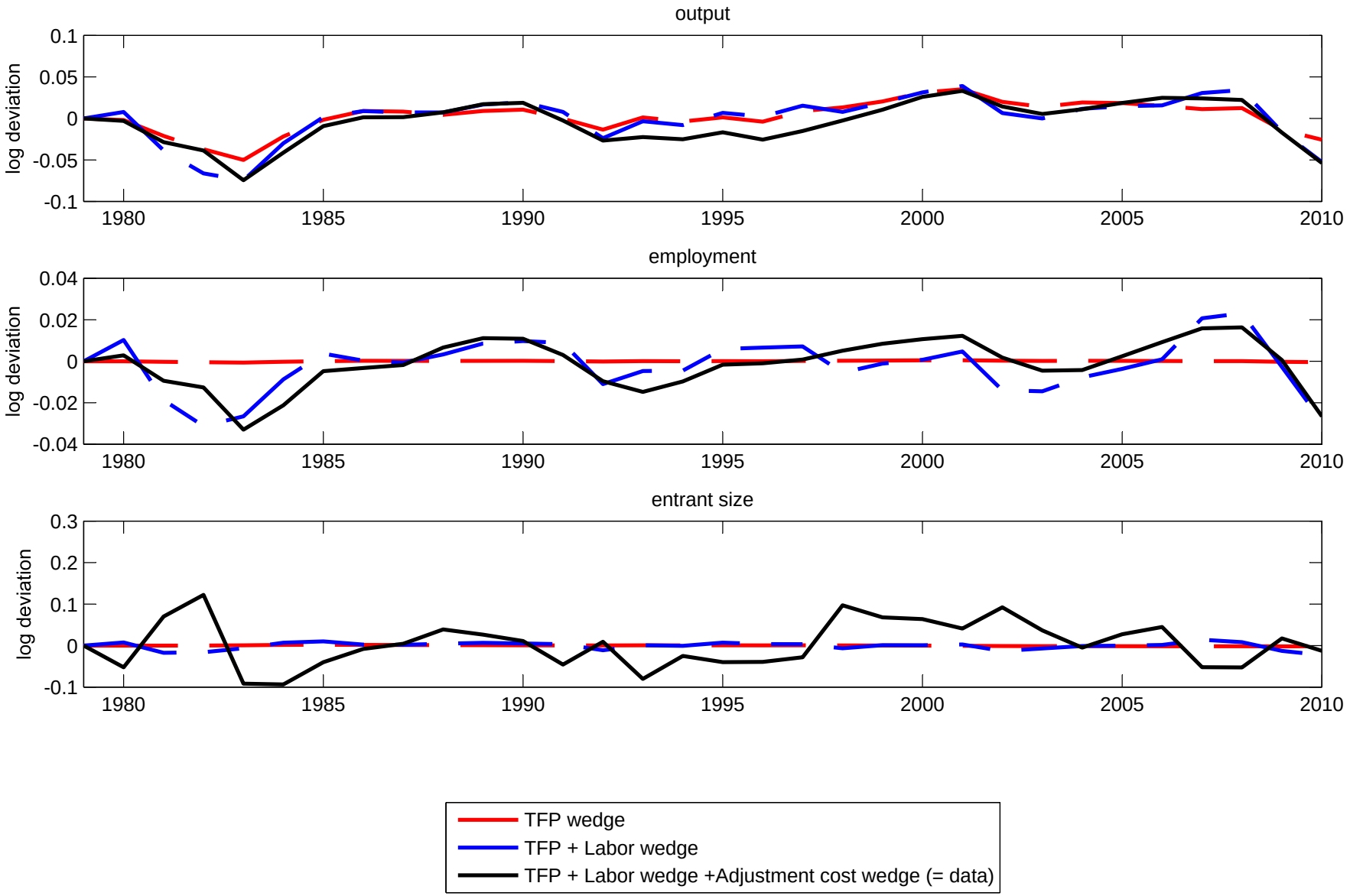




Steady state: Fraction of cohort-level employment by type and age



Shock estimation: Historical decomposition



Counterfactuals

- model matches observed aggregate output and employment by construction
- take estimated shocks
- run them through a model in which we fix the type-composition of entrants
- general equilibrium effects are preserved

Counterfactuals

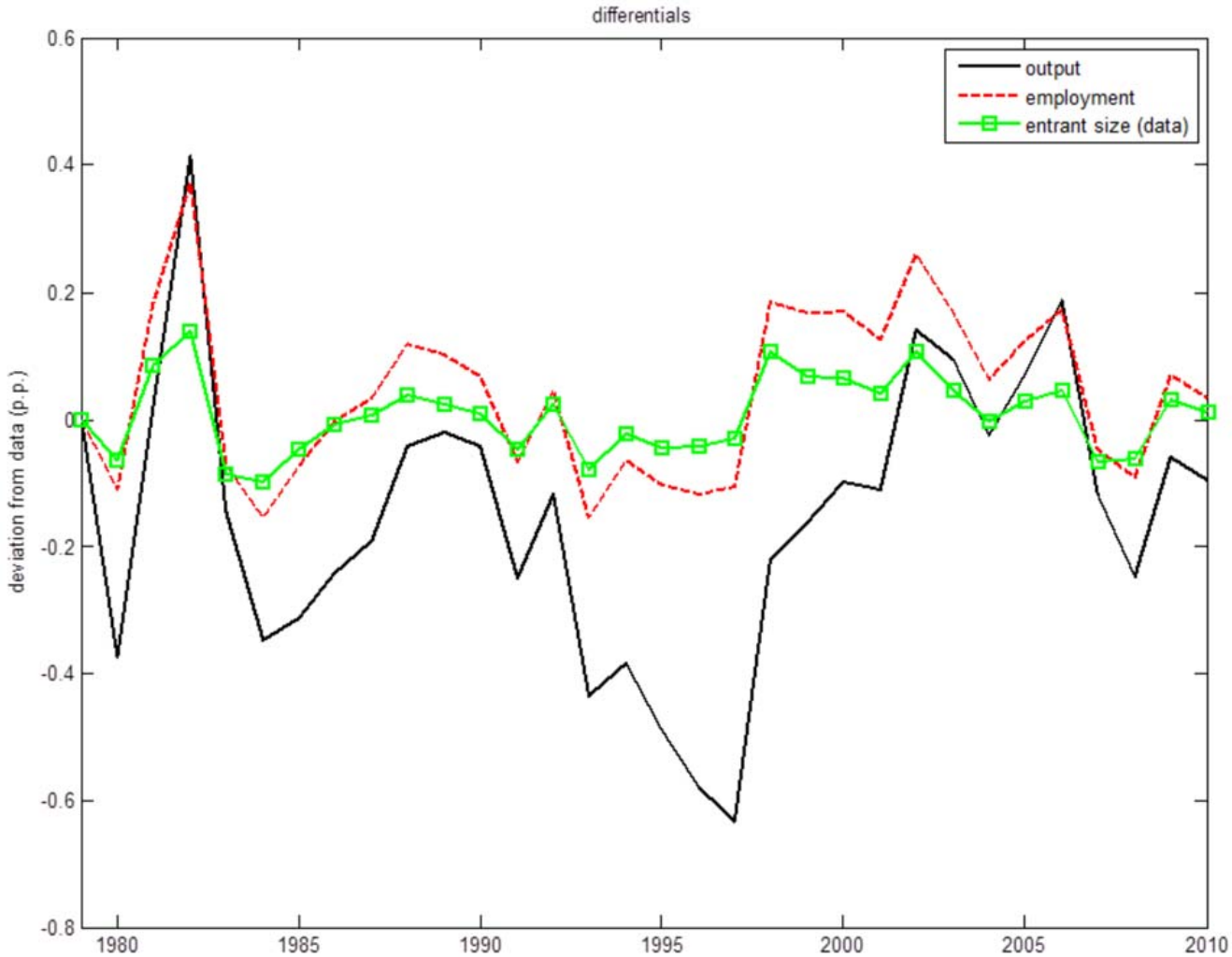
Figure: Output and employment differentials

Counterfactuals

- redo the same exercise
- now also fix adjustment cost shock to 1 for young firms
  - fix composition of startups at steady state, but let the number of entrants adjust
  - free young firms from adjustment cost fluctuations, but let growth rates respond to aggregate productivity and labor-leisure shocks
  - i.e. a less restrictive version of empirical counterfactuals

Counterfactuals

Figure: Output and employment differentials



Persistence - “recession scar”

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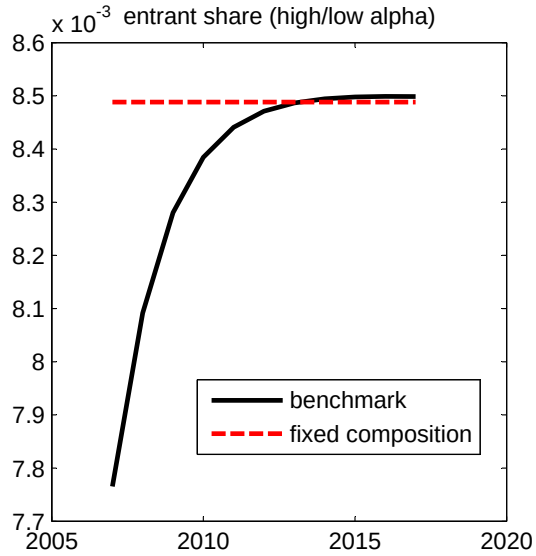

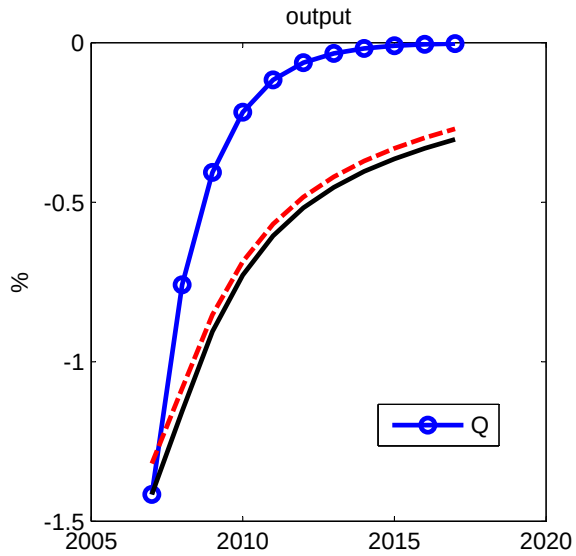

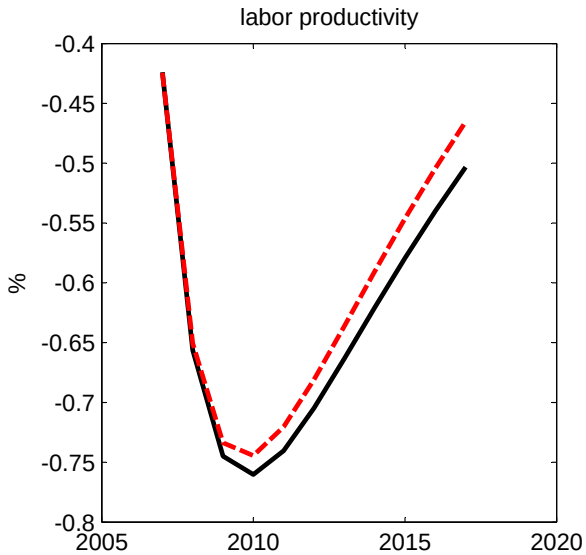

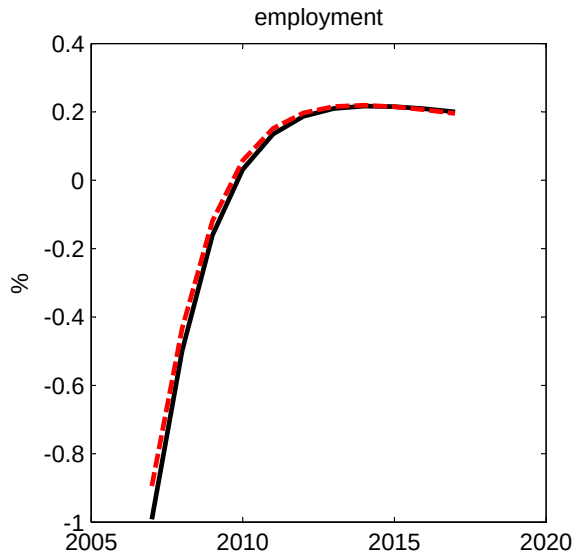

Conclusions

- fluctuations in composition of firm entrant cohorts important for aggregate outcomes
- smaller firms born in recessions, effects on output very persistent
- future work:
  - analyze micro data underlying BDS
  - endogenize wedges; more detailed explanation of drivers behind observed cyclical patterns

Thanks

Possible explanations: sectoral composition?

- sectoral composition of entrants?

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- manufacturing firms are on average larger
- $\rightarrow$ if also more sensitive to the BC
- $\rightarrow$ relatively less manufacturing firms in recessions

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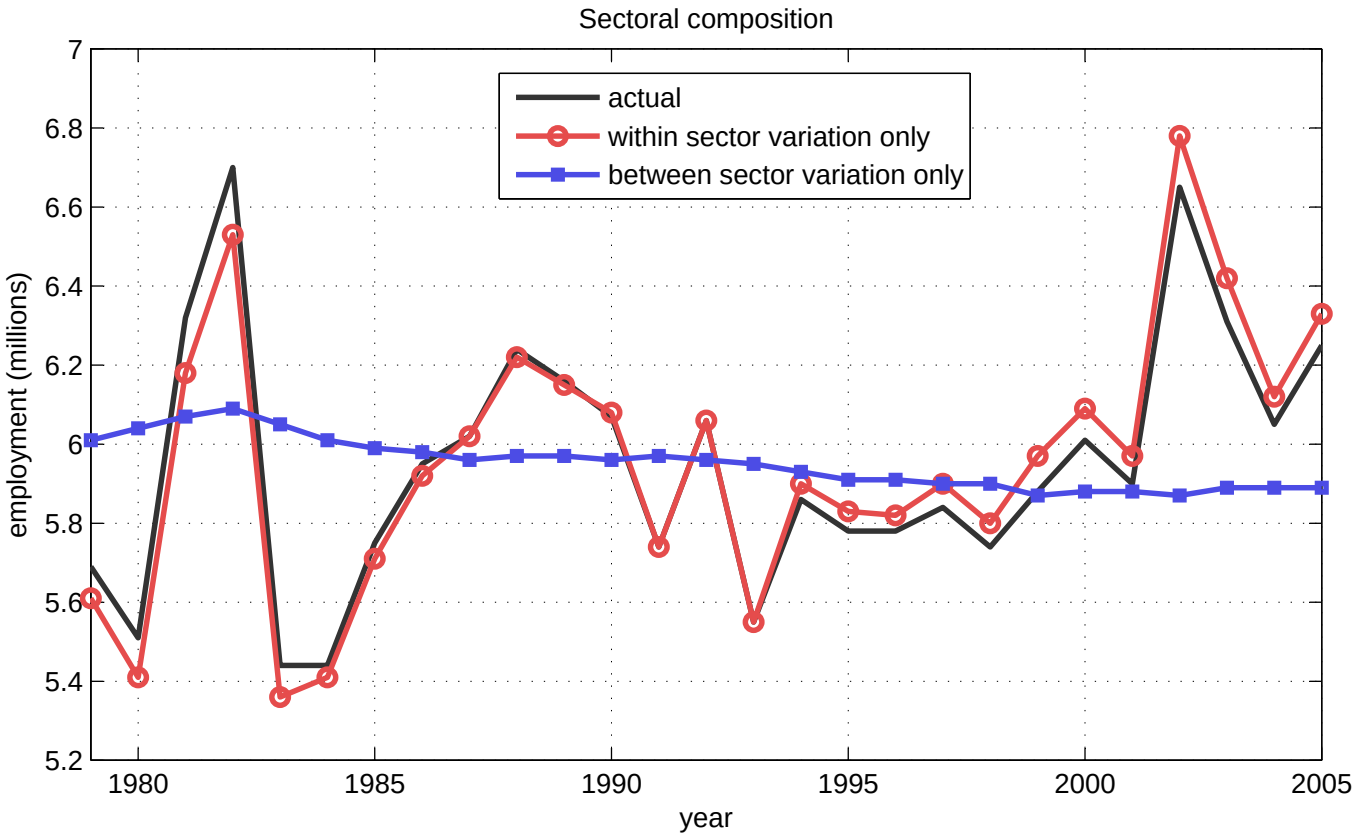

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- if entry of necessity entrepreneurs is counter-cyclical
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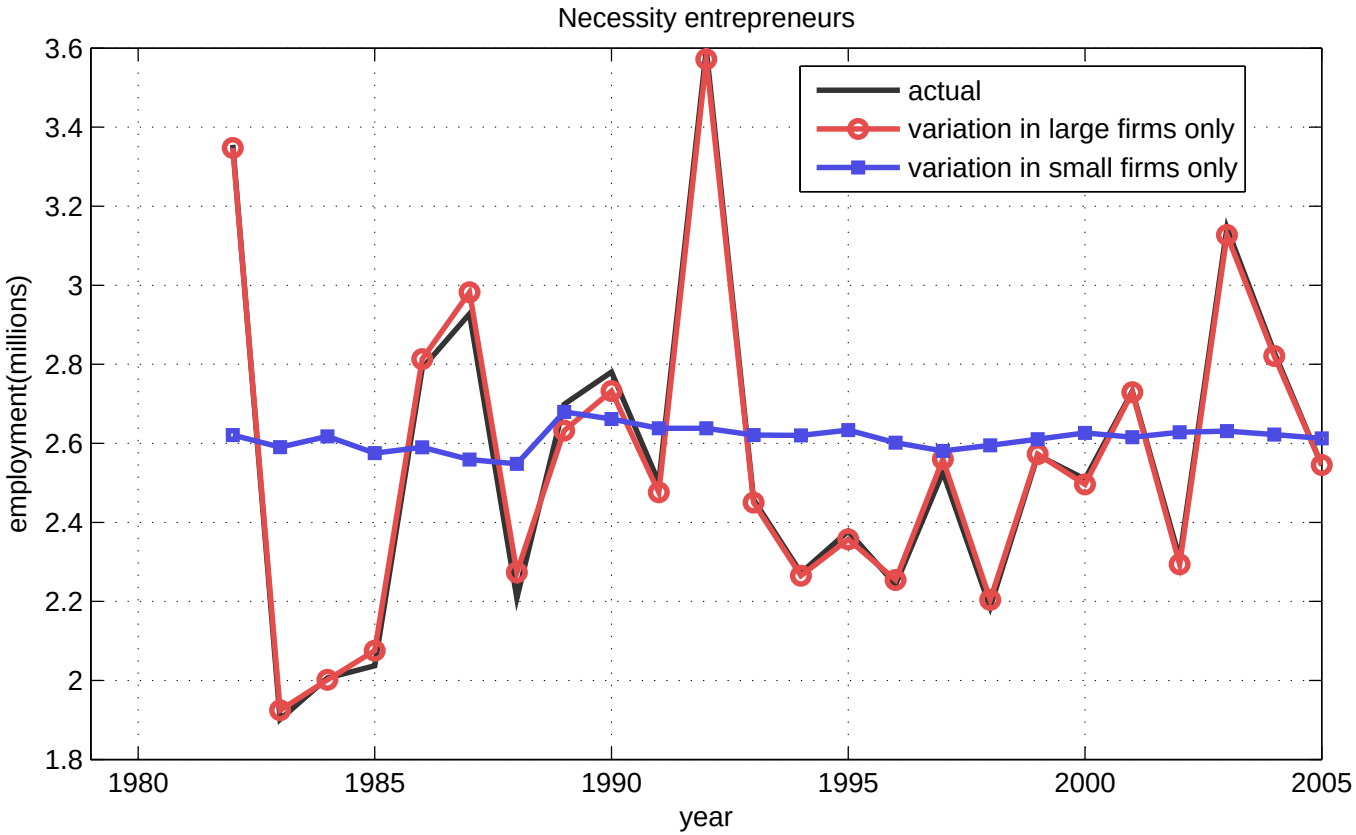

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