Exposure(s) to Trade and Earnings Dynamics: Evidence from the Collapse of Finnish-Soviet Trade

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A national labor market there is not ... Topolova (2010); ADH (2013); Kovak (2013); ...

But how do local labor markets actually shape the response to trade shocks?

▶ **Hypothesis #1**: There are more exposed workers in more exposed markets, but those exposed to negative trade shocks fare equally poorly across markets

▶ **Hypothesis #2**: There is something systematically different about experience of exposed workers in the most negatively affected markets

Hypothesis #1 versus hypothesis #2 has obvious policy implications:

▶ Hypothesis #1 $\implies$ National social programs compensating workers regardless of location well suited (unemployment benefits, trade adjustment assistance)

▶ Hypothesis #2 $\implies$ Scope for the same programs to inherit characteristics of place-based policies (as advocated by Austin, Glaeser, and Summers 2018)

Hypothesis #1 versus hypothesis #2 may also help shed light on structural determinants of the redistributional consequences of trade
To make progress on this question

- **Focus on a Massive Trade Shock**
  - Collapse of the Finnish-Soviet bilateral trade agreement in 1990
  - Newly-digitized Finnish firm exports to USSR + matched employer - employee data
  - Measure both **worker exposure** and **market exposure** to the USSR shock
    - Worker exposure \( (s) \) = USSR export share of output of a worker's plant in 1989
    - Market exposure \( (S) \) = Employment-weighted average of USSR export shares of output of a market's plants in 1989

- **Study earnings trajectories of Finnish workers from 1985 to 2004**
  - How they vary with worker exposure to the USSR shock \( (s) \)
  - As well as how this varies with the exposure of the local labor market \( (s \times S) \)
Road Map

1 Historical background and data
   ▶ Collapse of the Finnish-Soviet trade agreement
   ▶ Measures of worker and market exposure and other data sources

2 Reduced-form results on trade exposures and earnings dynamics
   ▶ More exposed workers systematically experience lower earnings after the shock
   ▶ Negative effect of worker exposure persistently larger in more exposed markets, a form of local scarring

3 Exploration of wage rigidity as driver of earnings dynamics
   ▶ Theory: Develop a simple model of labor-market dynamics with wage rigidity
   ▶ Empirics: Provide supporting evidence for additional predictions
Related Literature

- **Shift-share literature analyzing impact of negative labor demand shocks on market-level outcomes** Blanchard and Katz (92), Topalova (10), ADH (13), Kovak (13), Dix-Carniero Kovak (17)
  - We directly observe market shock, focus on worker outcomes ADHS (2014), Yagan (2019), ...
  - We observe more granular worker exposure, allowing us to study interaction of worker and market exposure

- **USSR shock has featured prominently in analyses of Finnish Great Depression**
  Honkapohja and Koskela (99), Jonung et al. (09), Gorodnichenko et al. (12), Gulan et al. (21)

- **Empirical analysis related to displacement literature** Jacobson et al. (1993), Couch and Placzek (2010)
  - Through the lens of our model, our regressions are the RFs of 2SLS regressions

- **Workhorse dynamic model of trade and labor markets: slow transition driven by idiosyncratic preference shocks** Artuç et al. (10), Dix-Carneiro (14), Caliendo et al. (19), and Traiberman (19)
  - We emphasize wage rigidities Friedman (53), Akerlof et al. (96), Rodriguez-Clare et al. (20),...
  - We get opposite predictions for employment and wage dynamics in short-run and long-run, for which we find support in the data
Historical Background and Data
The Finnish-USSR Trade Arrangement and its Demise

- Series of five-year, bilateral trade agreements starting in 1951
  - Trade was required to be annually balanced
  - Finland imported energy (world price) exported manufactures (negotiated high price)
- USSR unilaterally cancelled the agreement on Dec 6th, 1990

- Finnish manufacturers taken by surprise
  - Sutela (2014, 134): “That it was evident that the Soviet Union was collapsing was not of any importance: there were friends at the Soviet Ministry of Foreign Trade who claimed that everything would be fine after a short period of uncertainty.”
- This unexpected, persistent drop is what we will refer to as the “USSR shock”
Constructing Exposure(s) to the USSR Shock

- We start with data on exports to the USSR at the firm-and-product level
  - Firms required to notify Office of Licenses of all transactions w/ Soviet Union
  - Published these transactions in biweekly reports
  - We have digitalized all reports for the year 1989
  - $x_{fp,1989}$ = value of exports to USSR of product $p$ by firm $f$ in 1989

- We combine previous data with data on gross output at the plant-and-product level
  - We link exports data w/ Longitudinal Data on Plants in Finnish Manufacturing (LDPM)
  - info on inputs, outputs, the municipalities in which their plants are located, ...
  - $q_{jp,1989}$ = value of gross output of plant $j$ product $p$ for all $j$ in LDPM

- This allows us to construct plant-level USSR export intensity $s_j \equiv x_{j,1989} / q_{j,1989}$

- $q_{j,1989} \equiv \sum_p q_{jp,1989}$ is plant $j$’s total gross output
- $x_{j,1989} \equiv \sum_p x_{fp,1989} \times (q_{jp,1989} / q_{fp,1989})$ is plant $j$’s (inferred) USSR exports
Municipality $m$ exposure to the USSR trade shock

$$S_m = \sum_{j \in J_m} \omega_j s_j$$

with weights equal to the employment share of plant $j$ in market $m$ in 1989.
Worker Exposure to the USSR Shock

- For each worker \(i\), observe personal ID number and a firm and plant identifier which we use to match workers to their employers in 1989: \(s_i \equiv s_j\)
- Exposure to USSR exports was extremely skewed

Distributions of Worker Exposure (conditional on \(s_i > 0\)) in the Top and Bottom Quartiles of Market Exposure
Other Data Sources

- Baseline outcome variable is **annual earnings**
  - Finnish Tax Authority (wage and salary)
  - All earnings deflated to 2010 euros (markka-euro exchange rate and Finland’s Cost-of-living index)
  - Winsorize annual income at the top 1% within each year (following ADHS 2014)

- Later consider **number of days of employment** and **hourly wage**
  - Days of employment during a year as recorded in the Pension Register
    - Limitation: does not include information on hours (or intermittent work during spell)
  - Hourly wage from Confederation of Finnish Industry (TT) survey data
    - Limitation: Only available for smaller sample (large firms in manufacturing, construction)
Reduced-form Results on Trade Exposures and Earnings Dynamics
Empirical Design(s)

Goal: Study causal relationship btw worker and market exposures, $s_i$ and $S_m$, and path of Finnish workers’ earnings $y_{i,t}$ over the 1985-2004 period

1. Design (I): Study incidence of worker exposure, $s_i$, on annual earnings, $y_{it}$
   - **Double-Difference:** Compare changes in earnings trajectories of more and less exposed workers who are similar in terms of other observable characteristics
   \[ \Delta y_{it} = \beta_t s_i + Controls_i \zeta_t + \epsilon_{it} \]
   where $\Delta y_{it} \equiv y_{it} - \overline{y}_{i, pre}$ and Controls$_i$ is a long vector of initial characteristics
Empirical Design(s)

**Goal:** Study causal relationship btw worker and market exposures, $s_i$ and $S_m$, and path of Finnish workers’ earnings $y_{i,t}$ over the 1985-2004 period

2 Design (II): Study how previous incidence varies with market exposure, $S_m$

▶ **Triple-Difference:** Compare differences between changes in earnings trajectories of more versus less exposed workers in more and less exposed markets

$$\Delta y_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \text{Controls}_i' \zeta_t + \epsilon_{it}$$
Worker Controls and Sample

- **Worker Controls**:
  - Municipality dummy variables (where individual $i$ located in 1989)
  - Characteristics of employer (plant where individual $i$ worked in 1989)
    - avg pre-shock earnings, plant output*, capital/labor ratio* (missing category for non-manuf)
    - manufacturing dummy variable
  - Worker Socio-demographics
    - birth year, gender, language, education level + field, pre-shock earnings

- **Worker Sample**:
  - Private sector
  - High labor force attachment
  - Born 1945-1967
Worker Controls and Sample

<table>
<thead>
<tr>
<th></th>
<th>&quot;Attached workers&quot;</th>
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<tbody>
<tr>
<td></td>
<td>Baseline sample (1)</td>
</tr>
<tr>
<td><strong>A: Employer characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Average annual earnings</td>
<td>26,517 (7,430)</td>
</tr>
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<td>Output (LDPM)</td>
<td>67.4 (155.6)</td>
</tr>
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<td>Capital-labor ratio (LDPM)</td>
<td>102.8 (220.1)</td>
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<td><strong>B: Worker socio-demographics</strong></td>
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<td>Year of birth</td>
<td>1953.8 (5.9)</td>
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<td>Lower tertiary degree</td>
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<tr>
<td>General, arts or teaching degree</td>
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<td>Business degree</td>
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<tr>
<td>Technical degree</td>
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<td>Degree in other fields</td>
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<td>0.32</td>
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<td>Annual earnings</td>
<td>28,354 (13,101)</td>
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<td><strong>C: Sector of employment</strong></td>
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<tr>
<td>Manufacturing</td>
<td>0.36</td>
</tr>
<tr>
<td>Observations</td>
<td>627,070</td>
</tr>
</tbody>
</table>
Baseline Earnings Results (Double-Difference)

\[ \Delta y_{it} = \beta_t s_i + \text{Controls}' \zeta_t + \varepsilon_{it} \]

Estimated effect of worker exposure \((s_i)\)

- In 1992, worker at the 90th percentile of exposure experiences 809 euro \(\downarrow\) compared to worker at 10th percentile (conditional on \(s_i > 0\)), \(\approx 3\%\) of annual earnings.
Baseline Earnings Results (Double-Difference)

\[ \Delta y_{it} = \beta_t s_i + \text{Controls}' \zeta_t + \varepsilon_{it} \]

Estimated effect of worker exposure \((s_i)\)

- Another way to interpret the magnitude of \(\beta_t\) is as the RF of a 2SLS regression:
  - 1st stage: regress a dummy for being fired on exposure to the USSR shock
  - 2nd stage: regress earnings on a dummy for being fired similar to regression in mass-layoff literature

- Assume that, consistent with our model, probability that worker \(i\) is fired is \(s_i\)
  - \(\Rightarrow\) 1st-stage coefficient is one \(\Rightarrow \hat{\beta}_{1992} = -3,858\) euros of earnings losses for a fired worker, or approximately 15 percent of average annual income
Baseline Earnings Results (Triple-Difference)

\[ \Delta y_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \text{Controls}' \zeta_t + \epsilon_{it} \]

Estimated interaction effect between worker and market exposures \((s_i \times S_m)\)

- Within more exposed local labor markets, worker exposure leads to both larger and more persistent earnings declines, a form of local scarring.
- Moving from 10th to 90th percentile of \(s_i > 0\) distribution in 1992:
  - in 10th percentile exposure muni: 658 \(\downarrow\) euro
  - in 90th percentile exposure muni: decline is \(\approx 20\%\) larger
- Spatial counterpart of results in labor literature about heterogeneous impact of mass lay-offs over the business cycle e.g., Davis and von Wachter (11), Farber (17), and Schmider et al. (19)
Sensitivity Analysis

- Relative vs. Absolute Earnings
- Alternative Worker Controls
- Alternative Worker Samples
- Alternative Measures of Market Exposure
Exploration of Wage Rigidity as Driver of Earnings Dynamics (Part I: Theory)
A Simple Model with Wage Rigidity

Time is continuous and indexed by $t$

1. Labor market with fixed set of workers, $i \in \mathcal{I}$, and plants, $j \in \mathcal{J}$

2. Plant $j$ employment equals labor demand at $t$: $E_{jt} = \phi_{jt} W^{-\sigma}$

3. Workers are either employed or unemployed: $E_t + U_t = N$

4. Downward wage rigidity $\dot{W}_t = \gamma(\bar{W}_t - W_t)$ if $\bar{W}_t < W_t$
A Simple Model with Wage Rigidity

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   ▶ $\Rightarrow E_t = \Phi_t W_t^{-\sigma}$ where $\Phi_t \equiv \sum_{j \in \mathcal{J}} \phi_{jt}$

   ▶ Btw $t$ and $t + dt$, fraction $\lambda dt$ matches exogenously destroyed $\Rightarrow \lambda_{jt} = \max\{\lambda, -\dot{E}_{jt}/E_{jt}\}$

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2. Plant $j$ employment equals labor demand at $t$: $E_{jt} = \phi_{jt} W_t^{-\sigma}$

3. Workers are either employed or unemployed: $E_t + U_t = N$
   - If employed in $j$: wage $W_t +$ endogenous probability of separation $\lambda_{jt} dt$
   - If unemployed: endogenous probability $\kappa_t dt$ of switching to employment at $t + dt$
   - Job-finding rate: $\kappa_t = \max \left\{ 0, \frac{E_t + \lambda_t E_t}{U_t} \right\}$ with $\lambda_t = \sum_{j \in \mathcal{J}} \lambda_{jt} \frac{E_{jt}}{E_t}$

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4. Downward wage rigidity $\dot{W}_t = \gamma(\bar{W}_t - W_t)$ if $\bar{W}_t < W_t$
   - $\bar{W}_t \equiv (N/\Phi_t)^{-1/\sigma}$ is market-clearing wage
   - $\gamma \geq 0$ determines speed of wage adjustment
Comparative Static Exercise

- Suppose that market is initially in steady state at $t = 0$
  - $W_0 = \bar{W}_0 \implies E_0 = N$

- Then at $t = 0$, there is a one-time, permanent negative labor demand shock that differentially affects plants (call it the "USSR shock")
  - Labor demand parameter for plant $j$ falls from $\phi_j$ to $\phi'_j \equiv (1 - s_j) \phi_j$
  - "Worker exposure" is equal to exposure of her plant $s_i$
  - "Market exposure" is equal to average $S \equiv \sum_{j \in J} s_j (E_{j0}/E_0) = \sum_{i \in I} s_i / E_0$

- How do market and worker exposures affect the path of (i) market-level wages and employment and (ii) worker-level earnings and employment?
Proposition 1. In response to the USSR shock, more exposed markets experience

1. greater declines in wages, with wages slowly adjusting downward toward a new lower market-clearing wage

2. greater declines in employment, with employment jumping down at impact before adjusting upward slowly toward full employment

Proposition 2. In response to the USSR shock, more exposed workers experience

1. greater declines in expected employment, with larger declines in more exposed markets

2. greater declines in expected earnings, with larger declines in more exposed markets if wages are sufficiently rigid
Proposition 1. *In response to the USSR shock, more exposed markets experience*

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Exploration of Wage Rigidity as Driver of Earnings Dynamics (Part II: Empirics)
\[ \Delta n_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \text{Controls}_i \zeta_t + \varepsilon_{it} \]

Estimated effect of worker exposure \((s_i)\)

- **In line with Proposition 2:** more exposed workers experience greater declines in employment
  - Negative impact of worker exposure on employment peaks 1992-1993, dissipates shortly thereafter
From Earnings to Employment Dynamics

\[ \Delta n_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \text{Controls}' \zeta_t + \varepsilon_{it} \]

Estimated interaction effect between worker and market exposures \((s_i \times S_m)\)

- **In line with Proposition 2:** negative impact of worker exposure on employment more severe in more exposed markets
  - In contrast to the earnings results, \(\gamma_t\) converges to zero in the medium run, consistent with downward-wage adjustment in medium run
A Final Look at the Direct Effect of Market Exposure

- Drop municipality dummies from Controls\(_i\) and estimate

\[
\Delta n_{it} = \beta_t S_m + \text{Controls}_i' \zeta_t + \varepsilon_{it}
\]
\[
\Delta w_{it} = \beta_t S_m + \text{Controls}_i' \zeta_t + \varepsilon_{it}
\]

In line with Proposition 1: Wages respond more in the long-run than short-run. Employment responds more in short-run than long-run.
- Standard dynamic discrete choice models predict the opposite
Conclusions

- What role do local labor markets play in propagating trade shocks?
  - Hypothesis #1: Workers exposed to negative trade shocks fair equally poorly across regions
  - **Hypothesis #2**: There is something systematically different about experience of exposed workers in the most negatively affected markets

- Worker exposure to USSR shock lowers earnings throughout the post period, but persistently more so in more exposed markets, a form of **local scarring**

- We have developed a model of labor-market dynamics w/ downward **wage rigidity** that rationalizes our empirical findings and make additional predictions
  - Predictions are intuitive and supported in the data, but radically different than those of standard dynamic discrete choice models
  - Suggests distinct structural determinants of distributional consequences of trade: speed of wage adjustment/inflation rate + job churning in labor markets
Appendix
### 1. HYVÄKSYTYT VIENTITARKKAILUILMOITUKSET

**GODKÄNDA EXPORTKONTROLLANMÄLNINGAR**

**VIENTIOSASTO - EXPORTAVDELNING**

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How complete are recorded transactions?

- **Office of Licenses:**
  - Info on 3,380 transactions w/ value of 3.7 billion (in 2010 euros)

- **NBER-UN:**
  - Finland’s exports to the USSR in 1989 were 4.2 billion
Linking export data to LDPM

- **LDPM details:**
  - 1989 sampling frame of LDPM: all manufacturing plants with \( \geq 5 \) employees
  - Firms legally required to answer survey

- **Link firms in Office of Licenses to firms in LDPM using either**
  - firm names and product codes
  - or annual reports of export cartels

- **Link 71% of total value in export data to plants included in LDPM**

- **Missing construction, wholesale, trading companies not in LDPM**
### Table A.1: LDPM Plants by USSR Export Intensity, 1989

#### By share of gross output exported to the USSR in 1989

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<thead>
<tr>
<th></th>
<th>All</th>
<th>0%</th>
<th>0–10%</th>
<th>10–50%</th>
<th>50–100%</th>
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<tr>
<td><strong>A: Plant characteristics</strong></td>
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<tr>
<td>Gross output</td>
<td>8,207</td>
<td>4,991</td>
<td>33,860</td>
<td>38,277</td>
<td>15,615</td>
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<tr>
<td>Value-added</td>
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<td>1,725</td>
<td>11,140</td>
<td>11,906</td>
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<td>Number of workers</td>
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</tr>
<tr>
<td>Value-added per worker</td>
<td>44.0</td>
<td>42.2</td>
<td>58.5</td>
<td>45.7</td>
<td>41.0</td>
</tr>
<tr>
<td>Capital / labor ratio</td>
<td>60.3</td>
<td>59.2</td>
<td>70.5</td>
<td>57.1</td>
<td>41.5</td>
</tr>
<tr>
<td>Plant age</td>
<td>10.5</td>
<td>10.2</td>
<td>12.9</td>
<td>12.6</td>
<td>12.5</td>
</tr>
<tr>
<td>Multi-plant firm</td>
<td>0.31</td>
<td>0.25</td>
<td>0.82</td>
<td>0.67</td>
<td>0.58</td>
</tr>
<tr>
<td>Share of output exported to the USSR</td>
<td>0.01</td>
<td>0.00</td>
<td>0.02</td>
<td>0.24</td>
<td>0.82</td>
</tr>
</tbody>
</table>

#### B: Group characteristics

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of output</td>
<td>1.00</td>
<td>0.54</td>
<td>0.39</td>
<td>0.06</td>
<td>0.01</td>
</tr>
<tr>
<td>Share of workers</td>
<td>1.00</td>
<td>0.58</td>
<td>0.36</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Share of USSR exports</td>
<td>1.00</td>
<td>0.00</td>
<td>0.30</td>
<td>0.44</td>
<td>0.26</td>
</tr>
</tbody>
</table>

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of plants</td>
<td>6,865</td>
<td>5,989</td>
<td>734</td>
<td>99</td>
<td>43</td>
</tr>
<tr>
<td>No. of workers</td>
<td>404,462</td>
<td>229,507</td>
<td>162,787</td>
<td>24,327</td>
<td>6,192</td>
</tr>
</tbody>
</table>

**Notes:** This table reports how characteristics of LDPM plants vary with their export intensity (Panel a) as well as the shares of output, employment, and USSR exports accounted by groups of plants with different export intensity (Panel b).
## Table A.3: Worker Characteristics by Worker-Level Exposure to USSR Shock, 1989
### Manufacturing

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>0%</th>
<th>0–10%</th>
<th>10–50%</th>
<th>50–100%</th>
<th>Other industries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A: Demographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.28</td>
<td>0.29</td>
<td>0.25</td>
<td>0.28</td>
<td>0.31</td>
<td>0.47</td>
</tr>
<tr>
<td>Age</td>
<td>35.4</td>
<td>35.2</td>
<td>35.9</td>
<td>35.8</td>
<td>35.7</td>
<td>35.4</td>
</tr>
<tr>
<td>First language Finnish</td>
<td>0.96</td>
<td>0.95</td>
<td>0.97</td>
<td>0.96</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td><strong>C: Level of education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than secondary / unknown</td>
<td>0.33</td>
<td>0.33</td>
<td>0.32</td>
<td>0.30</td>
<td>0.23</td>
<td>0.27</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.44</td>
<td>0.44</td>
<td>0.43</td>
<td>0.45</td>
<td>0.44</td>
<td>0.35</td>
</tr>
<tr>
<td>Advanced vocational</td>
<td>0.15</td>
<td>0.15</td>
<td>0.14</td>
<td>0.14</td>
<td>0.17</td>
<td>0.22</td>
</tr>
<tr>
<td>College</td>
<td>0.09</td>
<td>0.08</td>
<td>0.10</td>
<td>0.11</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>D: Field of education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical</td>
<td>0.50</td>
<td>0.48</td>
<td>0.53</td>
<td>0.55</td>
<td>0.62</td>
<td>0.25</td>
</tr>
<tr>
<td>Other</td>
<td>0.16</td>
<td>0.17</td>
<td>0.14</td>
<td>0.14</td>
<td>0.15</td>
<td>0.45</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.33</td>
<td>0.33</td>
<td>0.32</td>
<td>0.30</td>
<td>0.23</td>
<td>0.27</td>
</tr>
<tr>
<td><strong>E: Earnings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual earnings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** This table reports how characteristics of workers vary with their exposure to the USSR shock.
In discrete time, probability unemployed worker at $t$ is employed at $t + \Delta$:

$$\kappa_t \Delta = \max \left\{ \frac{E_{t+\Delta} - \sum_{j \in \mathcal{J}} (1 - \lambda_{jt} \Delta) E_{jt}}{U_t} \right\}$$

As $\Delta$ goes to zero (and omitting the max...)

$$\kappa_t \Delta \simeq \frac{E_t + \Delta E'_t - \sum_{j \in \mathcal{J}} (1 - \lambda \Delta) E_{jt}}{U_t} = \frac{\Delta E'_t + \sum_{j \in \mathcal{J}} \lambda_{jt} \Delta E_{jt}}{U_t}$$

which gives

$$\kappa_t = \frac{\dot{E}_t + \sum_{j \in \mathcal{J}} \lambda_{jt} E_{jt}}{U_t}$$
Relative vs. Absolute Earnings

Estimated effect of worker exposure ($s_i$)

Estimated interaction effect between worker and market exposures ($s_i \times S_m$)
Estimated interaction effect between worker and market exposures \((s_i \times S_m)\)

Controlling for:
- Municipality FE
- + employer characteristics
- + worker characteristics
- + manufacturing (baseline)
- + 2-digit industry

Euros

Alternative Worker Controls
Non-Linear Effects of Worker Exposure

\[ \Delta y_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \delta_t s_i^2 + \text{Controls}'_i \zeta_t + \varepsilon_{it} \]

Estimated interaction effect between worker and market exposures \((s_i \times S_m)\)

![Graph showing the estimated interaction effect between worker and market exposures from 1985 to 2004.](image)
Alternative Worker Controls
Size of the Local vs. Manufacturing Decline

\[ \Delta y_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \delta_t (s_i \times ManuShare_m) + \text{Controls'} \zeta_t + \varepsilon_{it} \]

Estimated interaction effect between worker and market exposures \((s_i \times S_m)\)

Euros

Estimated interaction effect between worker and market exposures ($s_i \times S_m$)
Estimated interaction effect between worker and market exposures ($s_i \times S_m$)
Estimated interaction effect between worker and market exposures \((s_i \times S_m)\)
Employment Dynamics: Alternative Worker Controls

$$\Delta n_{it} = \beta_t s_i + \gamma_t (s_i \times S_m) + \text{Controls}' \zeta_t + \varepsilon_{it}$$

Estimated interaction effect between worker and market exposures ($s_i \times S_m$)