

# Estimating the Value of CEOs in Privately Held Businesses

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# Motivation

# What is the marginal product of a CEO?

## We know

- Management matters. Consulting (India: Bloom et al. 2013), large-scale training (Italy: Giorcelli 2019, US: Bianchi and Giorcelli 2022, Giorcelli 2023)
- Managers matter. Event studies around CEO changes (US: Bertrand and Schoar 2003, Schoar and Zuo 2016, Metcalfe et al. 2023, Italy: Sauvagnat and Schivardi 2024, Denmark: Bennedsen et al 2020)

## But

- Most studies focus on public firms in rich countries.

## What about privately held firms?

- 1 Limited data on compensation, decisions, financials
- 2 Owners often have oversized control roles
- 3 Data on small firms more noisy

# This paper

- 1 Model CEO effects in presence of owner-chosen inputs
- 2 Collect data on 1m+ firms, 1m+ CEOs in Hungary 1992–2022
- 3 Design a placebo-controlled event study to measure true CEO effects

# Preview of Results

- Standard approach: 22.5% performance gap between “good” and “bad” CEOs
- Our placebo test: 17% is noise
- **True CEO effect: 5.5%**

# Roadmap

- 1 Theoretical Framework
- 2 Data: The Hungarian Commercial Registry
- 3 Estimation Methodology
- 4 Results
- 5 Conclusion and Future Work



# Theoretical Framework

# Production Structure

Firms combine fixed and variable inputs:

$$Q_{imt} = \Omega_{it} A_i Z_m K_{it}^{\alpha} L_{imt}^{\beta} M_{imt}^{\gamma}$$

- $A_i$ : Organizational capital (owner-chosen)
- $Z_m$ : Manager skill ( $\rightarrow$  TFP)
- $K_{it}$ : Physical capital (owner-chosen)
- $L_{imt}, M_{imt}$ : Labor, materials (manager-chosen)
- $\Omega_{it}$ : *Residual* productivity

# Optimization Problem

Manager maximizes profit given fixed inputs:

$$\max_{L,M} P_{st}Q_{imt} - W_{st}L_{imt} - \varrho_{st}M_{imt}$$

First-order conditions pin down optimal scale

$$R_{imst} = (P_{st}\Omega_{it}A_iZ_m)^{1/\chi}K_{it}^{\alpha/\chi}W_{st}^{-\beta/\chi}\varrho_{st}^{-\gamma/\chi}(1-\chi)^{(1-\chi)/\chi}. \quad (1)$$

## Surplus = Rent to Fixed Factors

Surplus to fixed factors:

$$S_{imst} = R_{imst} - W_{st}L_{imst} - \varrho_{st}M_{imst} = \chi \cdot R_{imst}$$

where  $\chi = 1 - \beta - \gamma$

$$S_{imst} = \chi(P_{st}\Omega_{it}A_iZ_m)^{1/\chi}K_{it}^{\alpha/\chi}W_{st}^{-\beta/\chi}\varrho_{st}^{-\gamma/\chi}(1 - \chi)^{(1-\chi)/\chi}. \quad (2)$$

Owner controls  $A_i$  and  $K_{it}$

Manager controls  $Z_m$

## Estimable Equation

Taking logs and substituting out invariant terms,

$$r_{imst} = \frac{\alpha}{\chi} k_{it} + \frac{1}{\chi} z_m + \lambda_i + \mu_{st} + \tilde{\omega}_{it} \quad (3)$$

### Assumptions

- 1 All firms with the sector face the same prices
- 2 Residual TFP uncorrelated with owner and manager choices
  - Timing can be checked in event study.
- 3 Owner and manager choices can be arbitrarily correlated

### Estimate with Two-Way Fixed Effects

Data

# The Hungarian Context

## Why Hungary?

- Complete administrative data
  - All incorporated businesses
  - Mandatory CEO registration
- 30+ years of coverage

## Economic Background

- Transition economy 1990s
- EU accession 2004
- Mix of domestic and foreign firms

# Data Sources

## Firm Registry (Cégjegyzék LTS)

- CEO appointments and terminations
- Ownership structure
- Complete since 1992

## Balance Sheet Data (Mérleg LTS)

- All firms filing financial statements
- Revenue, costs, employment, assets
- 1980-2022 coverage
- 10.2 million firm-years



# Data Cleaning

## What is a firm?

Fairly good numeric identifier by Tax Authority (NAV). We follow one-to-one business transitions to match with commercial registry.

One firm = one legal entity (but we can see ultimate owners)

## Who is a CEO?

Owners, directors, accountants are all recorded.

- 1 No numerical identifier before 2013 (but name, home address, mother's name 1999+, birth date 2010+) → entity resolution
- 2 Time spells not always closed or contiguous
- 3 CEO ("Managing Director") title is not always recorded → impute from past and present

# Sample Construction

Exclude firms that:

- ever have more than 2 CEOs in a year
- have more than 6 CEOs during their lifetime
- are in their first year (often incomplete)
- were ever state owned
- operate in mining and finance
- never reach 5 employees

## CEO Characteristics

| Characteristic      | Share           |
|---------------------|-----------------|
| Hungarian name      | 95%             |
| Male (among HU)     | 73%             |
| Founder             | 69%             |
| Multiple firms      | 18%             |
| Connected component | 26,476 managers |

## Temporal Patterns

Table 2: Sample Over Time

| Year  | Total firms | Sample firms | CEOs    | Connected component |       |
|-------|-------------|--------------|---------|---------------------|-------|
|       |             |              |         | Firms               | CEOs  |
| 2015  | 433,371     | 97,282       | 107,205 | 1,053               | 895   |
| 2020  | 424,501     | 102,717      | 111,466 | 1,057               | 894   |
| 2022  | 454,106     | 101,292      | 110,443 | 996                 | 840   |
| Total | 699,991     | 127,296      | 186,143 | 1,317               | 1,848 |

*Notes:* This table presents the evolution of the sample from 1992 to 2022. Column (1) shows the total number of distinct firms with balance sheet data. Column (2) shows the number of distinct firms after applying data quality filters. Column (3) shows the number of distinct CEOs. Columns (4) and (5) show the subset of distinct firms and CEOs that belong to the largest connected component of the manager network, where managers are connected if they have worked at the same firm. The table shows every fifth year plus the first year (1992), last year (2022), and totals of distinct counts.

## CEO Turnover Patterns

| CEOs  | Firm-Year | Firm    |
|-------|-----------|---------|
| 1     | 81%       | 72%     |
| 2     | 16%       | 21%     |
| 3     | 2%        | 5%      |
| 4+    | 0%        | 2%      |
| Total | 4,498,494 | 664,584 |

| Length<br>(Years) | Actual<br>Spells | Placebo<br>Spells |
|-------------------|------------------|-------------------|
| 1                 | 27%              | 32%               |
| 2                 | 17%              | 21%               |
| 3                 | 13%              | 17%               |
| 4+                | 42%              | 30%               |
| Total             | 44,738           | 1,371             |

# Estimation

## Estimation steps

- 1 Estimate  $\chi$  as 1 – revenue share of labor and material
- 2 Estimate revenue function with rich fixed effects to recover coefficients of fixed factors
- 3 Estimate firm and manager fixed effects with TWFE on **largest connected component**
- 4 Check dynamics of effects via event study

## Surplus Share (1)

Follow Halpern et al. (2015), Gandhi et al. (2020)

$$\hat{\chi}_s := 1 - \frac{\sum_{i \in s} (W_{st} L_{it} + \varrho_{st} M_{it})}{\sum_{i \in s} R_{it}}$$



## Revenue Function (2)

$$r_{imst} = \frac{\alpha}{\chi} k_{it} + \frac{1}{\chi} z_m + \lambda_i + \mu_{st} + \tilde{\omega}_{it}$$

### Assumptions

- 1 All firms with the sector face the same prices
- 2 Residual TFP uncorrelated with owner and manager choices
  - Timing can be checked in event study.
- 3 Owner and manager choices can be arbitrarily correlated

## Recovering Firm and Manager Fixed Effects (3)

$$\tilde{r}_{imst} := \hat{\chi} r_{imst} - \hat{\alpha} k_{it} - \hat{\mu}_{st} = z_m + \lambda_i + \omega_{it}$$

Remove firm fixed effect by subtracting firm average,

$$\Delta \tilde{r}_{imt} = \Delta z_{m_{it}} + \Delta \omega_{it}$$

with

$$\Delta x_{it} := x_{it} - \frac{1}{N_i} \sum_{\tau} x_{i\tau}$$

# Identification Challenges

- 1 Residual TFP trends may be correlated with manager change (reverse causality)
  - We don't need *random mobility*.
  - Usual solution: exogenous removal of CEO (hospitalization: Bennedsen et al 2020, death: Sauvagnat and Schivardi 2024)
- 2 Firm and manager effects can only be interpreted against a baseline group in connected component
  - We use *largest connected component* (Abowd et al. 2002)
- 3 Fixed effects estimated with small-sample noise
  - IV designs can even exacerbate small-sample problem

## A Two-Manager Example

Manager effect

| 1          | 2          | 3          | 4          | 5          | 6          |
|------------|------------|------------|------------|------------|------------|
| $z_1$      | $z_1$      | $z_1$      | $z_2$      | $z_2$      | $z_2$      |
| $\omega_1$ | $\omega_2$ | $\omega_3$ | $\omega_4$ | $\omega_5$ | $\omega_6$ |

$$\hat{z}_1 := z_1 + \frac{1}{3}(\omega_1 + \omega_2 + \omega_3)$$

$$\hat{z}_2 := z_2 + \frac{1}{3}(\omega_4 + \omega_5 + \omega_6)$$

# Our Solution: Placebo Control

When CEO doesn't change

$$\Delta \tilde{r}_{imt} = \Delta \omega_{it}.$$

By doing the exact same estimation procedure around “non-changes,” we can filter out the noise.

## Constructing Placebos

- 1 Estimate time-variant hazard of CEO change ( $\approx 20\%$ /year)
- 2 Pick firms with long CEO tenures (7+ years)
- 3 Randomly assign placebo changes with the estimated hazard

## Event Study (4)

Treatment: CEO changes at time  $g$ .

Control: Placebo change at time  $g$ .

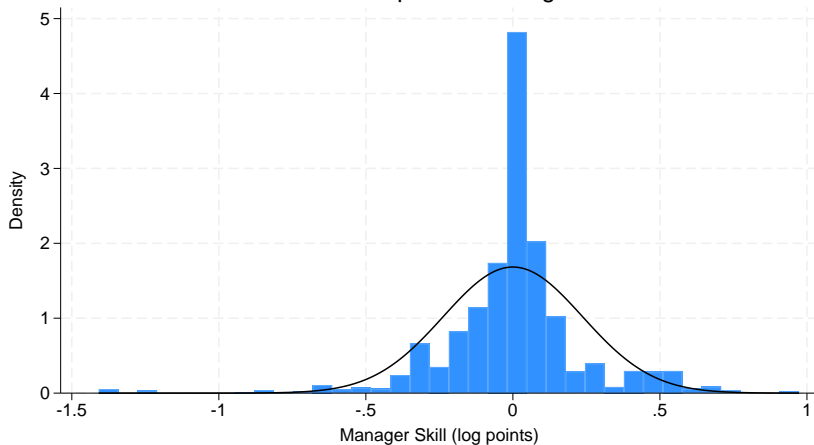
$$\tilde{r}_{imt} = \lambda_i + \gamma_{t-g} + \omega_{it}$$

with  $\gamma$  estimated with 2-treatment version of Callaway–Sant’Anna (2020), `xt2treatments` (Koren 2025) for different groups of managers.

## Results

## Manager Fixed Effects in the Giant Component (3)

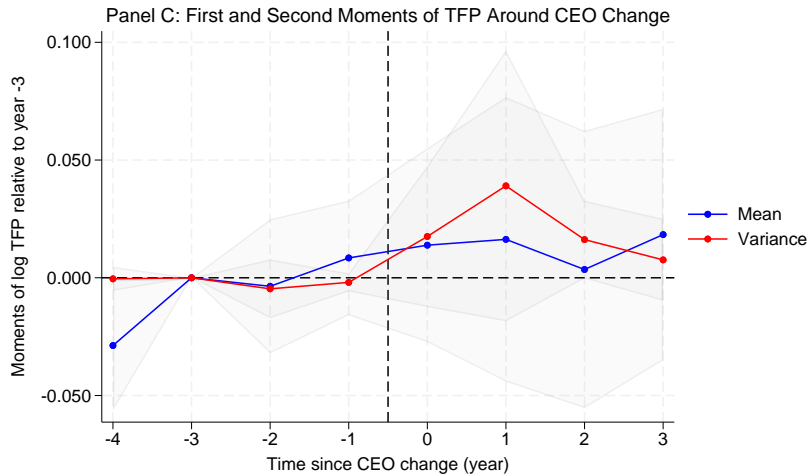
Panel B: Connected Component Manager Skill Distribution



P25-P75 difference: 24.6% productivity

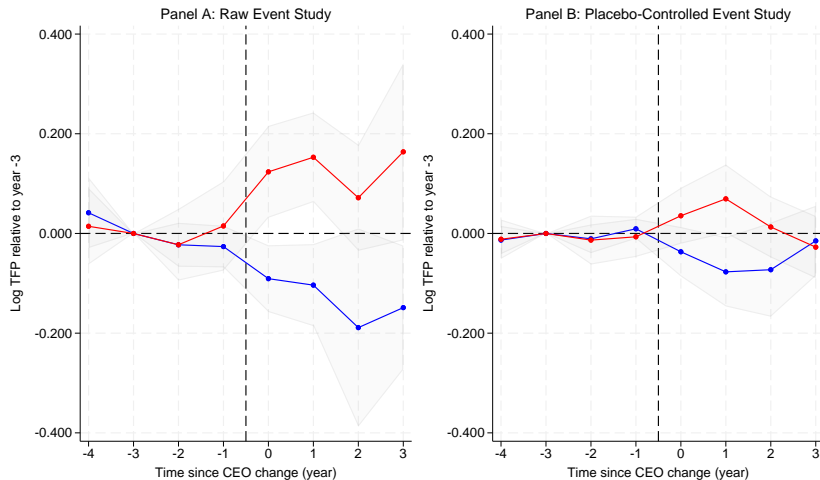


## Event Study (4)



Dip in average TFP before CEO change. Elevated variance, stabilizing after CEO change.

# Split by “Good” and “Bad” CEOs ( $\pm 1\%$ )



## Actual vs Placebo Effects

| Transition | Actual  | Placebo | Difference |
|------------|---------|---------|------------|
| Bad → Good |         |         | 3.9**      |
| Good → Bad |         |         | -1.2**     |
| Gap        | 22.1*** | 17.1*** | 5.0***     |

## Treatment Effects and Correlations with Outcomes (1)

|              | (1)              | (2)                | (3)              |
|--------------|------------------|--------------------|------------------|
|              | Sales (log)      | Wagebill (log)     | Materials (log)  |
| Better CEO   | 0.010<br>(0.184) | 0.367**<br>(0.154) | 0.105<br>(0.205) |
| Observations | 14323            | 14323              | 14323            |

## Treatment Effects and Correlations with Outcomes (2)

|              | (1)                | (2)                   | (3)               |
|--------------|--------------------|-----------------------|-------------------|
|              | Fixed assets (log) | Has intangible assets | Foreign owned     |
| Better CEO   | -0.100<br>(0.246)  | -0.024<br>(0.071)     | -0.039<br>(0.043) |
| Observations | 14323              | 14323                 | 14323             |

## Good Managers Gradually Receive/Build Intangible Assets

But They Immediately Purchase More Material

# Guidance For Empirical Research

## Don't Use Raw Manager FE

- 75% noise  $\rightarrow$  severe attenuation bias
- Correlations misleading

## Better Practices

- 1 Include observable characteristics
  - education and work experience (De Pirro, Koren and Laki 2025)
  - foreign name (Koren and Telegdy 2025)
  - selectiveness of entry cohort (Koren and Orbán 2025)
- 2 Manager quality on LHS only (never RHS due to attenuation)
- 3 Implement placebo checks



## Conclusion

# What We Did

- 1 **Modeled** CEO value in private firms
- 2 **Measured** using universe of Hungarian firms
- 3 **Developed** placebo-controlled method
- 4 **Found** 75% of “effects” are spurious. Better managers expand the firm, slowly receive more resources to do so.

# Appendix

# Division of Control

- Concentrated ownership limits managerial discretion (Fama & Jensen, 1983; Jensen & Meckling, 1976)
- Family firms retain control rights (Burkart et al., 2003)
- Plant managers have even more limited control over investments (Bloom et al., 2012, 2019)

## Owners Control

Physical capital investment, intellectual property, industry and location, CEO hiring/firing

## Managers Control

Labor hiring, input purchasing, operations, day-to-day decisions

## Evidence on Manager Control Rights

Table 5: Plant Manager Autonomy in Family-Controlled Firms

|                  | (1)<br>Investment   | (2)<br>Investment   | (3)<br>Marketing    | (4)<br>Product      | (5)<br>Hiring    |
|------------------|---------------------|---------------------|---------------------|---------------------|------------------|
| Family ownership | -0.369**<br>(0.161) | -0.200**<br>(0.100) | -0.344**<br>(0.153) | -0.299**<br>(0.151) | 0.086<br>(0.068) |
| Observations     | 2,915               | 2,379               | 3,133               | 3,114               | 3,138            |
| Country FE       | Yes                 | Yes                 | Yes                 | Yes                 | Yes              |
| Industry FE      | Yes                 | Yes                 | Yes                 | Yes                 | Yes              |

Standard errors in parentheses

Data source: Bloom, Sadun, and Van Reenen (2012). Sample restricted to private (non-publicly traded) firms

Investment autonomy measured as maximum capital investment plant manager can approve (USD).

Other autonomy dimensions are binary indicators for full autonomy (score = 5 on 1-5 scale).

PPML = Poisson Pseudo-Maximum Likelihood. Standard errors clustered at firm level.

All specifications include country and 2-digit SIC industry fixed effects.

## Surplus Share by Industry (1)

Table 6: Industry Breakdown

| Industry (NACE)                         | Obs.      | Firms   | CEOs    | Surplus share (%) |
|---|-----------|---------|---------|-------------------|
| Agriculture, Forestry, Fishing (A)      | 130,560   | 16,731  | 30,641  | 12.8              |
| Manufacturing (C)                       | 393,615   | 52,867  | 87,183  | 14.7              |
| Wholesale, Retail, Transportation (G,H) | 1,211,067 | 177,561 | 274,969 | 6.7               |
| Telecom, Business Services (J,M)        | 1,020,648 | 151,693 | 225,160 | 17.5              |
| Construction (F)                        | 448,996   | 76,352  | 103,263 | 13.6              |
| Nontradable Services (Other)            | 1,380,875 | 205,514 | 324,382 | 13.0              |
| Mining, Quarrying (B)*                  | 5,508     | 720     | 1,485   | 30.0              |
| Finance, Insurance, Real Estate (K,L)*  | 116,329   | 18,553  | 32,195  | 58.4              |

*Notes:* This table presents industry-level summary statistics using the TEAOR08 classification system. Column (1) shows the industry name and corresponding NACE sector codes. Column (2) shows the total number of firm-year observations in the balance sheet data (1992-2022). Column (3) shows the number of distinct firms with balance sheet data. Column (4) shows the number of distinct managers (CEOs) from the firm-year data. Column (5) shows the surplus share of the firm-year data. *Source:* EDINET, Japan Company Handbook, Ministry of Economy, Trade and Industry.

## Revenue Function Estimation (2)

Table 7: Surplus Function Estimation Results

|                       | (1)<br>Revenue      | (2)<br>EBITDA       | (3)<br>Wagebill     | (4)<br>Materials    | (5)<br>Revenue      | (6)<br>Revenue      |
|-----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Fixed assets (log)    | 0.272***<br>(0.002) | 0.263***<br>(0.002) | 0.251***<br>(0.002) | 0.323***<br>(0.002) | 0.260***<br>(0.002) | 0.271***<br>(0.034) |
| Has intangible assets | 0.140***<br>(0.004) | 0.085***<br>(0.005) | 0.155***<br>(0.004) | 0.165***<br>(0.005) | 0.135***<br>(0.004) | 0.212**<br>(0.089)  |
| Foreign owned         | 0.051***<br>(0.015) | 0.017<br>(0.017)    | 0.086***<br>(0.015) | 0.044**<br>(0.019)  | 0.059***<br>(0.015) | 0.167<br>(0.238)    |
| Observations          | 1169474             | 927037              | 1157713             | 1184973             | 1169474             | 4122                |

Standard errors in parentheses

All models include firm-CEO-spell fixed effects and industry-year fixed effects. Outcome variables are log-transformed. Models (5) and (6) include quadratic controls for firm age and CEO tenure.

## Placebo Spells are Similar to Actual Ones

| Length<br>(Years) | Actual<br>Spells | Placebo<br>Spells |
|-------------------|------------------|-------------------|
| 1                 | 27%              | 32%               |
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