Dynamic Efficiency and Productivity Analysis

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(ongoing work with Spiro Stefanou, Elvira Silva)

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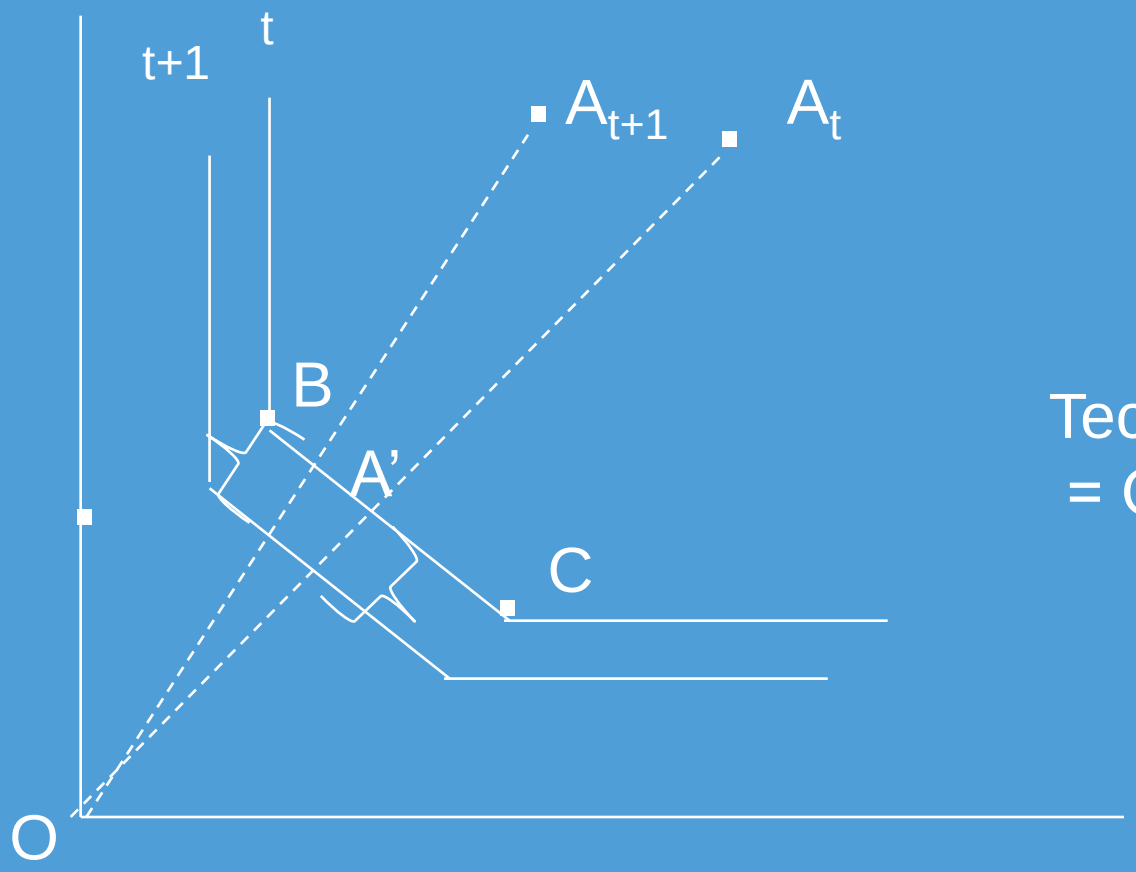
Overview

- Motivation
- Dynamic Directional Distance Function and Technical inefficiency
- Dynamic Cost function and Cost Inefficiency
- Applications

Motivation: Dynamic Technical Efficiency and productivity analysis

- Technical efficiency and total factor productivity are key determinants of the cross country competitiveness
- Technical efficiency reflects the extent to which the production potential is used
- Total factor productivity is usually reflected as a ratio of all outputs and all inputs (e.g. Tornquist, Malmquist) or as a difference between output and inputs (Luenberger)
- Investments in quasi-fixed factors (capital assets) can improve the productivity (better technology, more optimal scale of production)

Motivation: Static Technical Efficiency and productivity Analysis

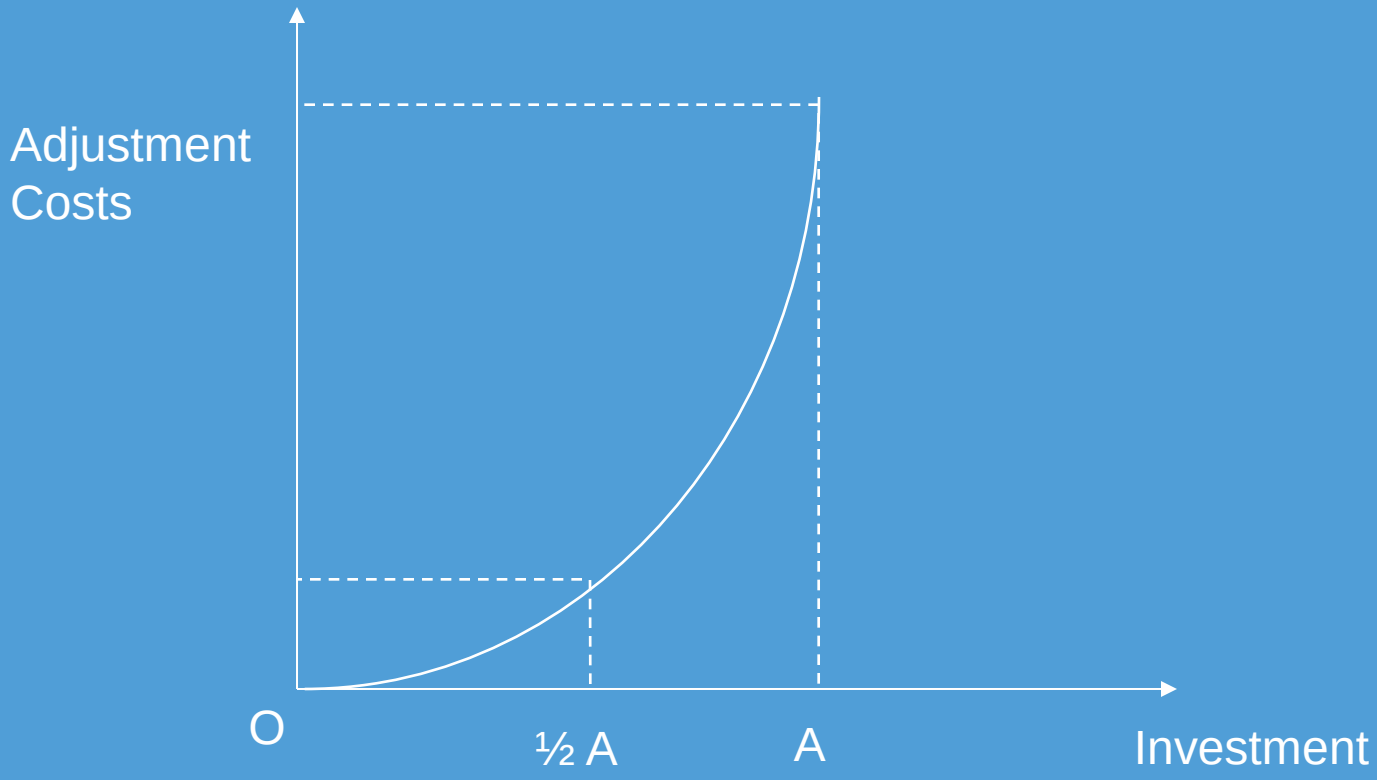


Technical Efficiency
= O'A'/O'A

Motivation: Dynamic Technical Efficiency

- Dynamic dimension of technical efficiency and productivity?
- Costs of adjustment in quasi-fixed factors of production
  - Low prices for second hand machinery due to asymmetric information in markets of second hand machinery
  - Environmental costs of disposal of buildings (e.g. asbestos)
  - Costs of capital increase with the size of the amount borrowed.
  - Human capital related costs: Learning costs and search costs

Motivation: Dynamic Technical Efficiency



- A = Investment needed to achieve the long-run optimal capital stock
- Cheaper to split investment in two steps of1/2A rather than in one step of size A

Dynamic Technical Efficiency

In the dynamic context the decision maker seeks to:

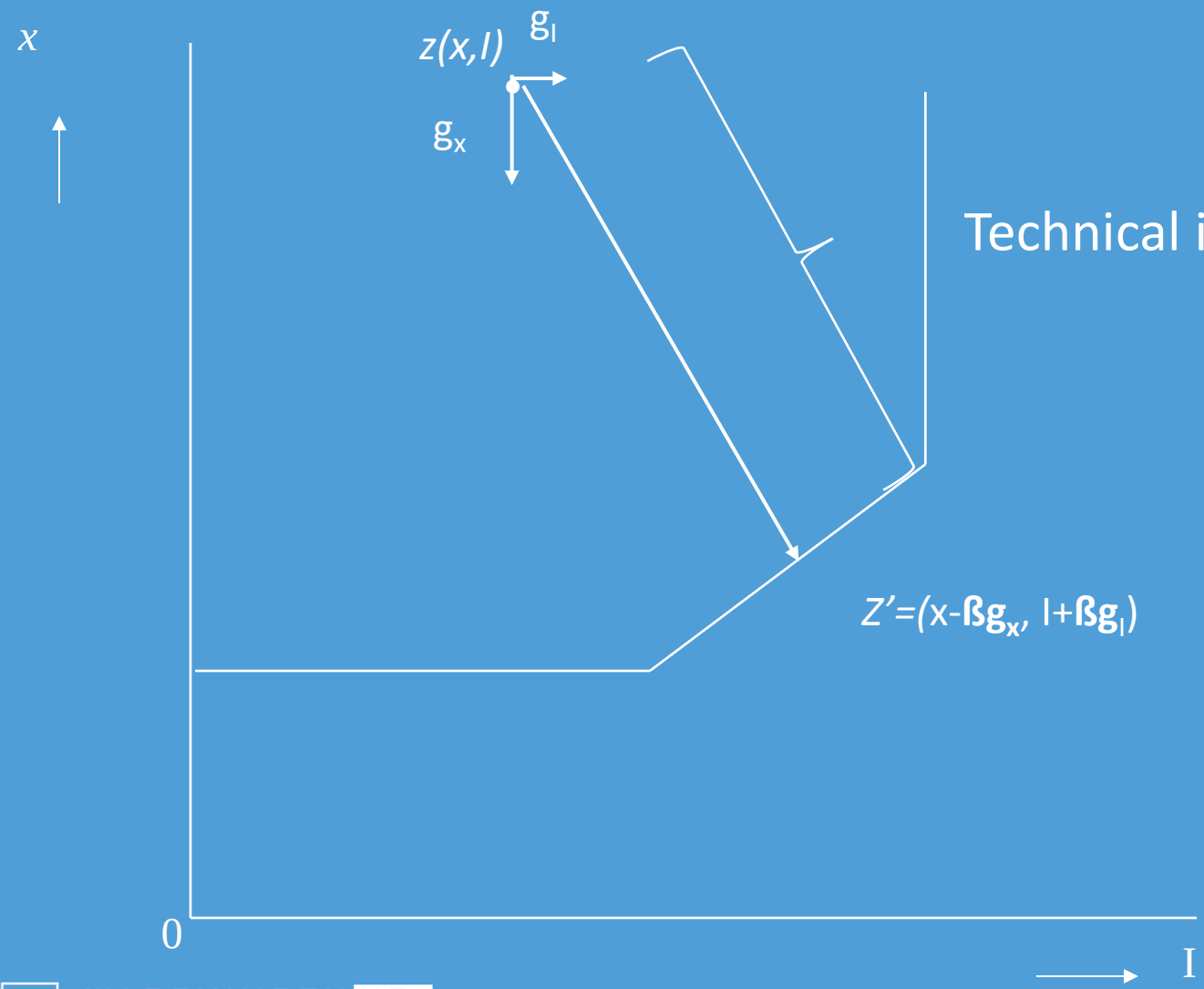
Minimize

- variable inputs

Maximize

- Investment in quasi-fixed factors
- Variable outputs

Dynamic Directional Input Distance Function and technical inefficiency



Dynamic Directional Input distance function

$$\overrightarrow{D}_i(y,x,I,k;g_x,g_I)=$$

$$\sup\left\{\beta:(x-\beta g_x, I+\beta g_I)\in V(y:k)\right\}$$

$V(y:k)$ *Technology* : x, I *can produce* y, *given* k

y *Output vector*

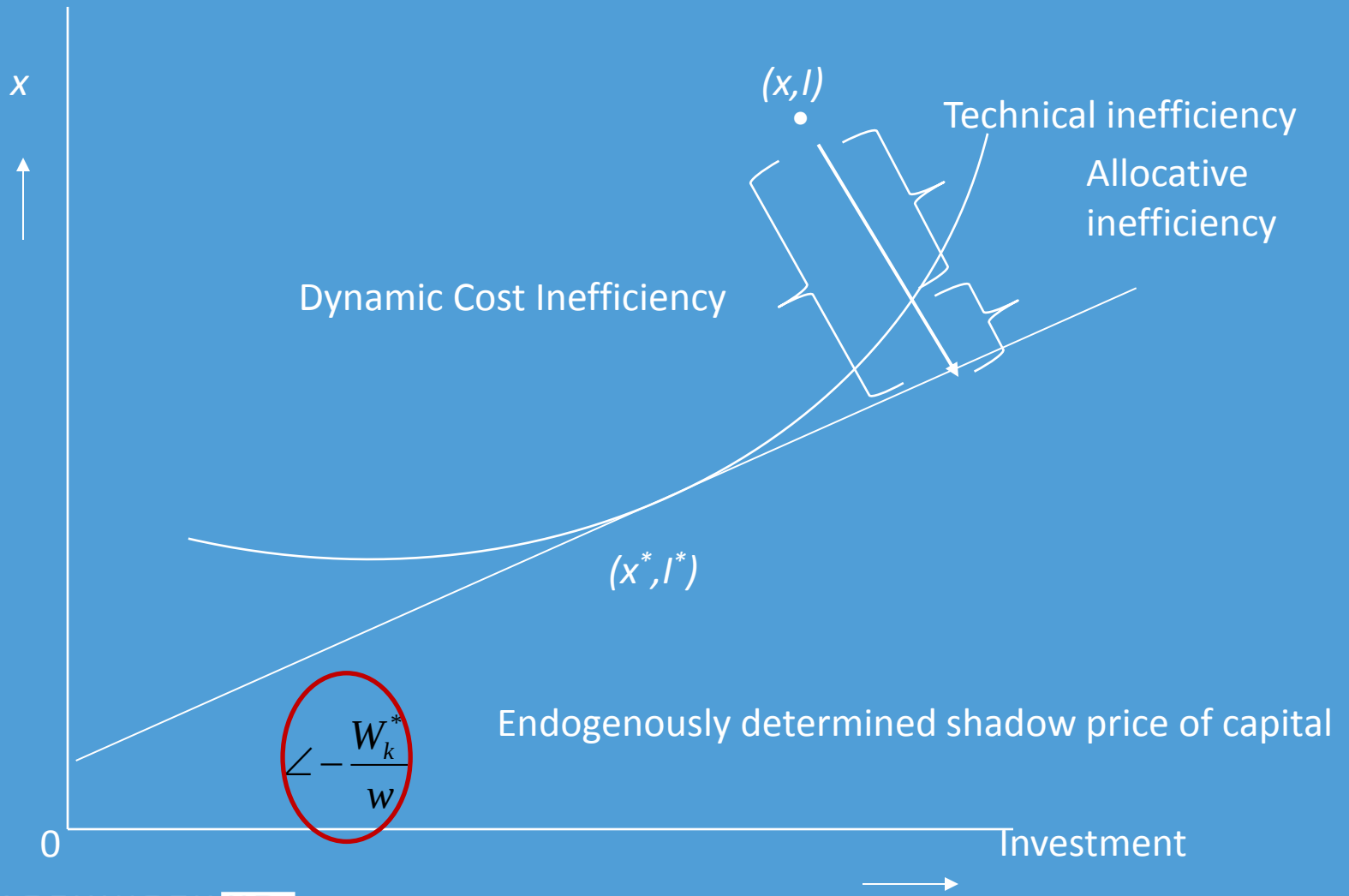
x *Variable input vector*

k *Quasi – fixed input vector*

I *Net investment quasi – fixed input*

g_x, g_I *Directional dist. vectors*

Dynamic Cost Inefficiency



Dynamic Cost function: Cost minimization

$$rW(w,c,k,L,y) = \min \{wx + ck + W_k (I - \delta' k)\}$$

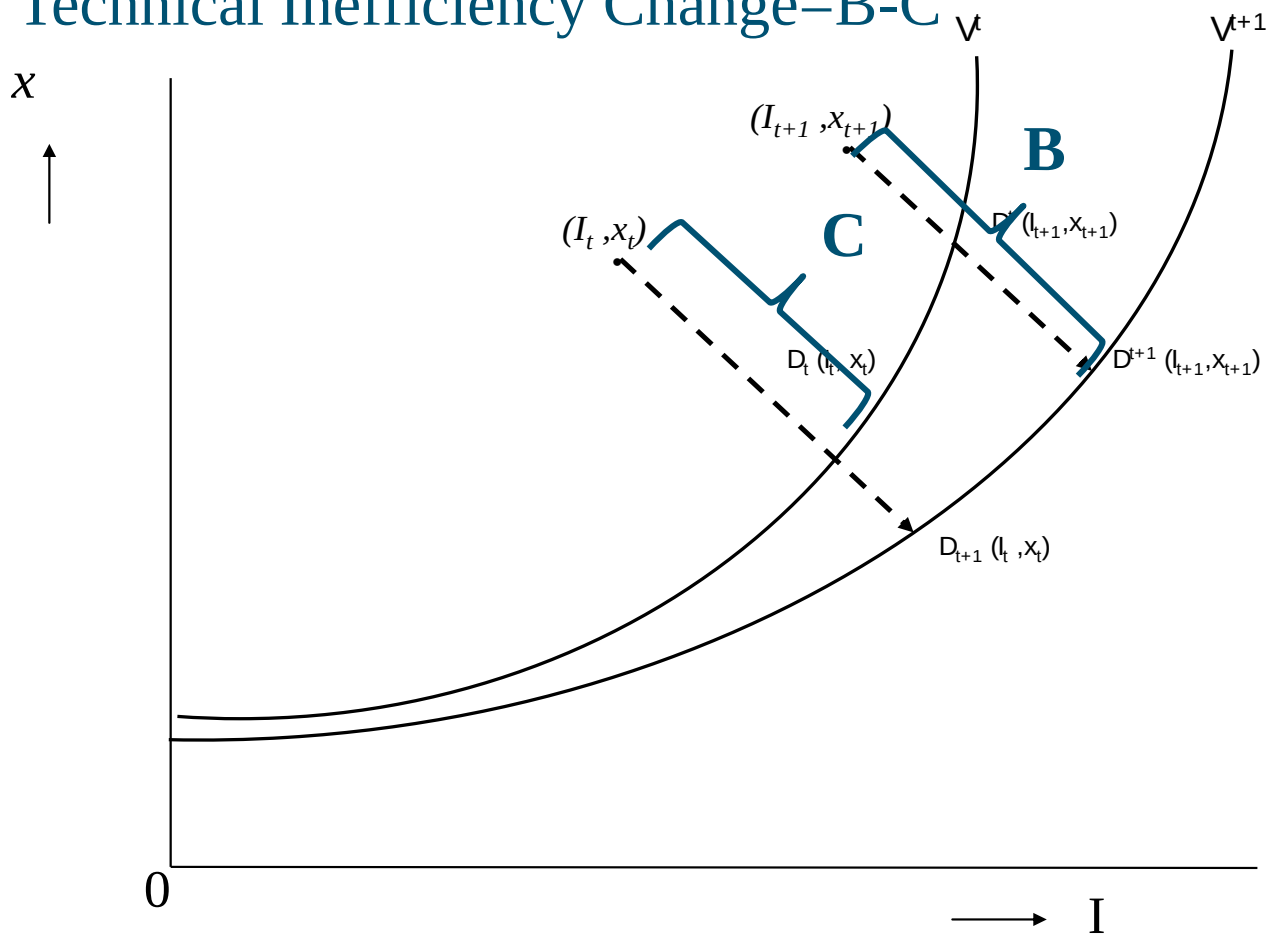
$$s.t. \quad \vec{D}(y,x,I,k,L;g_x,g_I) \geq 0$$

$W(\cdot)$	=	Intertemporal Shadow Cost Function
w,x	=	price, quantity variable inputs
c,k	=	price, quantity quasi fixed inputs
W_k	=	Shadow value capital
I	=	Investments
δ	=	Depreciation rate
y	=	Output
g_x, g_I	=	Directional distance vectors of *x* and *I*

Dynamic Luenberger TFP growth Indicator

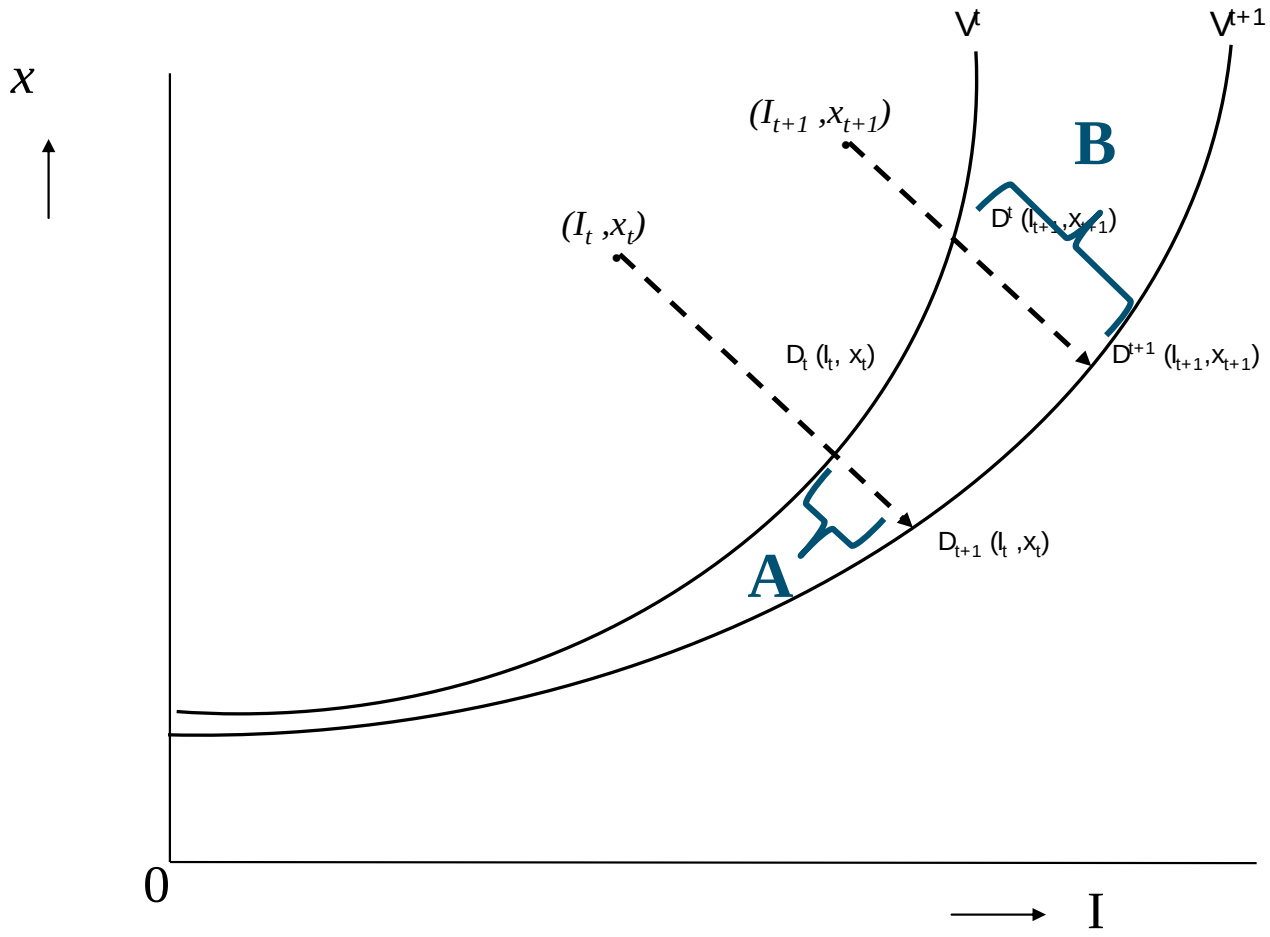
Technical inefficiency in *t* =C and in *t+1* it is B

Technical Inefficiency Change=B-C



Dynamic Luenberger TFP growth Indicator

Technical Change=½(A+B)



Application (DEA): Data Dutch Horticulture

- Specialized vegetables (greenhouse) firms in the Netherlands
- Main outputs: Peppers, Cucumbers, Tomatoes
- Farm Accountancy Data: 265 observations from 103 farms
- Data Envelopment Analysis was used to estimate dynamic technical, allocative and cost inefficiency

Results: Dynamic Technical, Allocative and Overall Cost Inefficiency

Period	Technical inefficiency
1997	0.39
1998	0.34
1999	0.26
1997-1999	0.33

Application (parametric): Data Dutch Dairy

- Specialized dairy farms from Farm Accountancy Data Network
- Main outputs: milk, beef plus some crops
- 80% of revenues are from milk
- 2614 observations from 669 farms

Empirical Specification

- Quadratic dynamic directional distance function
- Normalized Quadratic dynamic cost frontier
- Results: Serra, Oude Lansink and Stefanou, 2011 (*American Journal of Agricultural Economics*)

Results: Dynamic Technical, Allocative and Overall Cost Inefficiency

Period	Technical inefficiency
1995-2000	0.100
2001-2005	0.107
Mean	0.104

Application: Dynamic versus Static productivity growth in the Spanish Meat processing Industry

- More EU regulation regarding food safety, consumer information and sustainable practices. Leads to productivity decline?
- Data from Spanish meat processing firms (SABI data base)
- 928-1527 firms per year in the period 2000-2010
- Static Malmquist compared with dynamic Luenberger

Productivity growth Spanish Meat Processing firms

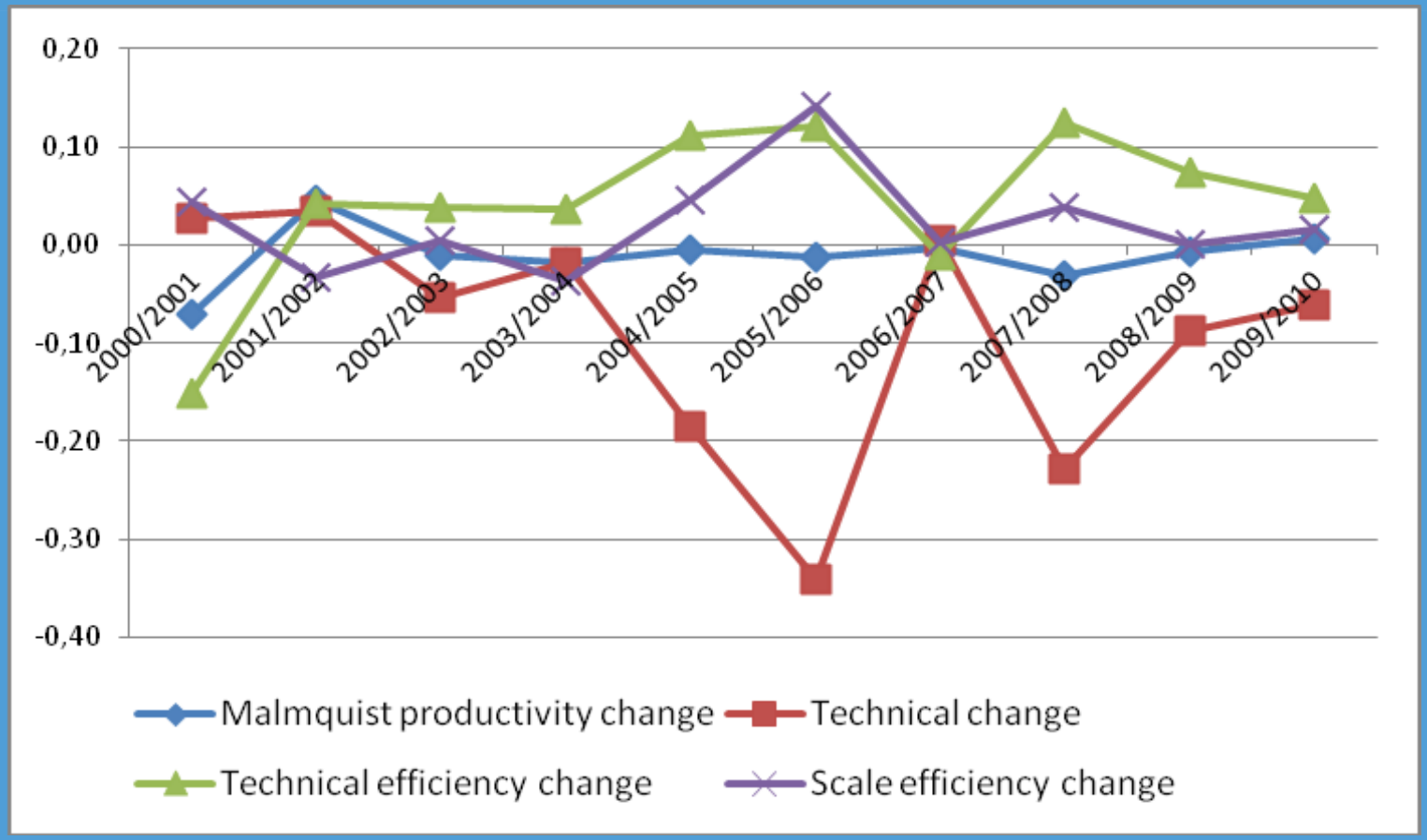
- Total Factor Productivity growth (static and dynamic)
  - Technical change
  - Technical efficiency change
  - Scale efficiency change

Results: Static versus Dynamic measures (2000-2010)

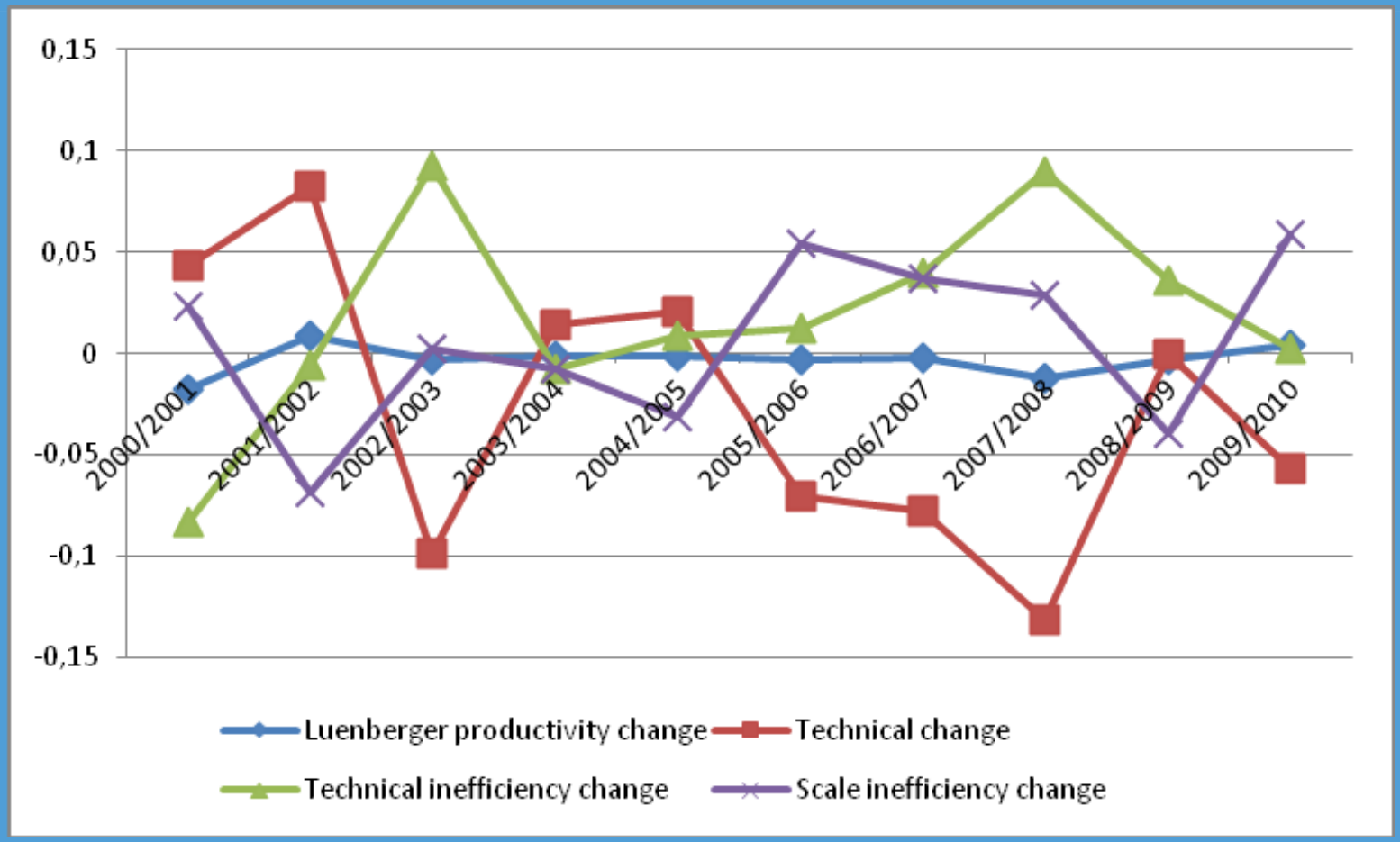
Static Malmquist productivity change	Technical change	Technical efficiency change	Scale efficiency change
-0.010	-0.093	0.052	0.025

Dynamic Luenberger productivity change	Technical change	Technical inefficiency change	Scale inefficiency change
-0.003	-0.031	0.022	0.005

Results: Evolution of Malmquist index and its components



Results: Evolution of the Luenberger indicator and its components



Conclusions

- Adjustment costs of investments in quasi fixed factors may have a (temporary) downward impact on the production potential
- Hence cross country competitiveness of countries with substantial investments may be temporarily negatively affected.
- Static models do not properly reflect the dynamic nature of capital and may misrepresent the sources of productivity growth

Thank you!