Efficiency in Education.
A review of literature and a way forward

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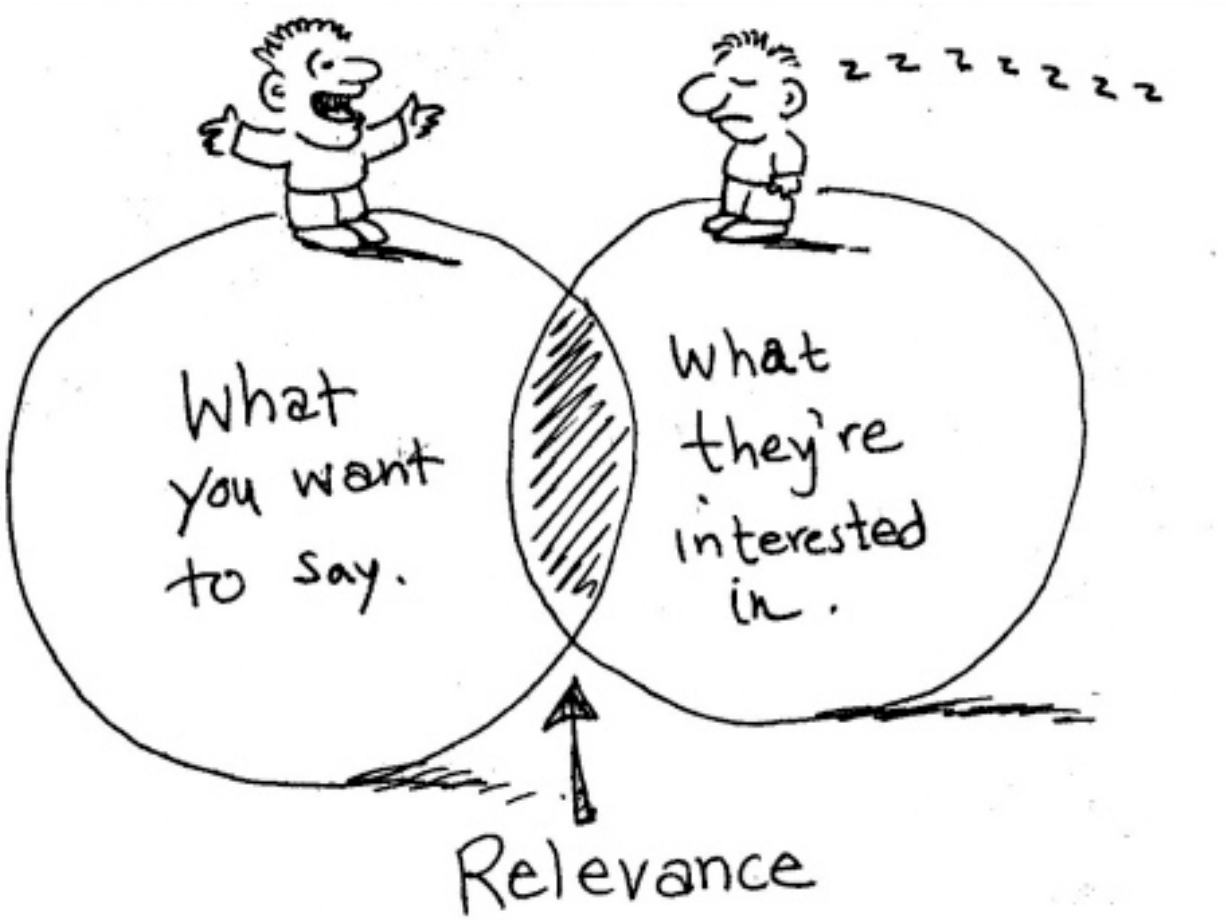
The issue

Is ‘Efficiency in education’ a relevant topic?



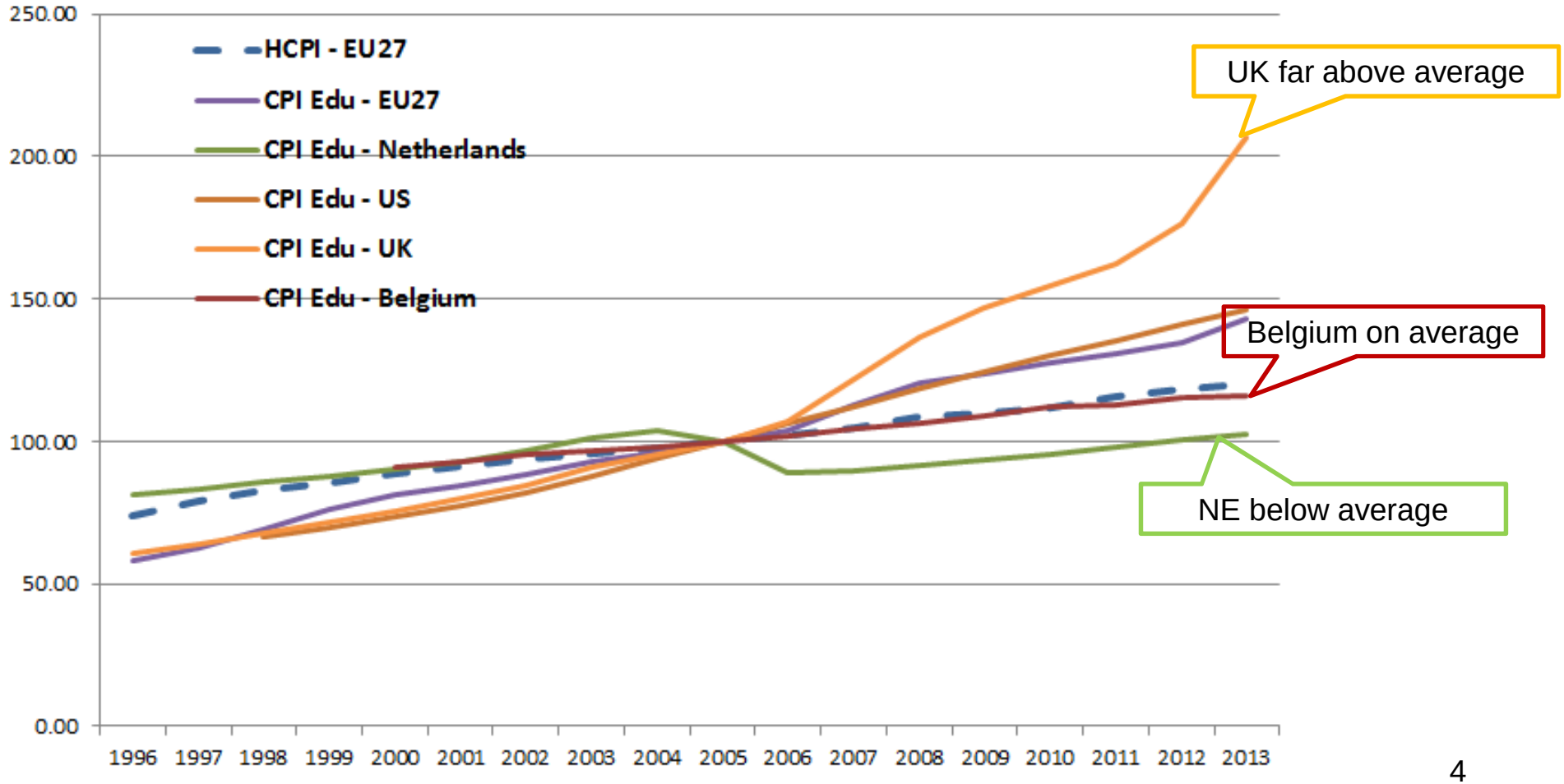
Efficiency in Education

Angel Gurria (OECD): "*what matters more are the choices countries make in how to allocate that spending and the policies they design to improve the efficiency and relevance of the education they provide*"

The issue

Empirical issue: rising cost of education.

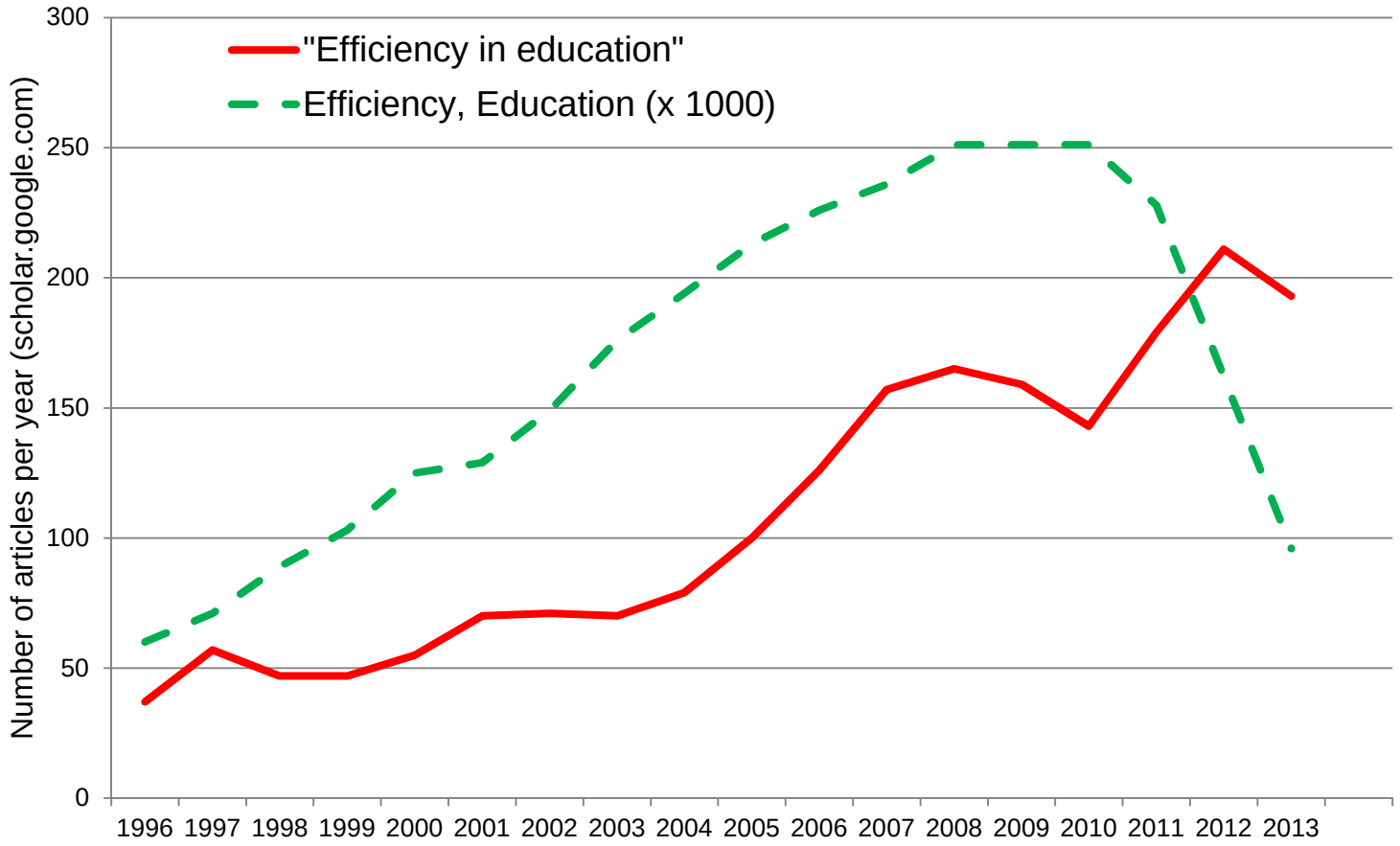
→ Comparison of average prices and prices for education (source: Eurostat)



The issue

Hotly debated topic in the literature

According to the number of papers on Google Scholar in a given year



Source: google.scholar.com

The issue

Hotly debated topic in the literature

According to the number of published books (source: Ngram viewer)

Efficiency vs effectiveness

Efficiency (means doing things right) in education should not been seen separately from effectiveness (means doing the right things)

→ **Effectiveness** comes close to 'educational effectiveness research': what works in education?

e.g. 'What works clearinghouse' (ies.ed.gov/ncee/wwc) or the Best evidence Encyclopedia (www.bestevidence.org, www.bestevidence.nl).

Efficiency in Education

How to measure **efficiency**?

Pioneering work by Bessent and Bessent (1980) and Bessent et al. (1982):

> "Conventional methods for comparing the relative productivity of schools employ least squares regression to find the expected achievement of schools with the same input characteristics. A newly developed input/output method for comparing the efficiency of decision making units is presented. (…) The method results in the identification of efficient and inefficient schools and provides management information relative to input and output measures. (p. 57)

Efficiency vs effectiveness

Efficiency (doing the things right) ≠ Effectiveness (doing the right things)

→ Efficiency literature = non-parametric (e.g., DEA), semi-parametric (e.g., SFA) and parametric measures (e.g. COLS)

→ Effectiveness literature = e.g. experiments, DiD, IV

→ BUT: Relatively distinct literatures.

→ Few studies combine efficiency and effectiveness

- Exemption: Powell et al. (2012): “The Benchmark Model of Institutional Efficiency and Effectiveness”
- Cherchye, Perelman and De Witte (2014): consider resource constraints as a way to combine efficiency and effectiveness

Efficiency vs effectiveness

Cherchye, Perelman and De Witte (2014): consider resource constraints as a way to unify productivity (= efficiency) and performance (=effectiveness)

$$R_E = \frac{Perf_E}{Prod_E} = \frac{\text{Benefit of the doubt model}}{\text{Efficiency model}}$$

Difference between $Prod_E$ and $Perf_E$ reveals information regarding possible output gains from weakened resource constraints or unexploited production capacity

$Prod_E > Perf_E$ → Maximum output expansion without constraints ($Perf_E$) exceeds the maximum output expansion with resource constraints ($Prod_{E)}$. Thus DMU E can gain in terms of output performance by weakening its resource constraints.

$Prod_E < Perf_E$ → The DMU does not fully exploit its production capacity

Efficiency vs effectiveness

Cherchye, Perelman and De Witte (2014): consider resource constraints as a way to unify productivity and performance

Application to Dutch schools indicates that:

- The average school does not fully exploit the production capacity
- While some schools would benefit from weaker resource constraints, this is not the case for the average school, nor for a large majority of schools.

Efficiency in Education

→ This presentation (based on joint work with Laura Lopez-Torres)

- Review of efficiency in education literature

- Bridging the gap between ‘economics of education’ literature and ‘efficiency in education literature’

Overview

1. Setting the scene

2. Literature review

3. Bridging literatures
   a. Endogeneity and its sources
   b. Methodological similarities

4. Conclusion

Efficiency in Education

Systematic review of the literature

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LEUVEN ECONOMICS OF EDUCATION RESEARCH

Systematic literature review:

- In ERIC and Web of Science
- English language literature
- From 1978 (Charnes et al.) until July 2014
- Keywords: “efficiency”, “education”, “frontier”, “school”, “performance” and “higher education”

→ In total 181 papers

Analyzed from different angles:

1. Level of analysis
2. Data sets used
3. Main input/output variables
4. Non-discretionary (control) variables
5. Methodological approaches

Business School, College, Department, Research Program, Researchers/University teachers, University levels studies

Observed in: Beasley (1990) (1995), Kao and Yang (1992), Johnes and Johnes (1993) (1995), Breu and Raab (1994), Sinuany et al. (1994), Athanassopoulos and Shale (1997), Madden et al. (1997), Haksever and Muriagishi (1998), Thursby (2000), Ying and Sung (2000), Avkiran (2001), Korhonen et al. (2001), Izadi et al. (2002), Moreno and Tadepali (2002), Abbott and Doucouliagos (2003), Flegg et al. (2004), Cherchye and Vanden Abeele (2005), Joumady and Ris (2005), Stevens (2005), Agasisti and Dal Bianco (2006) (2009), Bonaccorsi et al. (2006), Bougnol and Dulá (2006), Giménez and Martínez (2006), Johnes (2006) (2008), Koksal and Nalcaci (2006), McMillan and Chan (2006), Agasisti and Salerno (2007), Anderson et al. (2007), Tauer et al. (2007), Johnes et al. (2008), Johnes and Yu (2008), Kao and Hung (2008), Kuo and Ho (2008), Ray and Jeon (2008), Worthington and Lee (2008), Abramo and D'Angelo (2009), Agasisti and Johnes (2009) (2010), Johnes and Johnes (2009), Tyagi et al. (2009), Agasisti and Pérez-Esparrells (2010), De Witte and Rogge (2010), Kempkes and Pohl (2010), Agasisti et al. (2011) (2012), Johnes and Schwarzenberger (2011), Kounetas et al. (2011), Kuah and Wong (2011), Lee (2011), Thanassoulis et al. (2011), Wolszczak-Derlacz and Parteka (2011), Eff et al. (2012), Kong and Fu (2012), De Witte and Hudrlikova (2013), De Witte et al. (2013).

Classroom, Course levels studies

Observed in: Cooper and Cohn (1997), De Witte and Rogge (2011).

Council, County, District, City levels (municipality, Local Education Authorities, Province) levels studies

Observed in: Butler and Monk (1985), Sengupta and Sfeir (1986) (1988), Jesson et al. (1987), Sengupta (1987), Smith and Mayston (1987), Mayston and Jesson (1988), Färe et al. (1989), Callan and Santerre (1990), Barrow (1991), Ganley and Cubbin (1992), McCarty and Yaisawarng (1993), Chalos and Cherian (1995), Cubbin and Zamani (1996), Engert (1996), Ruggiero (1996) (1996b) (2000) (2007), Bates (1997), Chalos (1997), Duncombe et al. (1997), Grosskopf et al. (1997) (1999) (2001) (2014), Heshmati and Kumbhakar (1997), Ray and Mukherjee (1998), Ruggiero and Bretschneider (1998), Ruggiero and Vitaliano (1999), Chakraborty et al. (2001), Grosskopf and Moutray (2001), Banker et al. (2004), Primont and Domazlicky (2006), Denaux (2009), Davutyan et al. (2010), Houck et al. (2010), Naper (2010), Johnson and Ruggiero (2013).

School program level studies

Observed in: Charnes et al. (1981)

School level studies

Observed in: Bessent and Bessent (1980), Bessent et al. (1982), Diamond and Medewitz (1990), Ray (1991), Deller and Rudnicki (1993), Färe et al. (1993), Bonesrønning and Rattsø (1994), Thanassoulis and Dustan (1994), Jimenez and Paqueo (1996), Kirjavainen and Loikkanen (1998), Mancebón and Bandres (1999), Mancebón and Molinero (2000), McEwan and Carnoy (2000), Bradley et al. (2001) (2010), Daneshvary and Clauretie (2001), Muñiz (2002), Wang (2003), Kiong et al. (2005), Oliveira and Santos (2005), Oullette and Vierstraete (2005), Waldo (2007b), Conroy and Arguea (2008), Cordero-Ferrera et al. (2008) (2010), Mancebón and Muñiz (2008), Millimet and Collier (2008), Grosskopf et al. (2009), Hu et al. (2009), Kantabutra (2009), Sarrico and Rosa (2009), Alexander et al. (2010), Carpenter and Noller (2010), Essid et al. (2010) (2013) (2014), Khalili et al. (2010), Naper (2010), Sarrico et al. (2010), Agasisti (2011) (2013), Mongan et al. (2011), Gronberg et al. (2012), Haelermans and Blank (2012), Haelermans and De Witte (2012), Haelermans et al. (2012), Kirjavainen (2012), Mancebón et al. (2012), Misra et al. (2012), Portela et al. (2012), Haelermans and Ruggiero (2013), Blackburn et al. (2014), Brennan et al. (2014).

School system (country or multi-country) levels studies

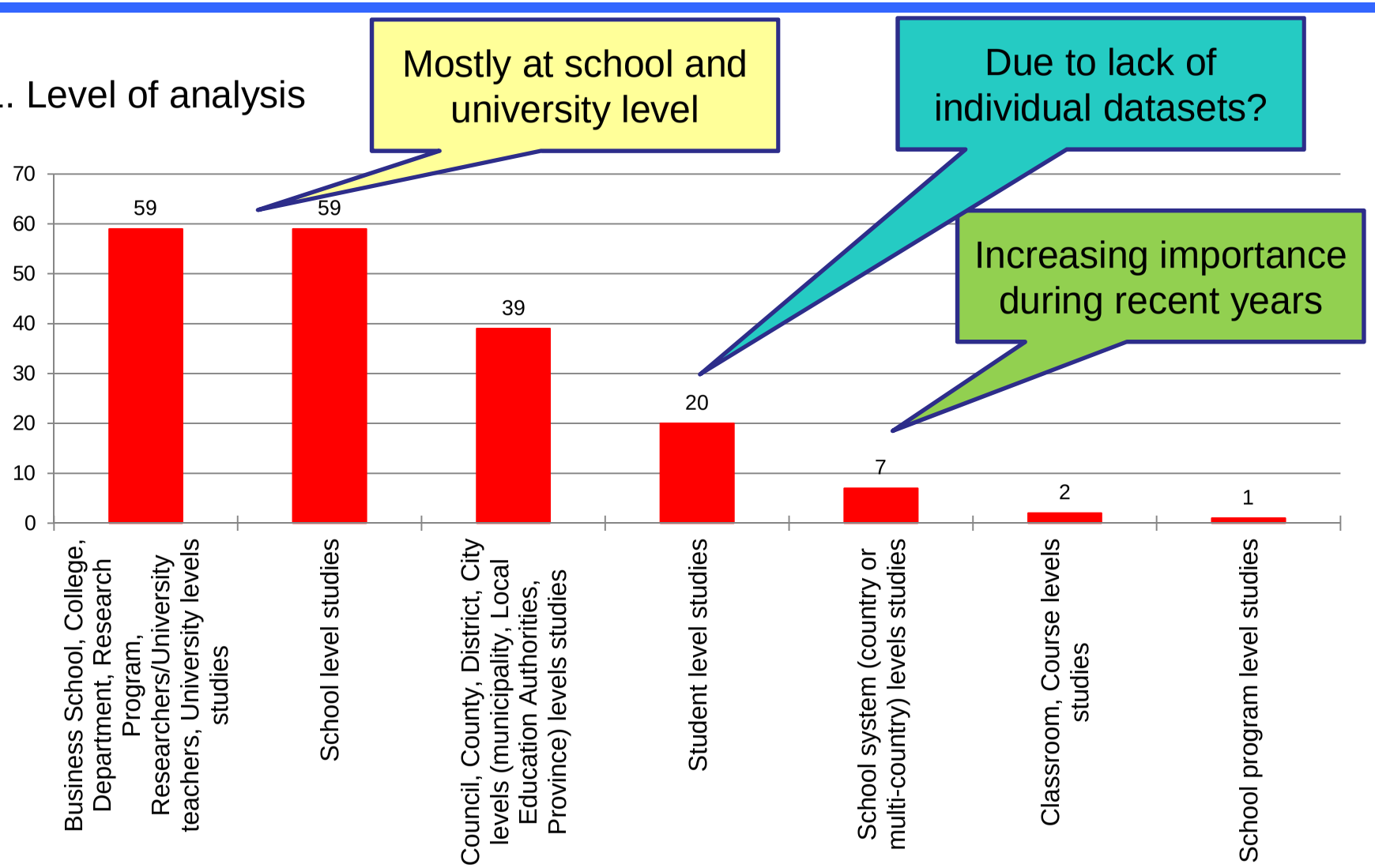
Observed in: Geshberg and Schuermann (2001), Hanushek and Luque (2003), Afonso and Aubyn (2006), Kocher et al. (2006), Giménez et al. (2007), Agasisti (2011b), Thieme et al. (2012).

Student level studies

Observed in: Thanassoulis (1999), Colbert et al. (2000), Portela and Thanassoulis (2001), Robst (2001), Mizala et al. (2002), Thanassoulis and Portela (2002), Dolton et al. (2003), Waldo (2007), Cherchye et al. (2010), De Witte et al. (2010), Portela and Camanho (2010), Cordero-Ferrera et al. (2011), Perelman and Santín (2011) (2011b), De Witte and Kortelainen (2013), Deutsch et al. (2013), Portela et al. (2013), Thieme et al. (2013), Crespo-Cebada et al. (2014), Podinovski et al. (2014).

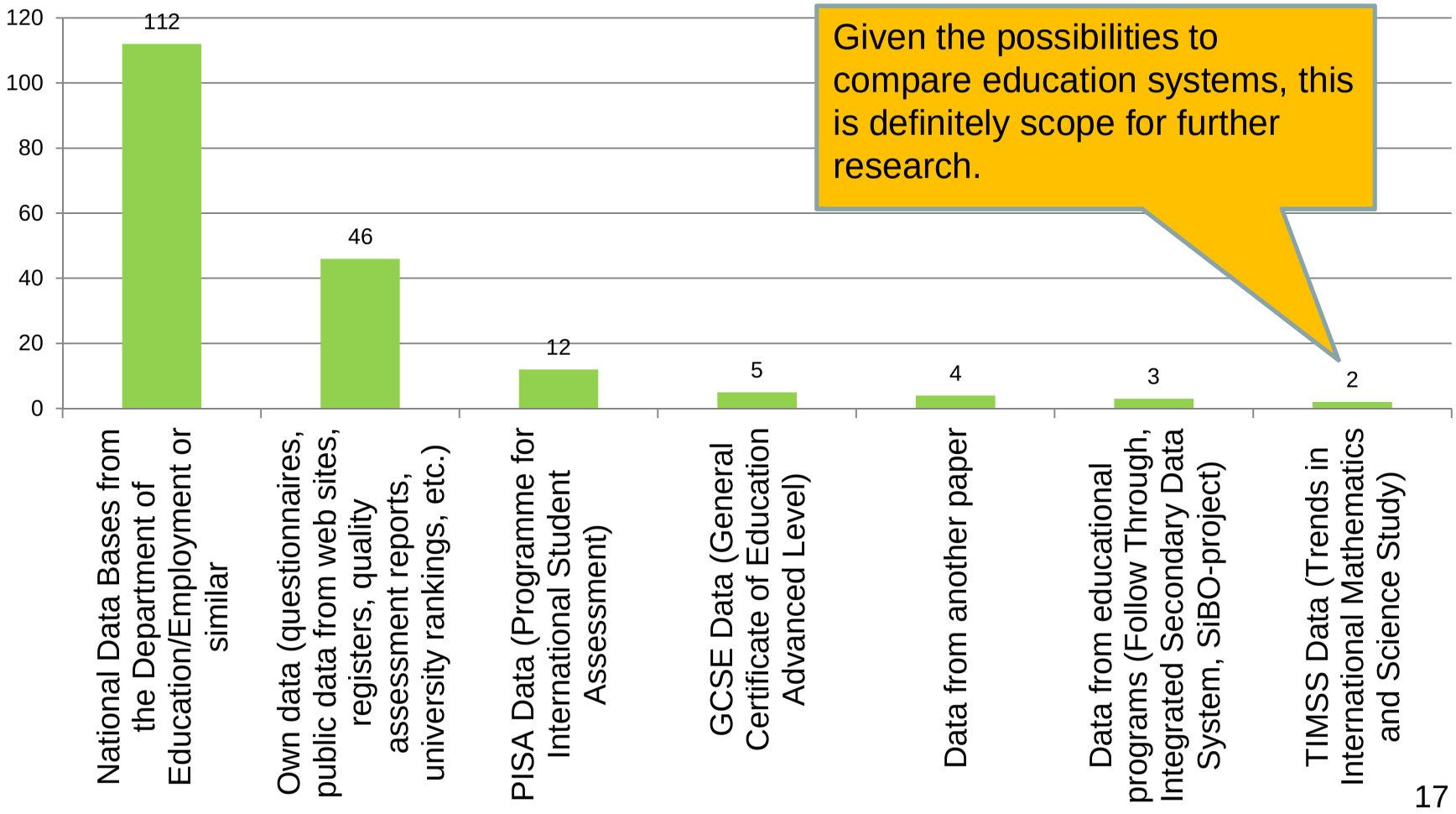
Efficiency in Education
Systematic review of the literature

1. Level of analysis



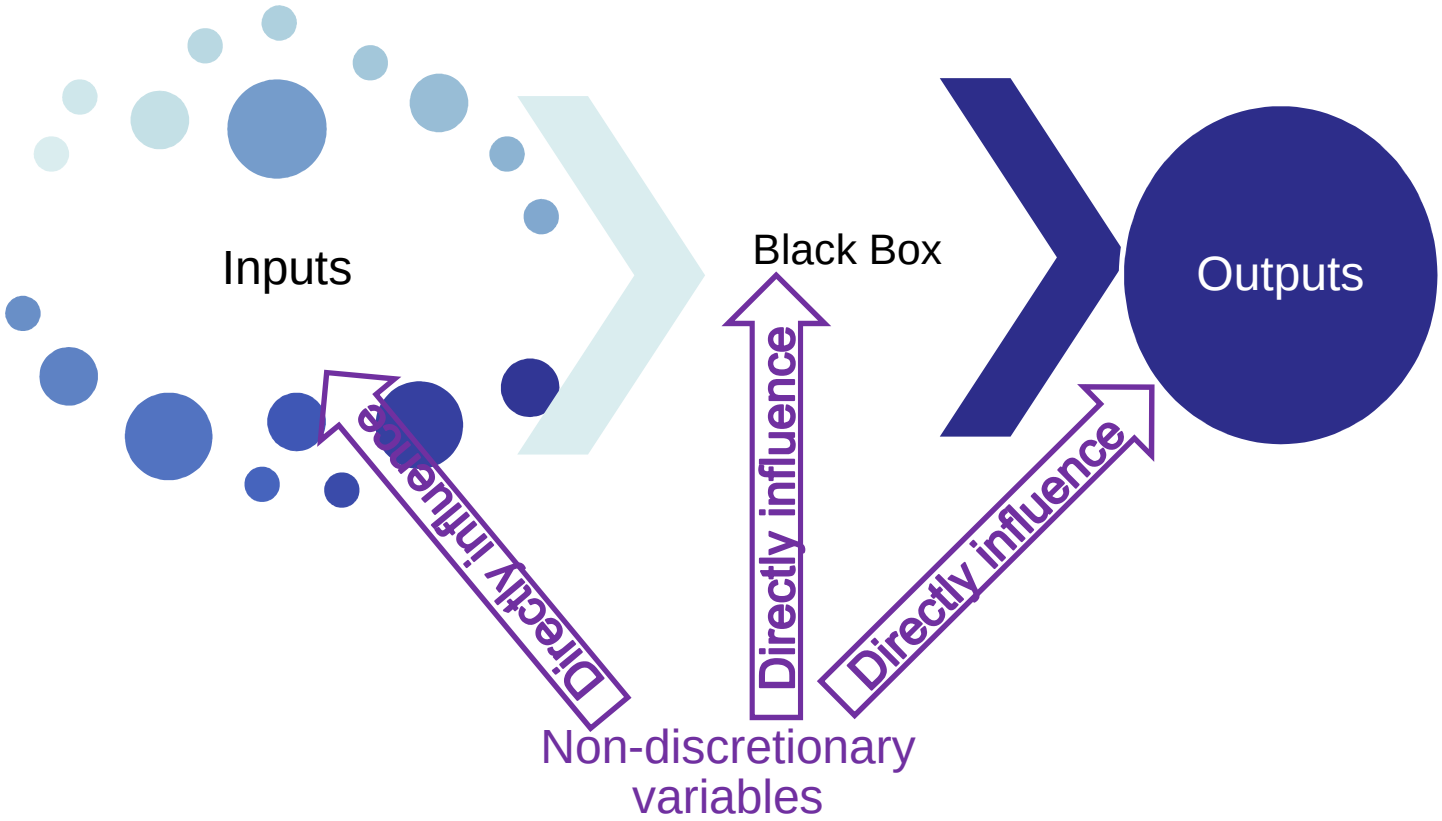
Efficiency in Education
Systematic review of the literature

2. Data sets used in the efficiency in education literature



Efficiency in Education
Systematic review of the literature

Educational production function (Worthington, 2001) with input, output and contextual variables

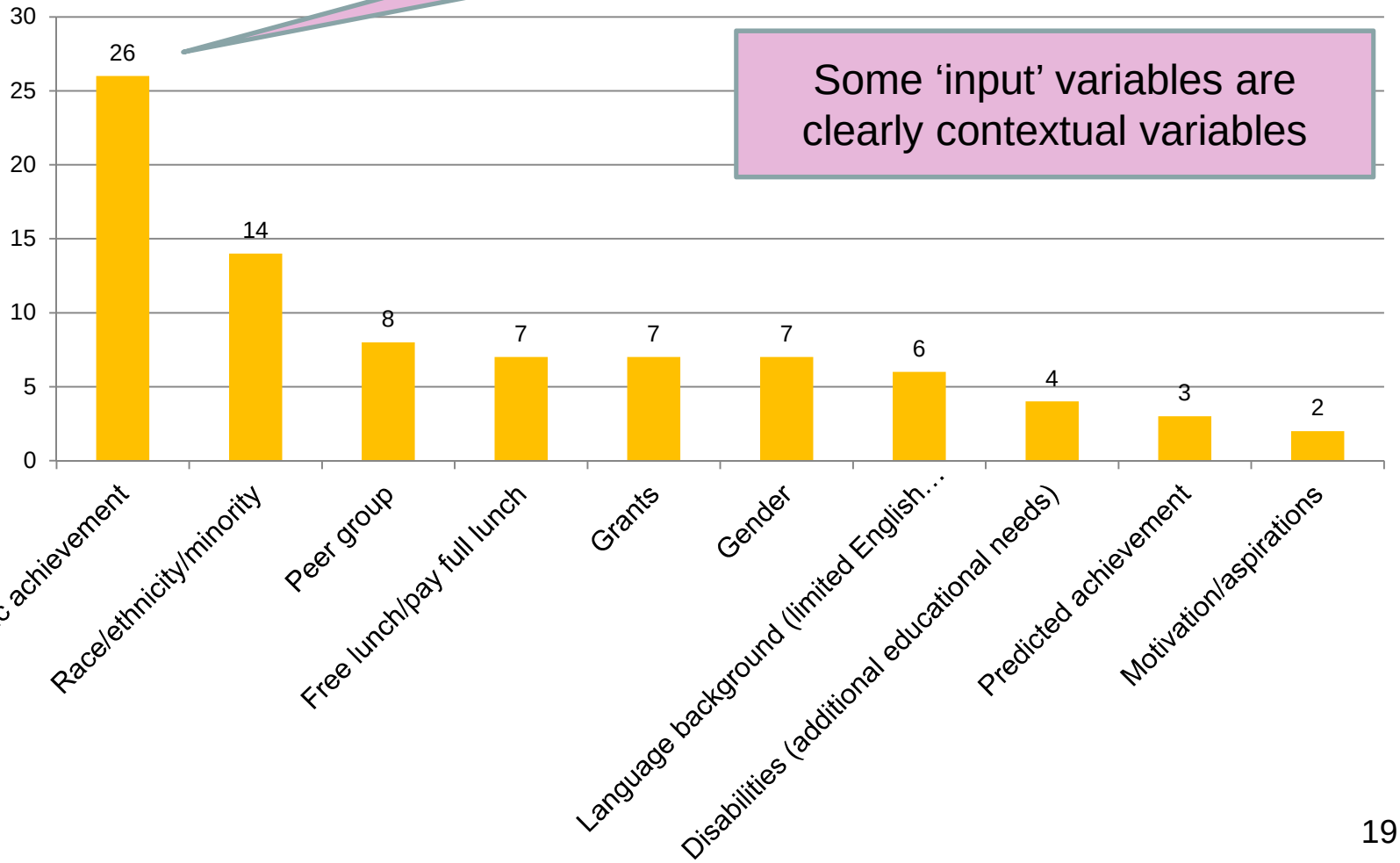


Efficiency in Education
Systematic review of the literature

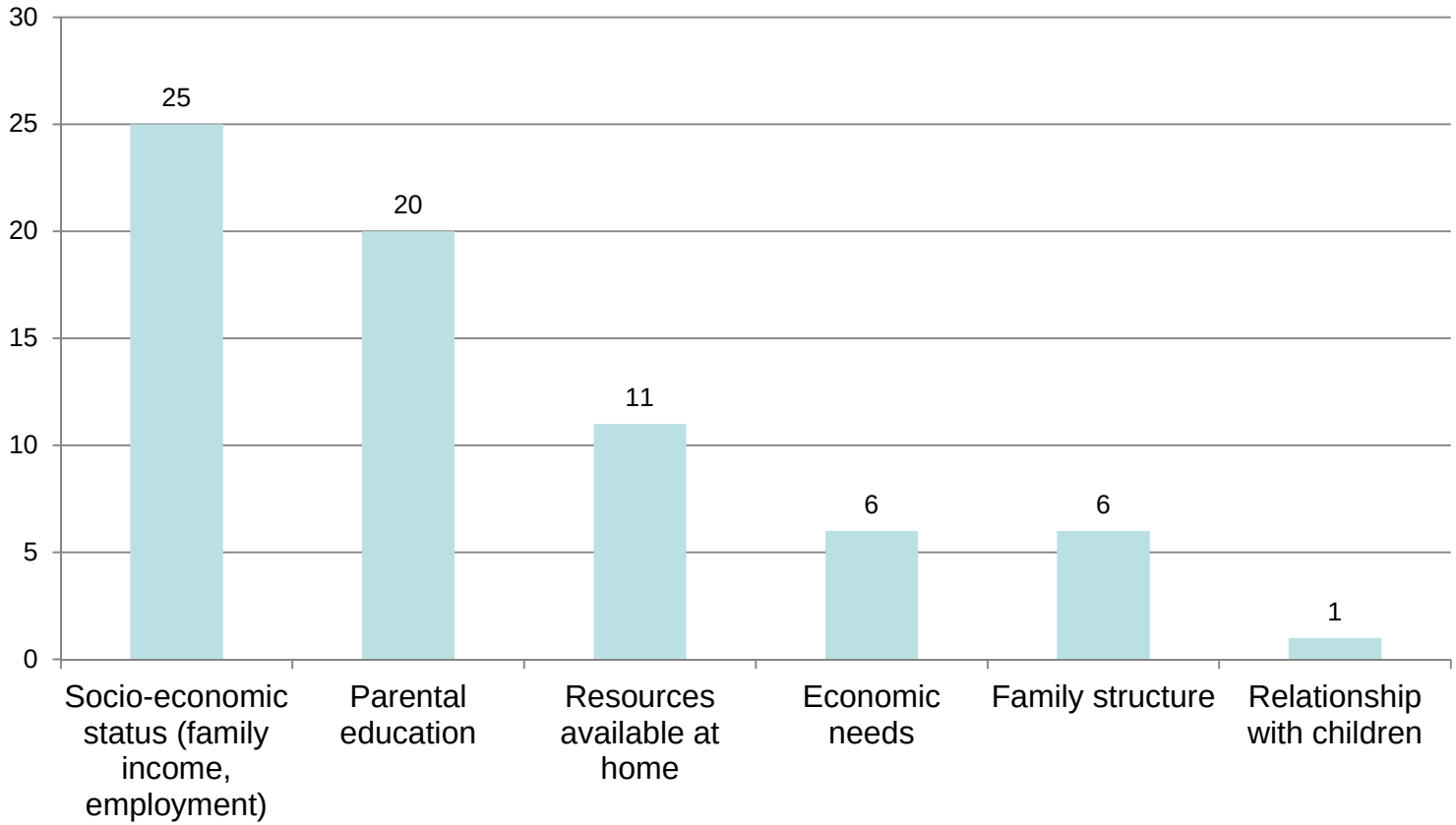
3. Student related input variables

As exam success, grade point average, test scores

Some 'input' variables are clearly contextual variables



2. Family related input variables



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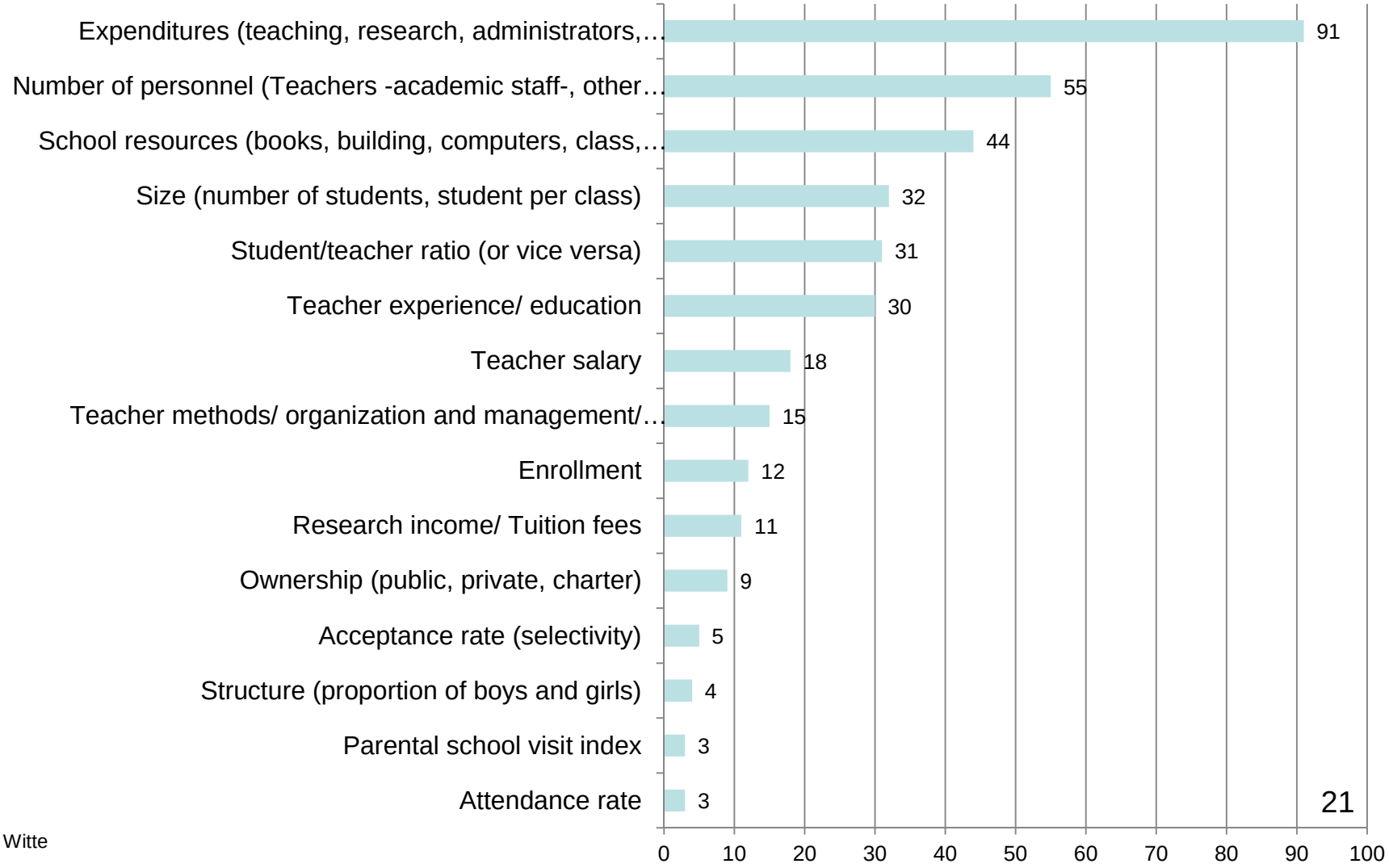
Systematic review of the literature

2. School related input variables



2. School related input variables

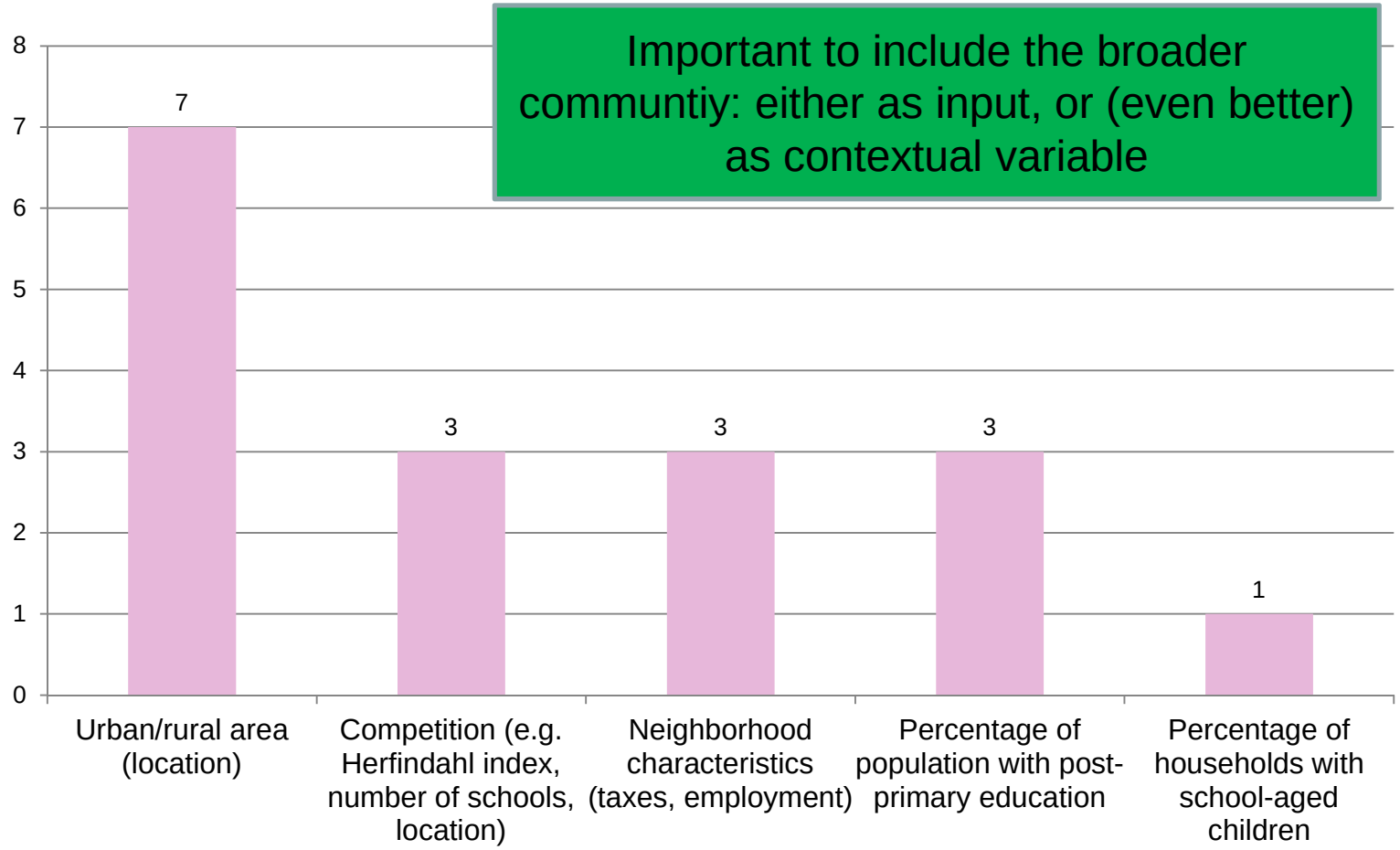
While extremely popular in the efficiency in education literature, these variables are largely disconnected from the general economics in education literature.

- Hanushek (2003, p. 91): “School resources are not closely related to student performance”
- Variables like ‘class size’ are unproductive policy

Better:

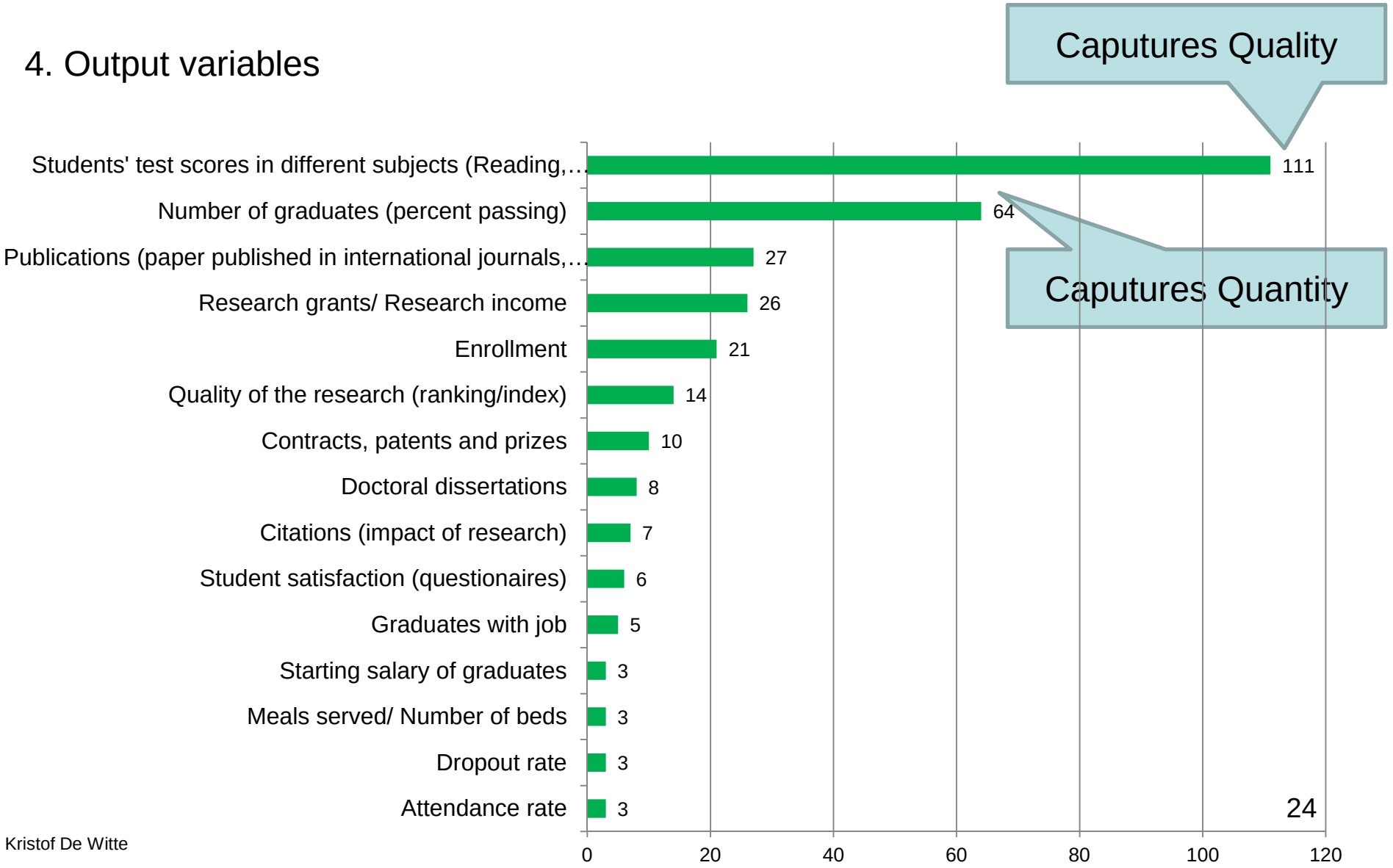
- Include teacher quality (but difficult to capture)

3. Community related input variables



Efficiency in Education
Systematic review of the literature

4. Output variables



4. Output variables

Two issues:

1. Many of the output variables are the product of earlier findings
   → Value added analysis

   In DEA since work by Portela and Thanassoulis (2001):
   It Isolates the effects on pupil results that are due to different efforts of pupils (i.e. pupil efficiency), from the effects that are due to differences in the school attended (i.e. school efficiency).

2. Most outputs concentrate on outcomes in the short run
   → More recent work (e.g. Agasisti, 2011) focusses on more long term outcomes as receiving a job after studying.

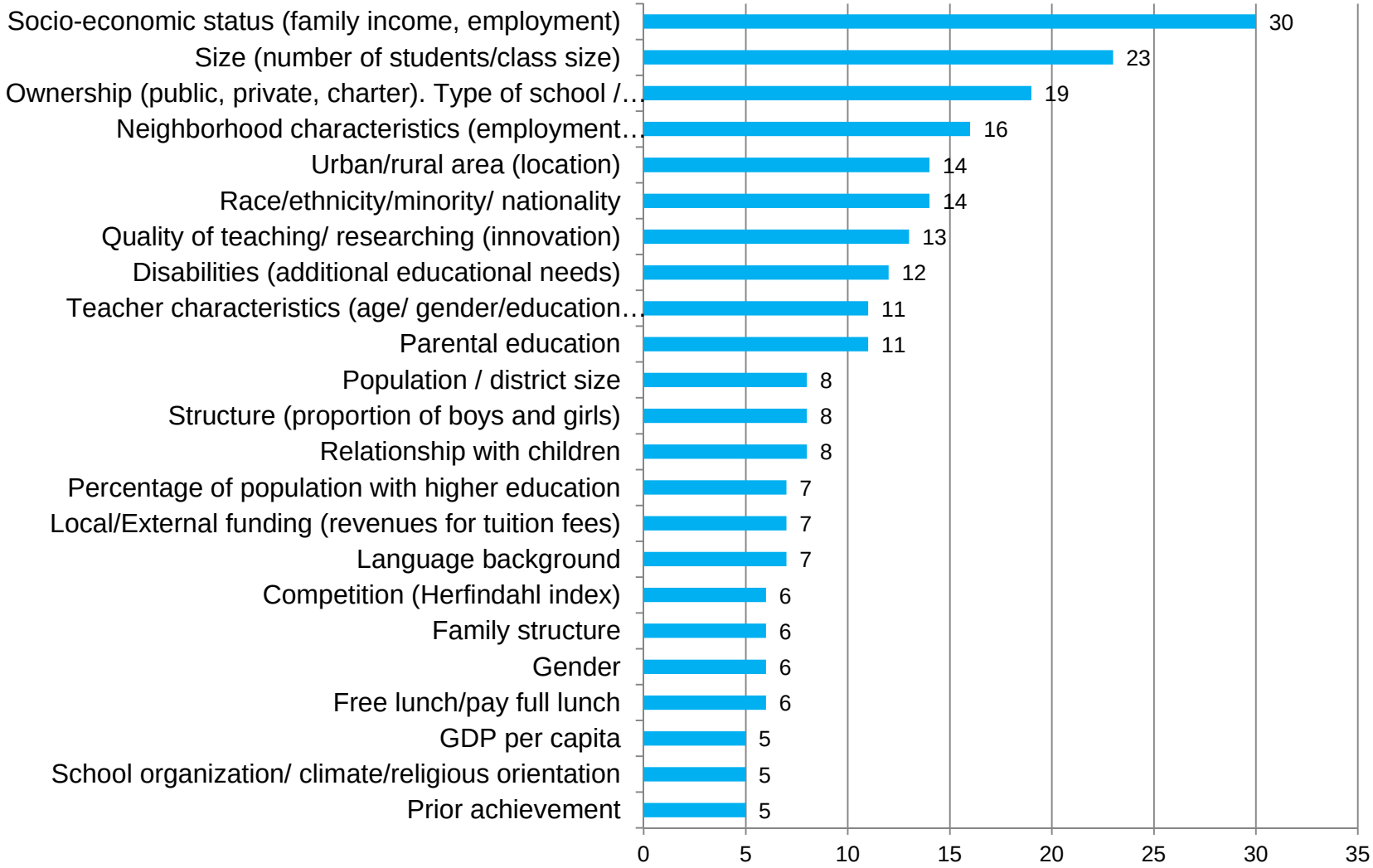
5. Non-discretionary variables

The Coleman Report (1996): School resources explain only 10% of academic results

→ What is the influence of structural, institutional and socio-economic variables on efficiency scores?

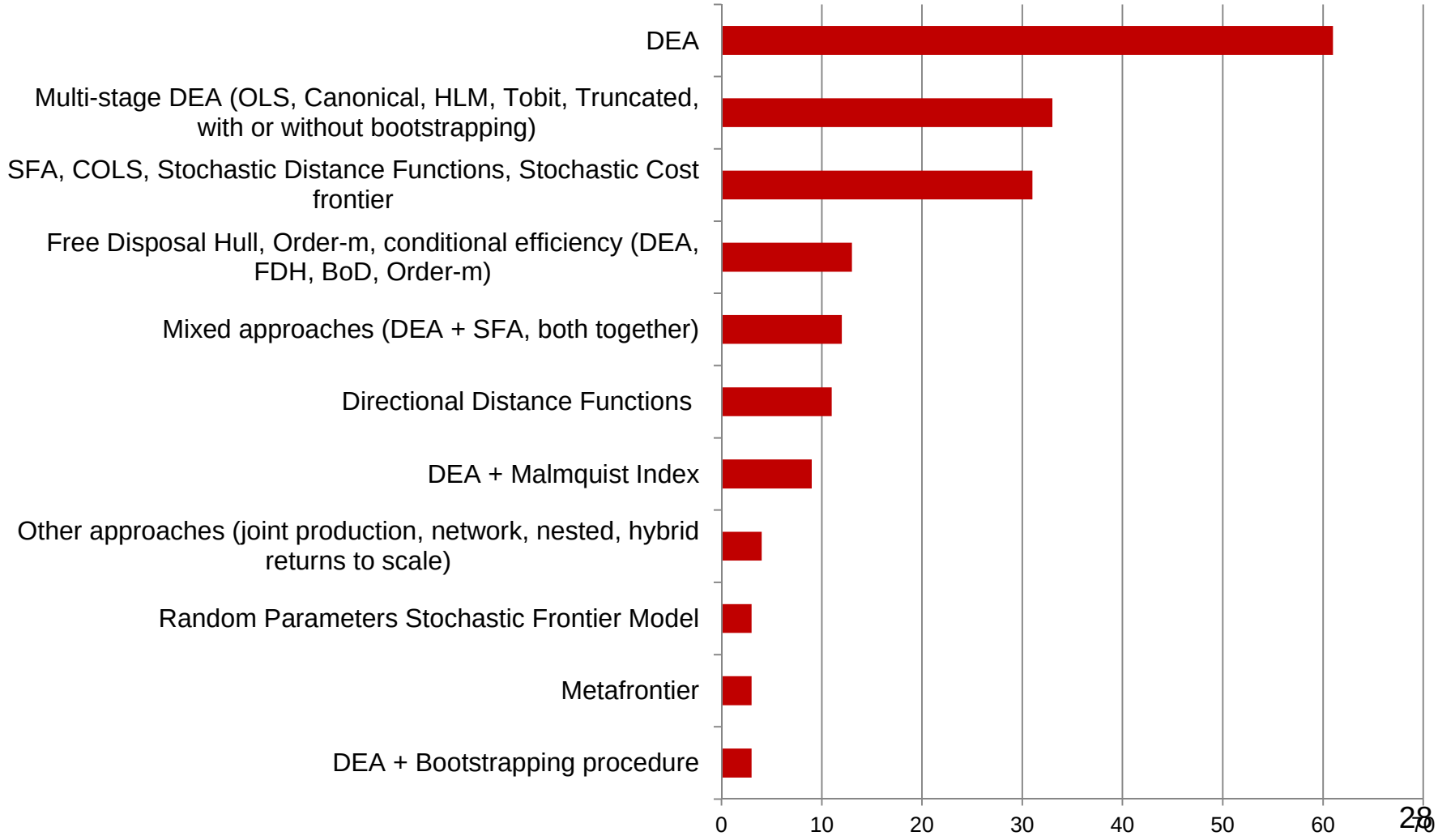
Efficiency in Education
Systematic review of the literature

5. Non-discretionary variables



Efficiency in Education
Systematic review of the literature

6. Applied methodologies



Overview

1. Setting the scene

2. Literature review

3. Bridging literatures
   a. Endogeneity and its sources
   b. Methodological similarities

4. Conclusion

Efficiency in Education
Bridging literatures

OR literature studying education ↔ economics of education literature

↓

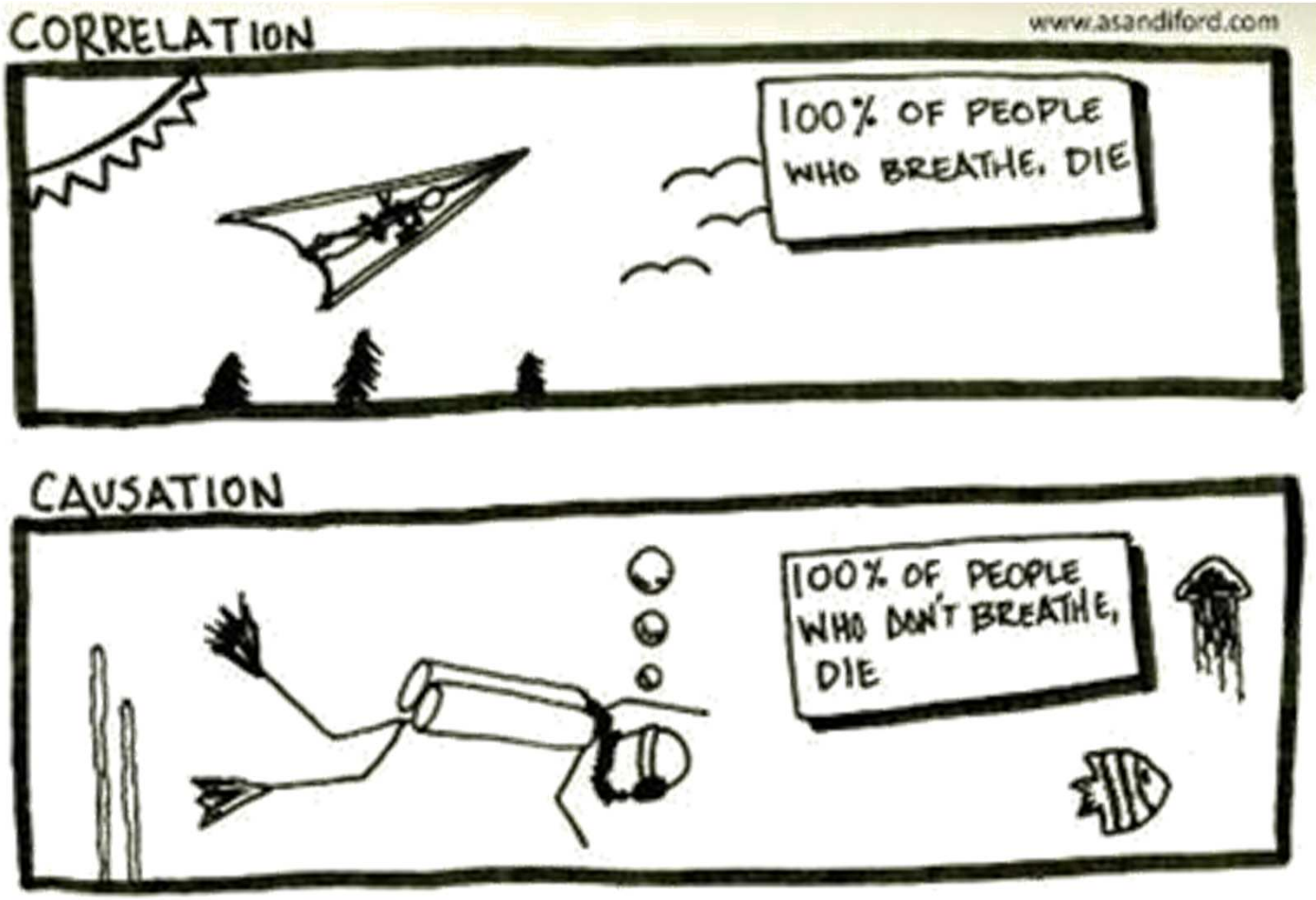
More ‘standard’ parametric literature

Focus on similar topics, but do not speak each other’s language

Efficiency in Education
Bridging literatures

Correlation ≠ Causation

Far too often, the efficiency literature interprets its outcomes in terms of causality rather than correlational evidence



Efficiency in Education
Bridging literatures

Correlation ≠ Causation

Far too often, the efficiency literature interprets its outcomes in terms of causality rather than correlational evidence

First step to bridge the gap

Acknowledge that nonparametric efficiency models do not estimate causal relationships

Second step: improve the internal validity of our work

Most notable: Check for endogeneity issues

? Perhaps because non-parametric DEA models do not have an error term, the issue is not picked up in the nonparametric efficiency in education literature ?

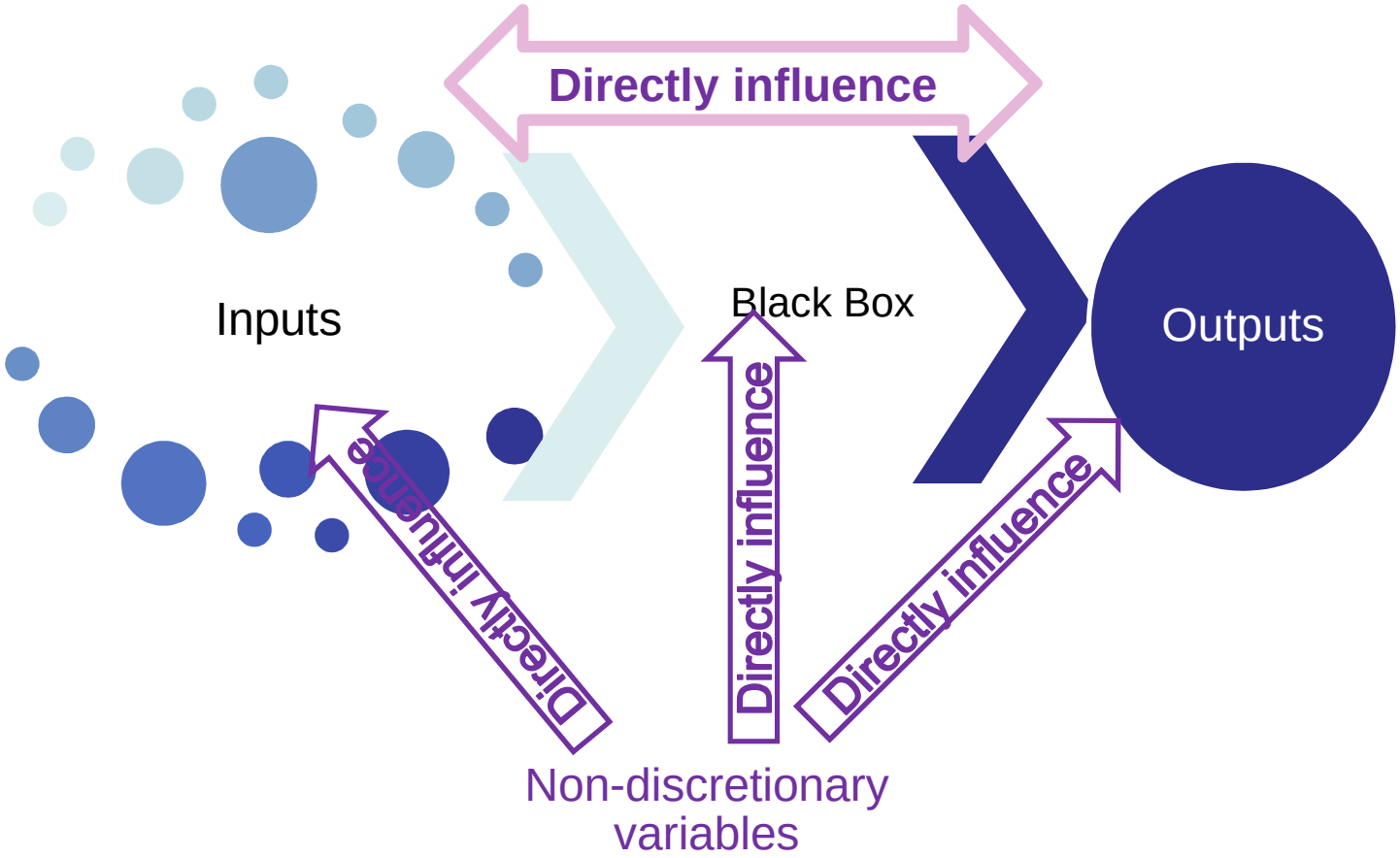
“the effects of endogeneity on such efficiency estimates have received little attention” (See “the alerts” in Cordero, Santin, Sicilia, 2014)

Efficiency in Education
Systematic review of the literature

Endogeneity has various origins

1. Inputs and outputs are not exogenously determined (see also Ruggiero, 2004 for an early (and sole?) remark on that)

   Note: assumption of monotonicity → Output will not decrease when inputs increase



Endogeneity and its sources

2. Omitted variable bias

= an uncontrolled confounding variable is correlated with the independent variable and the error term

Why is it an issue (see also Ruggiero, 2005)?

Large majority of the efficiency literature is prone to omitted variable bias

As large amount of confounding variables is infeasible due to:

(1) Curse of dimensionality (especially in studies at school level)

(2) Computational issues as non-parametric models 'let the data speak for themselves

(3) Use of datasets with insufficient control variables

Example:

Efficiency of education studies is the absence of prior attainments of students, e.g. in PISA data

Efficiency in Education
Bridging literatures

Fixed effects regressions

= To account for time invariant observed and unobserved heterogeneity by imposing time independent effects for the units of observation

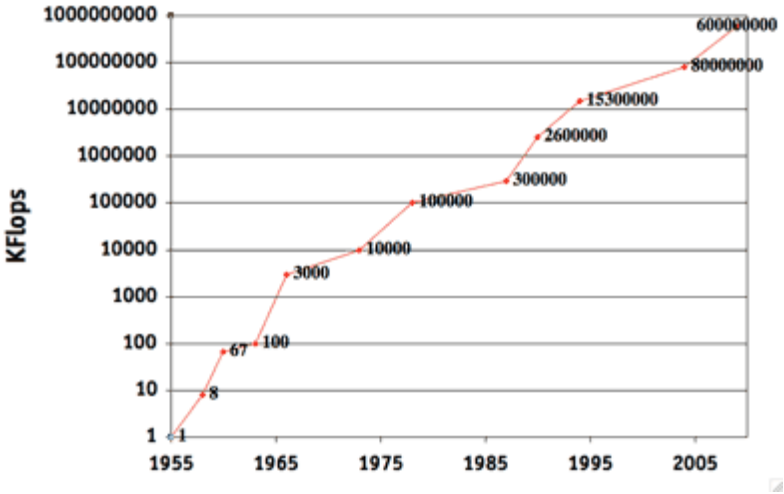
Why an issue?

Easy to do by including dummy variables,

But problematic due to computational burden and curse of dimensionality

Solution?

1. Speed of computers



2. Control better for observed heterogeneity

Endogeneity and its sources

3. Measurement errors

→ Bias the efficiency scores due to increased variability

Solution:

1. Use of order-m or order-alfa, which mitigate the influence of measurement errors
2. Discuss better the presence of measurement errors and its effects

→ e.g., they might result in an upper bound estimation of the efficiency score

→ This is again interesting for policy makers.

Endogeneity and its sources

4. Selection bias

= In the absence of random assignment (which is the case in most efficiency studies), observations can choose the degree to which they are exposed to a treatment, innovation or school.

Solution?

1. Minimal suboptimal step: to include the motivation for the treatment as a confounding variable

2. Optimal step: compare the efficiency scores of a treated and a nontreated group

→ Use experimental and quasi-experimental data

Reversed causality

Example from Haelermans and De Witte (2012):

In assessing the role of innovations in secondary schools
→ Reversed causality if innovative schools attract higher ability students.

We need to show that not student ability but competition (Lubienski, 2003), teacher attitudes (Ghaith and Yaghi, 1997) and teacher beliefs (Hermans et al., 2008) can be considered as determinants of innovations.

Overview

1. Setting the scene

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Given the issues, how can we move forward?

Learn from our sister literature…

Methodological similarities

1. Matching and conditional efficiency

Difference:

Matching: focusses on the effect of a treatment

Conditional: focusses on the relative efficiency of observations

Similarities:

Matching: searches (by Kernels) for every treated (cfr. evaluated) observation a non-treated observation with similar observed characteristics

→ Idea: As the observed characteristics are the same for both groups, the unobserved characteristics will also be similar

Conditional: uses non-parametric kernel estimations to attach weights to observations with similar observed characteristics

→ See De Witte and Van Klaveren, 2014, Education Economics

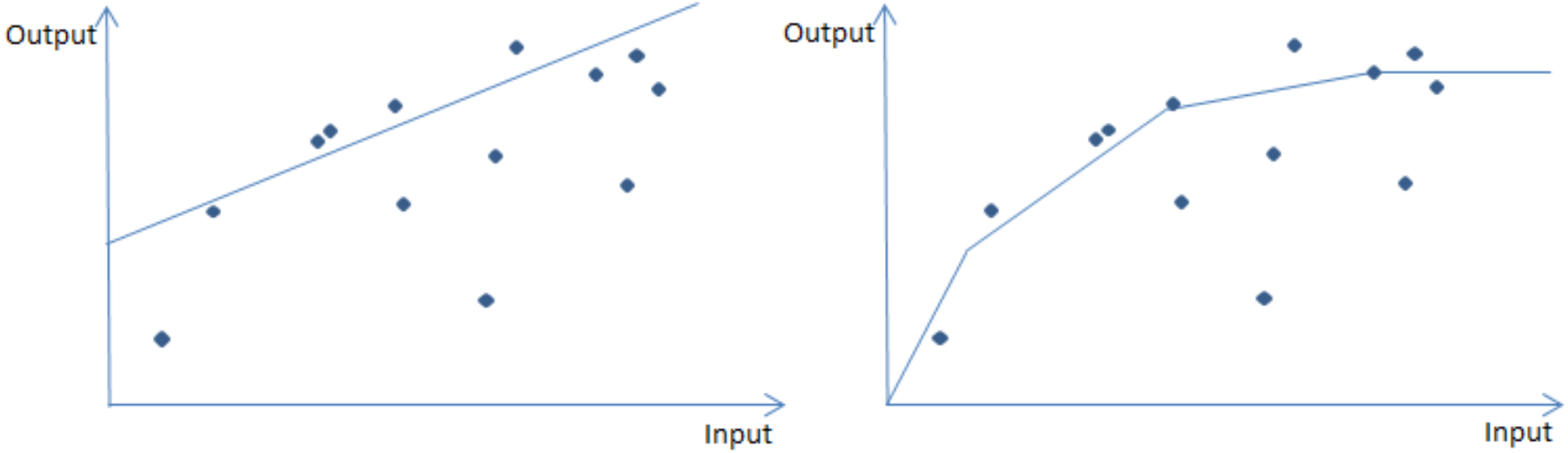
2. Quantile regressions and partial frontiers

Partial: Draw observations with replacement

Quantile: Estimate the conditional quantile of response variables

→ Stimulate methodological advances in partial frontiers by using insights from quantile regressions

Figure 2: Graphical representation of quantile regression (left) and partial frontiers (right)



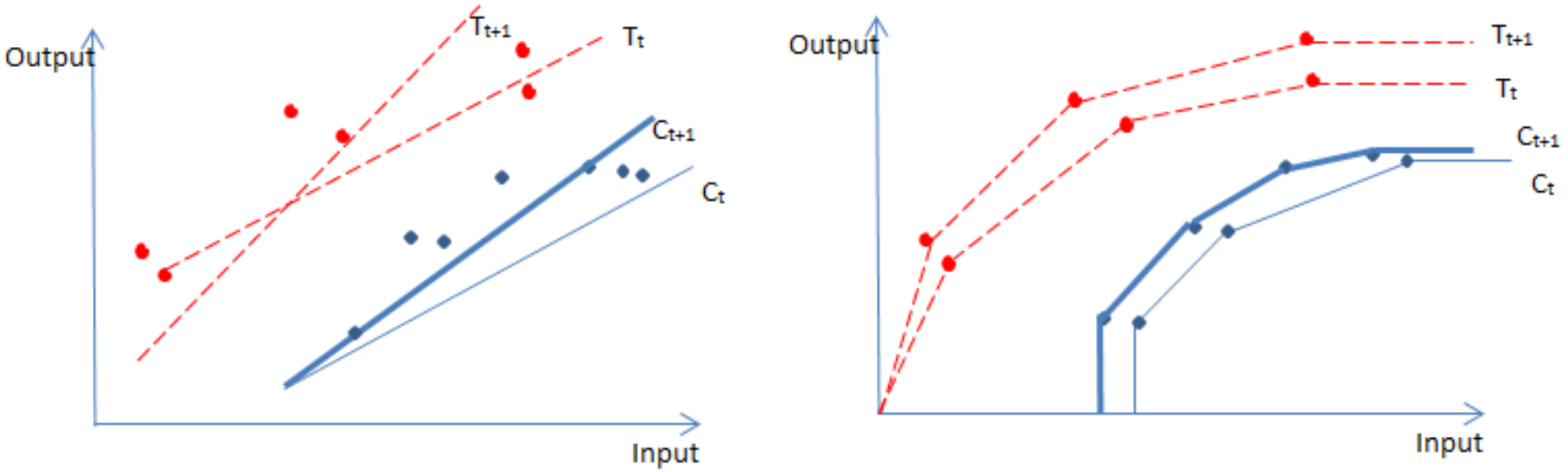
3. Difference-in-differences and metafrontier

DiD: compares the change over time of a treatment and a control group, before and after a treatment.

Metafrontier: measures the difference in efficiency between two groups, and, by extension, over time

(Note: ≠ Malmquist as it does not compare the change between two groups of observations)

Figure 3: Graphical representation of matching vs conditional efficiency



3. Experiments and metafrontier

Experiment: compares the change a treatment and a control group
Metafrontier: measures the difference in efficiency between two groups

→ Apply efficiency models to experimental data (e.g. The effect of ICT in De Witte, Haelermans and Rogge, mimeo)

Finally

1. Use the most rich data sets available, which include data on human resources, finance, ICT, procurement, estates, student services, …

2. Control for all sources of (at least) observed heterogeneity

3. Look across the fence to the ‘economics of education literature’

4. Focus less on methodological details, but more on serious shortfalls like endogeneity

Conclusion

Invitation

KU LEUVEN
LEUVEN ECONOMICS OF EDUCATION RESEARCH

Stephen Machin
University College London

Elena Del Rey Canteli
University of Girona

Geraint Johnes
Lancaster University

Tommaso Agasisti
Politecnico di Milano

LEER Workshop on 'Education Economics'

Leuven, Belgium
April 2 and 3, 2015

Submission deadline: January 15, 2015

Both posters and oral presentations

Further information:
www.econ.kuleuven.be/leer

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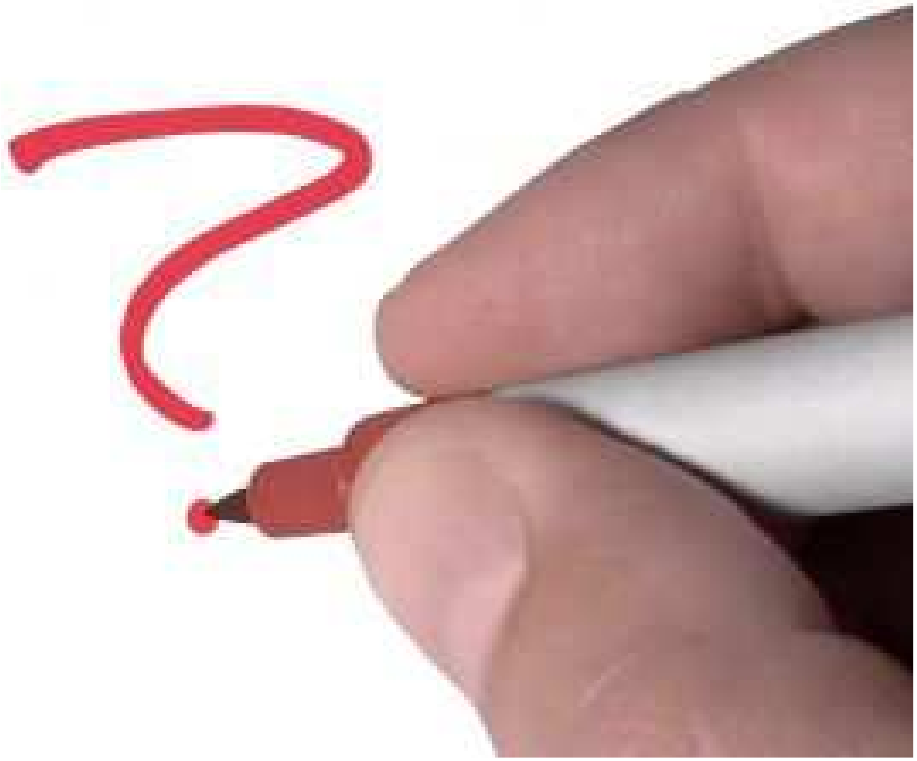

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