

Capitalism at Work

Labor Reallocation and Wage Growth in East Germany

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Labor Reallocation and Wage Growth in East Germany

► Case study of East German labor market post-reunification

- Planned economy with limited mobility → market economy
- Wage & labor productivity catch-up **from reallocation**

► **Finding:** Firm-worker reallocation a key component of initial convergence

- **Data:** excess mobility mostly driven by old cohorts ("*pent-up demand for reallocation*")
- **Model:** excess mobility explains a "sizable" share of wage growth in East

► Takeaways beyond the case study

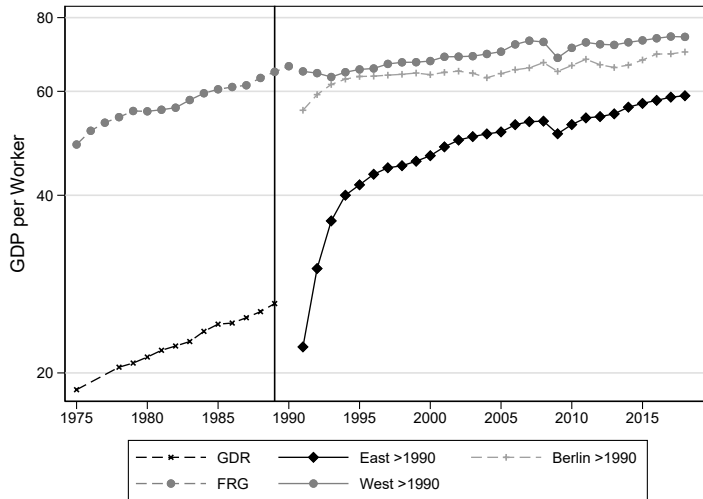
- **Large returns to capitalism in the labor market** (*dynamism*)
- "Institutions" can be quickly transformed (no persistence)

Overview

1. **Historical Background:** GDR labor allocation and East Germany post-reunification
2. **Motivation:** aggregate dynamics post-reunification
3. **Empirics:** five facts on reallocation and wage growth, **by cohort**
4. **Model:** reunification as a removal of labor market frictions in East
5. **Estimation and Counterfactual:** quantify gains from reallocation (*in progress*)

Historical Background

Rapid Increase in Productivity Post-Reunification



► Growth Accounting: mainly TFP rather than factors

East Germany before/ at Reunification

1. **GDR**: rigid, centrally planned allocation (of workers, firms, wages)
 - Constitutional "right and duty to work" → *full employment*
 - Firm structured into large state-owned integrated groups (*Kombinate*)
 - "Job tracks" predetermined, wages pegged to backgrounds
2. **Reunification**: Sudden and quick
 - Officially, absorption of East into Federal Republic of Germany (West)
 - Protests (**May 1989**); Berlin Wall (**Nov**); Legal reunification (**Oct 1990**)
3. **Treuhand**: quick privatization of GDR firms; ~15% liquidated
 - 1992: 80%, 1993: 95%, 1994: 99% sales complete
 - more than 75% to West Germans, 20% to East
 - **our sample: 1992 onward**
4. Managers at new East firms most mostly West

References: *Lipschitz and McDonald, eds (1990); Akerlof et al. (1991); Roesler (1994); Boltho et al. (2018); Mergele et al. (2020)*

Data

Large Administrative Data (IAB)

- ▶ Research center associated with (un)employment agency
- ▶ Universe of work histories for **1992-2014**: ~50 million workers
 - gender, age, educ, wage, occupation, part/full-time
 - **establishment**, Kreis (county), industry
- ▶ Observed annually (30% sample for daily)
- ▶ Focus on prime-age (25-54) German (domestic) men
 - 55+ offered early retirement incentives at reunification
- ▶ Sample divided into East/West-Born ("first appearance proxy")

c.f. *Berlin treated as West or left out: too small to matter for East Germany as a whole*

Aggregate Dynamics

to motivate the focus

Measuring Workers and Firms Reallocation

- ▶ **Worker reallocation:** share of workers changing establishment

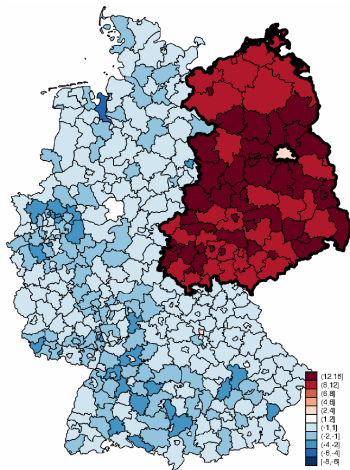
$$WR_{t,t+1} = \frac{F_{t,t+1} + H_{t,t+1}}{\sum_j (N_{j,t} + N_{j,t+1})}.$$

- ▶ **(Firm) Job reallocation:** sum of net changes in firm sizes

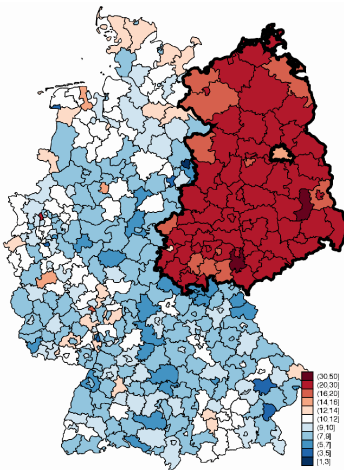
$$JR_{t,t+1} = \frac{JD_{t,t+1} + JC_{t,t+1}}{\sum_j (N_{j,t} + N_{j,t+1})},$$

1992: Wage Growth and Reallocation Explodes...

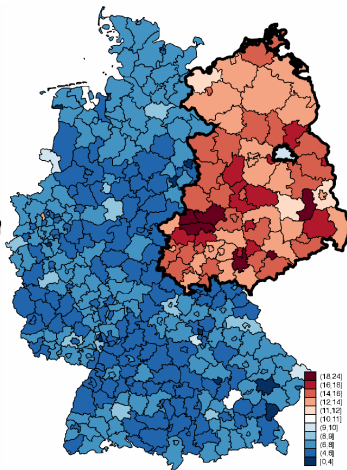
► Equations



(a) Wage Growth



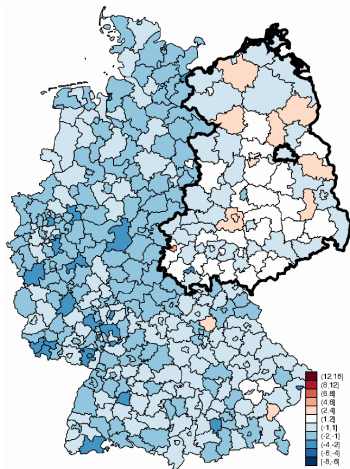
(b) Worker Reallocation



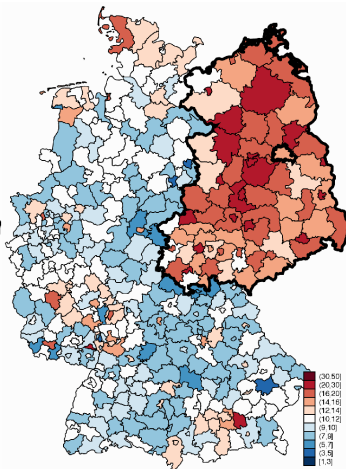
(c) Firm Job Reallocation

1995: Then Quickly Subsides

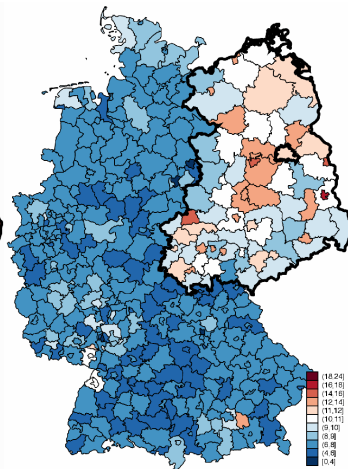
► Equations



(a) Wage Growth (1995)



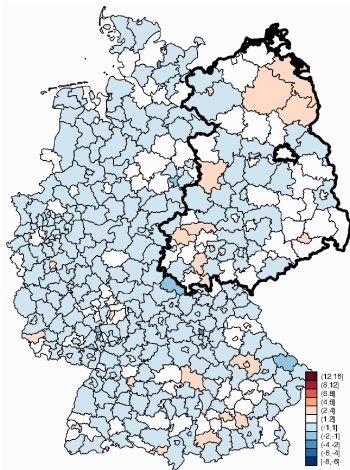
(b) Worker Reallocation



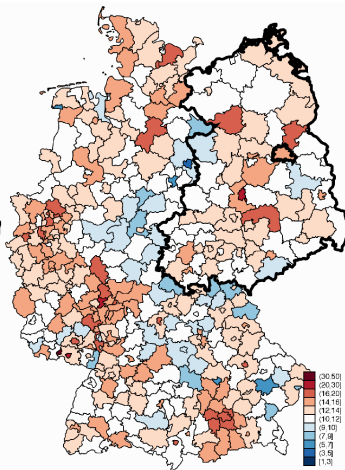
(c) Firm Job Reallocation

2000: Previous Border Becomes Invisible (for these variables)

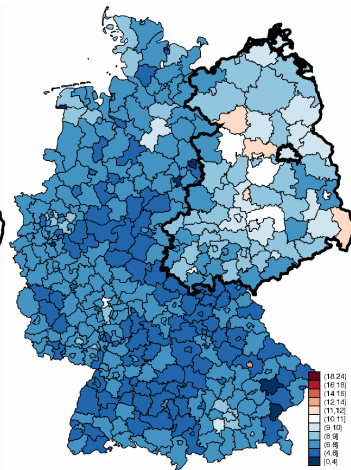
► Equations



(a) Wage Growth



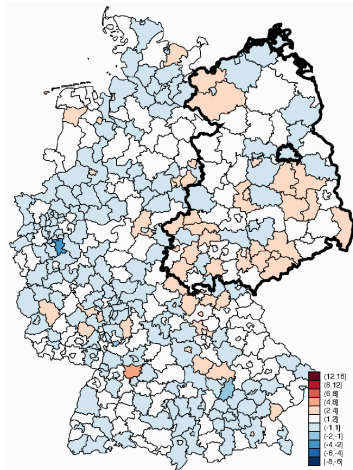
(b) Worker Reallocation



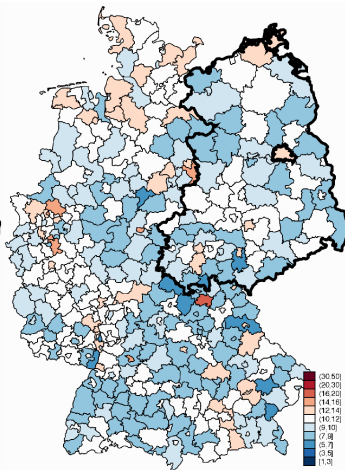
(c) Firm Job Reallocation

2013: Previous Border Stays Invisible (for these variables)

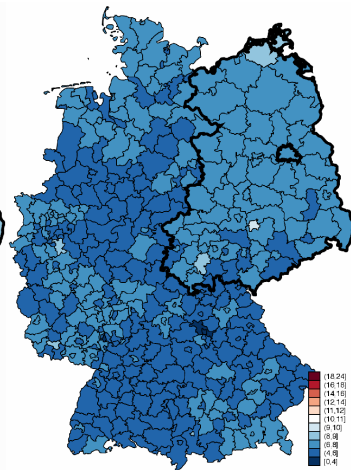
► Equations



(a) Wage Growth



(b) Worker Reallocation



(c) Firm Job Reallocation

Statistical Decomposition of Wage Growth

- Decompose extra wage growth in the East (a' la Olley-Pakes)

		5-Year extra Growth Rate				Total
		1992-1997	1997-2002	2002-2007	2007-2012	1992-2014
I	Excess Growth	25.7	2.1	-0.9	3.9	36.3
	θ	24.7	2.1	-0.3	2.8	33.0
II	Time	14.0	-0.4	-0.3	1.1	15.4
	Realloc	10.7	2.5	0.0	1.7	17.6
III	Shuffle	7.3	-1.4	-2.3	-0.1	2.5
	Firm N/X	0.6	-0.3	0.5	0.0	1.0
	Migration	1.4	1.9	1.0	1.0	6.3
	U-E/E-U	1.5	2.3	0.8	0.7	7.8

East Germans increasingly working in firms with high firm effects (θ)

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40% of excess growth due to changes in θ -size distribution

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Predominantly reallocation among existing East German workers and firms

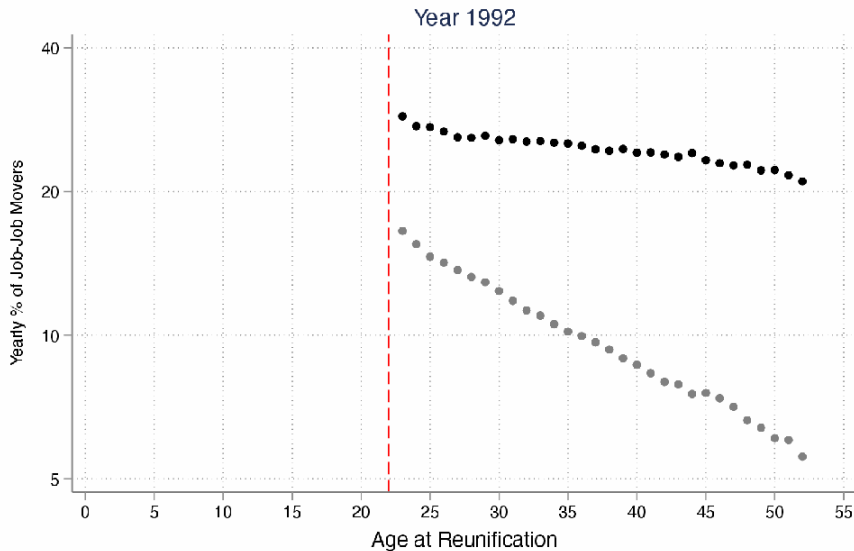
Five Empirical Facts

key evidence and model's targets

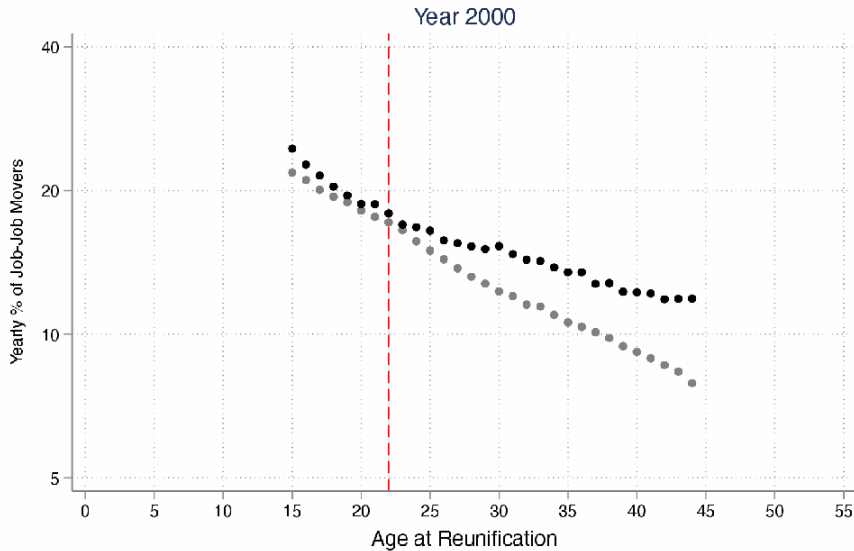
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1. Excess labor mobility of old cohorts
driven by EE moves, holds also for cohorts of firms
2. Labor mobility of young cohorts converge
holds also for cohorts of firms
3. Larger wage growth of old cohorts
holds also for cohorts of firms
4. Larger wage gains for switchers
driven by within location moves, not migrants
5. Convergence of distribution of relative firm wages and sizes
hold also conditional on controls, or using firm effects

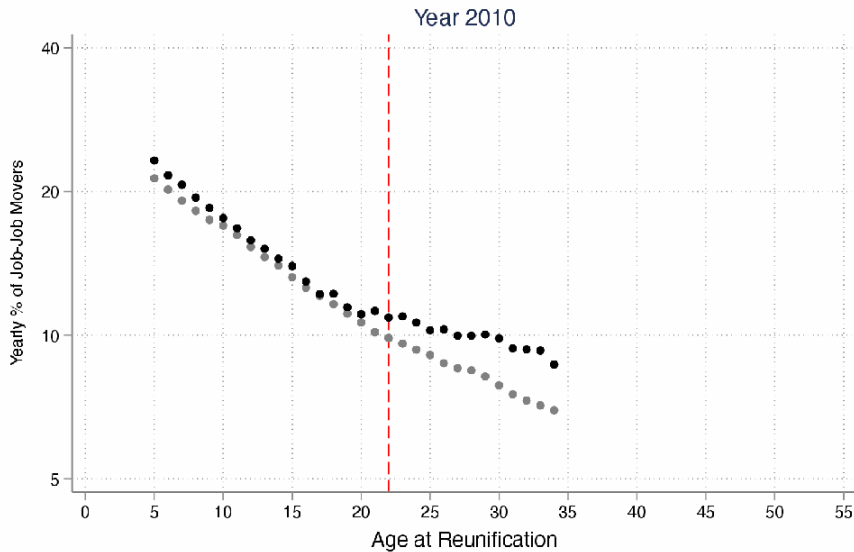
Worker Mobility by Cohort



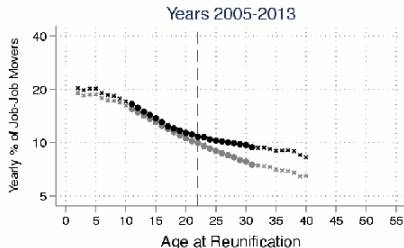
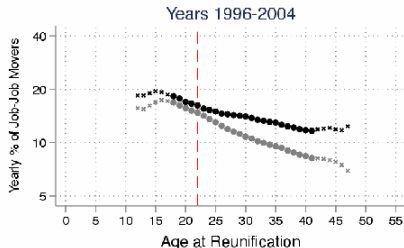
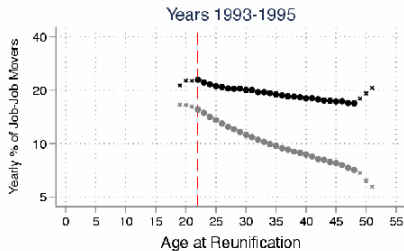
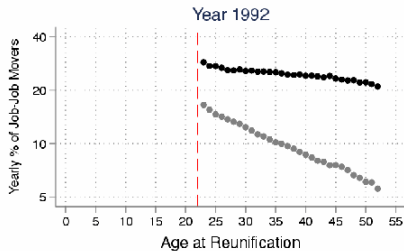
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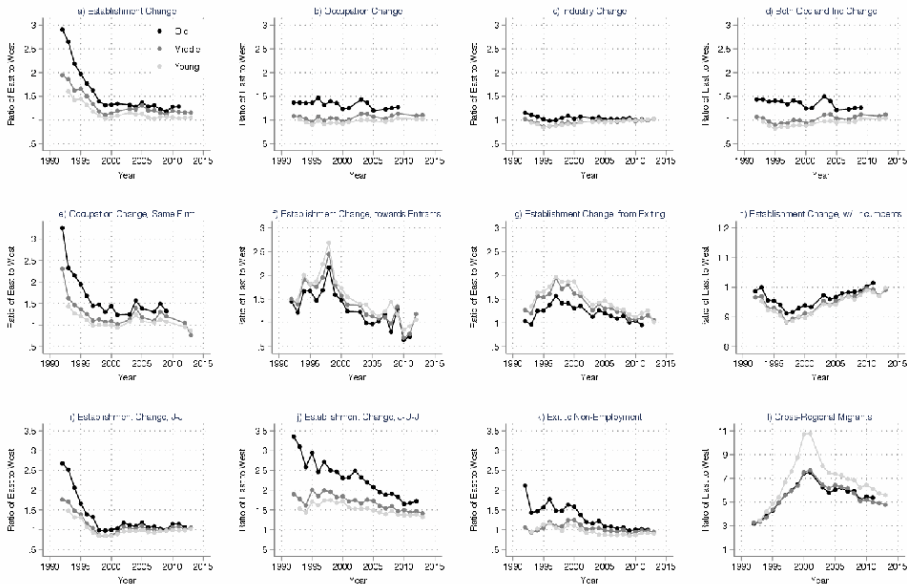
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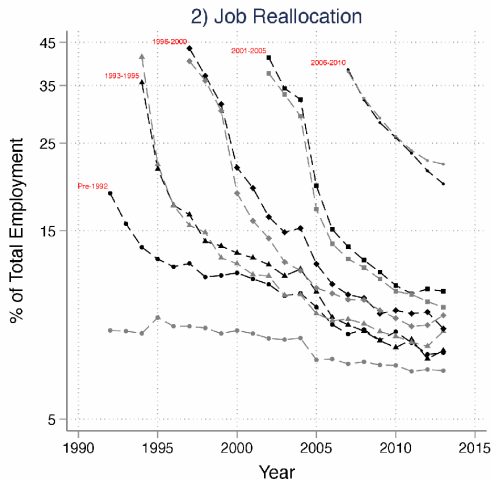
Worker Mobility by Cohort



Robustness: Excess Mobility of Old Cohorts Broadly Present



Firm Reallocation by Cohort

[▶ Back 1](#)[▶ Back 2](#)

1. **New Firms** (entered post-reunification)

- Identical job reallocation in East and West

2. **Old Firms** (present at reunification)

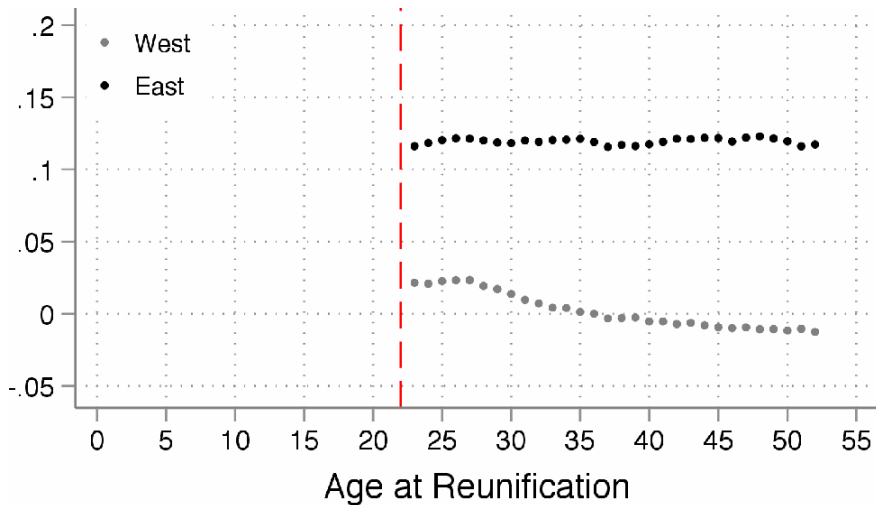
- Larger job reallocation in the East
- Converging over time to West level

[▶ Size By Tradable](#)[▶ JR By Tradable](#)[▶ More](#)[▶ By Size](#)[▶ Model](#)

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Wage Growth by Birth Cohort (1992)

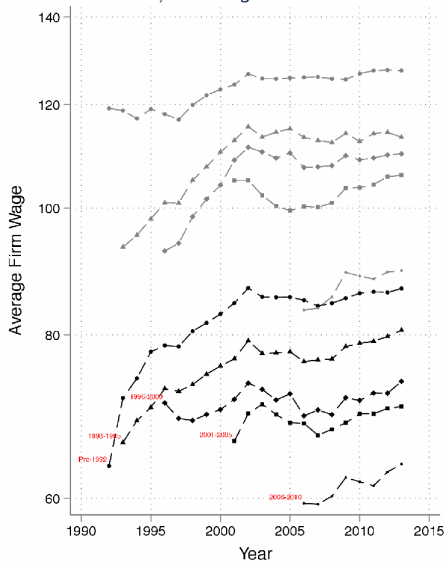


Wage Growth by Switchers and Stayers (1992)

Wages by Firm Cohorts

[▶ Back 1](#)[▶ Back 2](#)

1) Firm Wages Over Time



1. **Old Firms** (present at reunification)

- Fast initial wage catch up in the East
- Converging over time to West growth

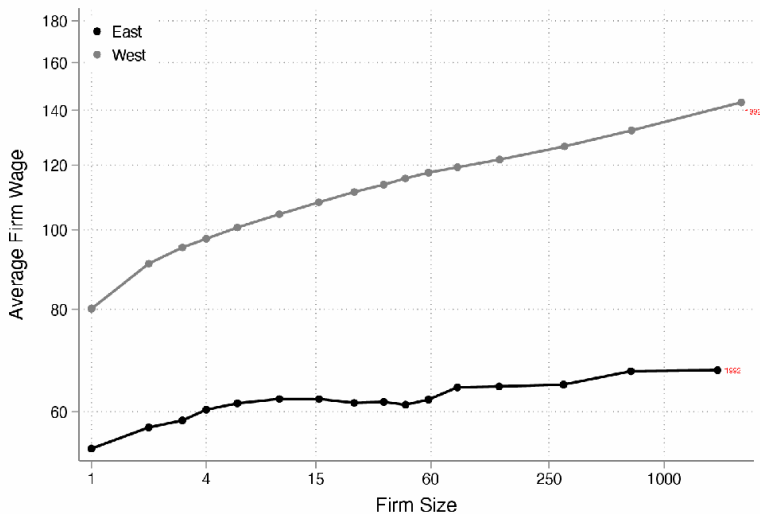
2. **New Firms** (entered post-reunification)

- Grew parallel to West

Five Empirical Facts on Reallocation and Wage Growth

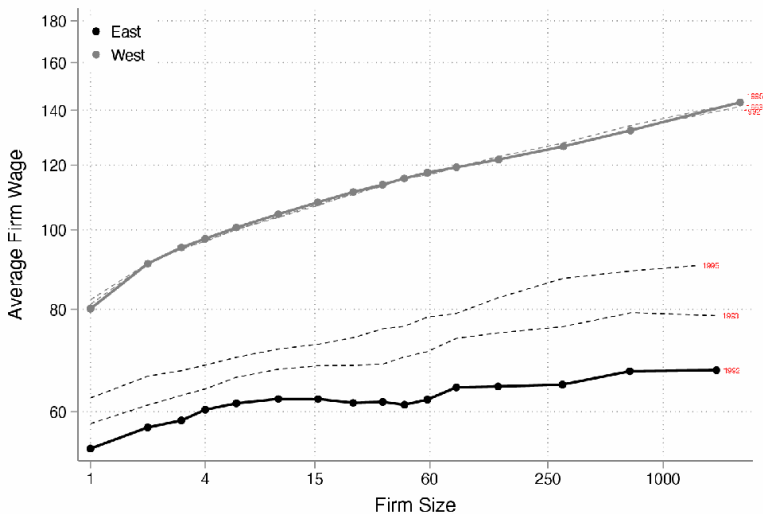
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Joint Distribution of Firm Wages and Size Over Time

[▶ Back](#)

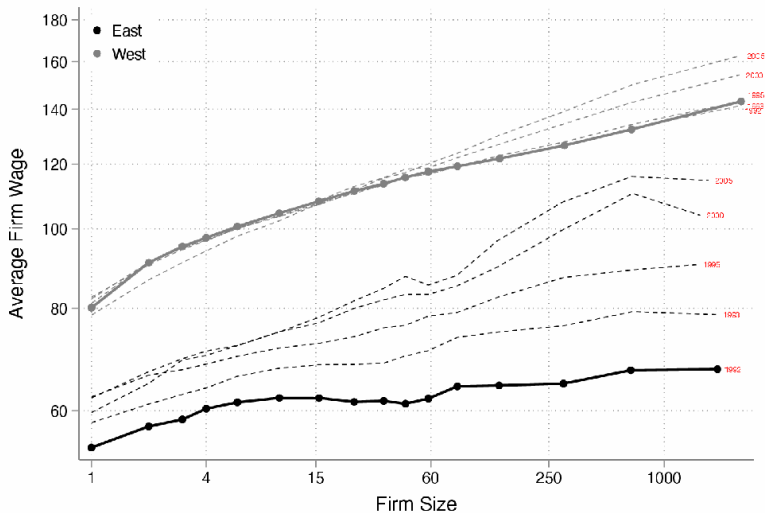
► *cf: very similar patterns if we flip axes*

Joint Distribution of Firm Wages and Size Over Time

[▶ Back](#)

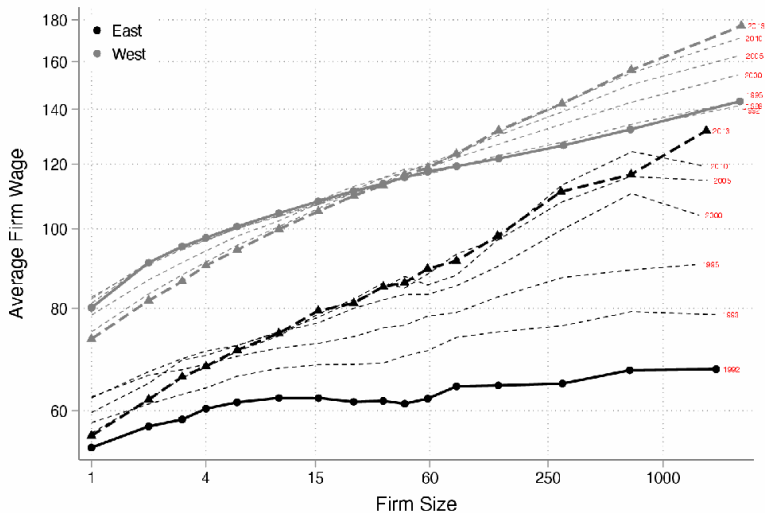
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Joint Distribution of Firm Wages and Size Over Time

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Interpretation: institutional transformation → labor reallocation → wage growth

- ▶ Facts 1, 3: unravelling of the misallocation caused by exposure to GDR
- ▶ Facts 2, 5: fast convergence of labor market institutions
- ▶ **Fact 4: labor mobility at least in part reallocation, not only churn**

Model

to quantify aggregate impact of reallocation

Overview and Motivation

- ▶ Design a model to **quantify** impact of reallocation on wage/productivity

⇒ **Quantify returns to capitalism in the labor market**

- ▶ **Approach:**

1. Estimate model to current East/West Germany (converged "labor institutions")
2. Use transition path post-reunification to estimate GDR allocation
3. **Counterfactual**: how would East look like today without institutional convergence?

⇒ **"Distorted"** version of market economy used to generate GDR allocation

- Model cannot directly describe planned economy
- But can use to generate initial allocation with **wedges on firms and workers**

Model: BM 1998 + OLG + Distortions and Mismatch

- ▶ Workers: file applications (**search**), receive and accept offers
 - n_0 -mass born every instant $\rightarrow$ human capital grows at stochastic rate φ_a , death rate $\varphi_{\bar{a}}$
 - match quality z_i drawn **after** offer accepted with prob ω_i $\rightarrow$ **climb match-ladder**
- ▶ Firms: post wages and vacancies
 - Heterogeneous productivity $q \sim P(q)$
 - Heterogeneous vacancies/"scale of operation" $v \sim C_q$ $\rightarrow$ **climb job ladder across firms**
- ▶ Labor market: matches created as a function of searches and vacancies
 - workers reallocate across firms climbing a job and match ladder

Worker's Problem: Search for Jobs and Accept Offers

- $W_{ai}(w)$: value of an employed worker of age a and type i

$$\begin{aligned} rW_{ai}(w) = & wh_a z_i + \varphi_a [W_{a+1,i}(w) - W_{ai}(w)] + \delta_{ai} [U_a - W_{ai}(w)] \\ & + \mathbf{s}_{ai}(\mathbf{w}) \cdot \lambda \left[\int V_{ai}(w, w') dF(w') - W_{ai}(w) \right]. \end{aligned}$$

$\mathbf{s}_{ai}(\mathbf{w})$: (endogenous) search intensity

- Assume logit choice model when encountering an offer (with associated CCP $\mu_{a,i}(w', w)$):

$$V_a(w, w') = \sigma \log \left[\exp \left(\frac{W_{ai}(w)}{\sigma} \right) + \exp \left(\frac{\bar{W}_a(w') - \kappa_a}{\sigma} \right) \right]$$

⇒ **Worker Distortion in GDR**: high cost to search $\mathbf{s}_{ai}(\mathbf{w})$

Firms' Problem: Post Wages

- ▶ Firm have productivity q and scale v
- ▶ Firms post wages to maximize steady state profit (standard BM – $r \rightarrow \infty$):

$$\max_w \left\{ \frac{q}{\gamma} \left(\sum_a h_a \sum_i z_i l_{a,i}(w) \right)^\gamma - w \sum_a h_a \sum_i z_i L_{a,i}(w) \right\} v$$

- ▶ Firms can be large either because they have high wage (high q) or large "scale" (high v)

⇒ **Firm Distortion in GDR:** inefficient distribution of vacancies $v \sim C_q$

Search and Matching

- ▶ Matching function from total searches S and vacancies V :

$$S = \sum_a \sum_i \left[\int s_{a,i}(w) dG_{a,i}(w) + s_a^U m_a^U \right]$$
$$M(V, S) = \zeta S^\nu V^{1-\nu}$$

so letting $\theta \equiv V/S$, job-finding and vacancy-filling rates are

$$\lambda = M/S = \zeta \theta^{1-\nu}, \quad \eta = M/V = \zeta \theta^{-\nu}$$

⇒ **Firm-Worker Distortion in GDR:** low match productivity ζ

Vacancies and Flow Accounting

► Firm size not monotonic in $w \rightarrow$ **solve for workers per vacancy** (monotonic in w)

$\Rightarrow$ Can be solved through usual **"flow accounting"**

$$l_{a,i}(w) \equiv \frac{A_{a,i}(w) + \varphi_{a-1} l_{a-1,i}(w)}{B_{a,i}(w)}, \quad \text{where}$$

$$\underbrace{A_{a,i}(w)}_{\text{inflows per vacancy}} \equiv \underbrace{\omega_i}_{i\text{-share}} \cdot \underbrace{\frac{\eta S_a}{S}}_{\text{filling rate by age } a} \cdot \underbrace{\frac{1}{S_a} \left[\mu_a^U(w) s_a^U \cdot m_a^U + \sum_{i'} \int \mu_{a,i'}(w', w) s_{a,i'}(w') dG_{a,i'}(w') \right]}_{\text{acceptance probability}}$$

$$\underbrace{B_{a,i}(w)}_{\text{out rate}} \equiv \underbrace{\varphi_a + \delta_{a,i}}_{\text{ageing + sep. to U}} + \underbrace{s_{a,i}(w) \lambda \int \mu_{a,i}(w, w') dF(w')}_{\text{poaching by better jobs}}$$

where $F(w(q)) \equiv \int^q v(\hat{q}) dC_{\hat{q}}(v) dP(\hat{q}) / \cdot$ is the offer distribution

Equilibrium

► Steady state equilibria (in Modern Germany and GDR)

1. Wage and vacancy postings are optimal
2. Search efforts and acceptance probabilities are optimal
3. Arrival rates, wage offers, and market tightness are consistent
4. Distributions are stationary

⇒ GDR SS stands in as initial, "*distorted*" distribution

► Transition from GDR to the Modern East steady state

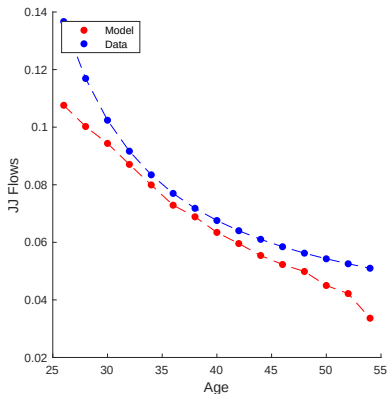
► Details

- Unexpected **one time regime shift** in (ζ, s, q, v)
- **Workers**: forward-looking, **optimize each instant** along transition path
- **Firms**: pick new steady state wage once at time $t = 0$ with commitment ($\sim$ BM)
 1. *Exogenous* shifts in firms postings $(w(q_0), v_0) \rightarrow (w(q_1), v_1)$ (stochastic, smooth transition)
 2. *Exogenous* reallocation of workers **within firms** $w_0 \rightarrow w_1$ (stochastic, smooth transition)

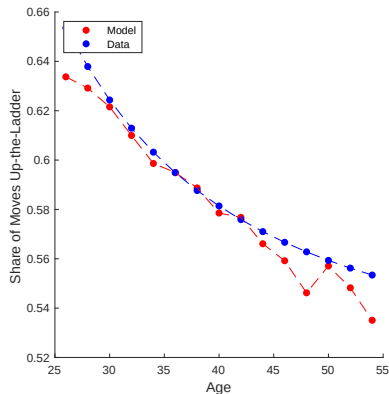
Using the Model

(Today: Transition Estimation Incomplete...)

1st Step: Estimate Modern Steady State



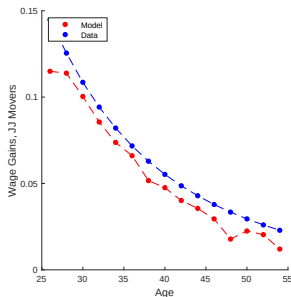
(a) JJ Movers



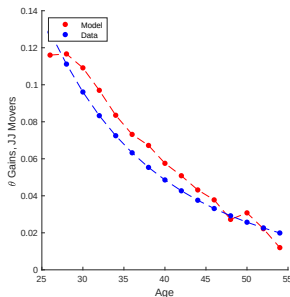
(b) % Move to Higher θ

► Moves and moves toward gains $\rightarrow [\zeta, s(w)]$ and Logit σ

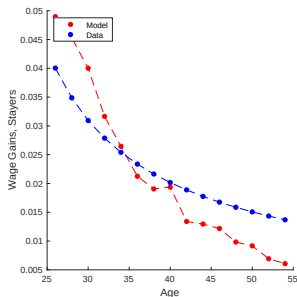
1st Step: Estimate Modern Steady State



(c) Wage Gains, JJ Movers



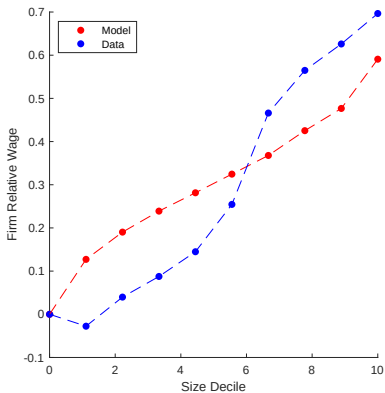
(d) θ Gains, JJ Movers



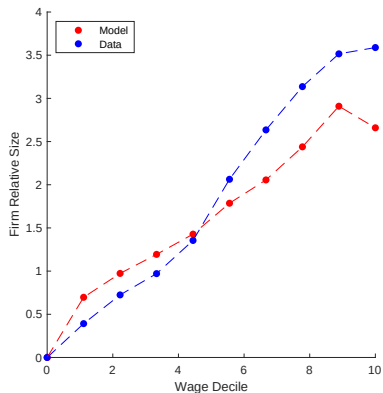
(e) Wage Gains, Stayers

- ▶ Wage gains of movers → Variances of q and match z productivity
- ▶ Wage gains of stayers → Human capital profile
(+ *later year effects: near steady state*)

1st Step: Estimate Modern Steady State



(f) Wage by Size



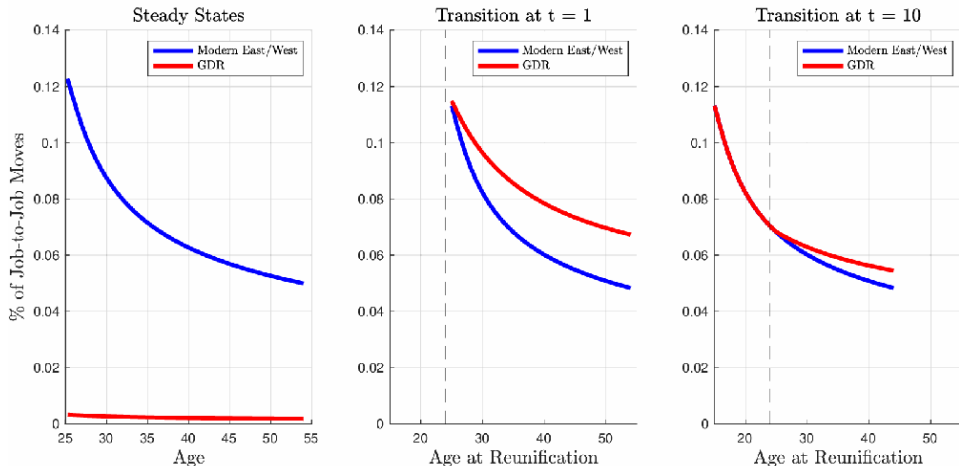
(g) Size by Wage

► Firm wage-size distribution: Joint distribution $C(q, v)$

2nd Step: Transition Identifies the Distorted GDR Allocation

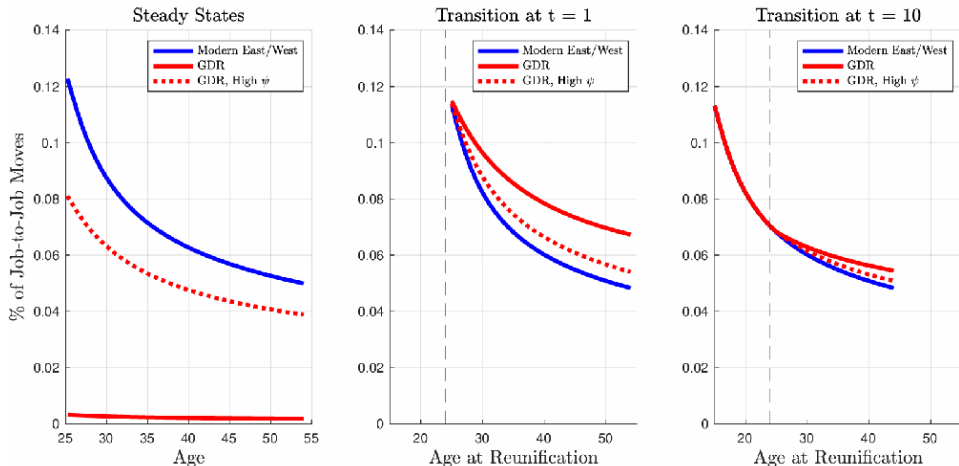
- ▶ We do not observe firm-worker allocation in GDR
 - ▶ Key idea: use transition path to identify initial allocation
⇒ Parameterize allocation with "*distorted*" model ("*wedges*")
 - ▶ Given estimate wedges → compute gains from transition to "*dynamism*"
- ⇒ Struggling with estimation time...trying new techniques
Identification of main mechanism is clear

Using the Transition to Identify the GDR (Mis)-Allocation



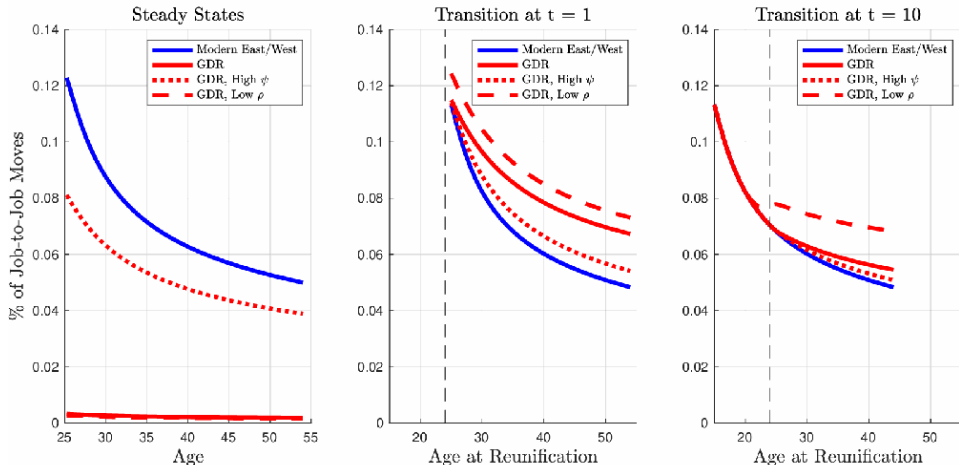
► **Example 1:** Low search intensity in GDR → Excess mobility among old

Using the Transition to Identify the GDR (Mis)-Allocation



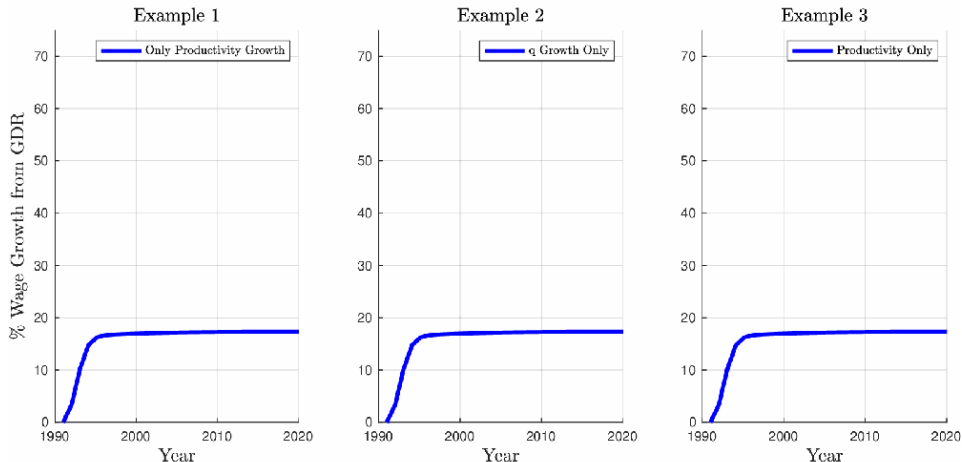
► **Example 2:** Higher search intensity in GDR → Less excess mobility among old

Using the Transition to Identify the GDR (Mis)-Allocation



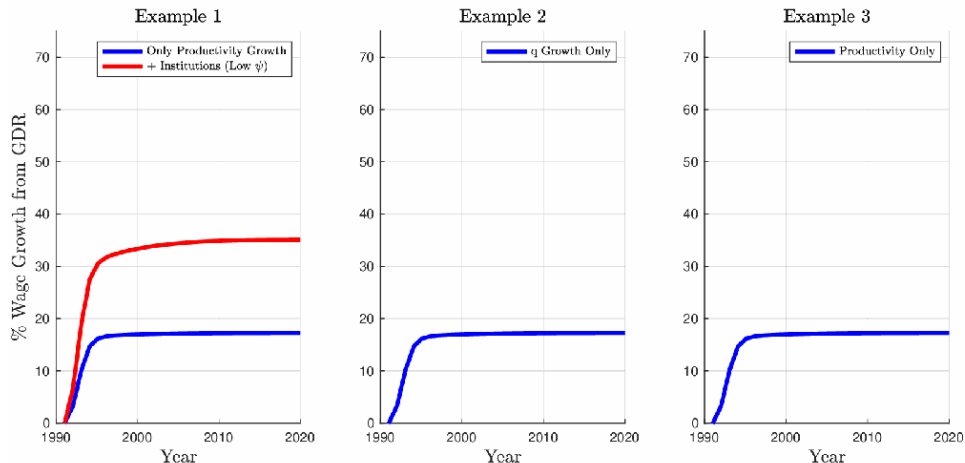
► **Example 3:** Add vacancy distortions (ρ_{qv}) → Overall excess mobility (young and old)

3rd Step: Computing Contribution of *Dynamism* to Wage Growth



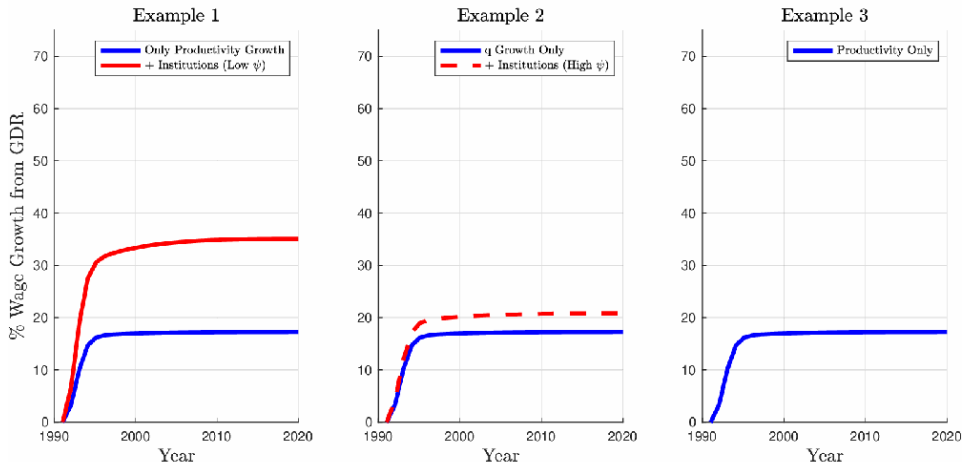
- Starting point: only average productivity $\bar{q}$ lower in GDR

3rd Step: Computing Contribution of *Dynamism* to Wage Growth



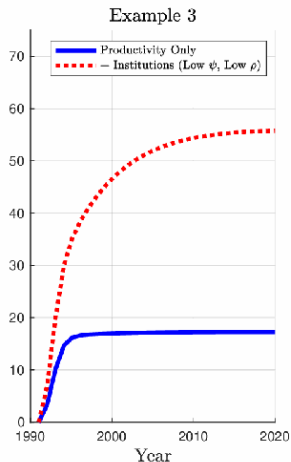
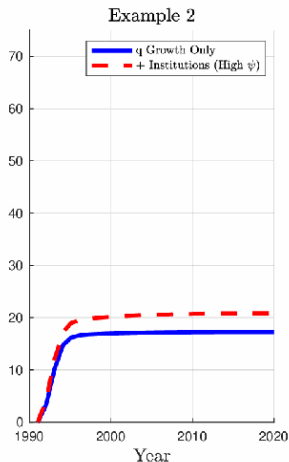
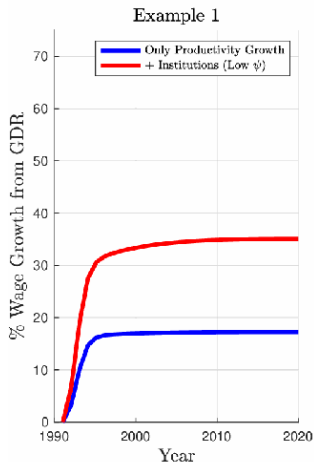
► Example 1: transition from very low search intensity

3rd Step: Computing Contribution of *Dynamism* to Wage Growth



- Example 2: transition from higher search intensity (but still below Modern)

3rd Step: Computing Contribution of *Dynamism* to Wage Growth



- Example 3: transition from very low search intensity and vacancy distortions

Conclusion

Conclusion

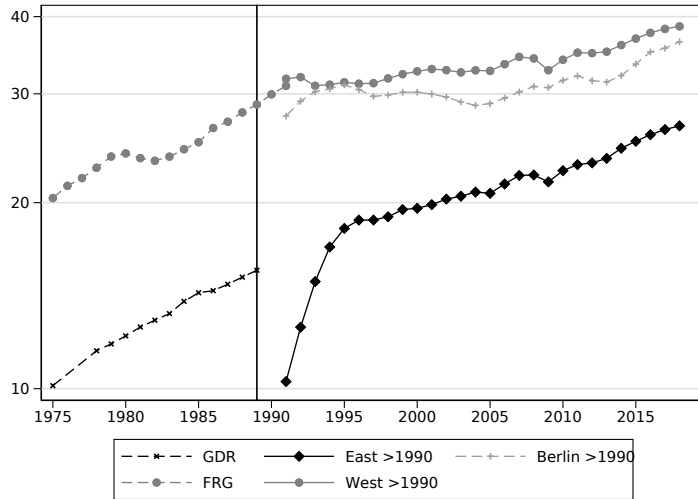
- ▶ Case study of East German labor market post-reunification
- ▶ Findings: **labor reallocation is a key component of East-West initial convergence**
- ▶ Takeaways beyond the case study
 - **Large returns of capitalism in the labor market (*dynamism*)**
 - "Institutions" can be quickly transformed (no persistence)

Appendix

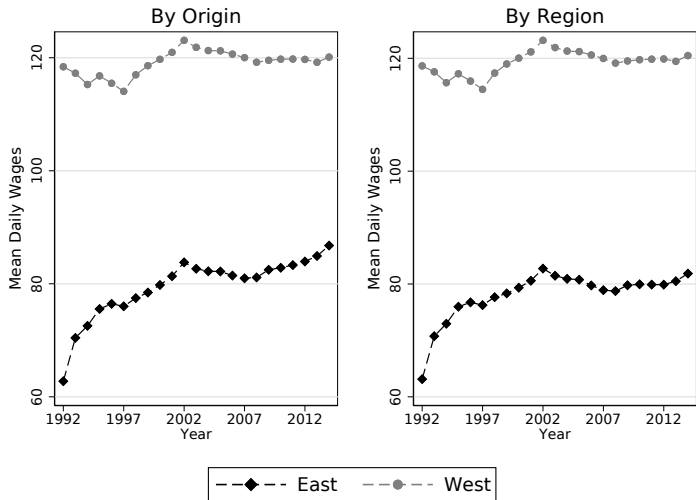
Douglass North

- ▶ Nobel Laureate (with Fogel) in Economics in 1993 for renewed research in economic history by applying economic theory and quantitative methods in order to explain economic and institutional change
- ▶ North's definition of institutions:
Humanly Devised Constraints that structure political, economic and social interactions.

GDP per Capita



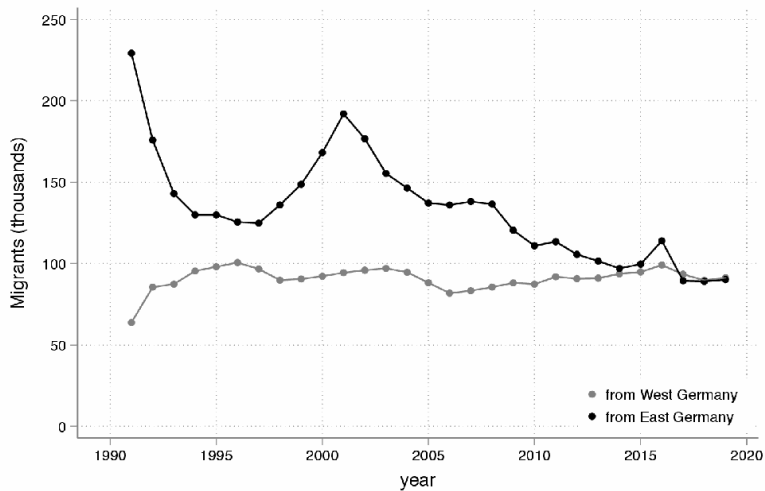
Average Wages



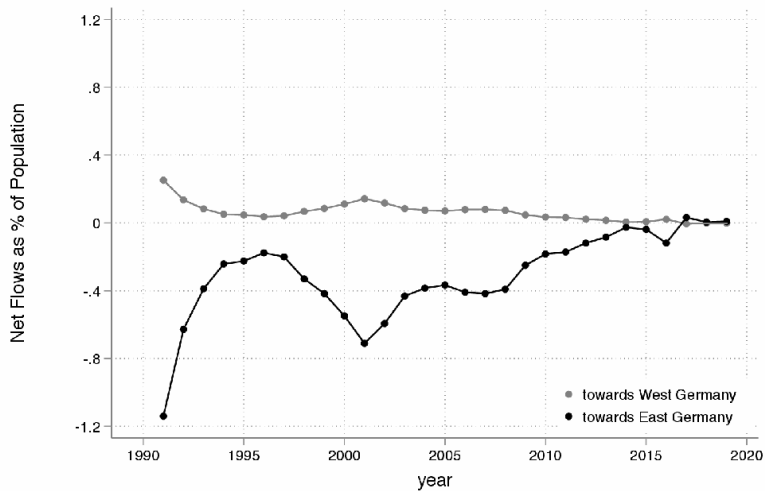
German Unemployment



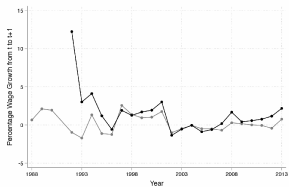
Gross Migration Flows



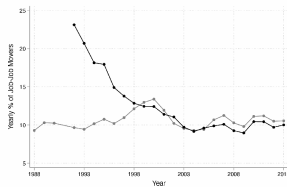
Net Migration Flows



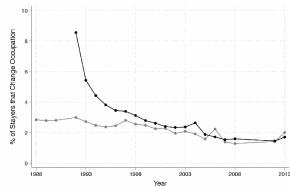
Time Series



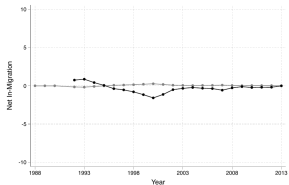
(h) Wage Growth



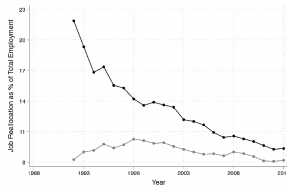
(i) Job-Job Changes



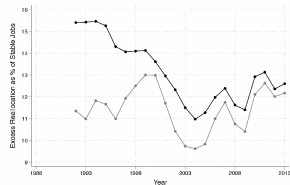
(j) Occupation Changes



(k) Net Migration

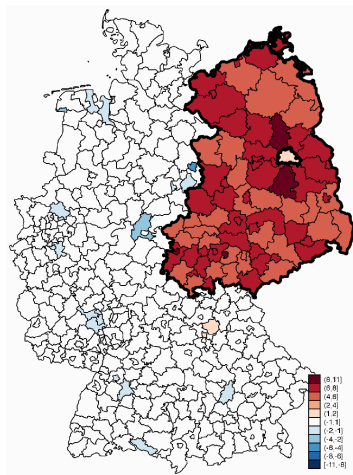


(l) Job Reallocation

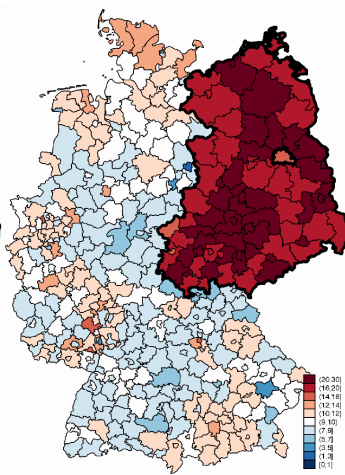


(m) Excess Reallocation

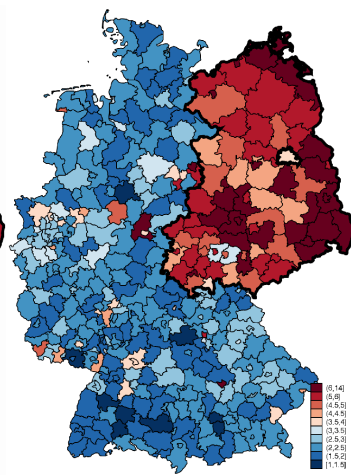
Spatial Series, 1992-1995



(a) Wage Growth

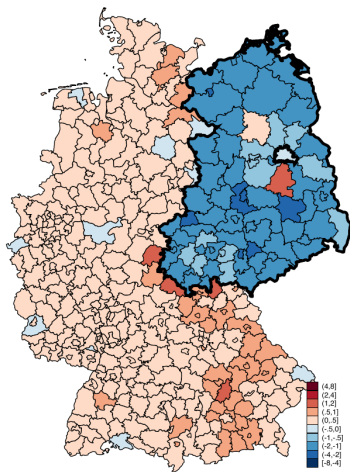


(b) Job-Job Changes

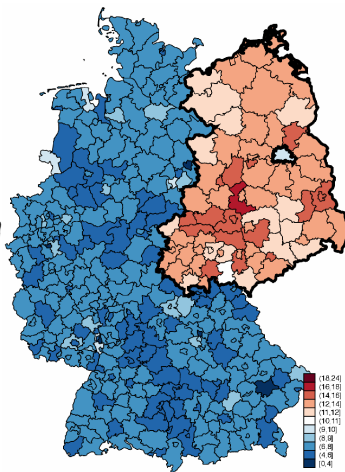


(c) Occupation Changes

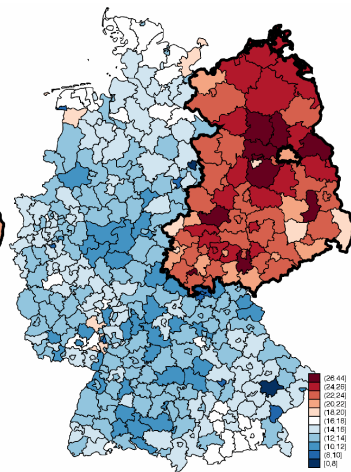
Spatial Series, 1992-1995



(d) Net Migration

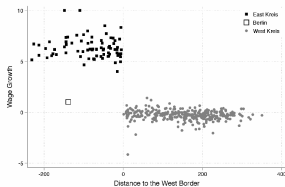


(e) Job Reallocation

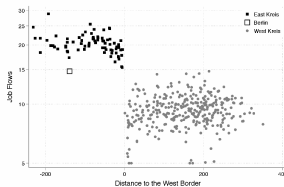


(f) Excess Reallocation

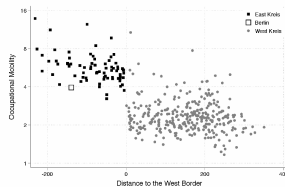
Border Regression, 1992-1995



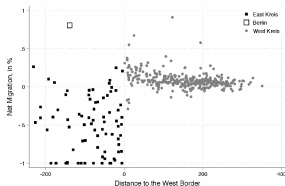
(a) Wage Growth



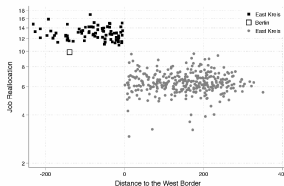
(b) Job-Job Changes



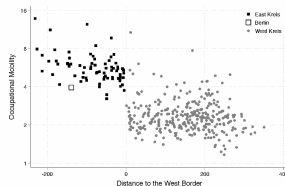
(c) Occupation Changes



(d) Net Migration

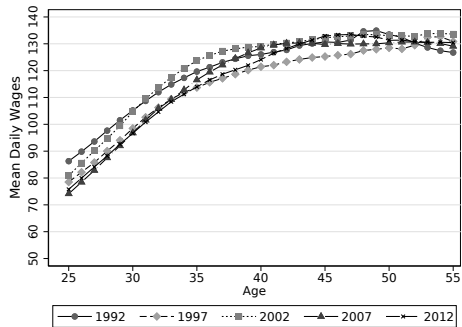
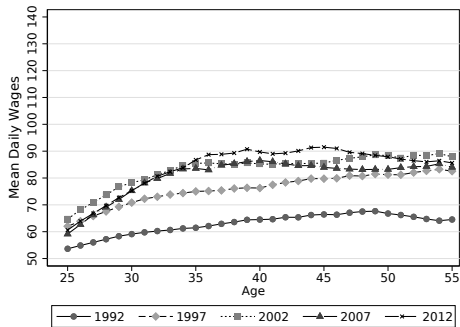


(e) Job Reallocation



(f) Excess Reallocation

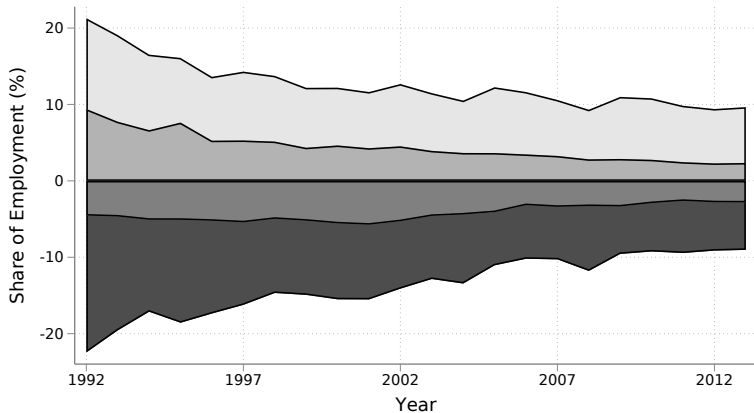
Cross Sectional Wage Profiles



► data

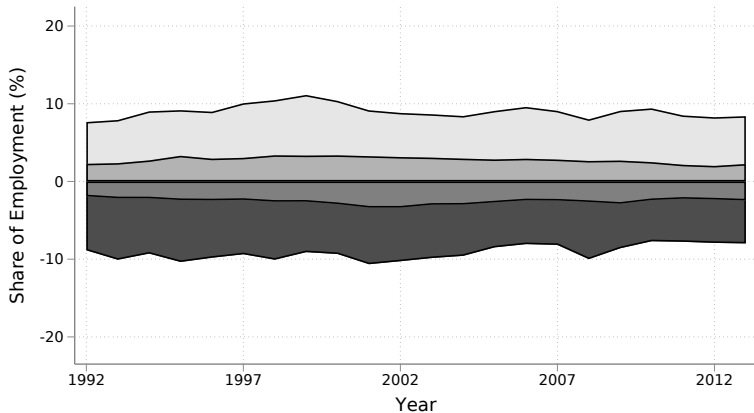
► model-ss

Hires and Fires: East



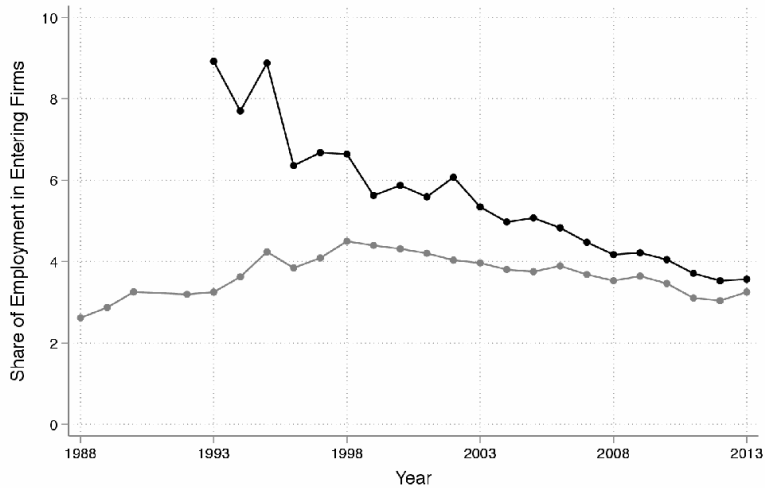
Job Creation by Incumbents (+) Firm Entrants (+)
Job Destruction by Incumbents (-) Firm Exits (-)

Hires and Fires: West

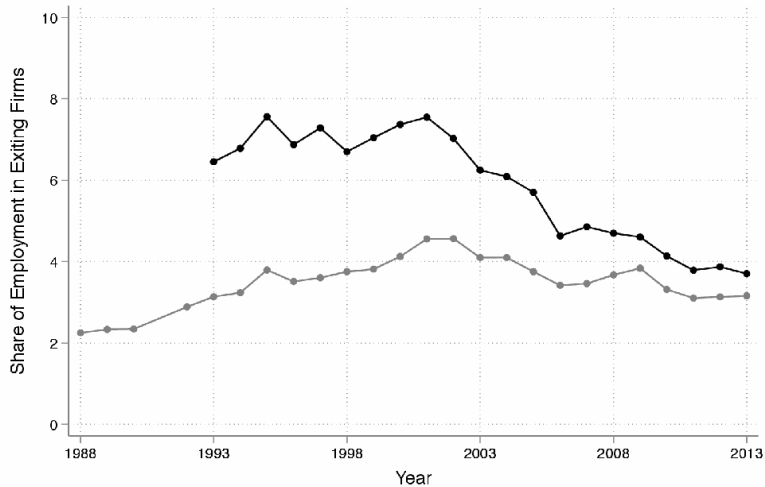


Job Creation by Incumbents (+) Firm Entrants (+)
Job Destruction by Incumbents (-) Firm Exits (-)

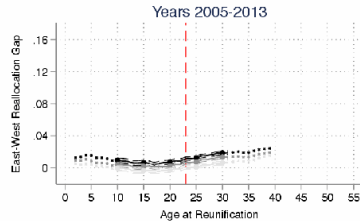
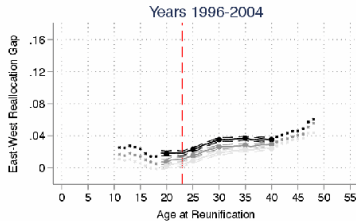
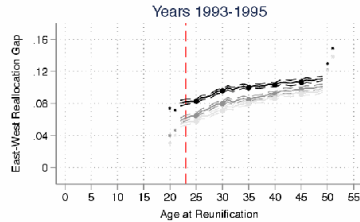
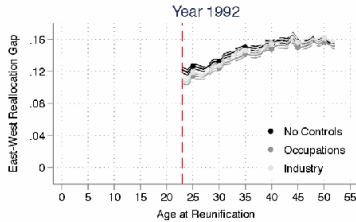
Firm Entry-Exit: East



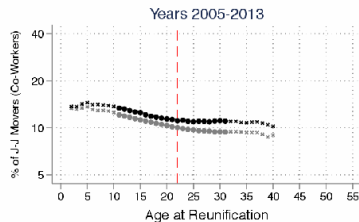
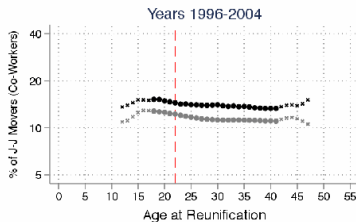
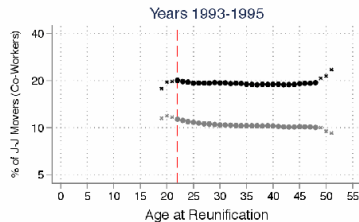
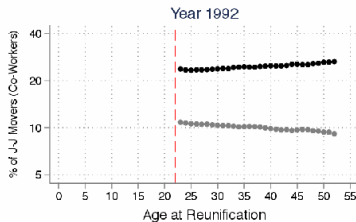
Firm Entry-Exit: East



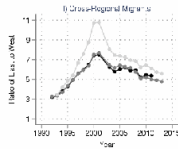
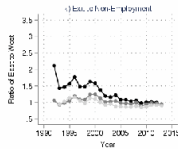
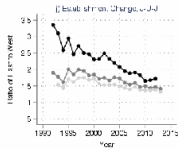
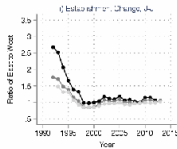
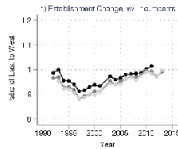
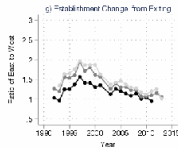
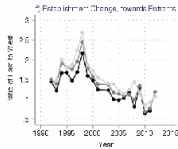
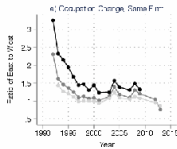
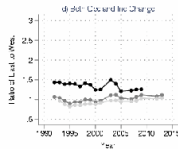
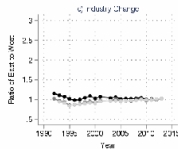
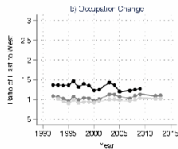
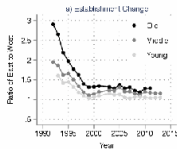
Worker Reallocation, Controls



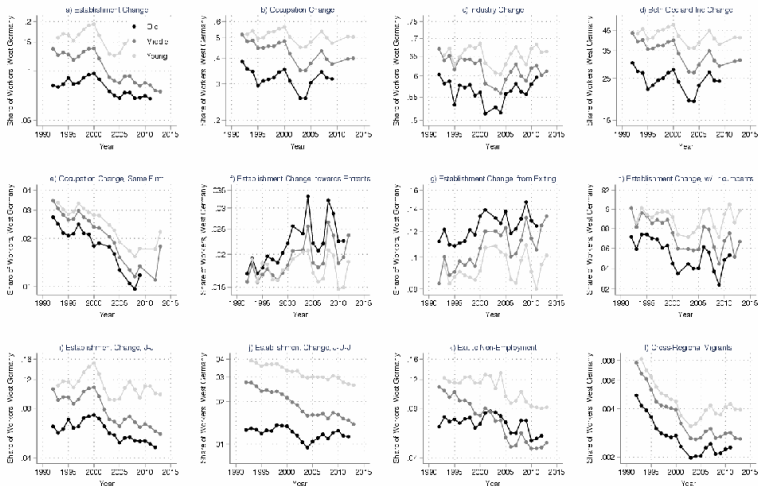
Coworker Reallocation



More: E-W Ratio

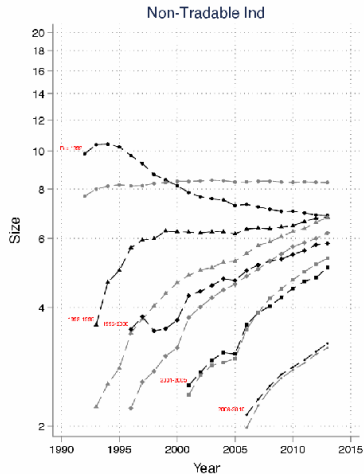
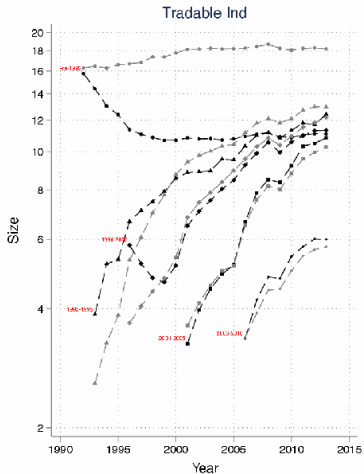


More: W Level



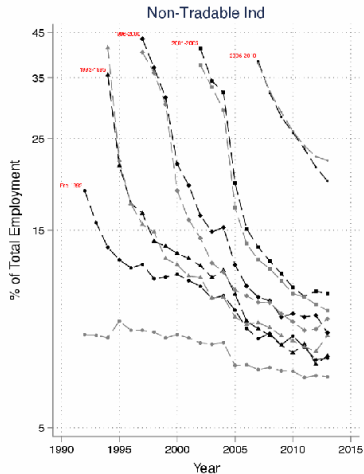
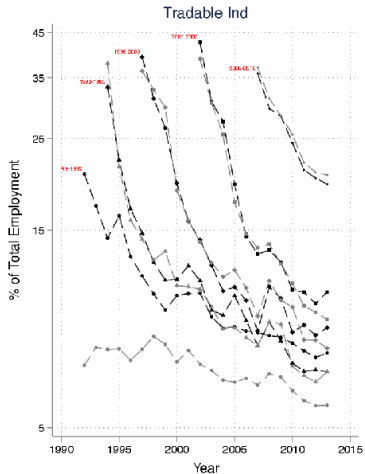
Firm Size for Tradable/Non-Tradable Industries

► back

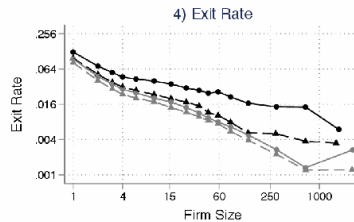
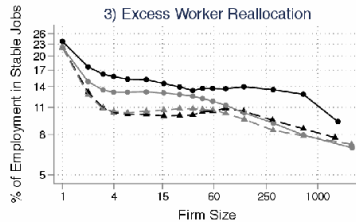
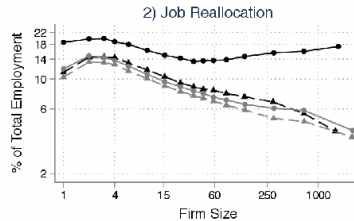
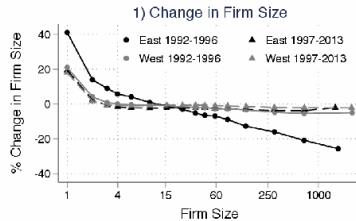


Job Reallocation for Tradable/Non-Tradable Industries

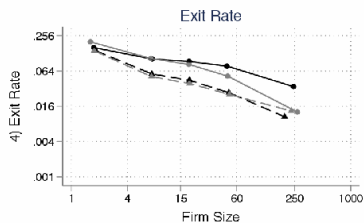
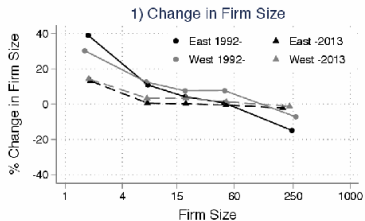
▶ back



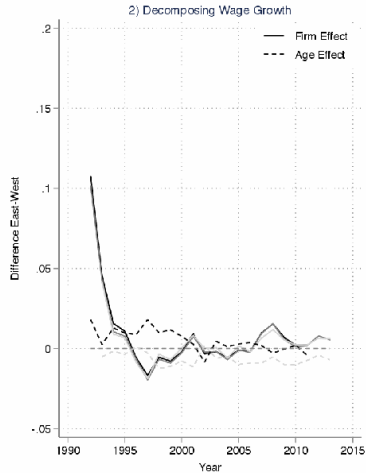
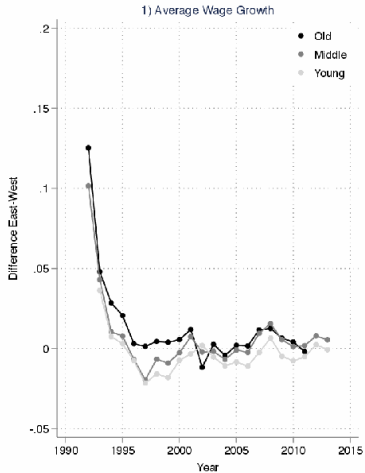
Firm Reallocation by Size, pre-1992



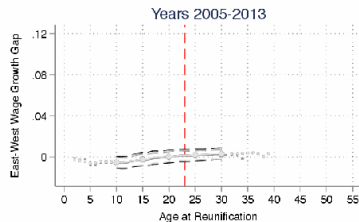
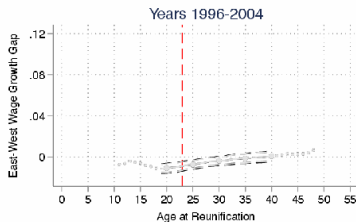
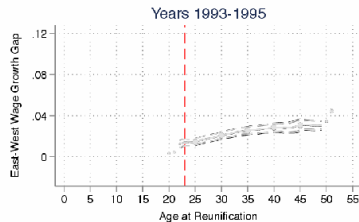
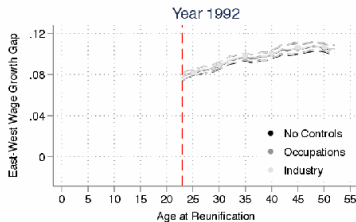
Firm Reallocation by Size, 1992-



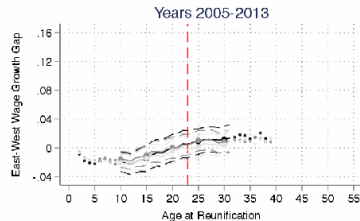
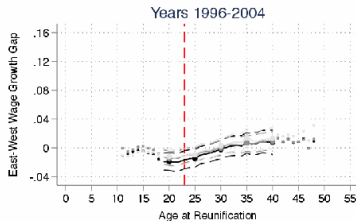
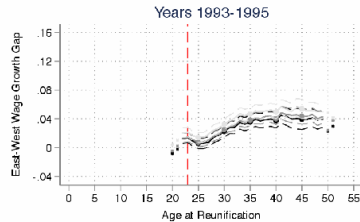
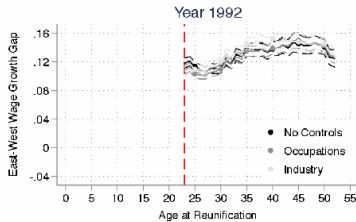
Cohort Wage Growth over Time



Stayer Wage Growth, Controls

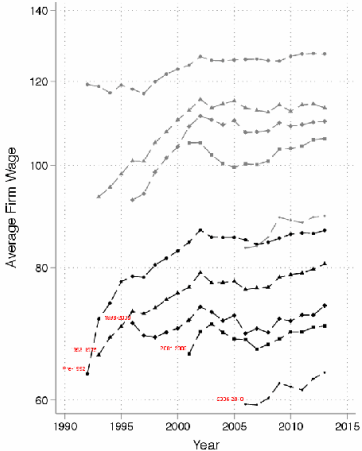


Switcher Wage Growth, Controls

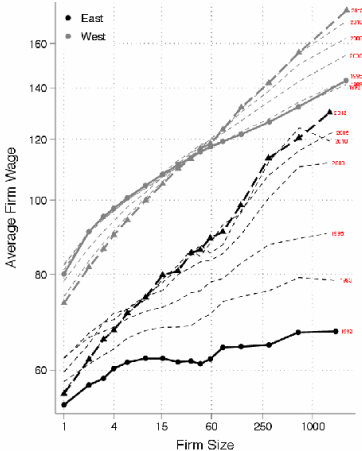


Firm Wages by Size-Cohort

1) Firm Wages Over Time



2) Firm Wages and Sizes



Decomposition Details 1

1. Firm and worker sets:

- Given a set $\mathbf{A}$ of workers, $\tilde{\mathbf{A}}$: set of firms with at least one worker in $\mathbf{A}$
- Given a set $\tilde{\mathbf{A}}$ of firms, $\mathbf{A}$: set of all workers working in $\tilde{\mathbf{A}}$

2. Means over sets: for a variable x , define the following:

- $\bar{x}(\mathbf{A}) := \mathbb{E}[x_i | i \in \mathbf{A}]$: mean of x over workers in set $\mathbf{A}$
- $\bar{x}(\tilde{\mathbf{A}}) := \mathbb{E}[x_j | j \in \tilde{\mathbf{A}}]$: mean of x over firms in set $\tilde{\mathbf{A}}$

Wage Growth Decomposition

- $\bar{w}(\mathbf{T}^r)$: average wage of workers all **from** region r

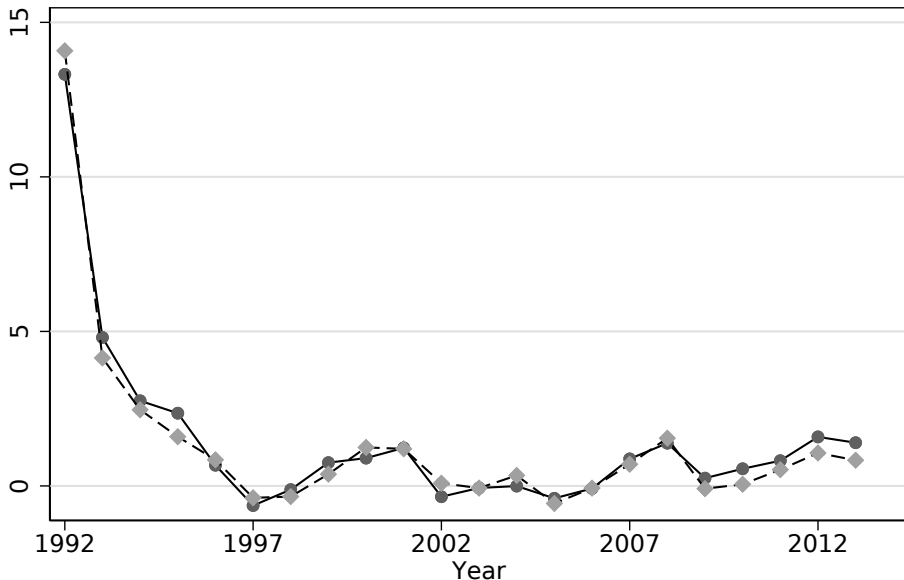
	1992	1997	2002	2007	2012	2014
East Wage Gap (%)	53.0	66.7	68.1	67.5	70.1	72.2

- Wage gap between East- and West-born workers is

$$\frac{\bar{w}(\mathbf{T}^E)}{\bar{w}(\mathbf{T}^W)} = \underbrace{\frac{\bar{\theta}(\mathbf{T}^E)}{\bar{\theta}(\mathbf{T}^W)}}_{\text{b/w gap}} \times \underbrace{\frac{\bar{h}(\mathbf{T}^E)}{\bar{h}(\mathbf{T}^W)}}_{\text{w/i gap}} \times \underbrace{\frac{\bar{\rho}(\mathbf{T}^E)}{\bar{\rho}(\mathbf{T}^W)}}_{\text{type corr.}}$$

1. b/w firm: gap in wages paid by firms with East- and West-born workers
2. w/i firm: gap between East- and West-born in the same firm

Extra Wage Growth



$\bar{\theta}$ Growth Decomposition

$$\underbrace{\frac{\bar{\theta}'(\mathbf{T}^{r'})}{\bar{\theta}(\mathbf{T}^r)}}_{\text{b/w firm growth}} = \underbrace{\frac{\bar{\theta}'(\tilde{\mathbf{S}}_r)}{\bar{\theta}(\tilde{\mathbf{S}}_r)}}_{\text{Common}} \times \underbrace{\frac{\frac{\bar{\theta}'(\mathbf{S}'_r \cap \mathbf{C}^r_{rr})}{\bar{\theta}(\mathbf{S}_r \cap \mathbf{C}^r_{rr})}}{\frac{\bar{\theta}'(\tilde{\mathbf{S}}_r)}{\bar{\theta}(\tilde{\mathbf{S}}_r)}}}_{\text{Shuffling}} \times \underbrace{\frac{\frac{\bar{\theta}'(\mathbf{C}^r_{rr})}{\bar{\theta}(\mathbf{C}^r_{rr})}}{\frac{\bar{\theta}'(\mathbf{S}'_r \cap \mathbf{C}^r_{rr})}{\bar{\theta}(\mathbf{S}_r \cap \mathbf{C}^r_{rr})}}}_{\text{Firm Entry/Exit}} \times \underbrace{\frac{\frac{\bar{\theta}'(\mathbf{C}^r)}{\bar{\theta}(\mathbf{C}^r)}}{\frac{\bar{\theta}'(\mathbf{C}^r_{rr})}{\bar{\theta}(\mathbf{C}^r_{rr})}}}_{\text{Migration}} \times \underbrace{\frac{\frac{\bar{\theta}'(\mathbf{T}^{r'})}{\bar{\theta}(\mathbf{T}^r)}}{\frac{\bar{\theta}'(\mathbf{C}^r)}{\bar{\theta}(\mathbf{C}^r)}}}_{\text{Workforce}}$$

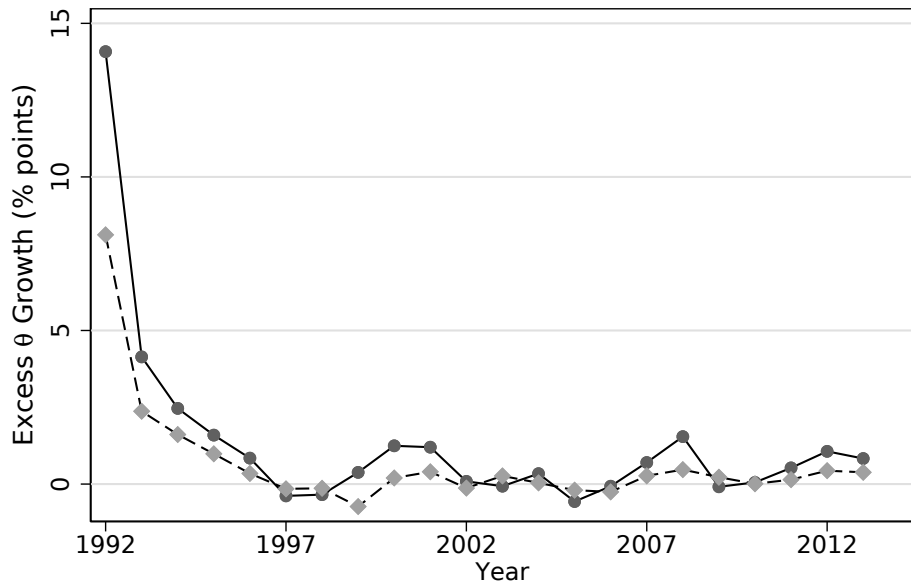
$\mathbf{T}^r, \mathbf{T}^{r'}$: set of all workers from r employed in r at time t and $t + 1$

$\tilde{\mathbf{S}}_r$: set of surviving firms from time t to $t + 1$ in r

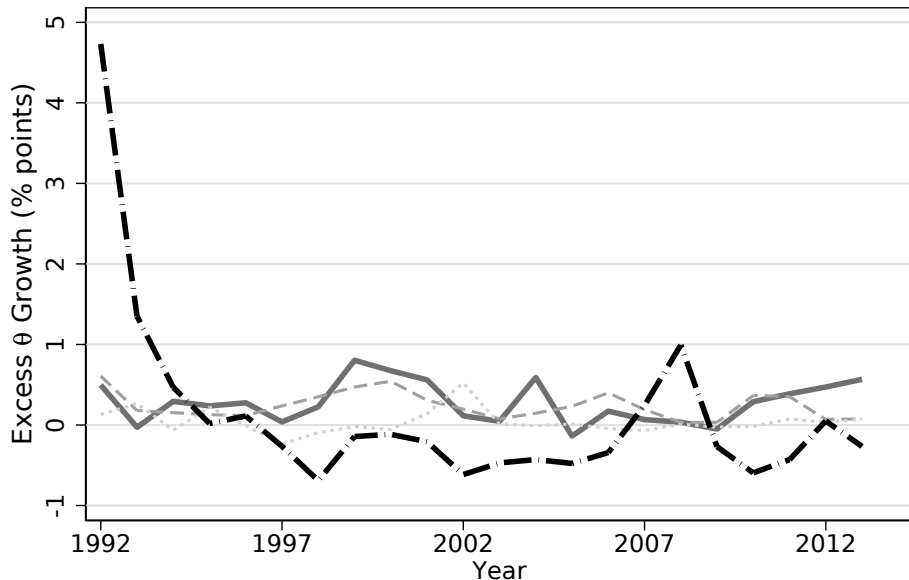
$\mathbf{C}^r_{rr}$: set of workers from r employed in r in both periods

$\mathbf{C}^r$: set of workers from r continuously employed in both periods

Extra θ Growth



Reallocation and Wage Growth



Covariance Decomposition

- ▶ Shuffling measures covariance between size and θ :

$$\underbrace{\frac{\frac{\bar{\theta}'(\mathbf{S}'_r \cap \mathbf{C}^r_{rr})}{\bar{\theta}(\mathbf{S}_r \cap \mathbf{C}^r_{rr})}}{\frac{\bar{\theta}'(\tilde{\mathbf{S}}_r)}{\bar{\theta}(\tilde{\mathbf{S}}_r)}}}_{\text{Shuffling}} = \underbrace{\frac{\bar{\theta}'(\mathbf{S}'_r \cap \mathbf{C}^r_{rr})}{\bar{\theta}'(\mathbf{S}'_r)} \times \frac{\bar{\theta}'(\tilde{\mathbf{S}}_r)}{\bar{\theta}(\mathbf{S}_r)}}_{\equiv \sigma} \approx \frac{\eta'(\tilde{\mathbf{S}}_r)}{\eta(\tilde{\mathbf{S}}_r)},$$

- ▶ Let s_j denote firm size, then

$$\frac{\eta'(\tilde{\mathbf{S}}_r)}{\eta(\tilde{\mathbf{S}}_r)} = \underbrace{\frac{\text{Cov}(s_j, \theta'_j)}{\text{Cov}(s_j, \theta_j)}}_{(\text{intensive})} \times \underbrace{\frac{\text{Cov}(s'_j, \theta'_j)}{\text{Cov}(s_j, \theta'_j)}}_{(\text{extensive}')} = \underbrace{\frac{\text{Cov}(s'_j, \theta_j)}{\text{Cov}(s_j, \theta_j)}}_{(\text{extensive})} \times \underbrace{\frac{\text{Cov}(s'_j, \theta'_j)}{\text{Cov}(s'_j, \theta_j)}}_{(\text{intensive}')}$$

Compares

1. Large firms have higher θ -growth?
2. High θ firms grow faster?

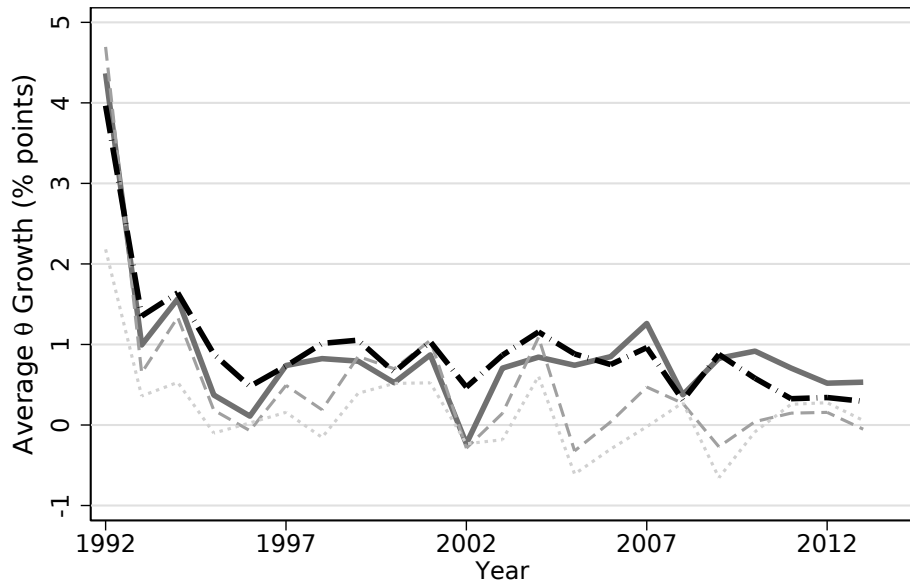
Extra θ Growth

- ▶ A bit of both...

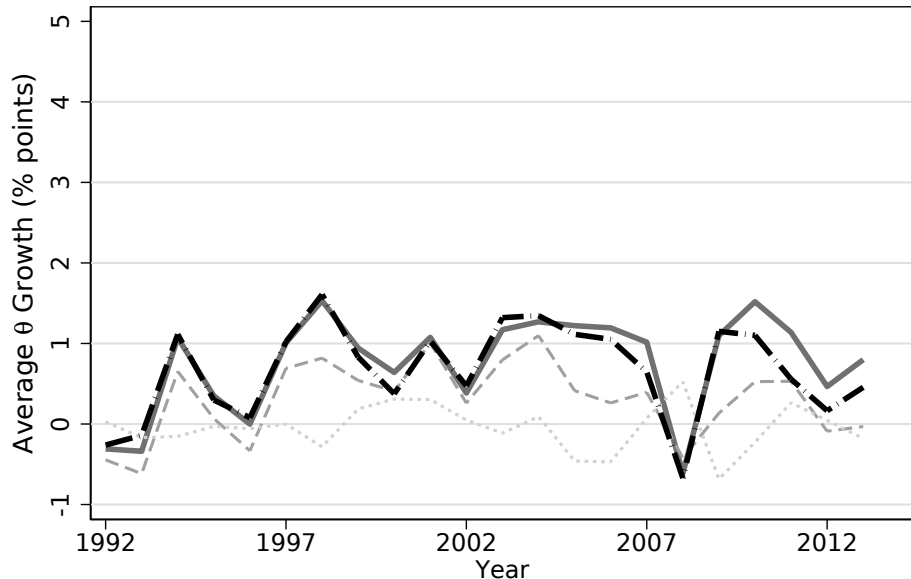
	5-Year extra Growth Rate				Total
	1992-1997	1997-2002	2002-2007	2007-2012	1992-2014
Shuffle	7.3	-1.4	-2.3	-0.1	2.5
Cov	8.3	-0.2	-2.2	-0.5	5.1
Extensive	3.7	0.9	0.2	-0.2	5.4
Intensive	8.0	-0.4	-1.2	-0.3	6.6

- ▶ Implies a negative correlation between size and θ change

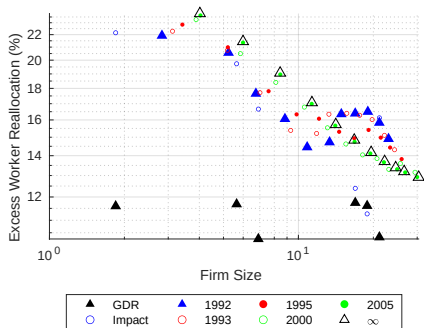
Size and θ , East



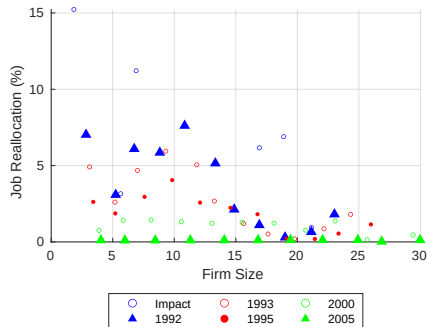
Size and θ , West



Transition: Firm Reallocation By Size



(g) Excess Worker Reallocation



(h) Job Reallocation

► Qualitative match to data:

1. Large firms do relatively more EWR; Both small and large firms to more JR

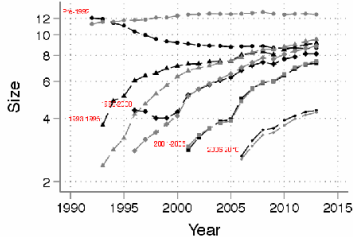
► data

► model

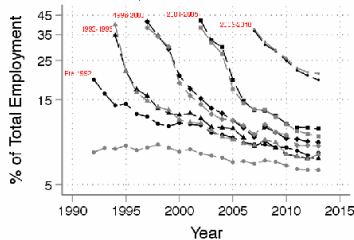
Firm Reallocation by Cohort

[▶ Back](#)

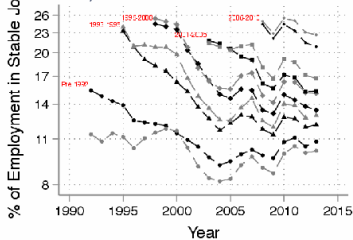
1) Firm Size



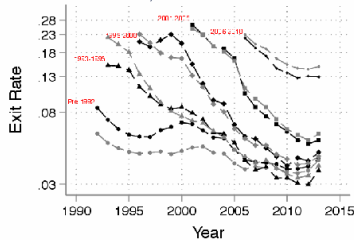
2) Job Reallocation



3) Excess Worker Reallocation



4) Firm Exit Rate



Aggregate Wage Gains

- ▶ **Dominant source of wage gains:** old workers and old firms
⇒ consistent with unraveling of previous misallocation
- ▶ Next: empirical (statistical) decomposition to get a sense of magnitudes
 - Olley and Pakes (1996); Melitz and Polanec (2015) style
 - relate firm effects to reallocation (i.e. controlling for workers' composition)
 - assumes time effects not affected by reallocation → need structural model

Reallocation and Wage Growth in Numbers

► Model

		5-Year extra Growth Rate				Total
		1992-1997	1997-2002	2002-2007	2007-2012	1992-2014
I	Xtra Growth	25.7	2.1	-0.9	3.9	36.3
	θ	24.7	2.1	-0.3	2.8	33.0
II	Time	14.0	-0.4	-0.3	1.1	15.4
	Realloc	10.7	2.5	0.0	1.7	17.6
III	Shuffle	7.3	-1.4	-2.3	-0.1	2.5
	Firm N/X	0.6	-0.3	0.5	0.0	1.0
	Migration	1.4	1.9	1.0	1.0	6.3
	U-E/E-U	1.5	2.3	0.8	0.7	7.8

⇒ Reallocation explains at least $\frac{1}{3}$ of the initial wage catch-up

Computing the Reunification Shock

► Return

- Start from distorted allocation of workers to firms
 - **Dumb firms:** approximate firms' decision rules as follows:
 1. jobs split into 2 types: jobs from GDR, and modern jobs
 2. Productivity associated with GDR jobs increase at logistic growth rate α_{wt} to new q
 3. GDR job wages also increase at rate α_{wt} toward modern SS wages
 4. Share of modern vacancy postings increase at logistic growth rate α_{vt} toward 1
 - **Smart workers:** immediately internalize drop in ψ_a
 1. Workers solve search problem taking λ as given
 2. Pool of OTJ searchers S must be consistent with λ
- ⇒ Transition dynamics of the joint distribution of firm-worker matches

Step 1: Estimate the Benchmark for West Germany

- ▶ Leverage matched employer-employee data → data on wages + flows + wage gains
- ▶ Heuristic identification argument

[▶ Return](#)

Worker Moments

j-j flows (by age)	$\bar{\psi}_a$
j-j flows (by firm wage)	ψ_1
Firm wage gains of j-j moves (by age)	κ_a
Firm wage gains of j-j moves (average)	σ
Within firm wage gains	h_a
Overall life-cycle wage gains	z_i
Unemployment rate (by age)	$\bar{\psi}_a^U$

Firm Moments

Joint distribution of firm wages and sizes	q, C_q
--	----------

Externally Calibrated

Separation rates and experience	δ_a, φ_a
Decreasing returns to scale	γ

Firm Reallocation by Cohort

[▶ Back 1](#)[▶ Back 2](#)

Facts:

- 1. New Firms** (entered post-reunification)
 - Identical job reallocation in East and West
- 2. Old Firms** (present at reunification)
 - Larger job reallocation in the East
 - Converging over time to West level

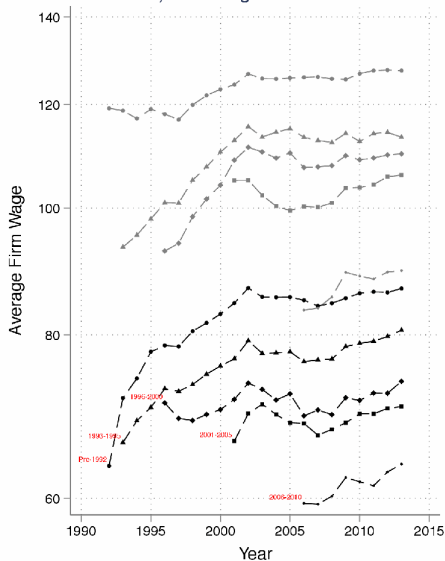
[▶ Size By Tradable](#)[▶ JR By Tradable](#)[▶ More](#)[▶ By Size](#)[▶ Model](#)

Wage Gains

Wages by Firm Cohorts

[▶ Back 1](#)[▶ Back 2](#)

1) Firm Wages Over Time



Facts:

1. Wage catch-up driven by **old firms**
2. **Young firms** grow Parallel to West

Interpretation:

- ▶ Job reallocation $\Rightarrow$ productivity gains

How to Compute Transitions Between Steady States?

- ▶ **Goal:** compute transition from GDR to the "modern East" steady state
 - Labor market "institutions" change between steady states (ϕ, ρ)
 - Firms' vector of productivities (q, v) may differ in new steady state
- ▶ **Challenges:**
 - Burdett-Mortensen solution concept hinges on steady state
 - Computation must be quick enough to use it to estimate "GDR institutions"
 - Need flexibility to match the possibly not-instantaneous firm-level changes
- ▶ **Solution?** Firm-level stochastic transition b/w steady states: $(q^0, v^0) \rightarrow (q^1, v^1)$
 - At $t = 0$, each firm "splits" into two sets: 1. old jobs (q_0, v_0) ; 2. new jobs (q^1, v^1) ;
 - Commitment + low r (as in benchmark BM) $\rightarrow$ firms pick steady state wage $w^1(q^1)$
 - Evolution of g^0, g^1 : i. w/i firm at random rate; ii. b/w firms due to vacancy posting
 - Workers? Easy, they solve the dynamic problem with perfect foresight
 - Distribution of labor and tightness are also determined in equilibrium as standard

Labor Flows During the Transition

- ▶ Define w^0, w^1 to be the optimal wages in the two steady states
- ▶ Masses of workers in the old and new jobs follow

$$\dot{g}_{a,i,t}^0(w^0, v^0) = \underbrace{-B_{a,i,t}(w^0)g_{a,i,t}^0(w^0, v^0)}_{\text{Separations/Quits/Aging}} - \underbrace{\alpha_t g_{a,i,t}^0(w^0, v^0)}_{\text{Stochastic Job Switches}} + \underbrace{\varphi_{a-1} g_{a-1,i,t}^0(w^0, v^0)}_{\text{Aging}}$$

$$\begin{aligned} \dot{g}_{a,i,t}^1(w^1, v^1) = & \underbrace{A_{a,i,t}(w^1)v^1}_{\text{Inflows}} - \underbrace{B_{a,i,t}(w^1)g_{a,i,t}^1(w^1, v^1)}_{\text{Separations/Quits/Aging}} + \underbrace{\alpha_t g_{a,i,t}^0(w^0, v^0)}_{\text{Stochastic Job Switches}} \\ & + \underbrace{\varphi_{a-1} g_{a-1,i,t}^1(w^1, v^1)}_{\text{Aging}} \end{aligned}$$

- ▶ Note: could allow inflows into old jobs by splitting v^1 into $\tilde{v}_t^1 + \tilde{v}_t^0 = v^1$

Firm Output During the Transition

▶ back

- ▶ Define $l_{a,i}^0(q^0), l_{a,i}^1(q^1)$ to be labor per vacancy in the two steady states
- ▶ Firm output at time t

$$y_t(q^0, q^1, v^0, v^1) = \left(\frac{1}{\gamma} \right) \left((q^0)^{\frac{1}{\gamma}} \sum_a h_a \sum_i z_i g_{a,i,t}^0(q^0, v^0) + (q^1)^{\frac{1}{\gamma}} \sum_a h_a \sum_i z_i g_{a,i,t}^1(q^1, v^1) \right)^{\gamma} \times$$
$$\underbrace{\left(\frac{\sum_a \sum_i g_{a,i,t}^0(q^0, v^0)}{\sum_a \sum_i l_{a,i}^0(q^0)} + \frac{\sum_a \sum_i g_{a,i,t}^1(q^1, v^1)}{\sum_a \sum_i l_{a,i}^1(q^1)} \right)^{1-\gamma}}_{v_t(q^0, q^1, v^0, v^1)^{1-\gamma}}$$

- Note: we are changing the argument of $g(\cdot)$ using the fact that w is monotonic in q
- ▶ This formulation is implicitly assuming that labor per vacancy/"job slot" is constant
 - Note: $v_0(q^0, q^1, v^0, v^1) = v^0$ when $t = 0$ and v^1 when $t \rightarrow \infty$

Worker's Problem: Search for Jobs and Accept Offers

► Value Function:

$$rW_{a,i}(w) - \dot{W}_{a,i}(w) = \underbrace{w h_a z_i}_{\text{flow value}} + \underbrace{\varphi_a [W_{a+1,i}(w) - W_{a,i}(w)]}_{\text{ageing}} - \underbrace{\delta_{a,i} [W_{a,i}(w) - U_a]}_{\text{separate to U}} + E(w)$$

► $E(w)$: value of search for better jobs and matches:

$$E(w) \equiv \max_s \left\{ s\lambda \left[\int V_a(w, w') dF(w') - W_{a,i}(w) \right] - \psi_a(s) \right\}$$

- Assume logit choice model when encountering an offer (with associated CCP $\mu_{a,i}(w', w)$):

$$V_a(w, w') = \sigma \log \left[\exp \left(\frac{\bar{W}_a(w)}{\sigma} \right) + \exp \left(\frac{\bar{W}_a(w') - \kappa_a}{\sigma} \right) \right]$$

⇒ **1st Distortion in GDR: high ψ_a , low search on-the-job**

- * Similar (but simpler) problem for the unemployed

Search and Matching

- **Aggregate matching function** generates matches from total searches S and vacancies V :

$$S = \sum_a \sum_i \left[\int s_{a,i}(w) dG_{a,i}(w) + s_a^U m_a^U \right]$$
$$M(V, S) = \zeta S^\nu V^{1-\nu}$$

so letting $\theta \equiv V/S$, job-finding and vacancy-filling rates are

$$\lambda = M/S = \zeta \theta^{1-\nu}, \quad \eta = M/V = \zeta \theta^{-\nu}$$

Vacancies and Flow Accounting

- ▶ Firm size is not monotonic in $w \rightarrow$ **solve for employees per vacancy** (monotonic in w)
- ▶ Employees per vacancy can be solved through usual **"flow accounting"**

$$l_{a,i}(w) \equiv \frac{A_{a,i}(w) + \varphi_{a-1} l_{a-1,i}(w)}{B_{a,i}(w)}, \quad \text{where}$$

$$\underbrace{A_{a,i}(w)}_{\text{inflows per vacancy}} \equiv \underbrace{\omega_i}_{i\text{-share}} \cdot \underbrace{\frac{\eta S_a}{S}}_{\text{filling rate by age } a} \cdot \underbrace{\frac{1}{S_a} \left[\mu_a^U(w) s_a^U \cdot m_a^U + \sum_{i'} \int \mu_{a,i'}(w', w) s_{a,i'}(w') dG_{a,i'}(w') \right]}_{\text{acceptance probability}}$$

$$\underbrace{B_{a,i}(w)}_{\text{out rate}} \equiv \underbrace{\varphi_a + \delta_{a,i}}_{\text{ageing + sep. to U}} + \underbrace{s_{a,i}(w) \lambda \int \mu_{a,i}(w, w') dF(w')}_{\text{poaching by better jobs}}$$

where $F(w(q)) \equiv \int^q v(\hat{q}) dC_{\hat{q}}(v) dP(\hat{q}) / \cdot$ is the offer distribution

Equilibrium

► Steady state equilibria (in GDR, East, West)

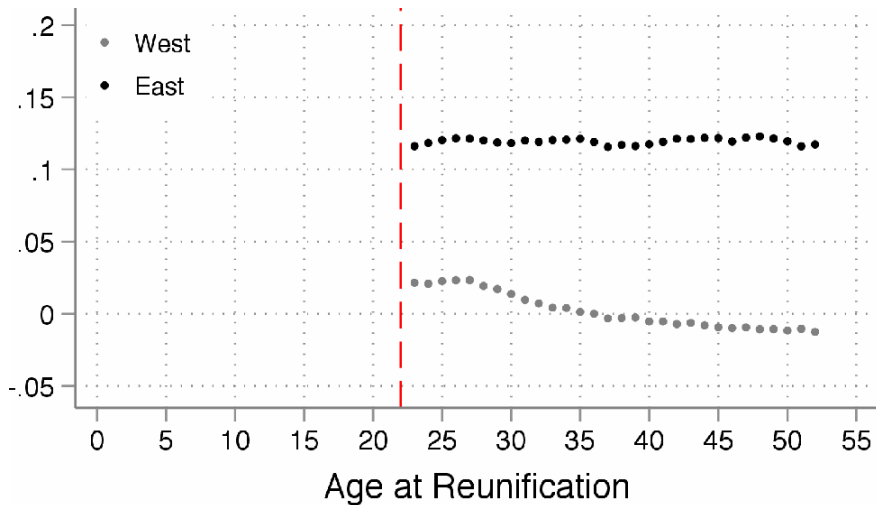
1. Wage and vacancy postings are optimal
2. Search efforts and acceptance probabilities are optimal
3. Arrival rates, wage offers, and market tightness are consistent
4. Distributions are stationary

► Transition from the GDR to the Modern East steady states

► Details

- Unexpected **one time regime shift** for workers and firms: $\bar{\psi}_0 \rightarrow \bar{\psi}_1$ & $(q_0, v_0) \rightarrow (q_1, v_1)$
- **Workers** are forward-looking and **optimize each instant** along the transition to new SS
- **Firms** pick their new steady state wage once at time $t = 0$ with commitment ($\sim$ BM)
- Firm shift from $(w_0, q_0, v_0) \rightarrow (w_1, q_1, v_1)$ is implemented stochastically (**smooth transition**)
- Labor reallocates across firms following the **usual law of motion**
- Labor **shifts within firms** (exogenously and stochastically) from (w_0, q_0) to (w_1, q_1)

Wage Growth by Birth Cohort (1992)



Wage Growth by Switchers and Stayers (1992)

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