Risk, Intangible Capital and Interindustry Differences in Rates of Return

Evidence from Germany

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Motivation

“In a competitive environment rates of return to capital tend to be randomly distributed around some normal [equilibrium] rate”

Neumann, Böbel, Haid (1979)

→ There sould be nor persistent differences in rates of return to capital

- We take up an EUKLEMS- social planner perspective
- Our focus: rate of return differences across **sectors**
- Are there persistent differences in return to capital ?
- … even if we adjust for **risk** and **intangible capital** ?

Outline

Our analysis proceeds in four steps

Step 1: **Convergence**?
β- or σ-convergence over 1970-2007

Step 2: **Adjusting for risk**
Sharpe ratio; CAPM

Step 3: **Adjusting for intangible capital**
augment KLEMS by EUKLEED data

Step 4: **Explaining adjusted returns**
effect of competiton (**entry**)

Data

Primary data set

- EUKLEMS-data for Germany
- 30 industries for the period 1970 till 2007.
- Our focus: rates of return on capital

Auxiliary data set

- INNODRIVE (Eukleed)
- micro data for nearly 1.4 million establ. in Germany
- information on own account **intangible capital** (**Step 3**)
- 1999 – 2003 for 25 industries
- LEED-data is also base for **entry** rate (**Step 4**)

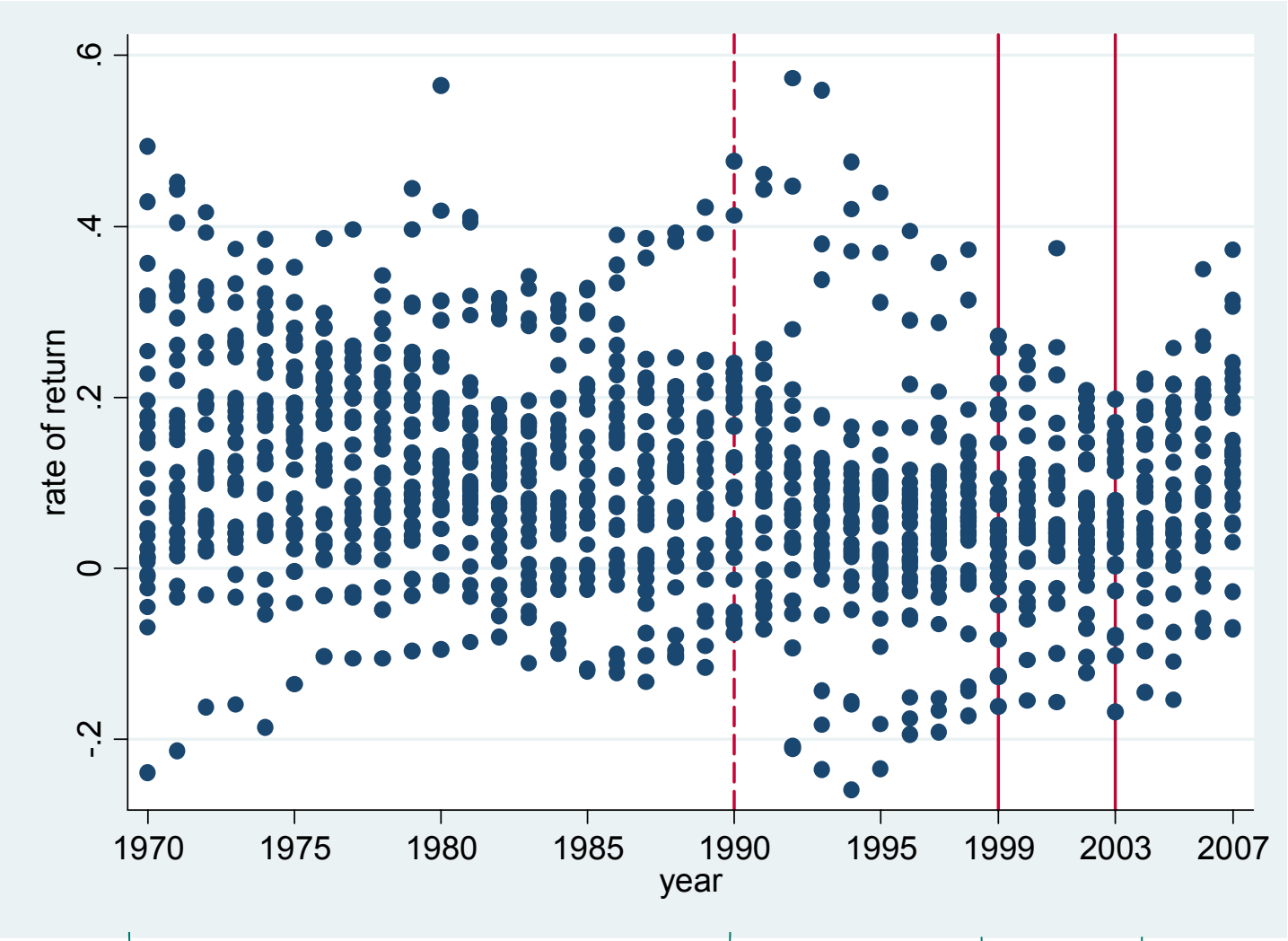
Data

EUKLEMS industry	EUKLEMS No.
Agriculture, hunting, forestry, fishing*	AtB
Mining and quarrying*	C
Food , beverages and tobacco	15t16
Textiles, leather and footwear	17t19
Wood and of wood and cork	20
Pulp, paper, printing, publishing	21t22
Coke, refined petroleum, nuclear fuel	23
Chemicals and chemical products	24
Rubber and plastics	25
Other non-metallic mineral	26
Basic metals and fabricated metal	27t28
Machinery, nec	29
Electrical and optical equipment	30t33
Transport equipment	34t35
Manufacturing nec.; recycling	36t37

EUKLEMS industry	EUKLEMS No.
Electricity, gas, water supply	E
Construction	F
Sale, repair of motor vehicles etc.	50
Wholesale trade, commission trade	51
Retail trade; repair of household goods	52
Hotels and restaurants	H
Transport and storage	60t63
Post and telecommunication	64
Financial intermediation	J
Real estate activities*	70
Other business activities	71t74
Public administration*	L
Education*	M
Health and social work	N
Other community; personal services	O

* Not included in the EUKLEED data

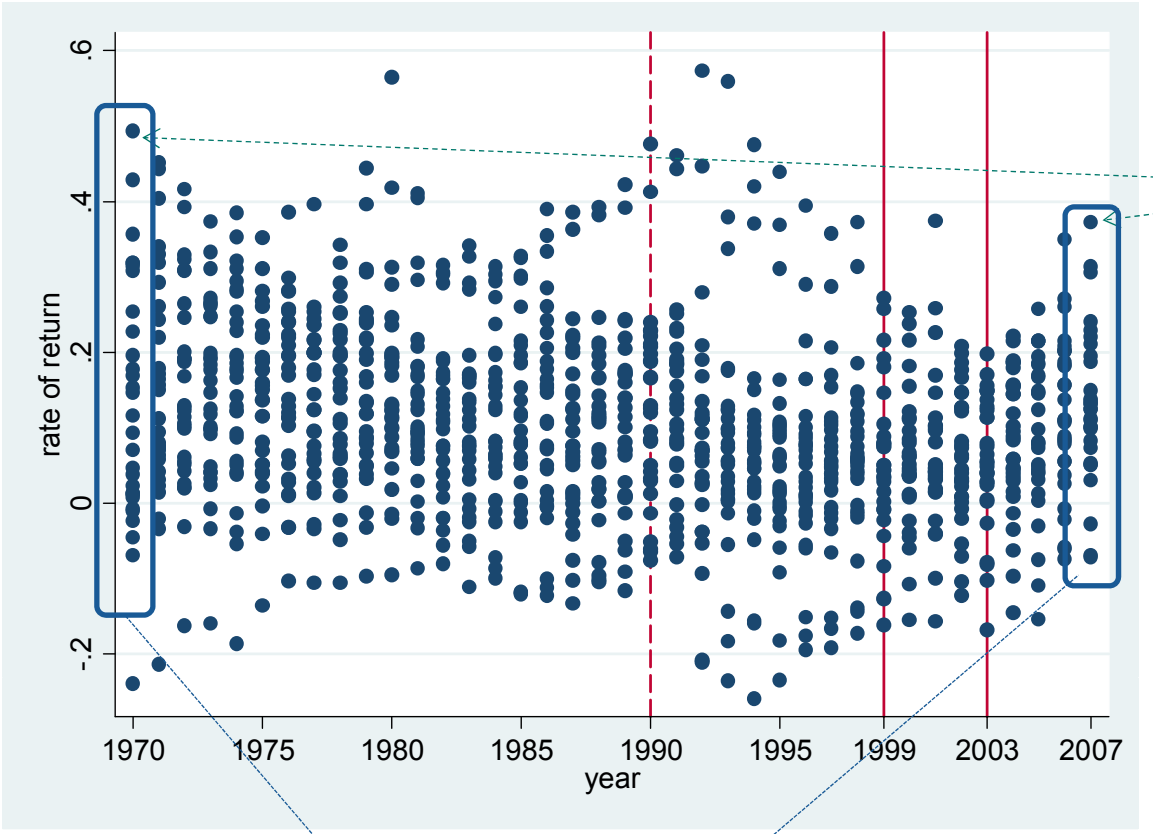
Step 1: convergence during 1970-2007?



West Germany

Intangible Capital

Step 1: convergence during 1970-2007?



β- convergence

σ-convergence

Do high-return sectors in T tend to be already high-return sectors in period 1?

$$y_{iT} = \alpha + (1-\beta)y_{i1} + \varepsilon_i$$

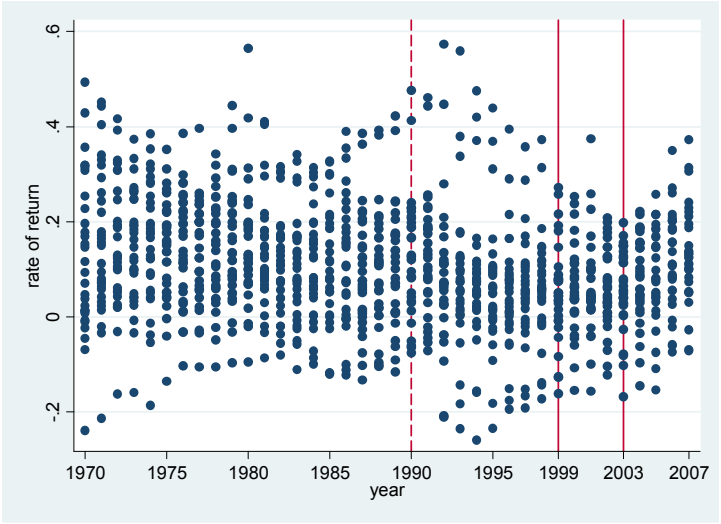
$\beta \approx 0$ → tight relationship
→ no convergence.

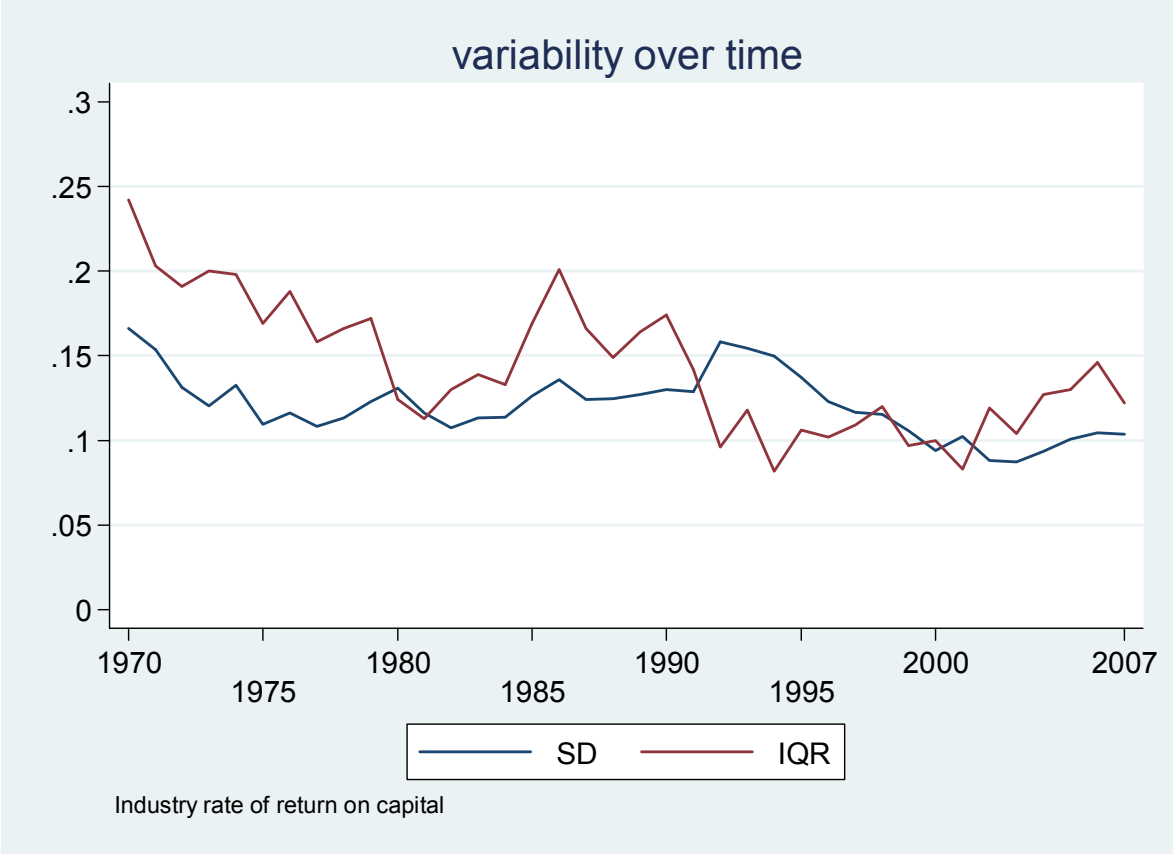
$\beta \approx 1$ → no relationship
→ convergence

Does the variance shrink ?

Step 1: σ-convergence

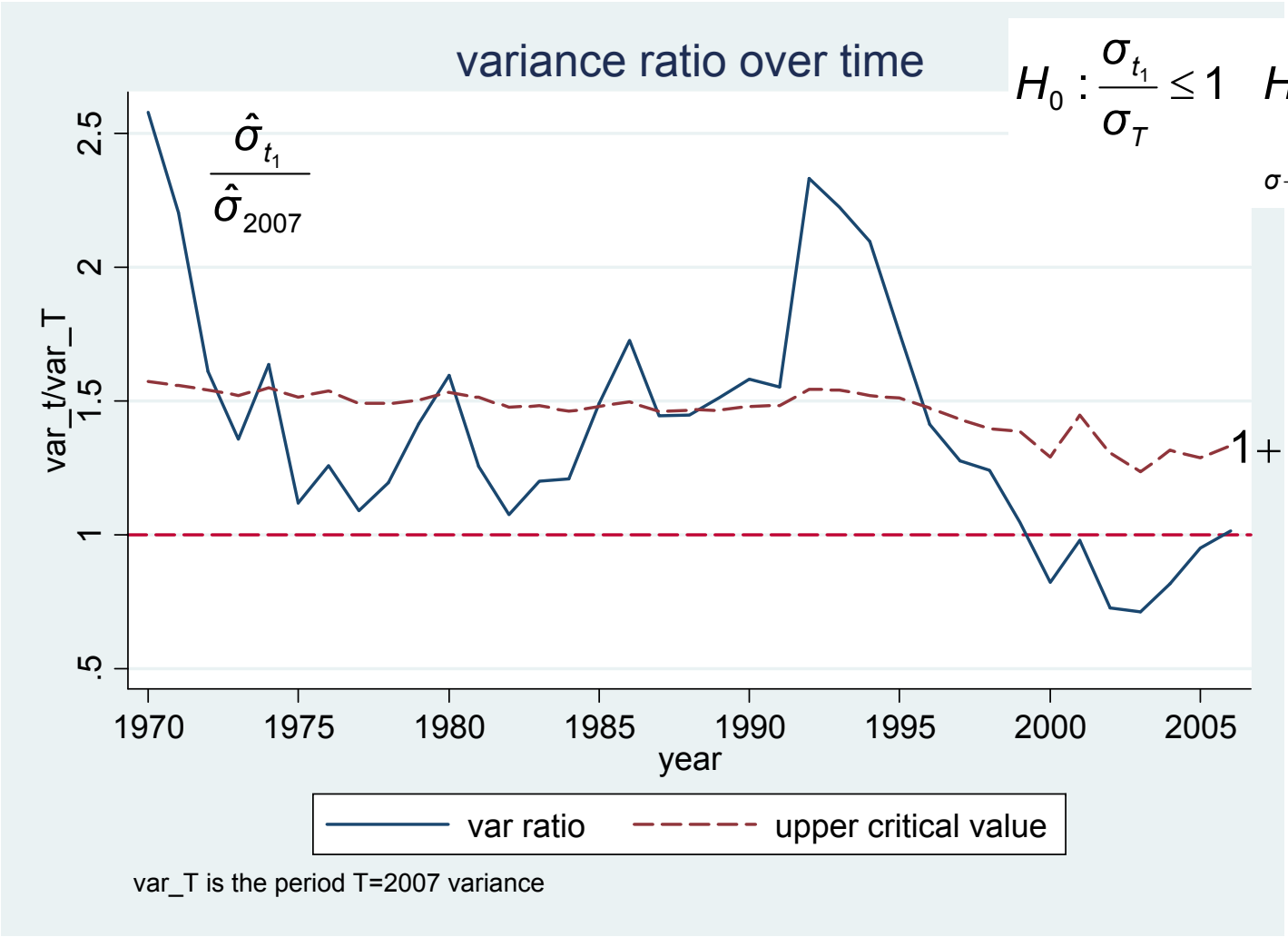
Standard deviation (SD) and inter-quartile range (IQR) over time





Declines in early 70s and after unification

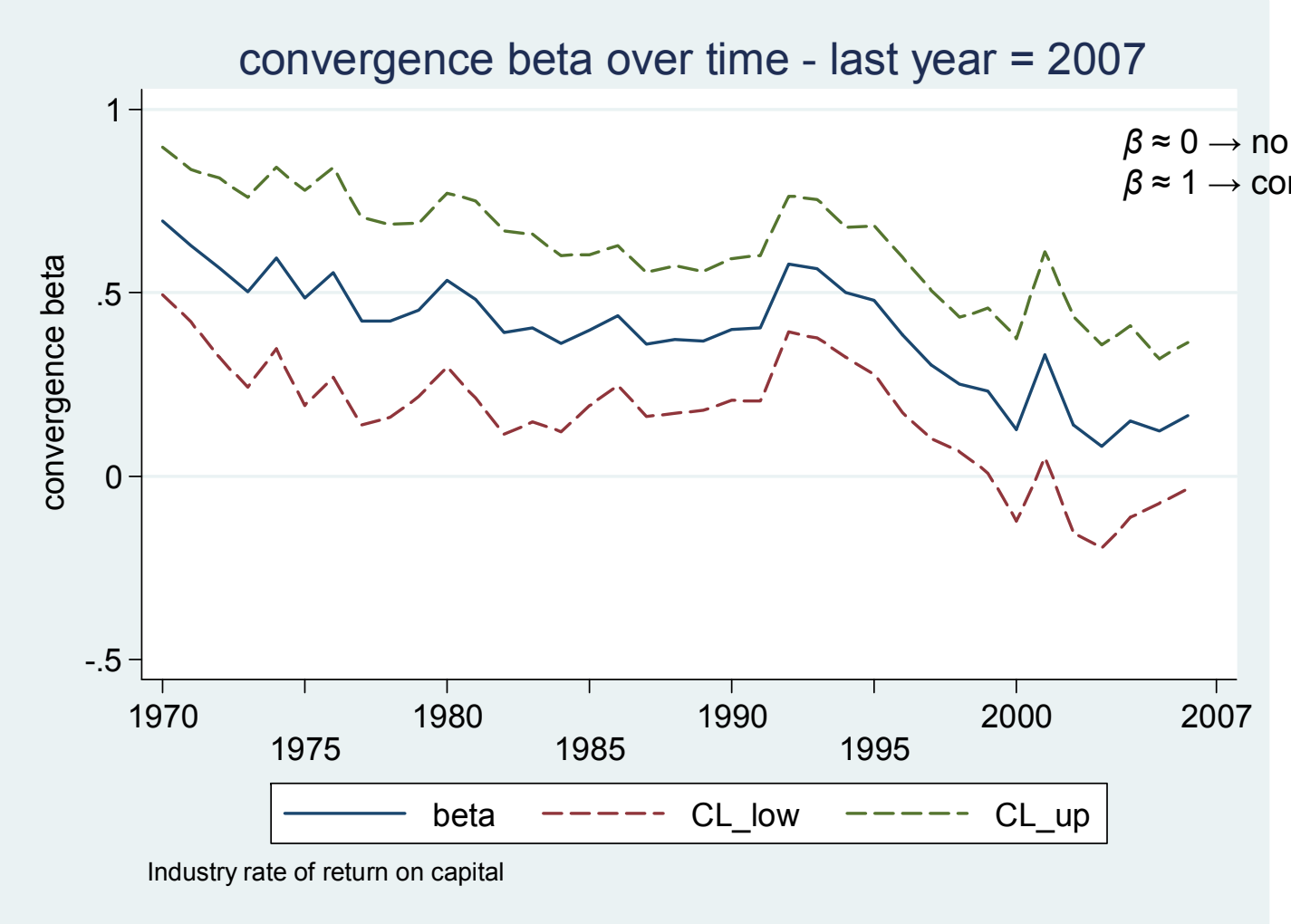
Step 1: σ-convergence



→ Rolling variance ratio shows some periods of decline but not uniformly

Step 1: β - convergence

We fix T=2007 and roll leftward from 1970 $y_{iT} = \alpha + (1-\beta) y_{it_1} + \varepsilon_i$



β usually ≤ 0.5 → relative positions fairly stable

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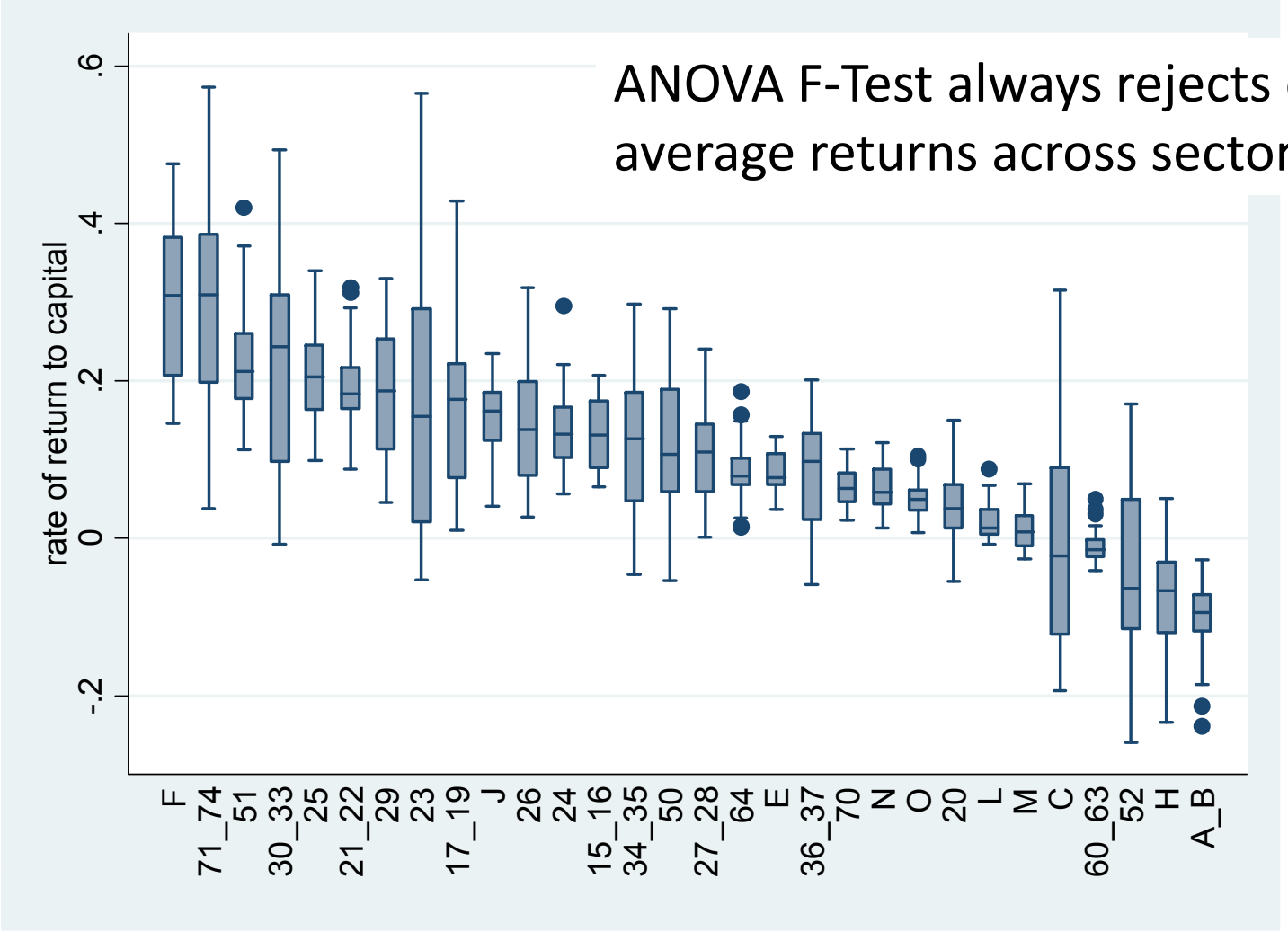
Step 1: F-Test of equal means

Box plots of return distributions by sector over 1970-2007 period



Step 1: Summary

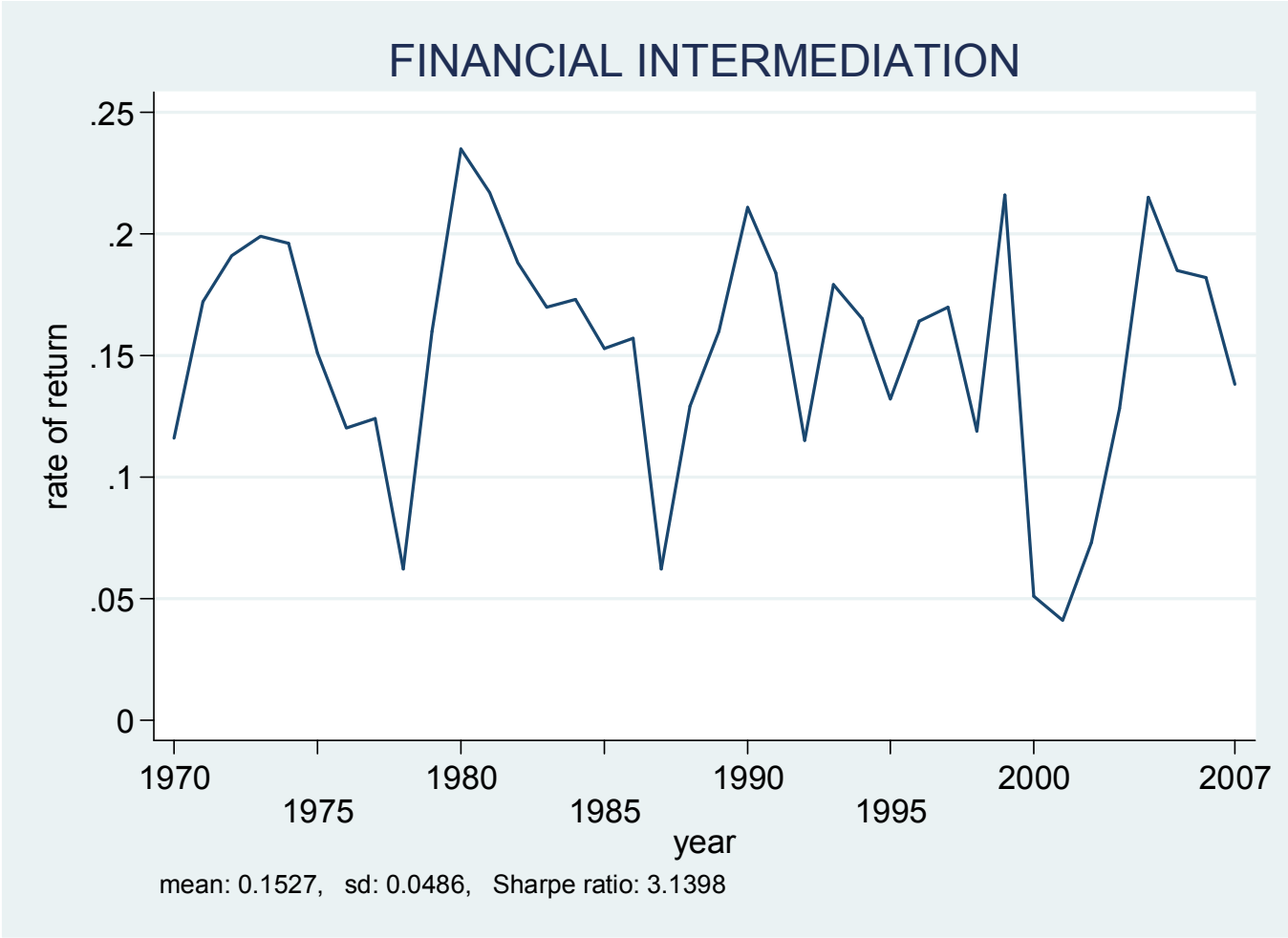
- Return distribution across sectors does vary over time
- Sub-periods of declining variabilty
- Some movements of relative positions of sectors
- However, considerable amount of persistency
  (This is in line with earlier results, e.g. Qualls 1974, Jacobson 1988)

- What can account for persistent differences in average returns?
  - Risk (→ **Step 2**)
  - Intangible capital (→ **Step 3**)
  - Competition / (Lack of) entry (→ **Step 4**)

Step 2: Adjusting for risk

- Rate of return differences could be “justified” by differences in risk
- No clear cut way to define and measure risk at industry level.
- We take up perspective of “social planner” who tries allocate capital across industries in order to maximize expected output (e.g. Eberly and Wang (2011))
- We use two methods
  1. **Sharpe ratios**
  2. **CAPM betas**

Step 2: Adjusting for risk - Sharpe ratio



$$SR_{ex,j} = \frac{\hat{\mu}_j}{\hat{\sigma}_j} = \frac{\bar{r}_j}{S_j}$$

$$SR_{ex,Fin} = \frac{0.1527}{0.0486} \approx 3.14$$

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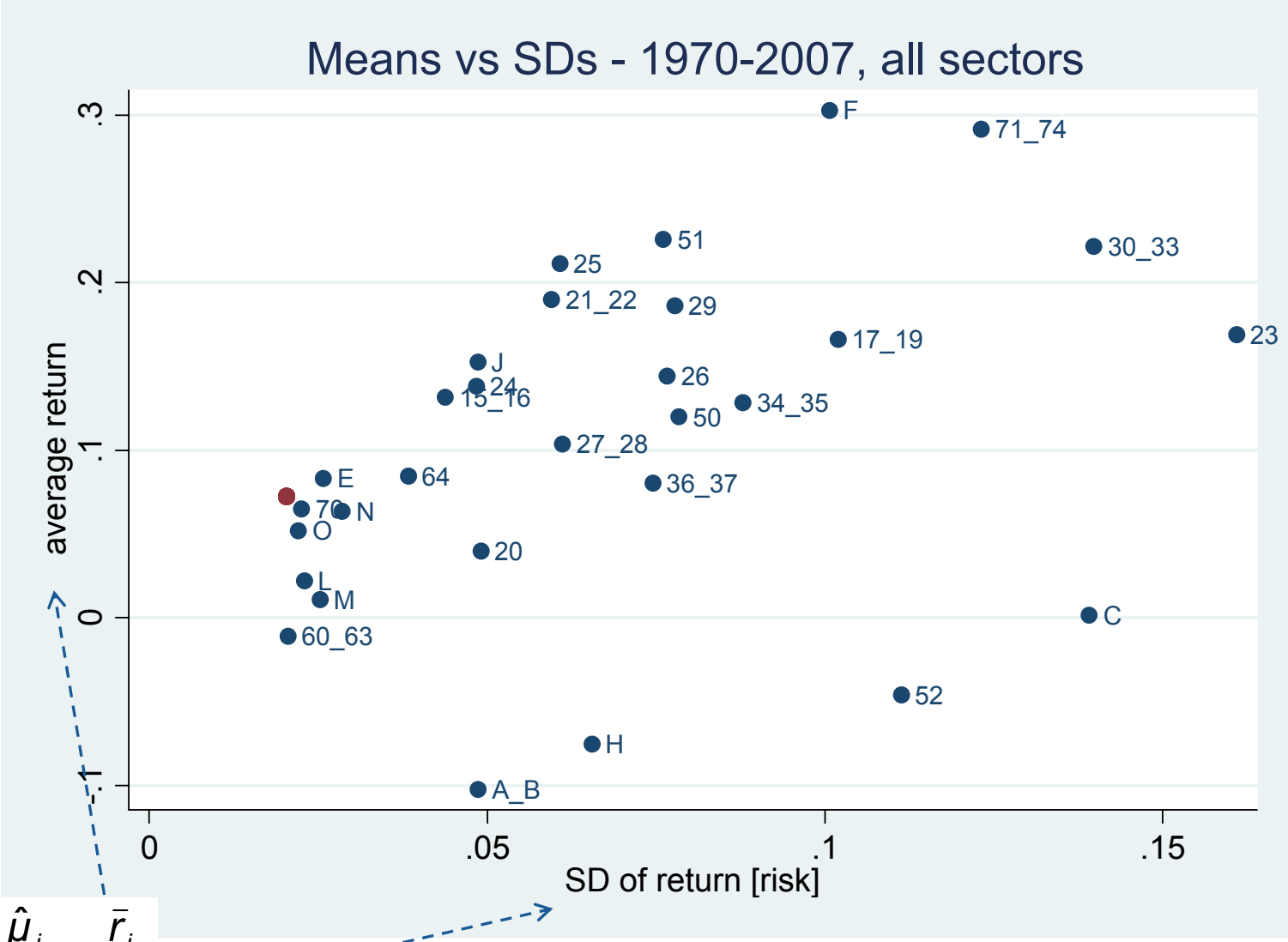
Step 2: Adjusting for risk - Sharpe ratio



$$SR_{ex,j} = \frac{\hat{\mu}_j}{\hat{\sigma}_j} = \frac{\bar{r}_j}{S_j}$$

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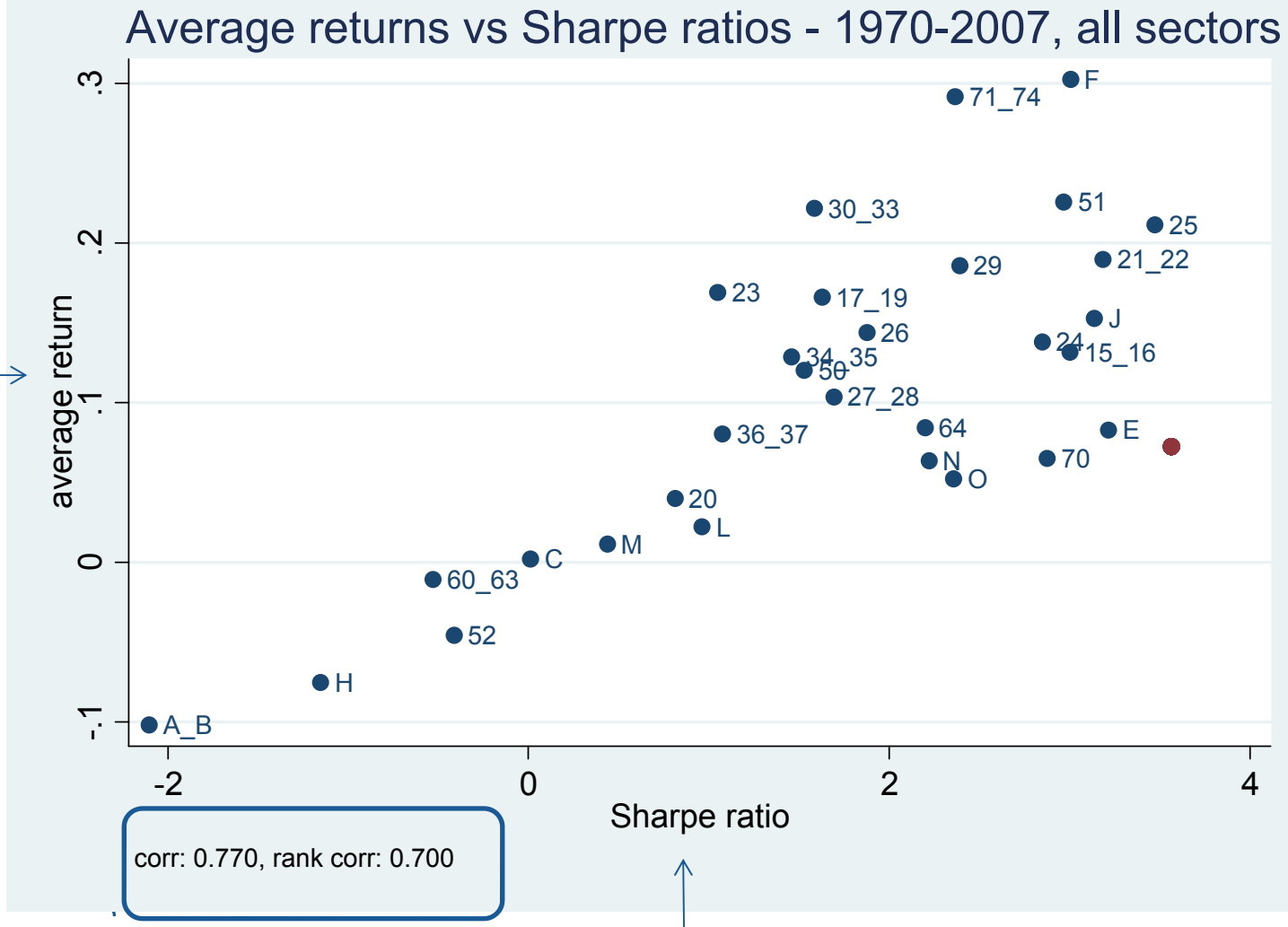
Step 2: Adjusting for risk - Sharpe ratio

$\bar{r}_j$ →



$$SR_{ex,j} = \frac{\bar{r}_j}{S_j}$$

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Step 2: Adjusting for risk - Sharpe ratio

Does risk-adjusting compress the distribution of average returns across sectors ?
To answer this question original returns and Sharpe ratios will be put on the same scale

$$\bar{r}_j \qquad SR_{ex,j} = \frac{\bar{r}_j}{S_j}$$

$$Z_{\bar{r}_j} = \frac{\bar{r}_j - \bar{r}}{S_{\bar{r}}} \qquad Z_{SR_{ex,j}} = \frac{SR_{ex,j} - \overline{SR}_{ex}}{S_{SR_{ex,j}}}$$

regression to the mean?

$$\bar{r}_j \qquad S_{\bar{r}_j} \cdot SR_{ex,j} = S_{\bar{r}_j} \cdot \frac{\bar{r}_j}{S_j}$$

kernel densities

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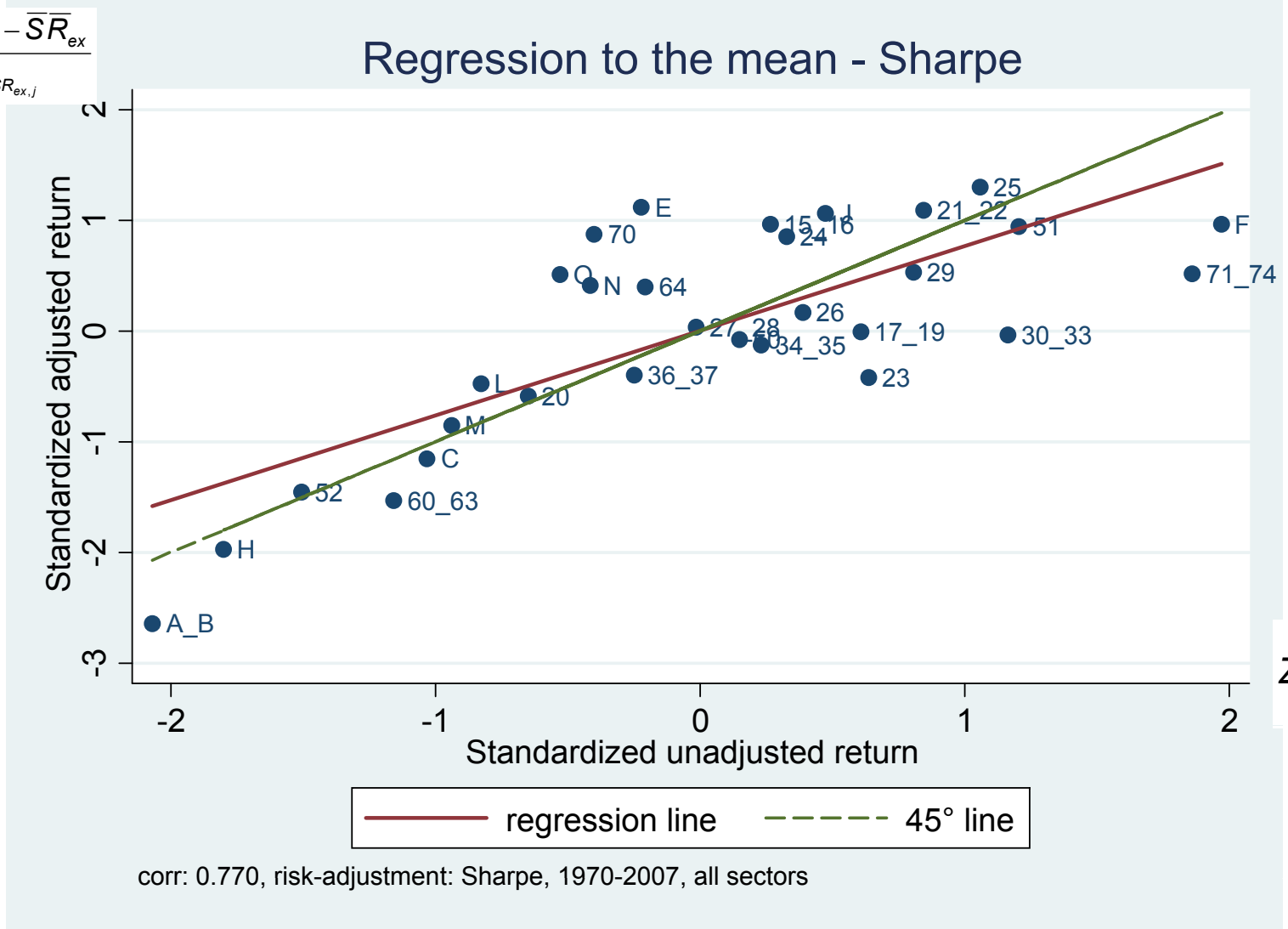
Step 2: Adjusting for risk - Sharpe ratio

$$Z_{SR_{ex,j}} = \frac{SR_{ex,j} - \overline{SR}_{ex}}{S_{SR_{ex,j}}}$$



corr: 0.770, risk-adjustment: Sharpe, 1970-2007, all sectors

$$Z_{\bar{r}_j} = \frac{\bar{r}_j - \bar{r}}{S_{\bar{r}}}$$

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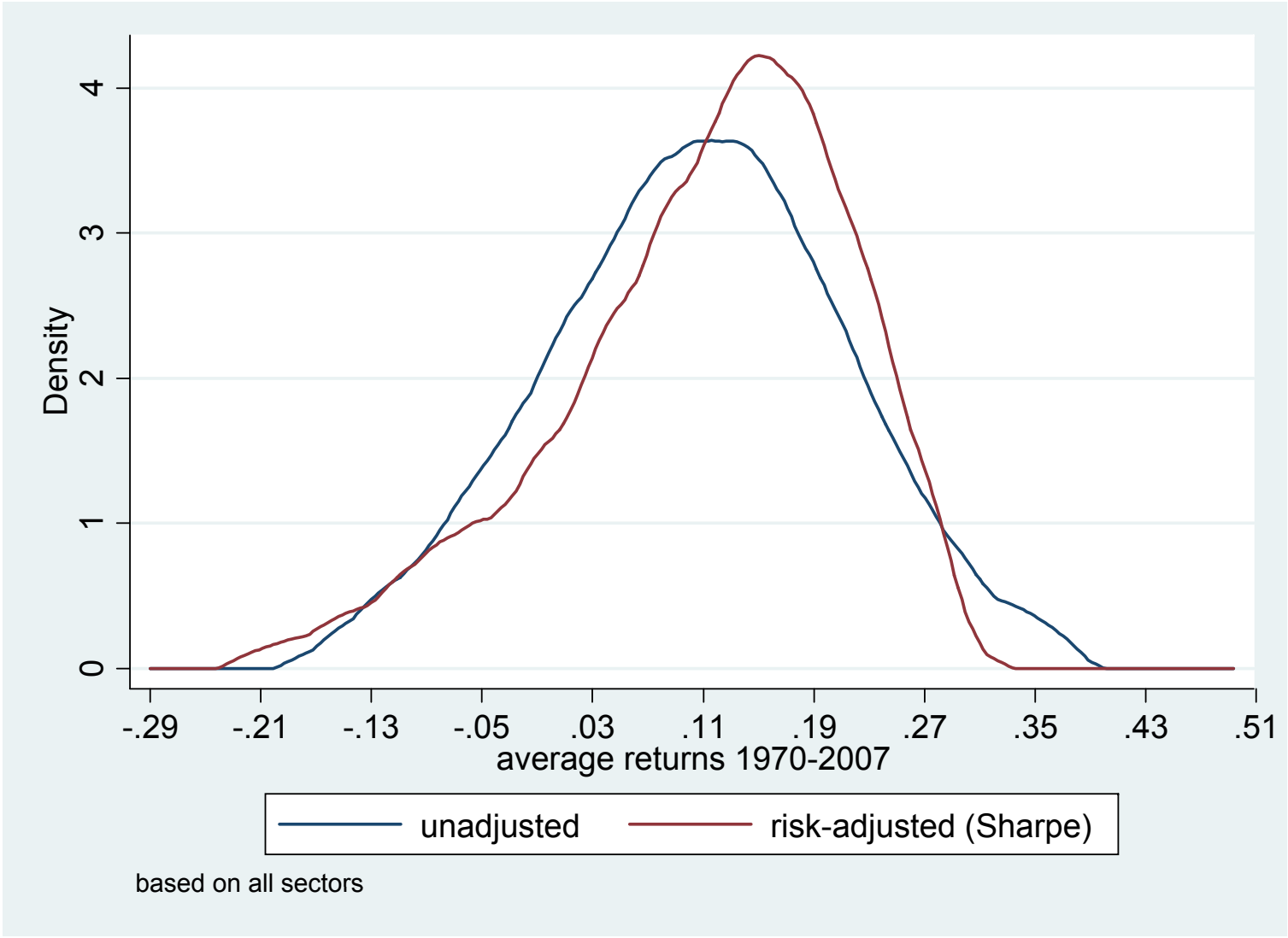
Step 2: Adjusting for risk - Sharpe ratio



Step 2: Adjusting for risk - Sharpe ratio

Summary: Sharpe ratio

- Adjusting for risk by dividing sectoral average rates of return by their standard deviations somewhat reduces variability in returns

- **Sharpe ratio**:
  - Risk = time series variation of returns
- **CAPM**
  - some of these fluctuations are irrelevant
  - all that matters is correlation with aggregate return

Step 2: Adjusting for risk - CAPM

CAPM equilibrium relationship for sector i

$$E[r_i] - r_f = \beta_i \left(E[r_M] - r_f\right) \qquad \beta_i = \frac{\sigma_{Mi}}{\sigma_M^2}$$

$$\Rightarrow \frac{E[r_i] - r_f}{\beta_i} = \left(E[r_M] - r_f\right)$$

→ So after adjusting with sector-specific betas, average excess returns should equal aggegate excess return.

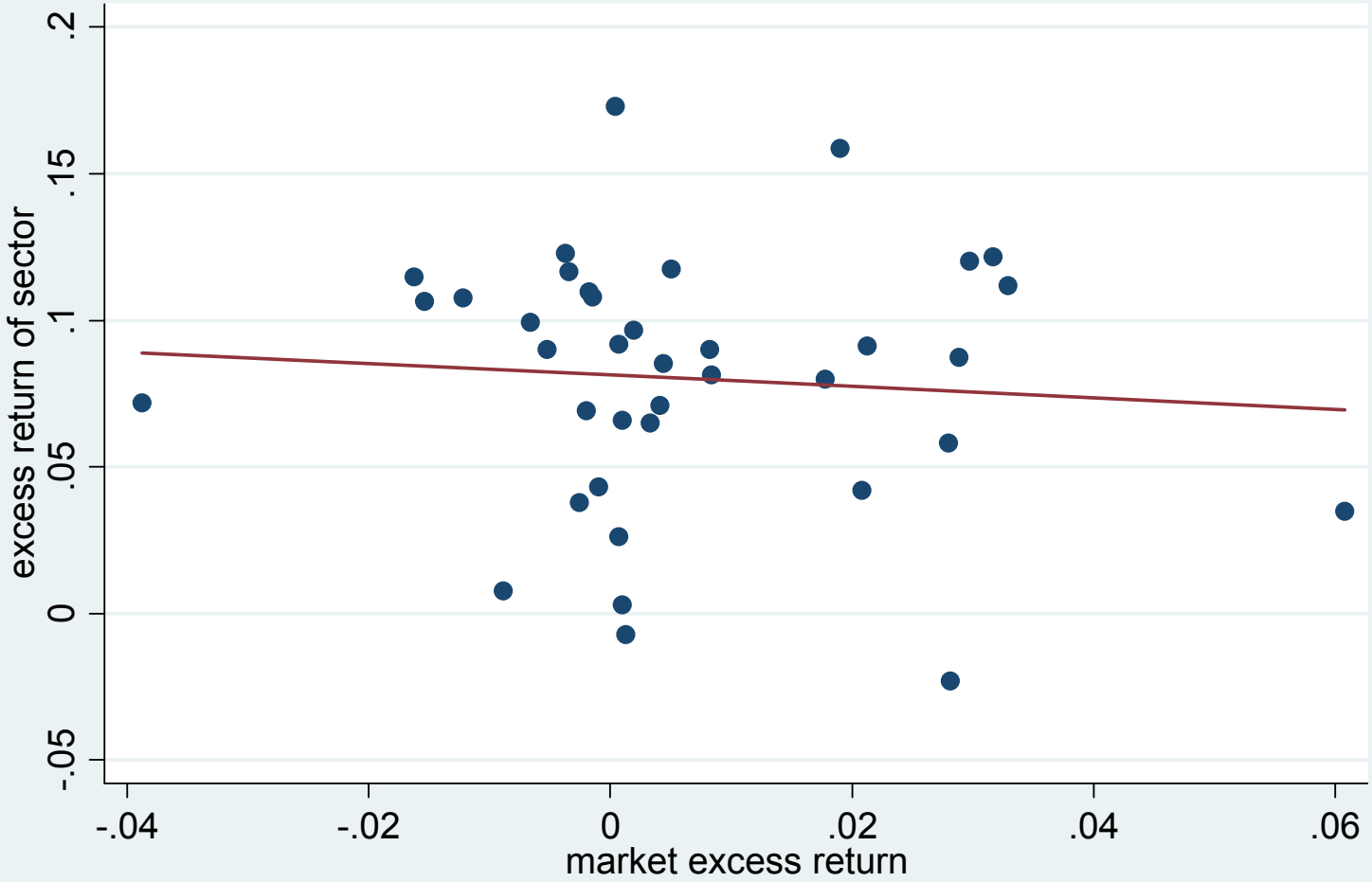
Step 2: Adjusting for risk - CAPM

CAPM estimating equation

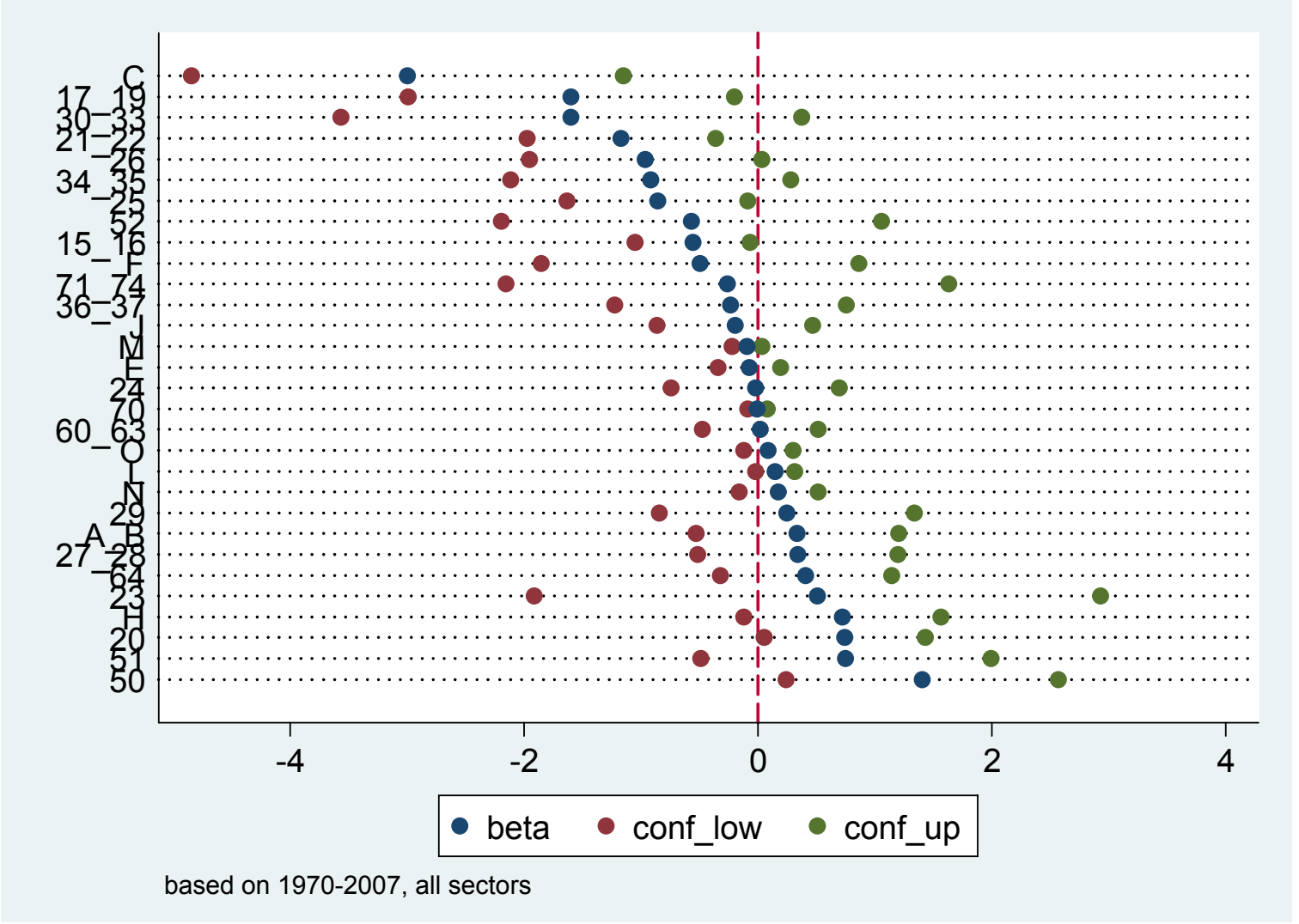
$$r_{it} - r_{ft} = \alpha_i + \beta_i \left[r_{Mt} - r_{ft} \right] + \varepsilon_{it}$$

- t=1970,…,2007
- r_f = risk free rate
  return of government bonds
- r_M = return of market portfolio
  we use capital-weighted average KLEMS return

Step 2: Adjusting for risk - CAPM



Step 2: Adjusting for risk - CAPM



→ As of yet, too many implausible and imprecisely estimates βs

Step 3: Adjusting for intangible capital [1999-2003}

Intangible capital

- INNODRIVE (Eukleed)
- own account production of ICT, R&D and org. capital via employment characteristics at the establishment level
- IC is aggregated to sectoral level
- INNODRIVE return ratios:

$$\frac{\text{rate of return of sector } i \text{ with IC}}{\text{rate of return of sector } i \text{ without IC}}$$

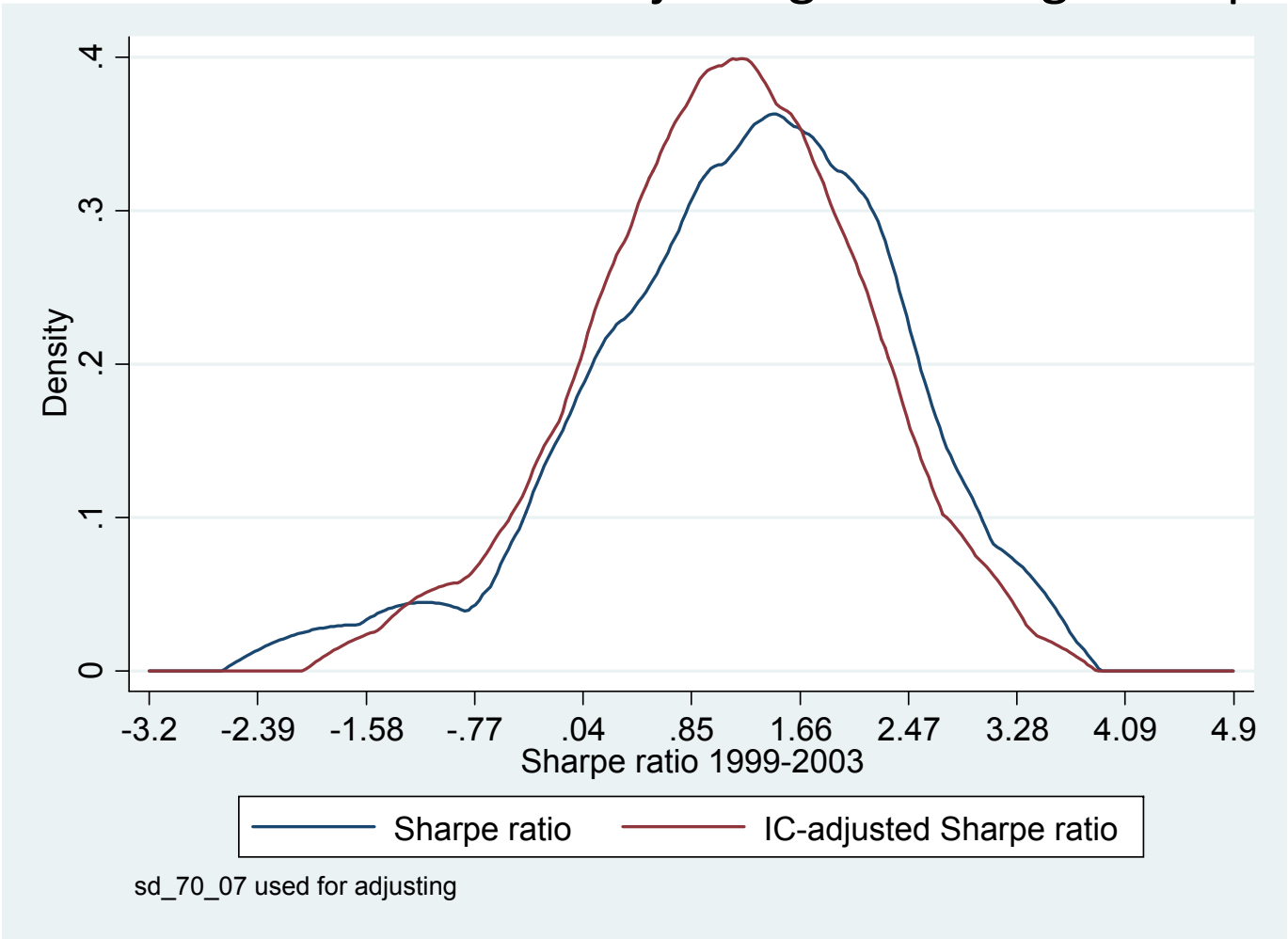
is applied to EUKLEMS rates of returns

→ IC adjusted rates of return for 25 industries

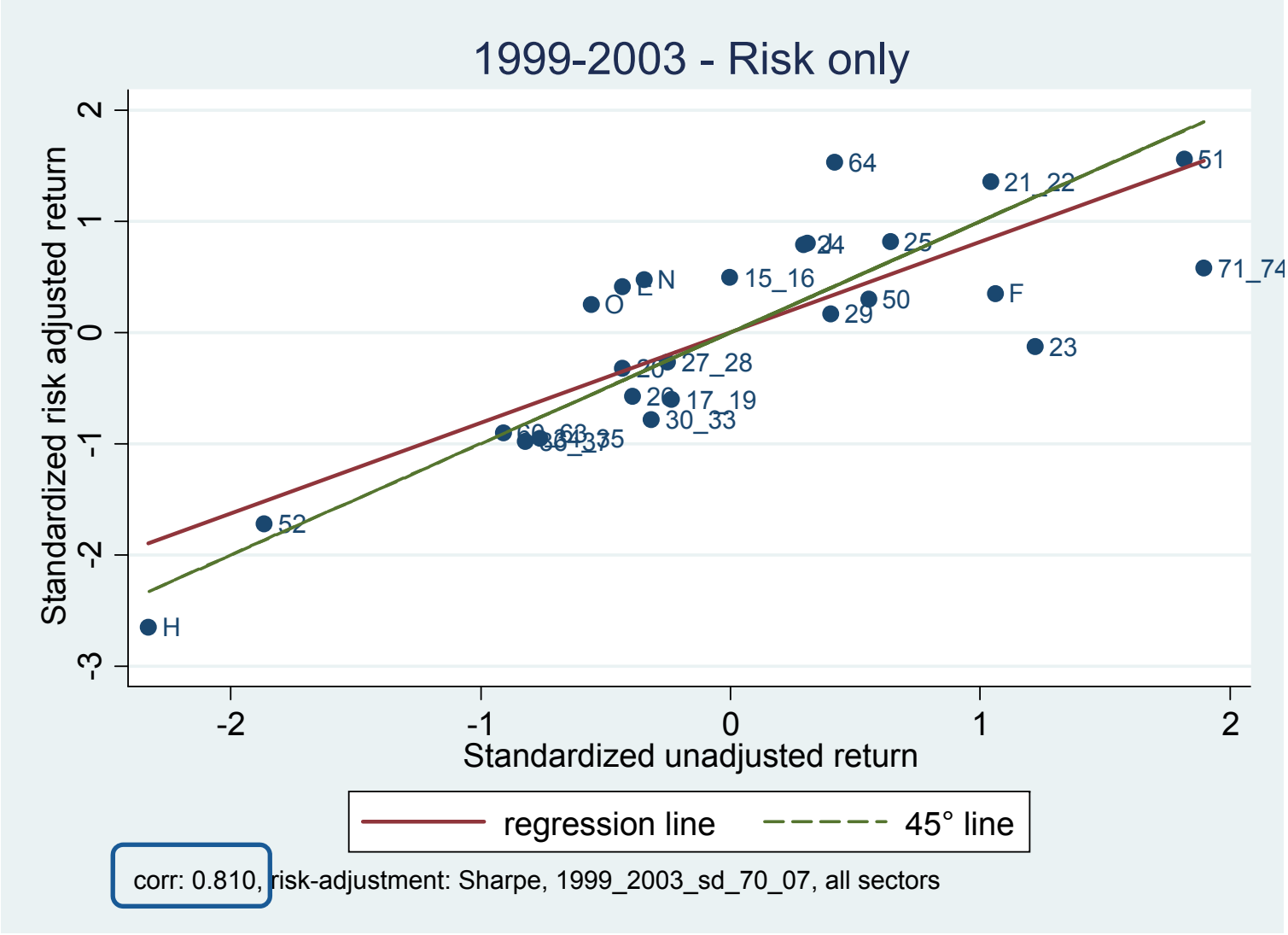
→ 1999 – 2003 figures are collapsed by industry

Step 3: Adjusting for intangible capital [1999-2003]

Kernel densities of Sharpe ratios
with and without adjusting for intangible capital



Step 3: Adjusting for intangible capital [1999-2003]



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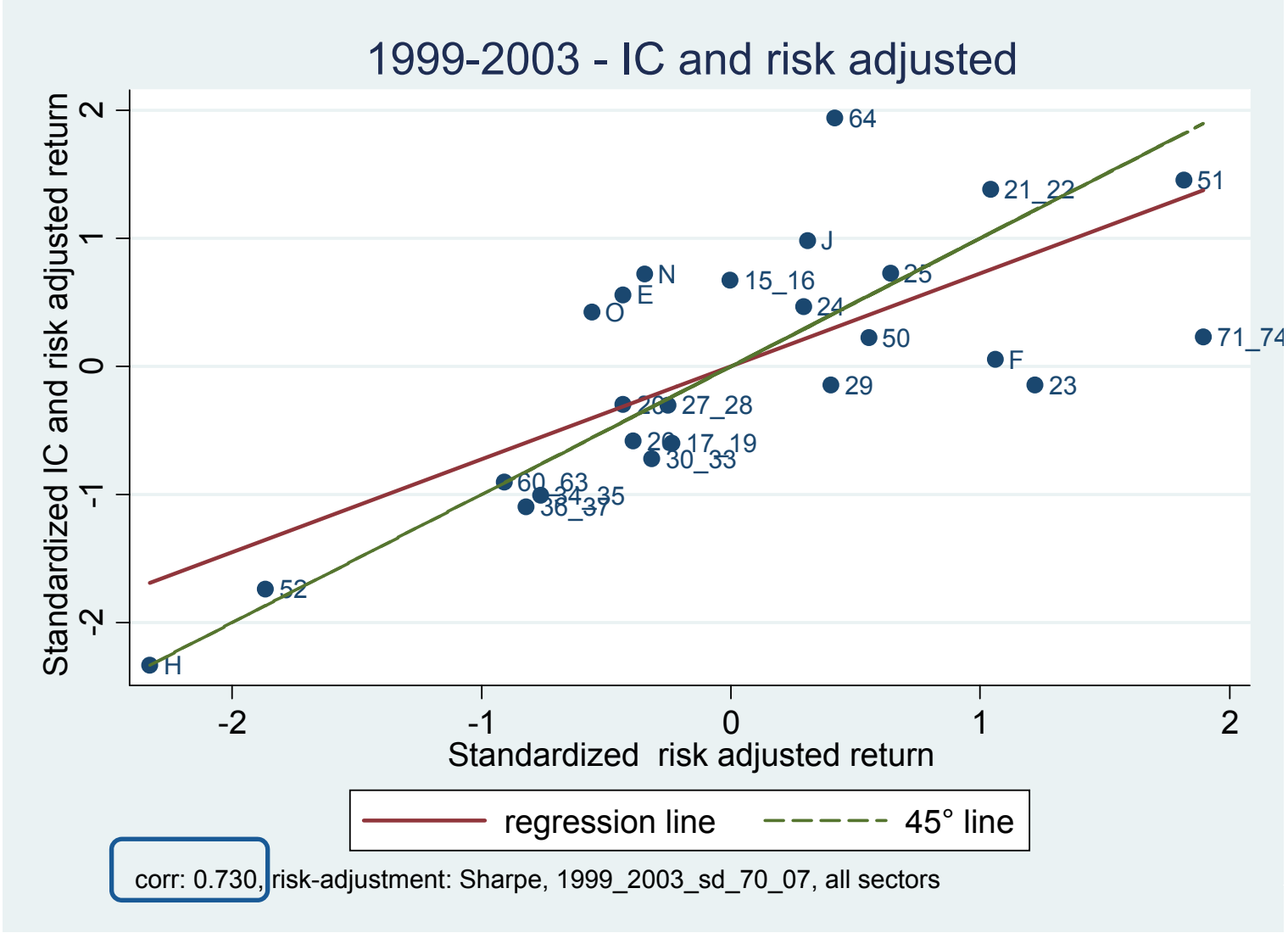
Step 3: Adjusting for intangible capital [1999-2003}



Step 3: Adjusting for intangible capital

Summary of **Step 3**:

- Adjusting for intangible capital leads to additional reduction in variability of returns across sectors
- However: substantial differences remain

"Because competition acts to direct resources towards uses offering the highest returns, persistently unequal returns mark the presence of either natural or contrived impediments to resource flows"

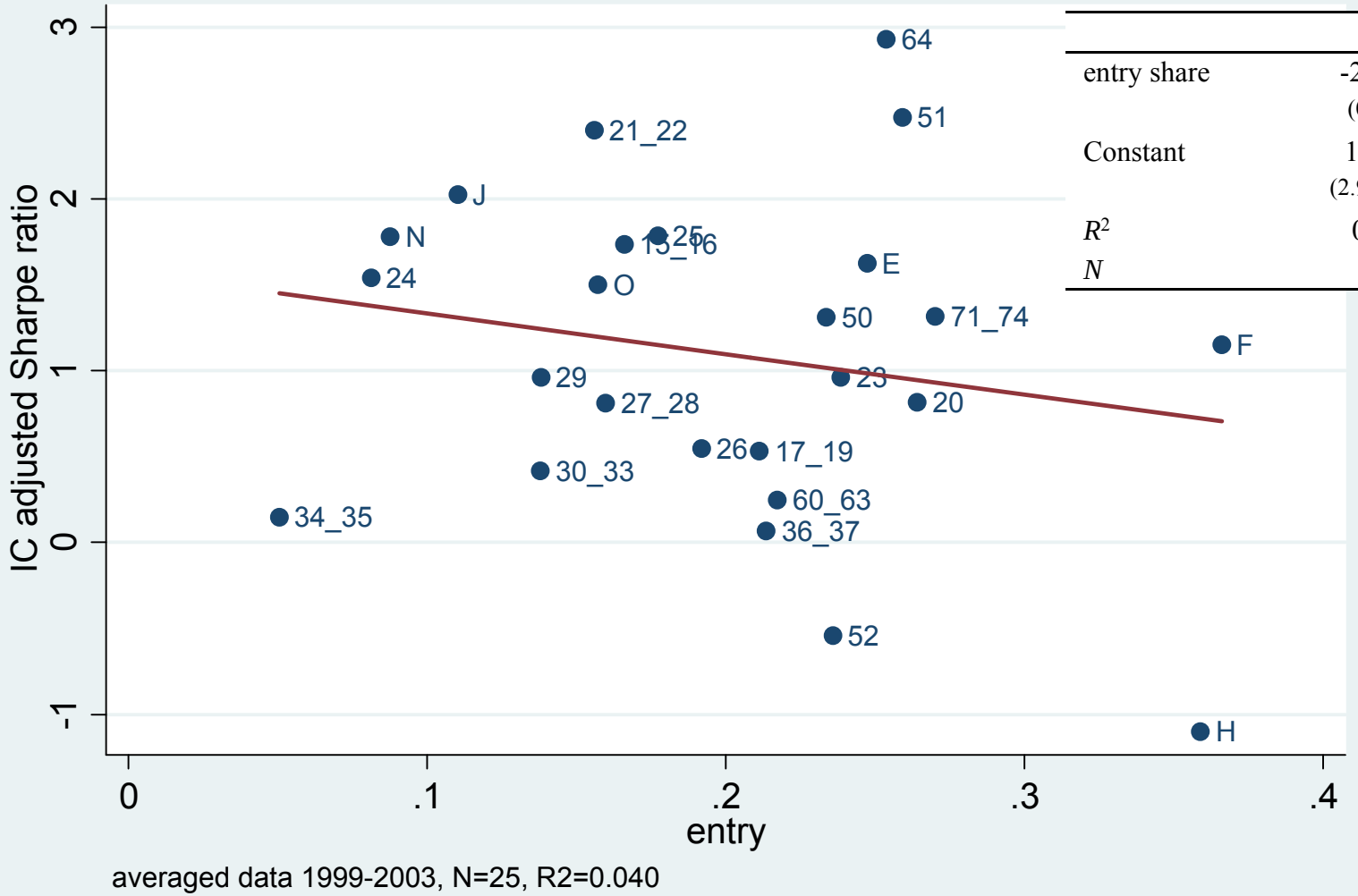
Rumelt (1979)

→ **Step 4**: **entry rate**

= average employment share of new establishments from 1999 - 2003 for each sector

Step 4: Accounting for entry [1999-2003}

Regression of risk and IC adjusted returns on entry



entry share	-2.360
	(0.96)
Constant	1.569
	(2.98)***
R^2	0.04
N	25

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Summary

- Using EUKLEMS-data for Germany we study rate of return differences across **sectors**
- By and large, **persistent** differences in return to capital
- Adjusting for **risk** (via Sharpe ratio) and **intangible capital** (using INNODRIVE-Eukleed data) somewhat diminishes these differences.
- How can remaining differences be explained?
- Weak evidence for effects of barriers to ressource flows (to competition)