Labor Reallocation and Wage Growth: Evidence from East Germany

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IN PROGRESS
Introduction

- Resource misallocation a source of cross-country income gaps
  1. Capital across firms, managers across technologies...
  2. Possibly due to bad policies, market imperfections...

- Can reallocation of inputs lead to convergence across regions?
  1. Theoretical evidence is obvious
  2. Empirical evidence is scant

- This Paper: historical evidence from German Reunification
  * Firm-worker reallocation contributed significantly to wage catchup
Ideal Empirical Setting to Study Labor Reallocation

- Policy change that is
  1. Exogenous, or sudden
  2. Efficient benchmark to compare the evolution of allocations
  3. Related only to the reallocation of a fixed set of firms and workers
  4. Data before and after to compare the allocations

- Most existing counterfactuals are artificial:
  based on hypothetical reforms, and/or against U.S. as a benchmark
German Reunification is Quasi-Ideal

1. Quick and largely unexpected

2. Comparison against West Germans provides natural benchmark

3. Three treatments: change in labor market + firm entry/exit + mobility
   ⇒ follow workers “from” East, decompose each

4. Scarce data before, but matched employer-employee data afterward
   ⇒ quasi-experimental variation (exposure) across cohorts

⇒ Separate between-firm effects from within-firm effects, for each
   East cohort, at all ages, relative to West
Main Results

- Decompose initial wage gap and ensuing catchup into:
  1. Between-firm: difference in firms East/West workers work
  2. Within-firm: difference in worker productivities, “human capital”?

- ~8 of the 20 ppt catchup up to 2014 happens between-firms
  1. 1992-1997: ~4 ppt due to reallocation of workers across firms in East,
  2. 1997-2014: rest due to reallocation of workers to West firms

⇒ Speed and magnitude points to the possibility of labor market efficiency as a potent policy directive
Average Wages, 1992 vs 2014
Average Wages, 1995 vs 2014
Average Wages, 2007 vs 2014
East Share of Population, 1992 vs 2014
East Share of Population, 1995 vs 2014
East Share of Population, 2000 vs 2014
East Share of Population, 2007 vs 2014
1. **Source**: IAB, research center associated with (un)employment agency
   - universe of work histories - civil servants and self-employed ($\sim 85\%$)
   - $\sim 50$ million workers followed over their life-cycles 100% sample!

2. **Sample restriction**: average daily wage of working-age German men*
   - Years: $[t, \bar{t}] = [1992, 2014]$ (earlier data used to identify origin)

3. Divide sample into East/West-“Born”
   - Berlin treated as West (for now)

* i.e., non-Germans are dropped. For women, patterns are more distinct in employment, not wages
E-E Transitions for East/West-Born

### East

<table>
<thead>
<tr>
<th>Year</th>
<th>Firm Switchers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>25</td>
</tr>
<tr>
<td>1997</td>
<td>20</td>
</tr>
<tr>
<td>2002</td>
<td>15</td>
</tr>
<tr>
<td>2007</td>
<td>10</td>
</tr>
<tr>
<td>2012</td>
<td>5</td>
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### West

<table>
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<td>1992</td>
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</table>

Legend:
- **Within**
- **Across**
- **Return**
- **Abroad**
E-E Transitions by Cohort (East in black)
Baseline Regression

\[
\log w_{isrct} = \log \theta_{j(i,t),t} + \tau_{srt} + \kappa_{src} + \alpha_{srct} + \epsilon_{isrct}
\]

- individual \( i \), skill \( s \), from \( r \), birth year \( c \), working at firm \( j \) at time \( t \)

- **Firm effects \( \theta \) are not fixed**, allowed to vary over time
  1. Cannot include individual worker fixed effects
  2. Fully stratified by skill, region and cohort

- \( \alpha_{srct} \): **skill-origin-cohort-specific age effects**
Wage Gap: Firms and Workers
Wage Convergence: Firms and Workers

- College cannot explain much

Equations
Growth Decomposition of $\theta$

- Extend Olley and Pakes (1996); Melitz and Polanec (2015) to consider worker migration
- Differences in average firm wage growth (unexplained)

1. Change in covariance across firms and workers
2. Firm entry/exit
3. Migrants and migration

- Then decompose each explainable component further
Growth Decomposition of $\theta$: Within-Region

![Graph showing growth decomposition over years with labeled axes and lines representing wage, reallocation, and shuffling components.](image-url)
Growth Decomposition of $\theta$: Firm Entry/Exit

[Graph showing the decomposition of growth into wage, reallocation, and entry(exit) effects over the years 1992 to 2012.]

- **Y-axis**: East-West Catchup (% points)
- **X-axis**: Year
- **Legend**:
  - Wage
  - Reallocation
  - Entry/Exit

[Link to formulae]

[Diagram]
Growth Decomposition of $\theta$: Migrants

![Graph showing growth decomposition of $\theta$: Migrants](image_url)

- **Wage**: Represented by a dashed grey line.
- **Reallocation**: Represented by a dotted grey line.
- **Migrants**: Represented by a solid black line.

Formal expressions and data analysis are available in the supplementary material.
Growth Decomposition of $\theta$: Migration
## Sum Up in Numbers

<table>
<thead>
<tr>
<th>Decomposition</th>
<th>Contribution to Catchup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First 5 years: <strong>13 ppt</strong></td>
</tr>
<tr>
<td>I</td>
<td>w/i firms</td>
</tr>
<tr>
<td></td>
<td>b/w firms</td>
</tr>
<tr>
<td>II</td>
<td>unexplained</td>
</tr>
<tr>
<td></td>
<td>explained</td>
</tr>
<tr>
<td>III</td>
<td>w/i region</td>
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<tr>
<td></td>
<td>entry/exit</td>
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<tr>
<td></td>
<td>migrants</td>
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<tr>
<td></td>
<td>migration</td>
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</tbody>
</table>

- **Within region in first 5 years, then across region**
Decomposition by Cohort

- Old cohorts are initially allocated worse, catchup faster
- Can similarly decompose reallocation effects by cohort
- Shuffling effect in first years dominant
- Out-migration strong for post-RU cohorts
Lessons Learned So Far

1. Firm-worker reallocation effects can be large and quick
   - Explains about a quarter of East-West wage convergence
   - Most within-region reallocation occurs in first 5 years

2. Migration plays persistent, growing role
   - Need to understand intensive/extensive margins (in progress)
   - East-West effects are opposite (in progress)

3. Almost no difference/catchup from human capital firm entry/exit
Understanding Shuffling Effects

- Workers moving across firms (gross flows of hiring, firing, job-to-job)
- Changes the size distribution over $\theta_j$'s, but also the $\theta_j$'s: $\theta_j$'s are not fixed but change over time

- Wage growth from change in $\theta$-size correlation (Olley and Pakes, 1996):

$$
S_r \equiv \frac{\bar{\theta}'(S'_r)/\bar{\theta}(S_r)}{\bar{\theta}'(\tilde{S}_r)/\bar{\theta}(\tilde{S}_r)}
\quad \text{change in mean } \theta \text{ across workers} / \text{change in mean } \theta \text{ across firms}
$$

$$
= \eta'(\tilde{S}_r)/\eta(\tilde{S}_r) \quad \text{where}
$$

$$
\eta(\tilde{S}_r) \equiv 1 + \text{Corr} \left[ \frac{\theta_j}{\bar{\theta}(\tilde{S}_r)}, \frac{s_j}{\bar{s}(\tilde{S}_r)} \right] \cdot \text{StD} \left[ \frac{\theta_j}{\bar{\theta}(\tilde{S}_r)} \right] \cdot \text{StD} \left[ \frac{s_j}{\bar{s}(\tilde{S}_r)} \right]
$$

- First verify correlation vs. dispersion effect
Reallocation Comes from Change in Correlation

East

West

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean θ Growth (% points)</th>
</tr>
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<tbody>
<tr>
<td>1992</td>
<td></td>
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<td></td>
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- Correlation
- Size Disp.
- θ Disp.
- All
Size or $\theta$?

- We can think of the following types of counterfactual correlations:

- Keep $\theta$ distribution constant, change size distribution:

  \[
  \text{Corr} \left[ \frac{\theta_j}{\bar{\theta}(\tilde{S}_r)}, \frac{s_j'}{\bar{s}'(\tilde{S}_r)} \right]
  \]

- Keep size distribution constant, change $\theta$ distribution:

  \[
  \text{Corr} \left[ \frac{\theta_j'}{\bar{\theta}'(\tilde{S}_r)}, \frac{s_j}{\bar{s}(\tilde{S}_r)} \right]
  \]
Size and $\theta$
ΔRank(θ) – ΔSize Correlation

- East in black
- On average, θ-growth firms are shrinking
We view a firm as a collection of workers

Abstract from skill-origin-cohort-age for illustration

Suppose individual $i$’s wage is determined by

$$w_i = \underbrace{\zeta_j(i)(\omega_i)}_{\text{match quality}} \cdot \underbrace{\psi_j(i)\left(\{\omega_n\}_{n \in \mathcal{I}_j(i)}; \lambda_j, s_j\right)}_{\text{worker complementarities}}$$

where $\mathcal{I}_j$ are the set of workers in firm $j$ and

- $\omega_i$: vector of individual-specific components (partially observable)
- $\zeta_j$: firm-specific function that depends only on $\omega_i$
- $\psi_j$: firm-specific wage function that depends on all workers’ $\omega_n$
- $\lambda_j$: firm-specific inputs
• Our \( \log \theta_j \)’s are basically mean firm log wages:

\[
\epsilon_i = \log \zeta_j(i)(\omega_i) - \log \zeta_j(i)(\omega_n)_{n \in \mathcal{I}_j(i)}
\]

\[
\theta_j = \exp \left[ \log \zeta_j(\omega_i)_{i \in \mathcal{I}_j} \right] \cdot \psi_j \left( \{ \omega_i \}_{i \in \mathcal{I}_j}; \lambda_j, s_j \right)
\]

• Suppose \( \zeta_j, \psi_j \) are increasing in \( \omega_i \)’s

• So \( \theta_j \)’s may rise from swapping \( \omega_i \)’s due to
  1. Rise in average match quality
  2. Rise in worker complementarities

• Negative growth correlation can be understood as letting go of low \( \omega_i \) workers (firms are too large...in progress)
Conclusion

1. Use German micro-level employment data to study East German wage convergence from 1992-2014

2. Labor market efficiency potentially an important source of income gaps and development
   - Misallocation of workers across firms explains bulk of initial East-West wage gap
   - Evidence that older cohorts were more misallocated due to longer communist exposure

3. Firm-Worker reallocation plays major role in catchup
   - More misallocated older East German cohorts reallocate faster
   - Younger cohorts persistently migrate with larger gains
Way Ahead

- Individual firm-worker understanding of size and $\theta$ effects
  1. Firm wages grow by relieving low-wage movers
     $\Leftrightarrow$ Stayers gain more than movers by staying in high-growth firms
  2. High-growth firms are NOT those with initially high wage!

- Cohort effects for migrants

- Control for further observables (industries, unions, etc.)
  - Occupation composition and premia may also be changing

- Tractable model that explains negative growth correlation
Way Ahead

- Individual firm-worker understanding of size and $\theta$ effects
  1. Firm wages grow by relieving low-wage movers
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THANK YOU!
East-West German Wages

### By Origin
- **Mean Daily Wages**
- **St. Dev. Daily Wages**

### By Region
- **Mean Daily Wages**
- **St. Dev. Daily Wages**

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**Graphs:**
- **East** (solid line)
- **West** (dashed line)
Wage Growth by Cohort

Year 1992

Year 1993 - 1995

Year 1996 - 2007

Year 2008 - 2013
Raw Profiles in the Data

### East

- **Age:** 25, 30, 35, 40, 45, 50, 55
- **Mean Daily Wages:** 50, 60, 70, 80, 90, 100

### West

- **Age:** 25, 30, 35, 40, 45, 50, 55
Definitions and Level Decomposition

- For any period $t$, drop time subscripts to ease notation
- Define $R_r$: set of workers from $r$
- For any set $A$ of workers, $\tilde{A}$: set of firms with at least worker in $A$
  For any set $\tilde{A}$ of firms, $A$: set of all workers working in $\tilde{A}$
- $\bar{x}(A) \equiv \mathbb{E}[x_i | i \in A]$: mean of $x$ over workers in set $A$
- $\bar{x}(\tilde{A}) \equiv \mathbb{E}[x_j | j \in \tilde{A}]$: mean of $x$ over firms in set $\tilde{A}$
- At any time $t$, E-W wage gap is
  \[
  \frac{\bar{w}(R_E)}{\bar{w}(R_W)} = \frac{\bar{\theta}(R_E)}{\bar{\theta}(R_W)} \cdot \frac{\bar{h}(R_E)}{\bar{h}(R_W)} \cdot \frac{\rho(R_E)}{\rho(R_W)}
  \]
  - between-firm gap
  - within-firm gap
  - type-correlation
Wage Growth Decomposition

- Change in E-W wage gap (≡ growth rate gap)

\[ \Delta \log \frac{\bar{w}(R_E)}{\bar{w}(R_W)} \approx \Delta \log \frac{\bar{\theta}(\tilde{S}_E \cap \tilde{R}_E)}{\bar{\theta}(\tilde{S}_W \cap \tilde{R}_W)} \quad : \text{unexplained firm wage growth} \]

\[ + \Delta \log \frac{\bar{\theta}(R_E)/\bar{\theta}(\tilde{S}_E \cap \tilde{R}_E)}{\bar{\theta}(R_W)/\bar{\theta}(\tilde{S}_W \cap \tilde{R}_W)} + \Delta \log \frac{\bar{h}(R_E)}{\bar{h}(R_W)} \]

where \( \tilde{S}_r \): set of surviving firms in \( r \in E, W \)

- Cannot explain why East firms grow faster (≈ “TFP shocks”)

- But can extract allocative gain
Firm Survival

- **Continuing Firms (%):**
  - 1992: 80
  - 1997: 85
  - 2002: 90
  - 2007: 95
  - 2012: 100

- **Workers in Continuing (%):**
  - 1992: 90
  - 1997: 95
  - 2002: 100
  - 2007: 100
  - 2012: 100

- **Domestic in Continuing (%):**
  - 1992: 75
  - 1997: 80
  - 2002: 85
  - 2007: 90
  - 2012: 95

- **Domestic Workers (%):**
  - 1992: 50
  - 1997: 40
  - 2002: 30
  - 2007: 20
  - 2012: 10

---

**East vs. West:**
- **East:**
  - 1992: 80
  - 1997: 85
  - 2002: 90
  - 2007: 95
  - 2012: 100

- **West:**
  - 1992: 75
  - 1997: 80
  - 2002: 85
  - 2007: 90
  - 2012: 95

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College Attainment by Year

Year
East
West
College Share (%)
Cohort Share of College by Year

East

West
College Attainment by Cohort

Cohort 1946

Cohort 1947

Cohort 1948

Cohort 1949

Cohort 1950

Cohort 1951

Cohort 1952

Cohort 1953

Cohort 1954

---

East

West
College Attainment by Cohort

Cohort 1955

Cohort 1956

Cohort 1957

Cohort 1958

Cohort 1959

Cohort 1960

Cohort 1961

Cohort 1962

Cohort 1963

--- East ---

--- West ---
College Attainment by Cohort

Cohort 1964

Cohort 1965

Cohort 1966

Cohort 1967

Cohort 1968

Cohort 1969

Cohort 1970

Cohort 1971

Cohort 1972

East

West

College Share (%) vs. Year
College Attainment by Cohort

- Cohort 1982
- Cohort 1983
- Cohort 1984
- Cohort 1985
- Cohort 1986
- Cohort 1987
- Cohort 1988
- Cohort 1989

Graphs showing college attainment by cohort from 1992 to 2012, with data points for East and West regions.
Growth Decomposition Formula

- For any time $t$, define the sets
  
  1. $\tilde{T}_r$: all firms in $r \in \{\text{East, West}\}$
  
  2. $M_r$: set of workers who migrate out, or only appear in $t + 1$

- Decompose firm component as:

\[
\frac{\bar{\theta}'(R'_r)}{\bar{\theta}(R_r)} = \frac{\bar{\theta}'(\tilde{S}_r)}{\bar{\theta}(\tilde{S}_r)} \cdot \frac{\bar{\theta}'(R'_r \cap \tilde{S}_r)}{\bar{\theta}(R_r \cap \tilde{S}_r)} \cdot \frac{\bar{\theta}'(S'_r)}{\bar{\theta}(S_r)} \cdot \frac{\bar{\theta}'(R'_r \cap S'_r)}{\bar{\theta}(R_r \cap S_r)} \cdot \frac{\bar{\theta}'(R'_r \cap T'_r)}{\bar{\theta}(R_r \cap T_r)} \cdot \frac{\bar{\theta}'(R'_r \setminus M_r)}{\bar{\theta}(R_r \setminus M_r)}
\]

  - $\gamma_T$: year effect
  - $\tilde{S}_r$: extensive
  - Regional shuffling
  - $S_r$: domestic shuffling
  - Firm entry/exit
  - Migrants
  - Migration
Component Decomposition

- For shuffling, note that for any set of workers $A$,

$$\frac{\bar{\theta}'(A')/\bar{\theta}'(\tilde{A}')}{\bar{\theta}(A)/\bar{\theta}(\tilde{A})} = \frac{\eta'(A')}{\eta(A)}$$

captures $\theta$-size correlation

- Each component can be split into firm extensive and sub-shuffling gains, since for sets $A \subset B$:

$$\frac{\bar{\theta}'(B')}{\bar{\theta}(B)} \cdot \frac{\bar{\theta}'(\tilde{A}')/\bar{\theta}'(\tilde{A})}{\bar{\theta}'(A')/\bar{\theta}'(\tilde{A})} = \frac{\bar{\theta}'(\tilde{B}')/\bar{\theta}'(\tilde{B})}{\bar{\theta}'(A')/\bar{\theta}'(\tilde{A})} \cdot \frac{\eta'(B')/\eta'(\tilde{B})}{\eta'(A')/\eta'(\tilde{A})}$$

extensive gain

shuffling gain

- Shuffling: domestic, firm entry/exit, foreign
- Not considered across borders: all soaked into migration
Growth Decomposition of $\theta$
Growth Decomposition of $\theta$: Levels

### East

- **Year Effect**
- **+Shuffling**
- **+Entry/Exit**
- **+Foreign**

### West

- **Year Effect**
- **+Shuffling**
- **+Entry/Exit**
- **+Foreign**
- Migrants move to high $\theta$ firms, but shuffling effect is negative
Cohort Shuffling

Year 1992

Year 1993 - 1995

Year 1996 - 2007

Year 2008 - 2013
Cohort Seeding N’ Weeding

Year 1992

Year 1993 - 1995

Year 1996 - 2007

Year 2008 - 2013
Migrants by Cohort
Migration by Cohort

Year 1992

Year 1993 - 1995

Year 1996 - 2007

Year 2008 - 2013
Size and $\theta$ moments

![Graphs showing changes in mean and variance of firm size and $\theta$ moments over years.](image)
$\Delta \theta$ – Relative Gross Flows Correlation

- East in black
- No $\theta$ (firm wage) change for firms with no flows