European competitiveness: A semiparametric stochastic metafrontier analysis at the firm level

Marijn Verschelde[13] Michel Dumont[21] Glenn Rayp[1]
Bruno Merlevede[1]

[1]Ghent University
Department of General Economics

[2]Federal Planning Bureau

[3]KU Leuven Kulak

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Introduction

Competitiveness at the firm level

- Productivity at the firm level
- Cross-country comparison
- How to measure productivity?

Parametric TFP estimation

- TFP as the residual of a production function estimation
- Potential functional misspecification bias

Stochastic Frontier Analysis

- Inefficiency and noise
- Issue: country-specific heterogeneity
  - Functional form
  - Inefficiency distribution

Introduction

Deterministic nonparametric frontier analysis

- No a priori assumptions on functional form
- *'No noise'* assumption

Recently: Semiparametric Stochastic Frontier

- No a priori assumptions on functional form
- Inefficiency and noise

We: Semiparametric Stochastic Metafrontier Analysis

Data

AMADEUS in augmented form

- Compilation in one database of the information provided in each issue of AMADEUS
- Increased coverage as result

Output

- Deflated value added

Input

- Deflated tangible fixed assets
- Labour use in persons

Data

Time period

- 2002-2009

Countries

- Belgium, Germany, Spain, Finland, France, United Kingdom and Italy

Sectors

- 10 Nace 2 digit rev. 1.1 sectors
- Focus on '*Manufacture of fabricated metal products, except machinery and equipment*'
  - Largest sector
  - Results in line with general picture

Sample size

- 620,342 observations
- 140,595 firms

Data

Table: Selected countries and sectors

Selected countries	
Belgium, Germany, Spain, Finland, France, United Kingdom and Italy	
Selected Nace rev. 1.1 sectors	
NACE 15:	Manufacture of food products and beverages
NACE 17:	Manufacture of textiles manufacture of articles of straw and plaiting materials
NACE 22:	Publishing, printing and reproduction of recorded media
NACE 24:	Manufacture of chemicals and chemical products
NACE 25:	Manufacture of rubber and plastic products
NACE 26:	Manufacture of other non-metallic mineral products
NACE 28:	Manufacture of fabricated metal products, except machinery and equipment
NACE 29:	Manufacture of machinery and equipment n.e.c.
NACE 31:	Manufacture of electrical machinery and apparatus n.e.c.
NACE 36:	Manufacture of furniture; manufacturing n.e.c.

Outline methodology

Level of competitiveness

- Based on estimation of frontier and inefficiency
- For each year and sector:

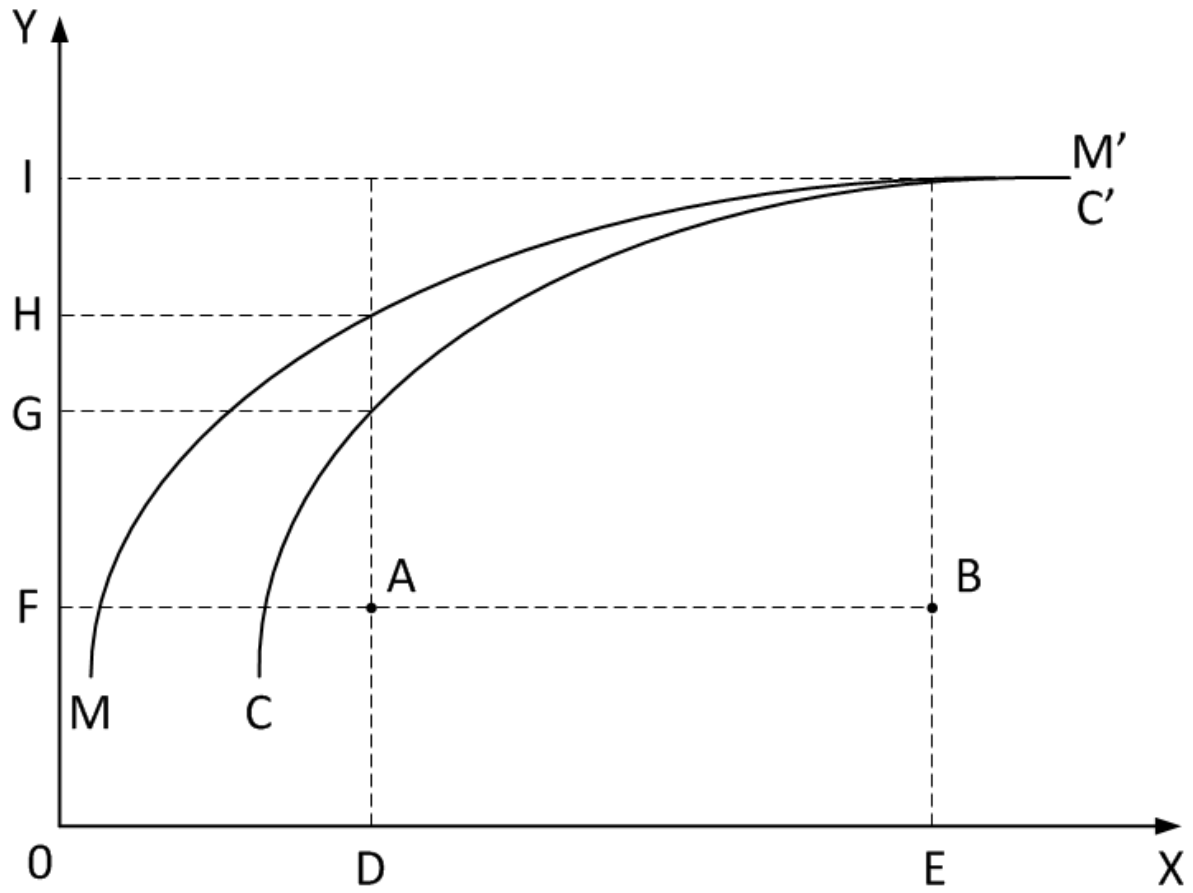
1. Estimate country-specific stochastic FDH frontier
2. Estimate metafrontier as FDH of country-specific stochastic FDH frontiers
3. Obtain estimates of Metafrontier Efficiency and Technology Gap Ratio

Dynamics of competitiveness

- Estimate TFP change by a Metafrontier Hicks-Moorsteen index

Level of competitiveness

- Metafrontier efficiency
- Technology gap ratio



Dynamics of competitiveness

Metafrontier TFP change

- Efficiency change
- Scale efficiency change
- Technological change

Malmquist index

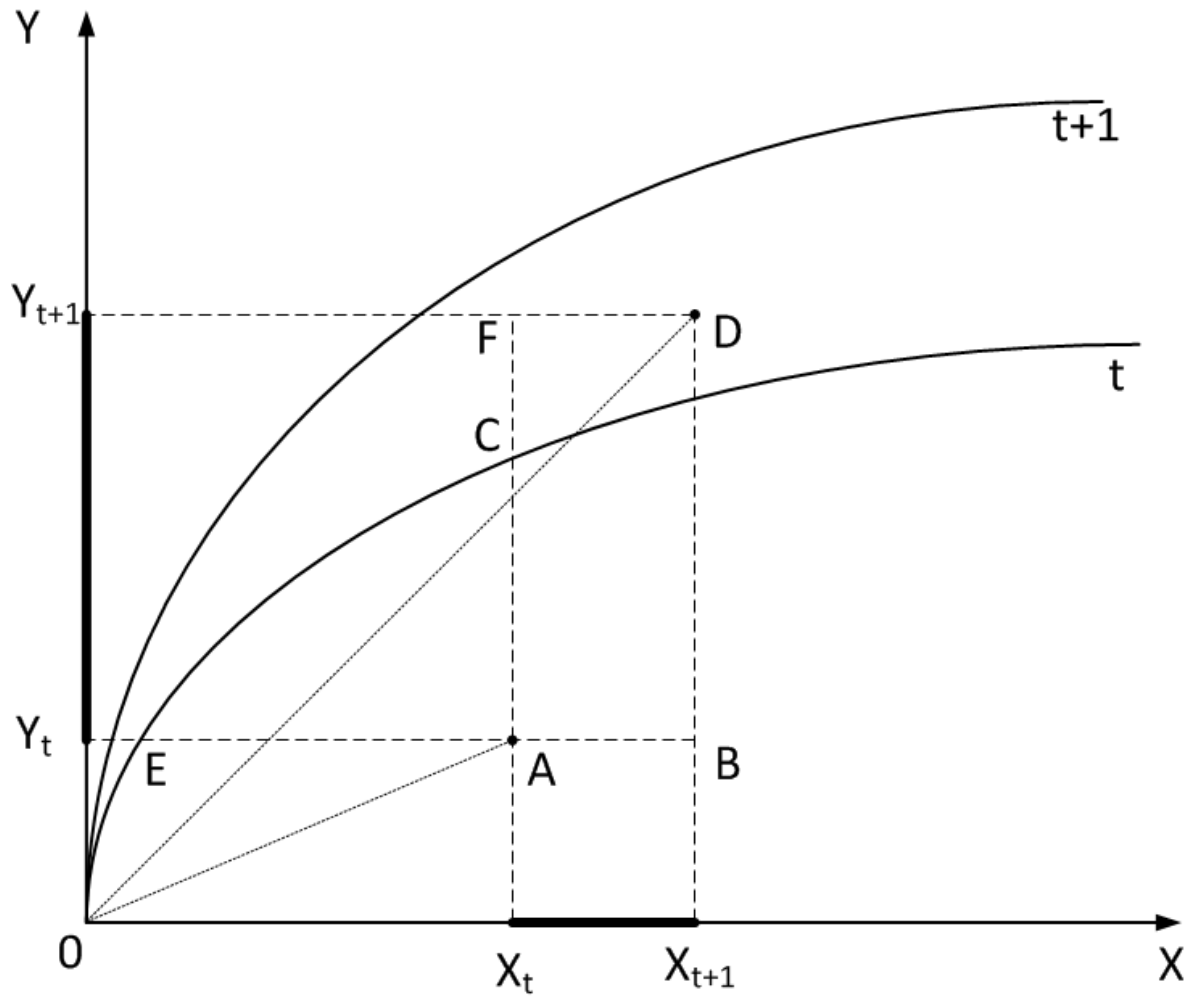
- Used in numerous publications
- Incomplete: not always equal to TFP

Hicks-Moorsteen TFP index

- Complete: always equal to TFP

Dynamics of competitiveness

- Metafrontier Hicks-Moorsteen



Dynamics of competitiveness

$$\prod_{k}^{t} = \frac{|FA|}{|BA|}$$
$$= \frac{X_t F / X_t A}{Y_t B / Y_t A}$$
$$= \frac{(X_t F / X_t C)/(X_t A / X_t C)}{(Y_t B / Y_t E)/(Y_t A / Y_t E)}$$
$$= \frac{D_t^o(Y_{t+1}, X_t)/D_t^o(Y_t, X_t)}{D_t^i(Y_t, X_{t+1})/D_t^i(Y_t, X_t)} = HMTFP_t \qquad (1)$$

Semiparametric stochastic frontier analysis

StoNED

- Stochastic Non-Smooth Envelopment of Data
- Kortelainen and Kuosmanen, 2012, JPA
- Convex least squares

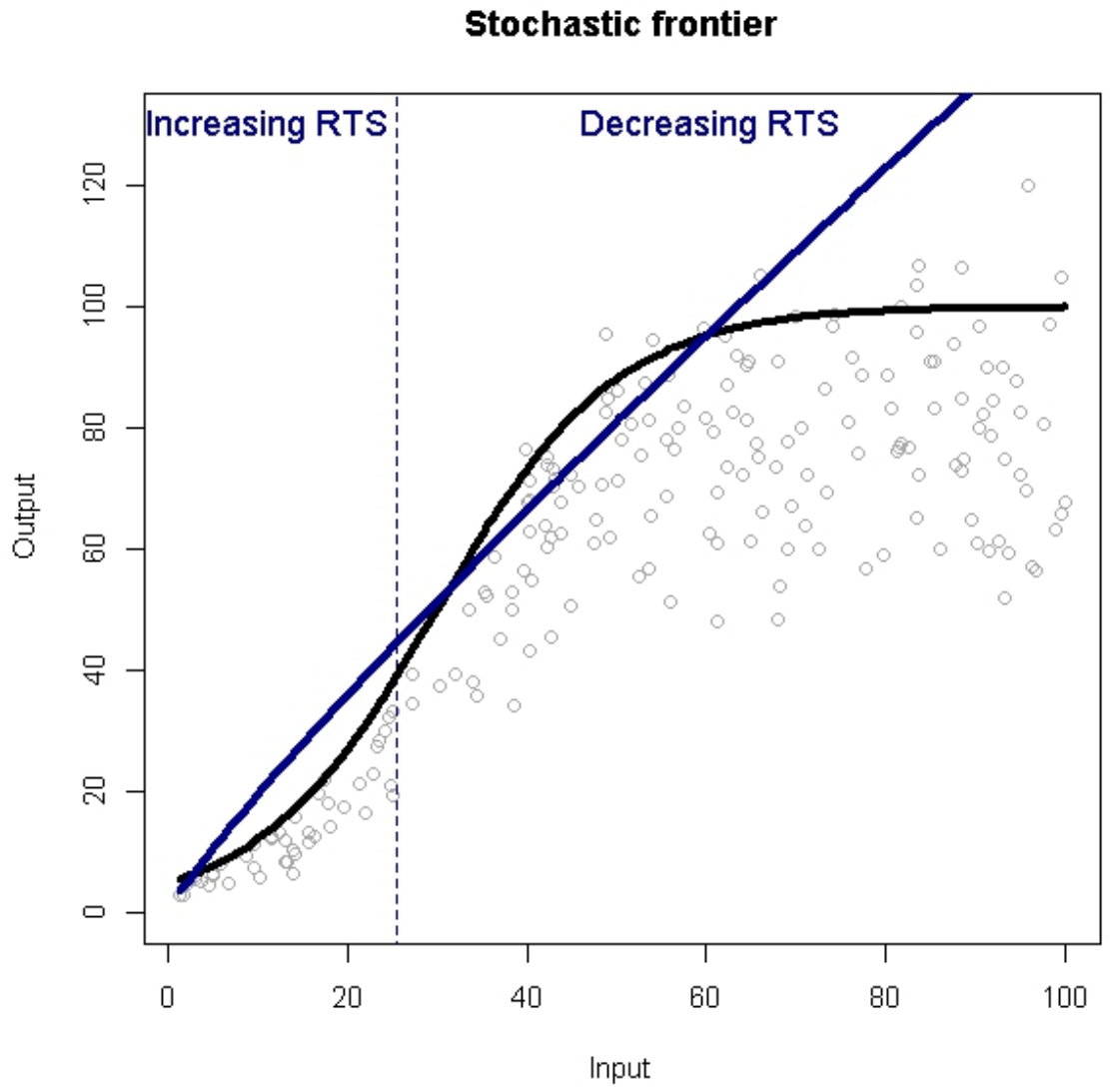
Profile Likelihood stochastic frontier

- Martins-Filho and Yao, 2013, Econometric Reviews

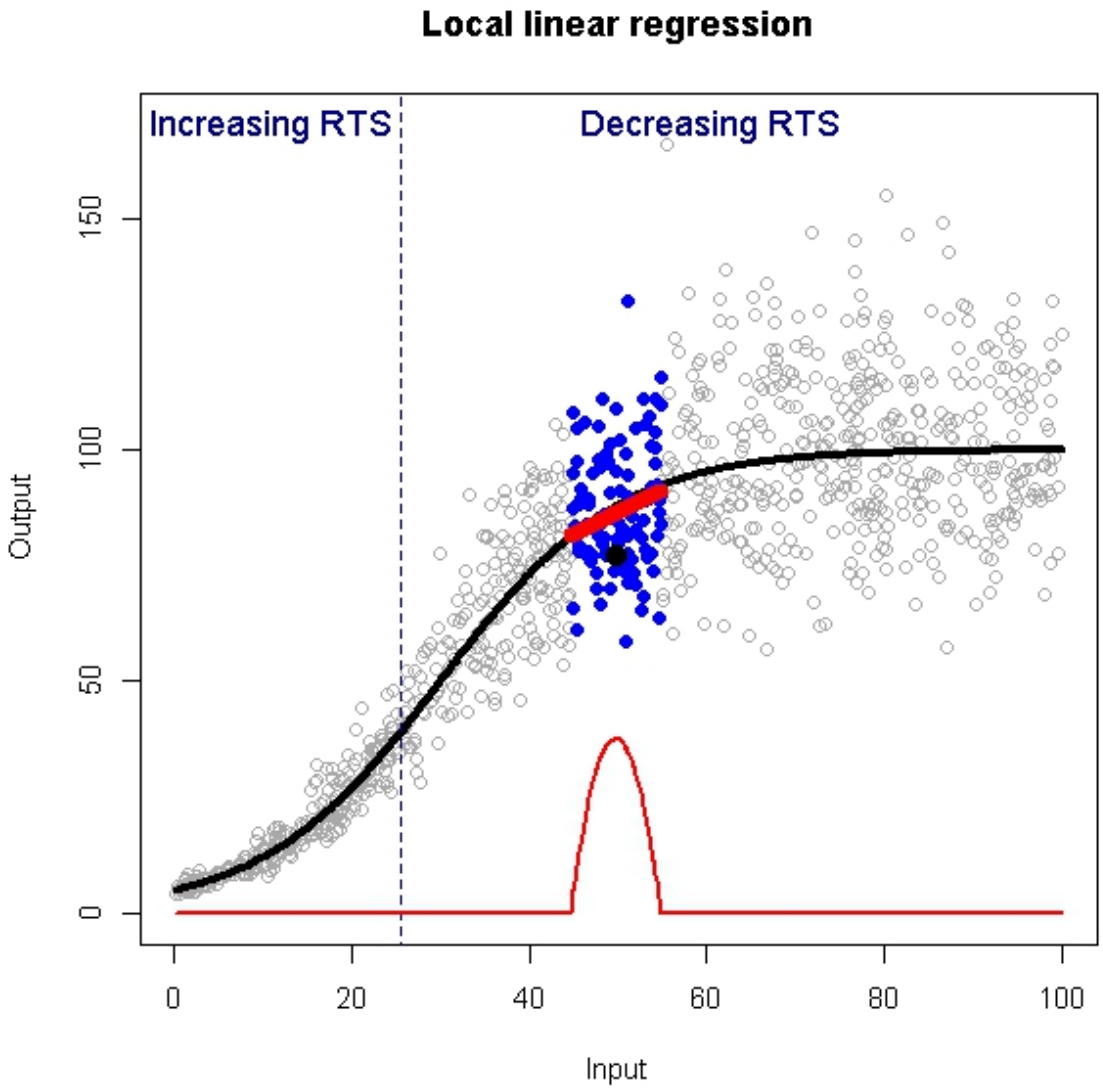
Nonparametric stochastic frontier

- Kumbhakar, Park, Simar, Tsionas, 2007, Journal of Econometrics
- Kernel weighting
- Local Maximum likelihood estimation
- Stochastic FDH/DEA
  - Simar and Zelenyuk, 2012, JPA

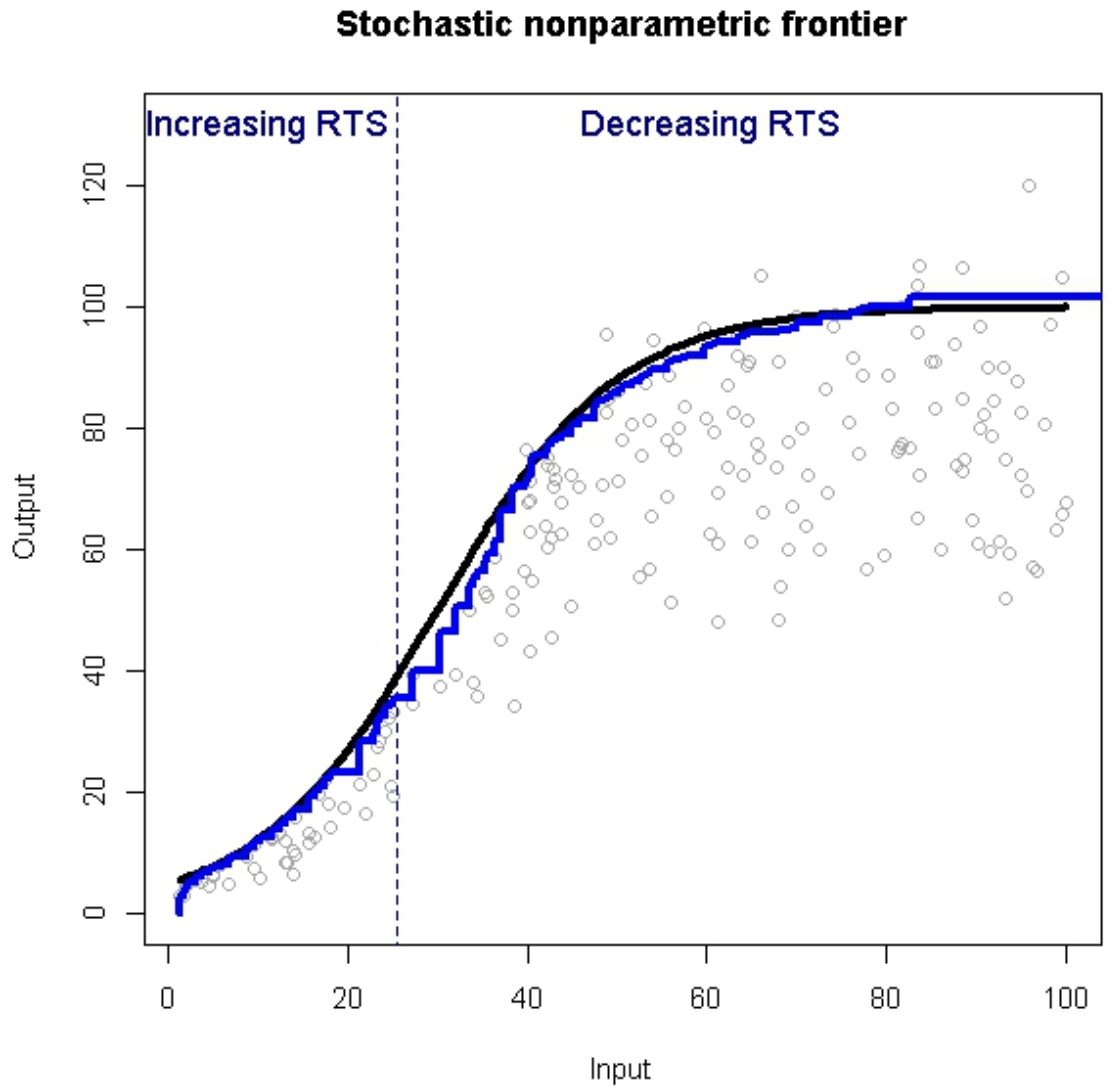
Stochastic FDH - illustration



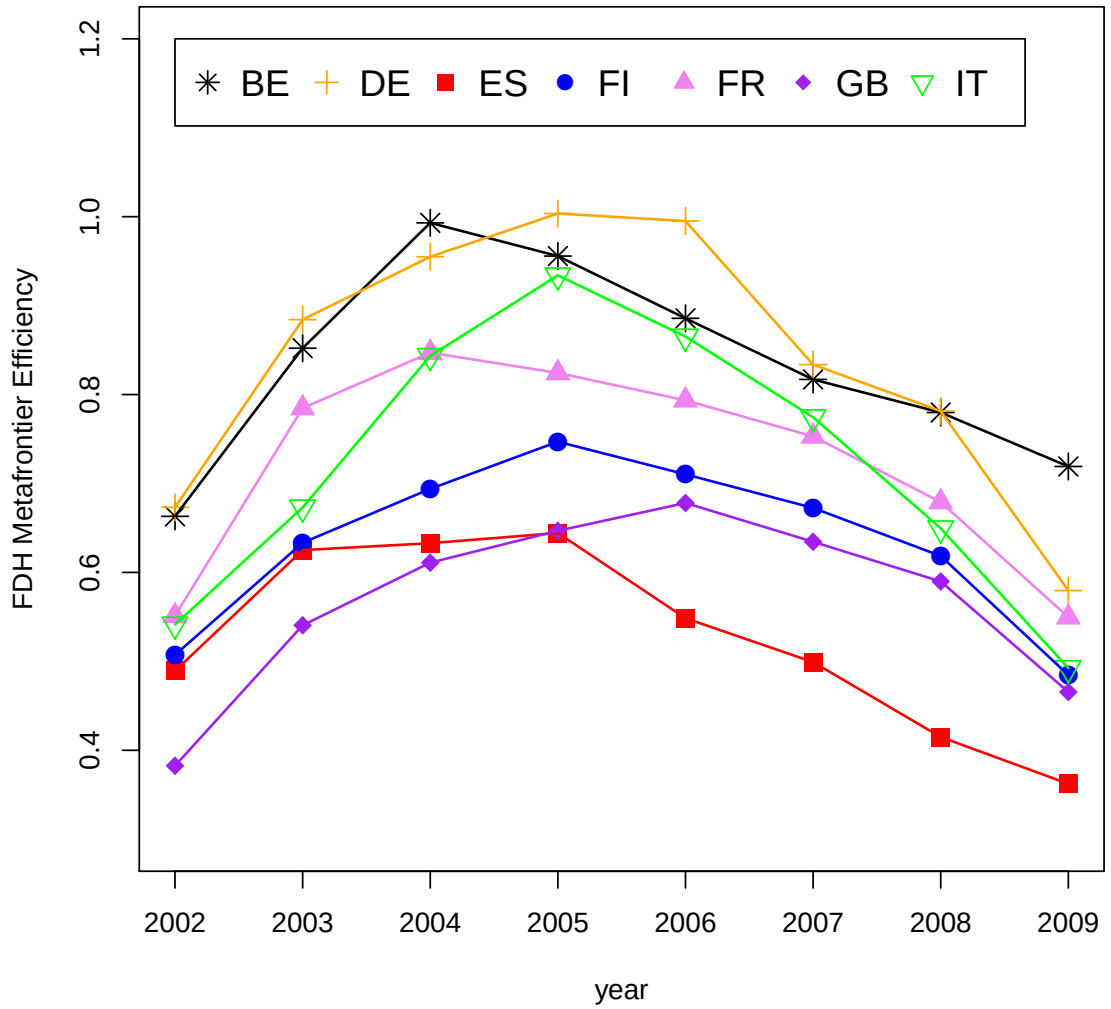
Stochastic FDH - illustration



Stochastic FDH - illustration



Metafrontier efficiency

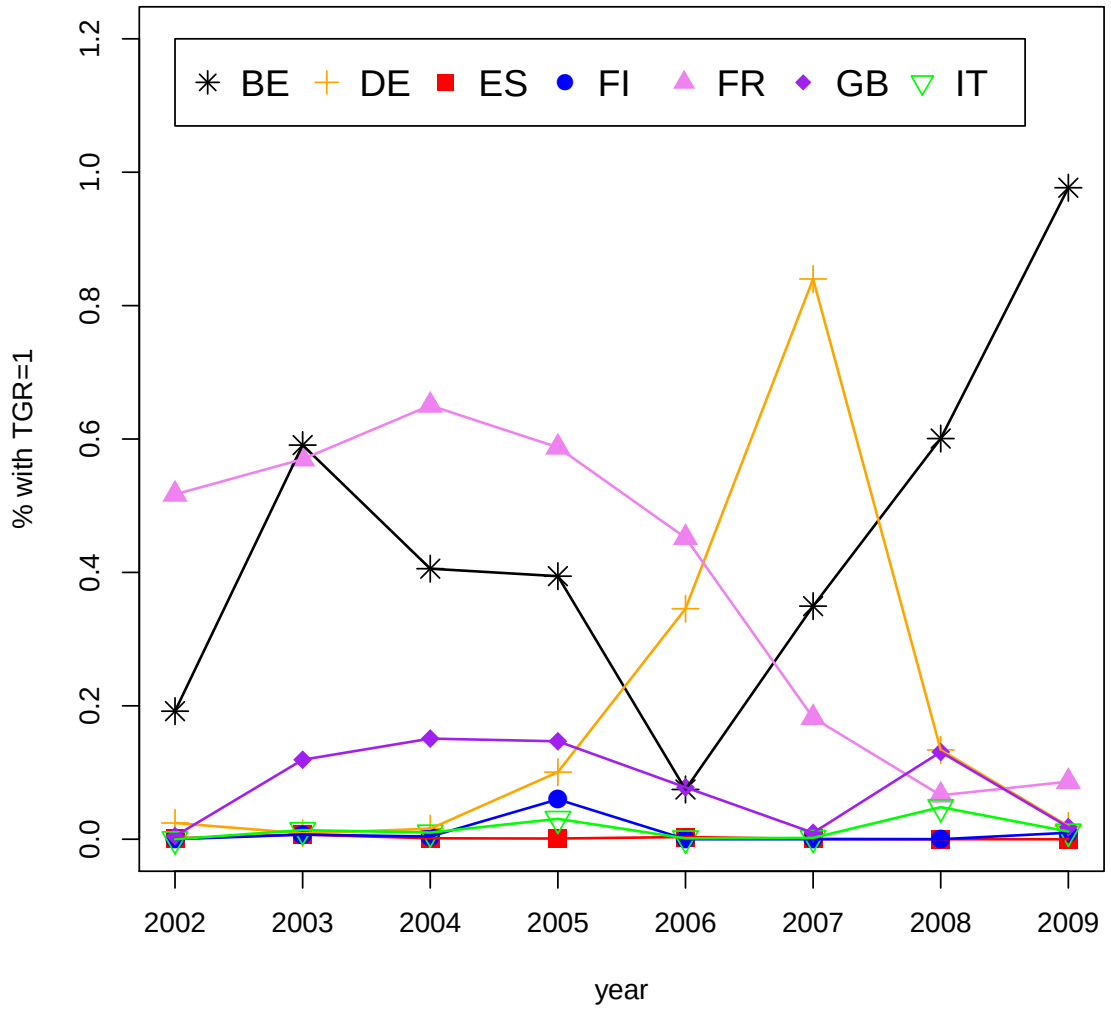


ME: Stochastic Dominance

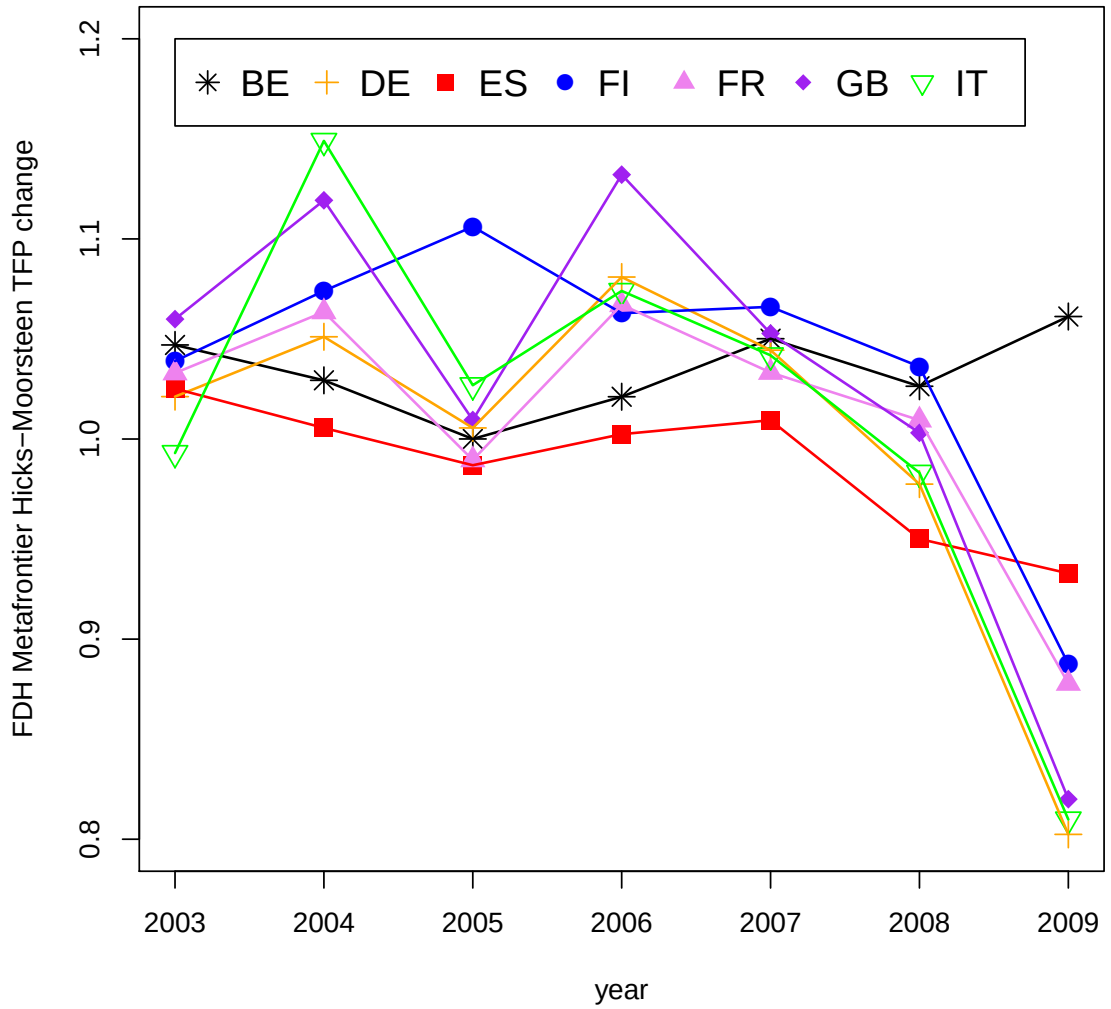
- Davidson and Duclos (2013)
- H_0: non-dominance

	BE	DE	ES	FI	FR	GB	IT
BE	0	0	0	0	0	0	0
DE	2	0	0	0	0	0	0
ES	8	8	0	4	8	4	4
FI	8	8	0	0	7	0	0
FR	8	5	0	0	0	0	0
GB	8	6	1	2	5	0	0
IT	3	1	0	0	1	0	0

Technology Gap Ratio



Metafrontier Hicks-Moorsteen

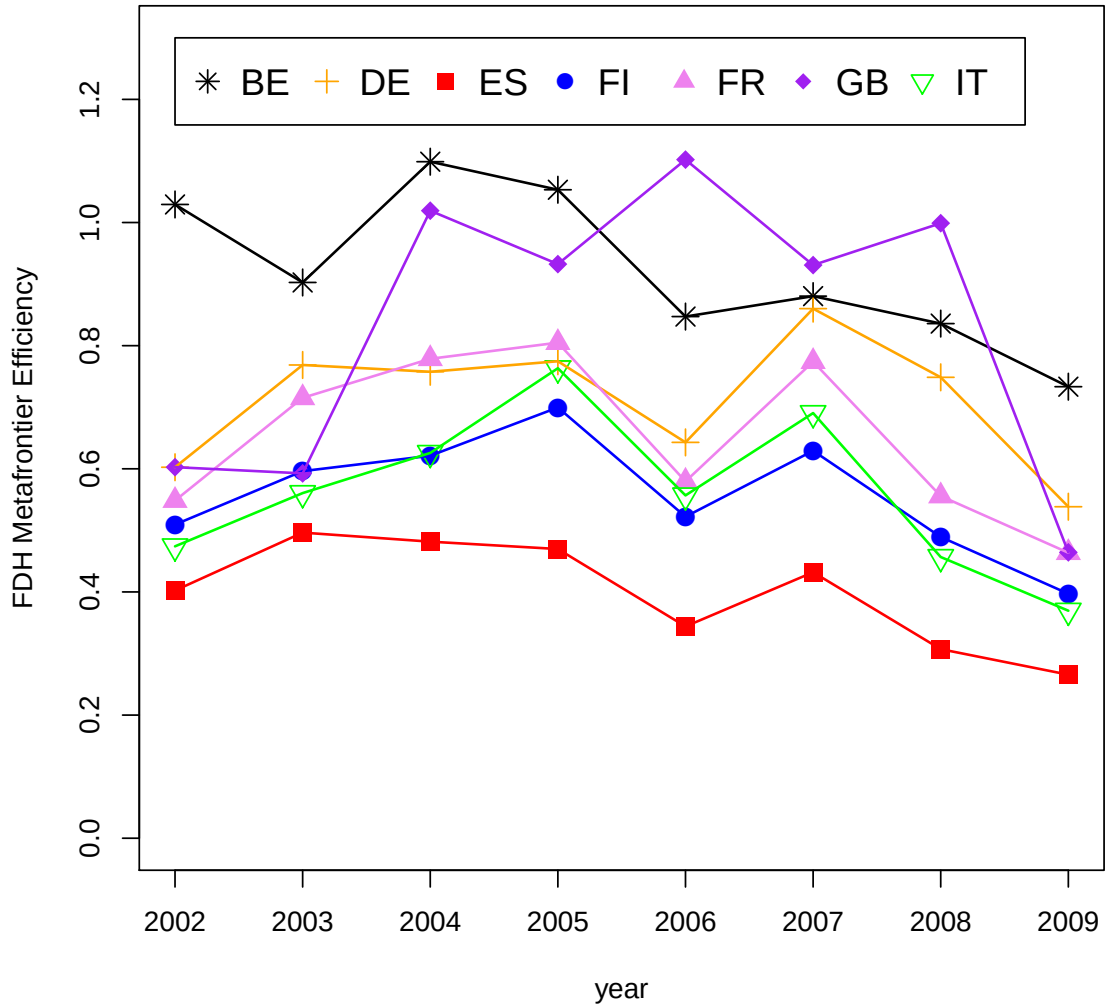


MHM: Stochastic Dominance

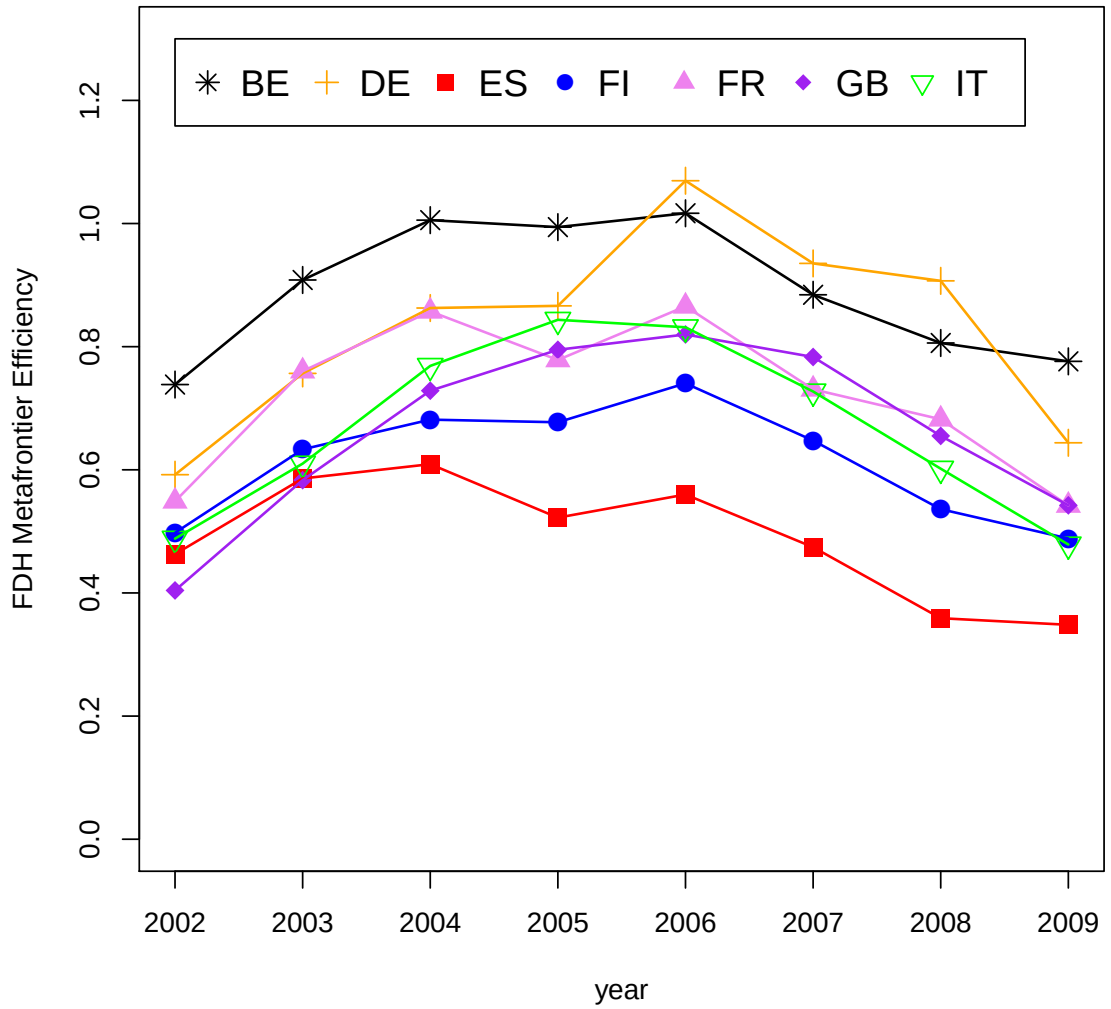
- Davidson and Duclos (2013)
- H_0: non-dominance

	BE	DE	ES	FI	FR	GB	IT
BE	0	0	0	1	0	0	0
DE	1	0	1	1	1	1	1
ES	2	0	0	3	1	3	3
FI	1	0	1	0	0	0	0
FR	0	0	0	1	0	0	0
GB	1	0	0	1	0	0	0
IT	1	0	1	2	0	0	0

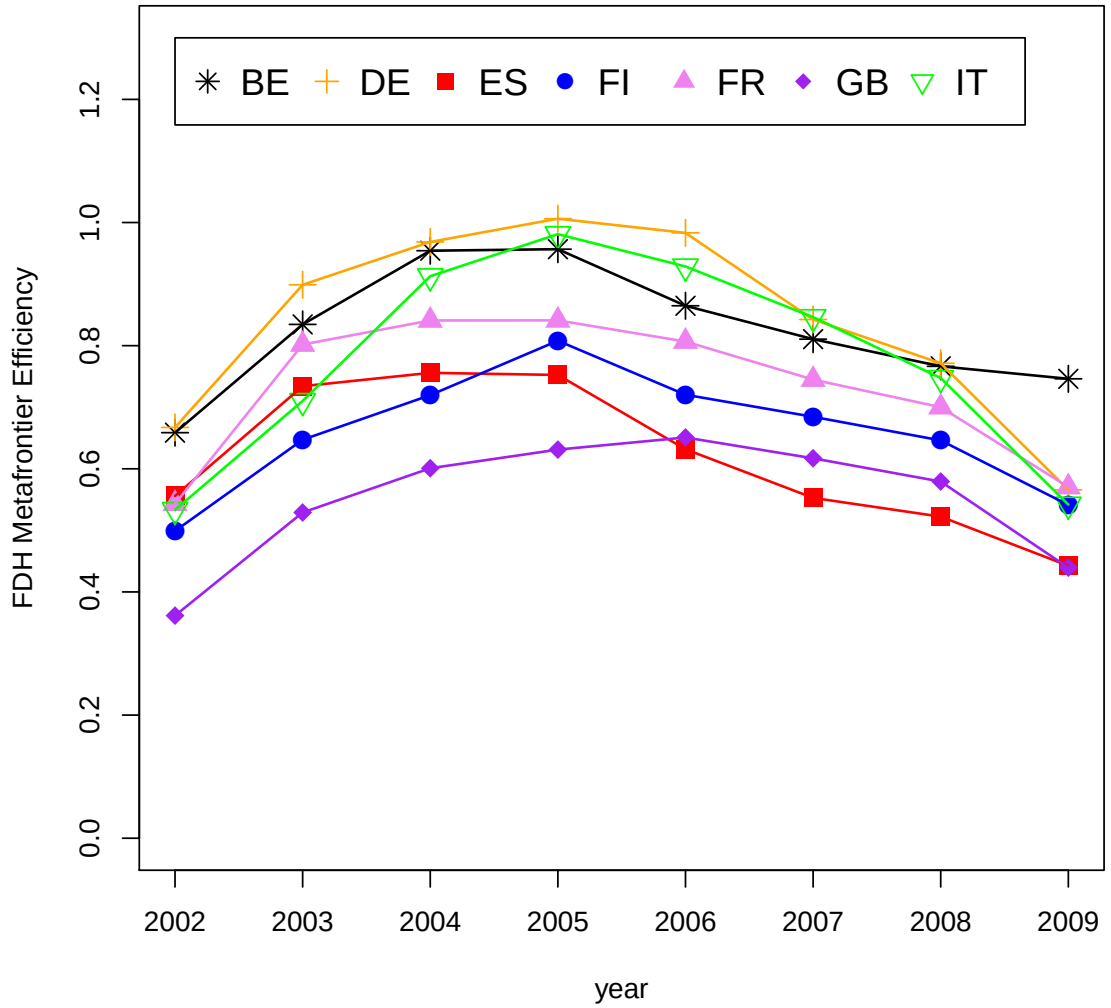
Metafrontier efficiency - micro firms



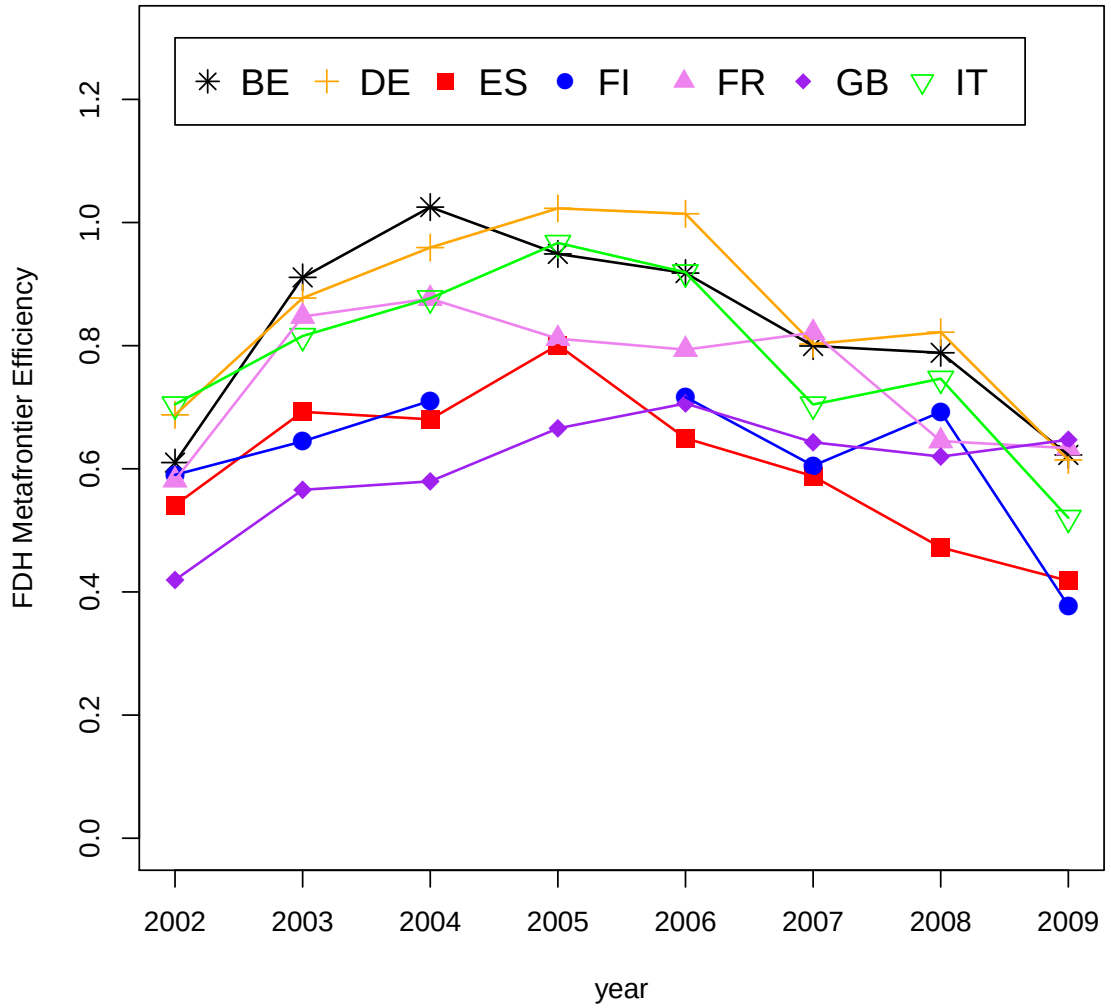
Metafrontier efficiency - small firms



Metafrontier efficiency - medium firms



Metafrontier efficiency - large firms



Contribution to industry-level efficiency growth

Table: Intra-industry variables

Entry	Year for which AMADEUS first reports a strictly positive number of employees, as long the firm is not older than five years according to the year of incorporation.
Exit	Year for which employment is no longer reported, after having been reported in previous year(s), insofar the firm does not reappear in the following years of the period under consideration
Incumbents	
Starting	After entry but younger than five years
Young	Firm age between 6 and 10 years
Old	More than 10 years old

Average (median) relative contribution to industry-level efficiency growth

	Belgium	Finland	France	Germany	Italy	Spain	Corr. Prod. growth
Within-firm	0.76	0.51	1.18	1.45	0.87	1.11	0.04
(Mature)	(0.89)	(1.01)	(1.15)	(1.05)	(1.30)	(1.28)	(-0.54)
Reallocation	-0.16	0.25	0.04	-0.31	0.04	-0.43	0.43
(Mature)	(0.08)	(0.02)	(-0.15)	(-0.03)	(-0.26)	(-0.35)	(0.63)
Within-firm	-3.33	-1.01	1.85	0.92	1.16	-3.25	0.51
(Start)	(0.45)	(0.76)	(0.95)	(1.08)	(1.39)	(-1.74)	(0.81)
Reallocation	0.09	-0.21	-0.08	0.02	0.06	1.94	-0.86
(Start)	(0.00)	(0.00)	(-0.01)	(0.04)	(-0.01)	(0.13)	(-0.84)
Within-firm	**3.59**	**0.56**	**0.88**	**1.21**	**0.85**	**-10.32**	**0.92**
(Young)	**(0.99)**	**(0.69)**	**(1.30)**	**(0.89)**	**(1.38)**	**(-4.97)**	**(0.90)**
Reallocation	0.08	0.21	-0.09	-0.04	-0.04	-0.08	0.09
(Young)	(-0.01)	(0.04)	(-0.01)	(-0.03)	(-0.04)	(-0.03)	(0.09)
Entry	-0.04	0.09	0.09	-0.03	0.05	0.02	-0.03
	(0.00)	(0.00)	(0.03)	(0.00)	(0.02)	(0.01)	(0.10)
Exit	0.00	0.04	0.02	0.01	0.01	0.02	-0.44
	(0.00)	(0.00)	(0.02)	(0.02)	(-0.01)	(-0.01)	(0.66)

Conclusion

- Semiparametric stochastic metafrontier frontier analysis
- Firm-level data from AMADEUS in augmented form
- Substantial and persistent differences in competitiveness within EU15
- Larger differences between countries for micro and small firms
- Large contribution of within-firm growth of young firms to industry-level efficiency growth