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Dynamic Efficiency and Productivity Analysis

Alfons Oude Lansink

Selected Paper prepared for presentation at the International Agricultural Trade Research Consortium's (IATRC's) 2013 Symposium: Productivity and Its Impacts on Global Trade, June 2-4, 2013, Seville, Spain

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Dynamic Efficiency and Productivity Analysis

Sevilla 2-4 June

Alfons Oude Lansink

(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

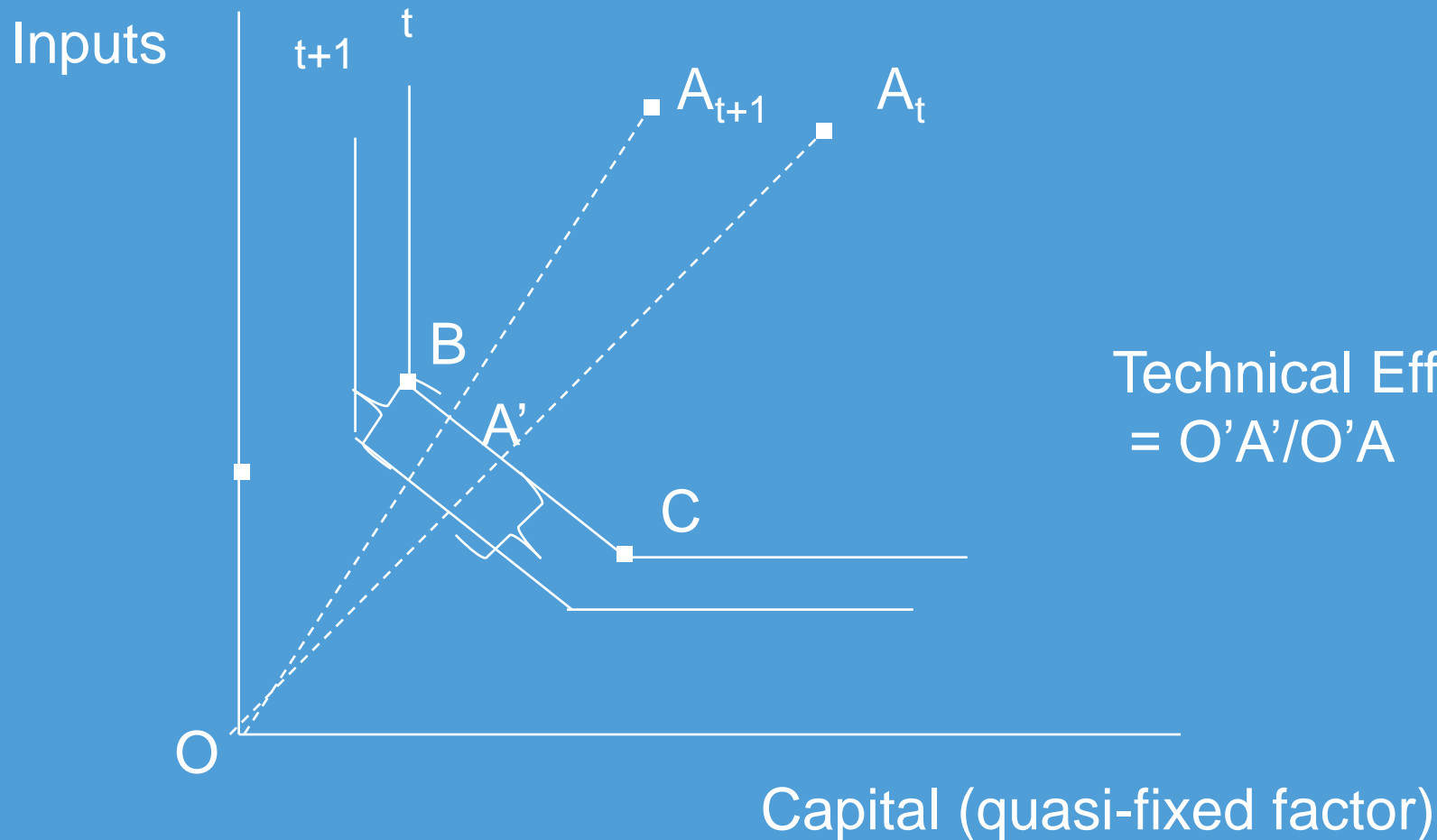


Motivation: Dynamic Technical Efficiency and productivity analysis

- 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

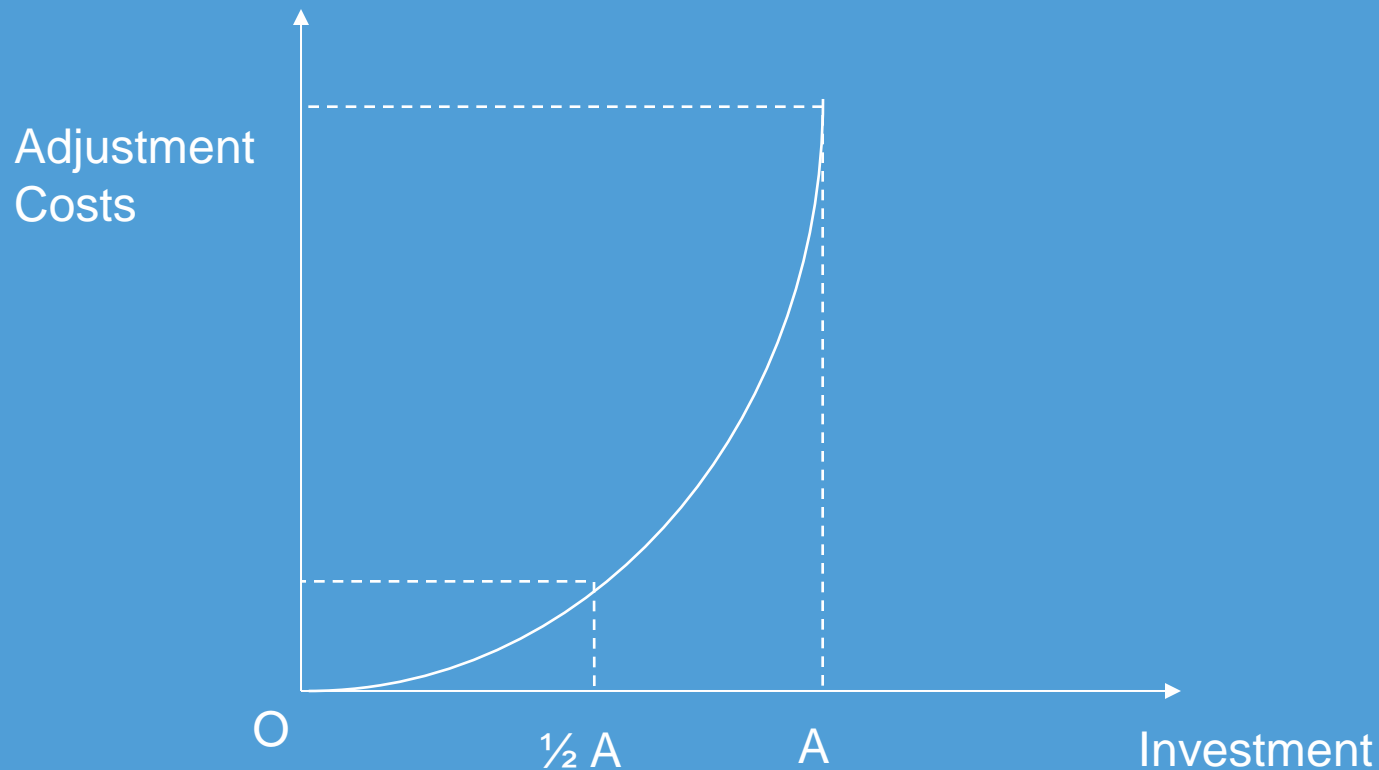


Motivation: Dynamic Technical Efficiency

- 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 of $\frac{1}{2}A$ rather than in one step of size A



Dynamic Technical Efficiency

In the dynamic context the decision maker seeks to:

Minimize

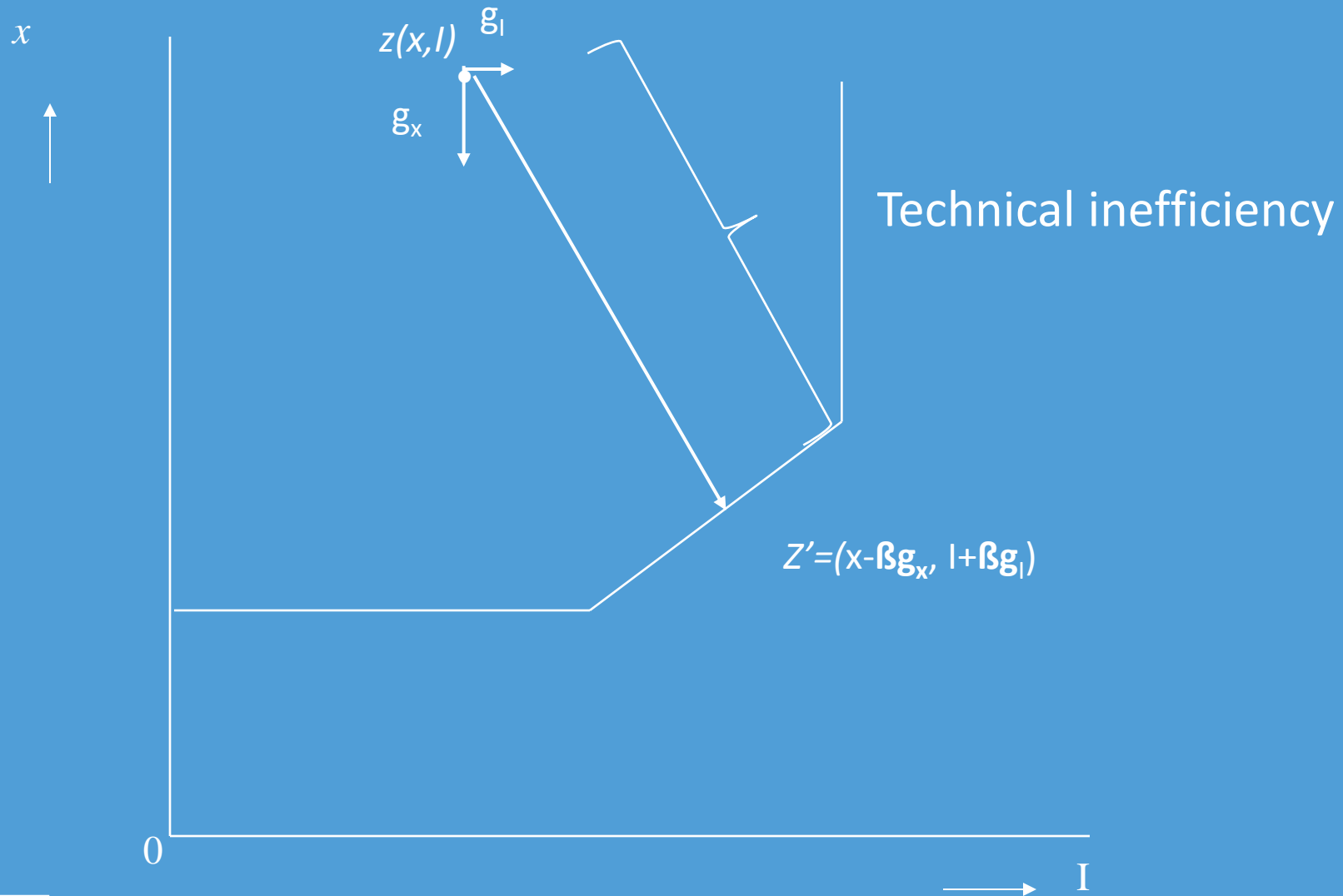
- variable inputs

Maximize

- Investment in quasi-fixed factors
- Variable outputs



Dynamic Directional Input Distance Function and technical inefficiency



Dynamic Directional Input distance function

$$\vec{D}_i(y, x, I, k; g_x, g_I) = \sup \{ \beta : (x - \beta g_x, I + \beta g_I) \in V(y : k) \}$$

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

y Output vector

x Variable input vector

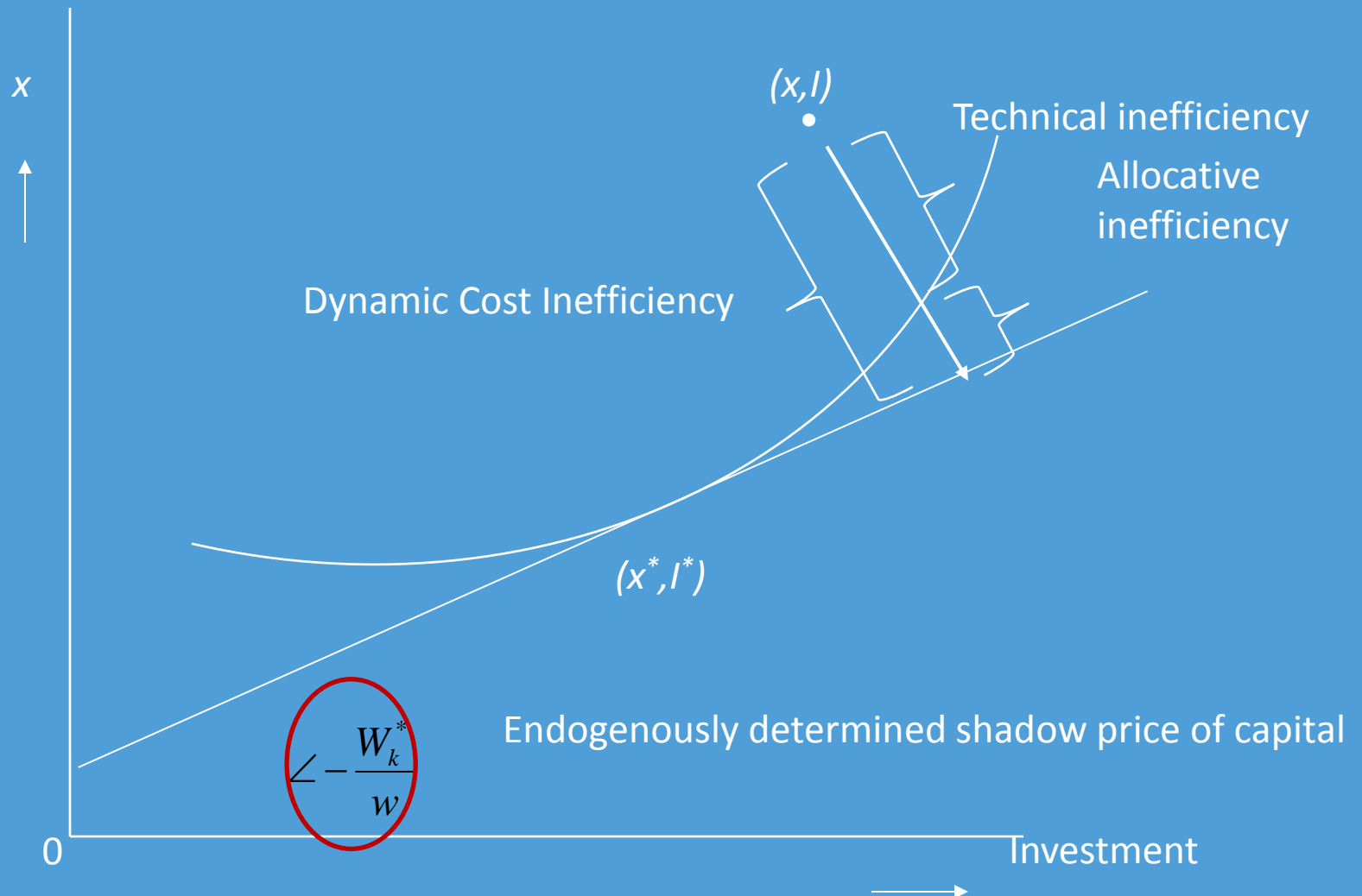
k Quasi – fixed input vector

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

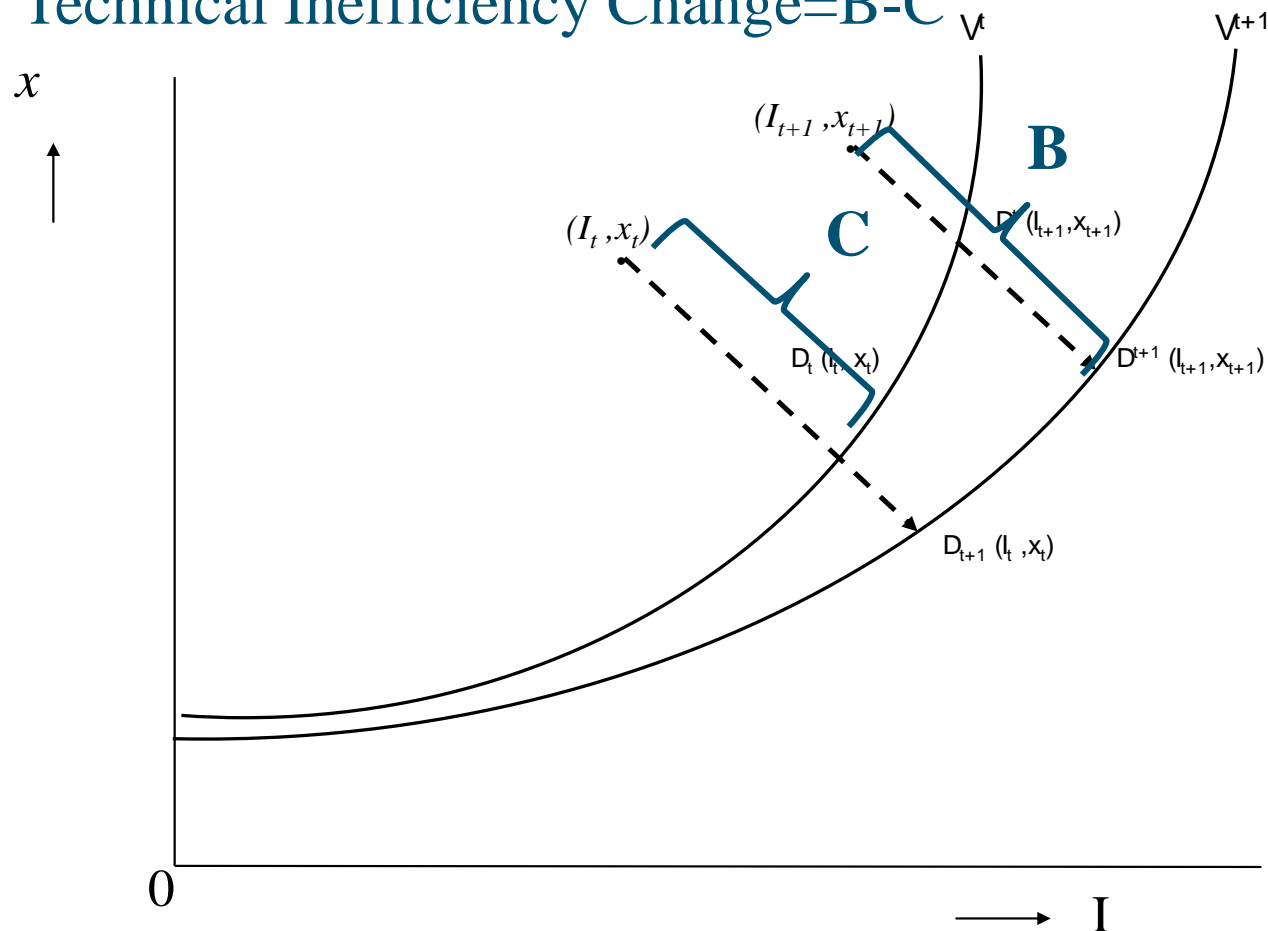
g_x, g_I = Directional distance vectors of x and I



Dynamic Luenberger TFP growth Indicator

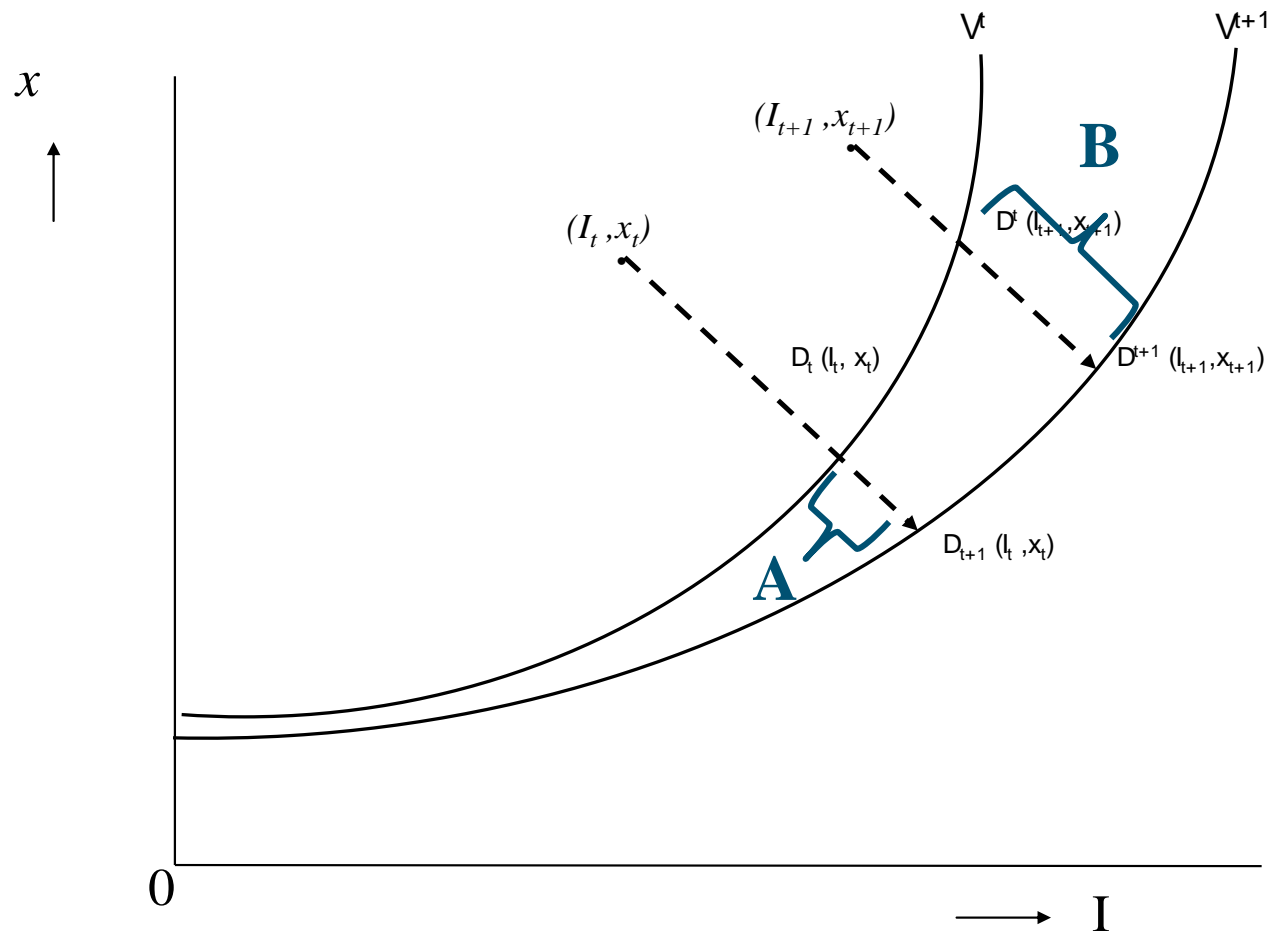
Technical inefficiency in $t = C$ and in $t+1$ it is B

Technical Inefficiency Change = $B - C$



Dynamic Luenberger TFP growth Indicator

$$\text{Technical Change} = \frac{1}{2}(A+B)$$



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



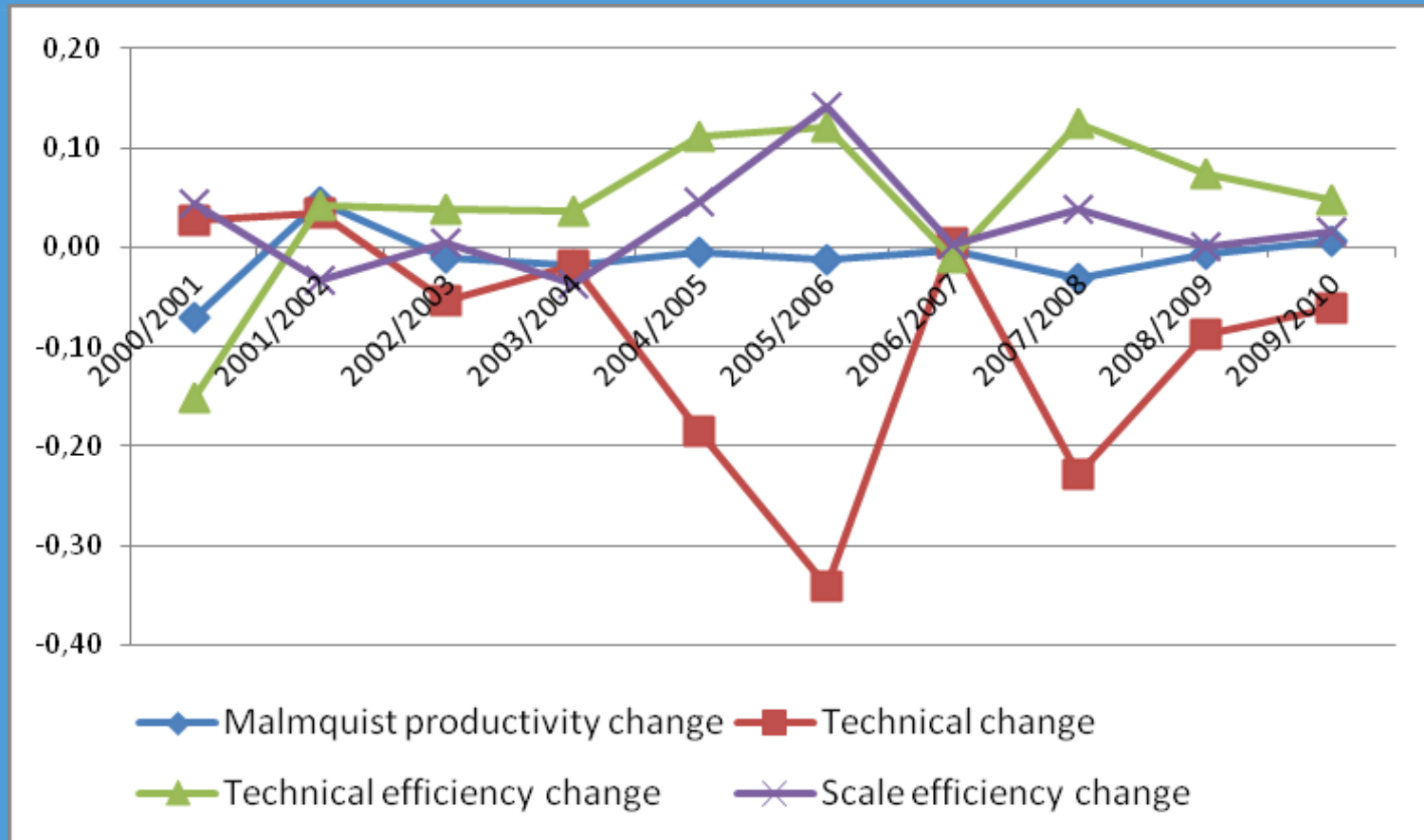
Results: Static versus Dynamic measures (2000-2010)

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

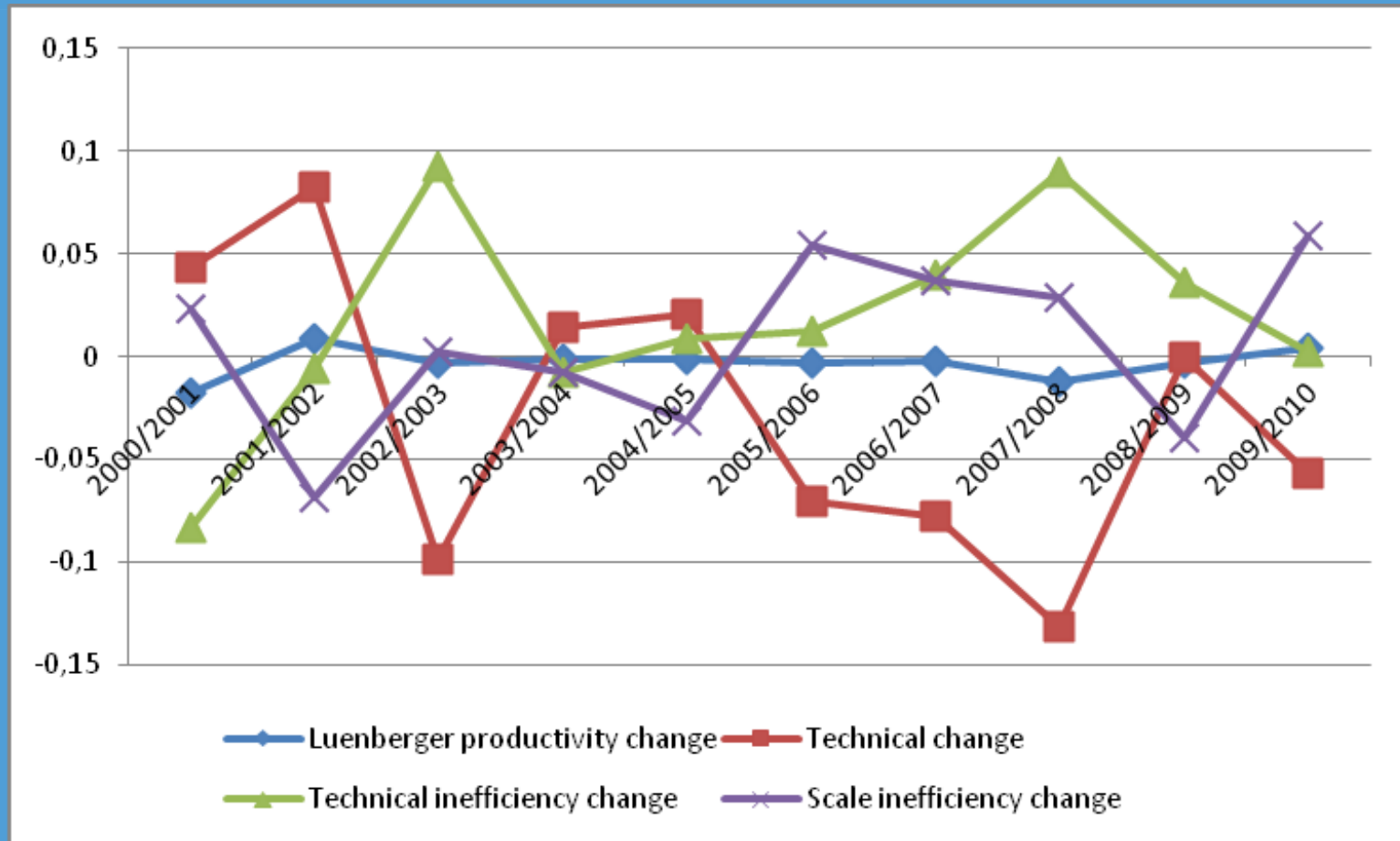
Dynamic Luenberger productivity change	Technical change	Technical inefficiency change	Scale inefficiency change
-0.003	-0.031	0.022	0.005



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!



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