

ERS 2017

Sustainability and **Efficiency** in
**Transportation, Logistics and Supply Chain
Management: Foes, Strangers or Friends?**
Longitudinal Sustainability Evaluation for
European Logistics Service Providers (LSP):
A DEA Malmquist Index Calculation

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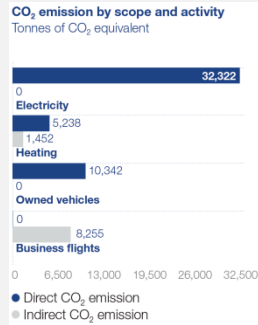
Agenda

- 1. Research Question**
- 2. Sustainability Measures**
- 3. DEA Malmquist Index Method**
- 4. LSP Sustainability Data**
- 5. Calculation Results**
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1. Research Question

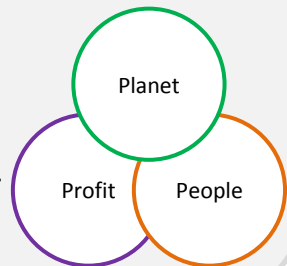


Existing:
Single
indicator
sustaina-
bility LSP
evaluation
(e.g. CO₂)



(Panalpina 2016, p. 55)

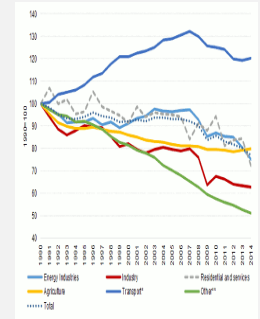
Existing:
TBL approach
for multi-
criteria
sustaina-
bility eva-
luation



How can a **DEA Malmquist index calculation** be applied to the **question of longitudinal sustainability efficiency** development of **LSP** regarding the **sustainability triple bottom line** and what are the results?



Existing:
Single
indicator
dynamic
evaluation
(e.g. CO₂)

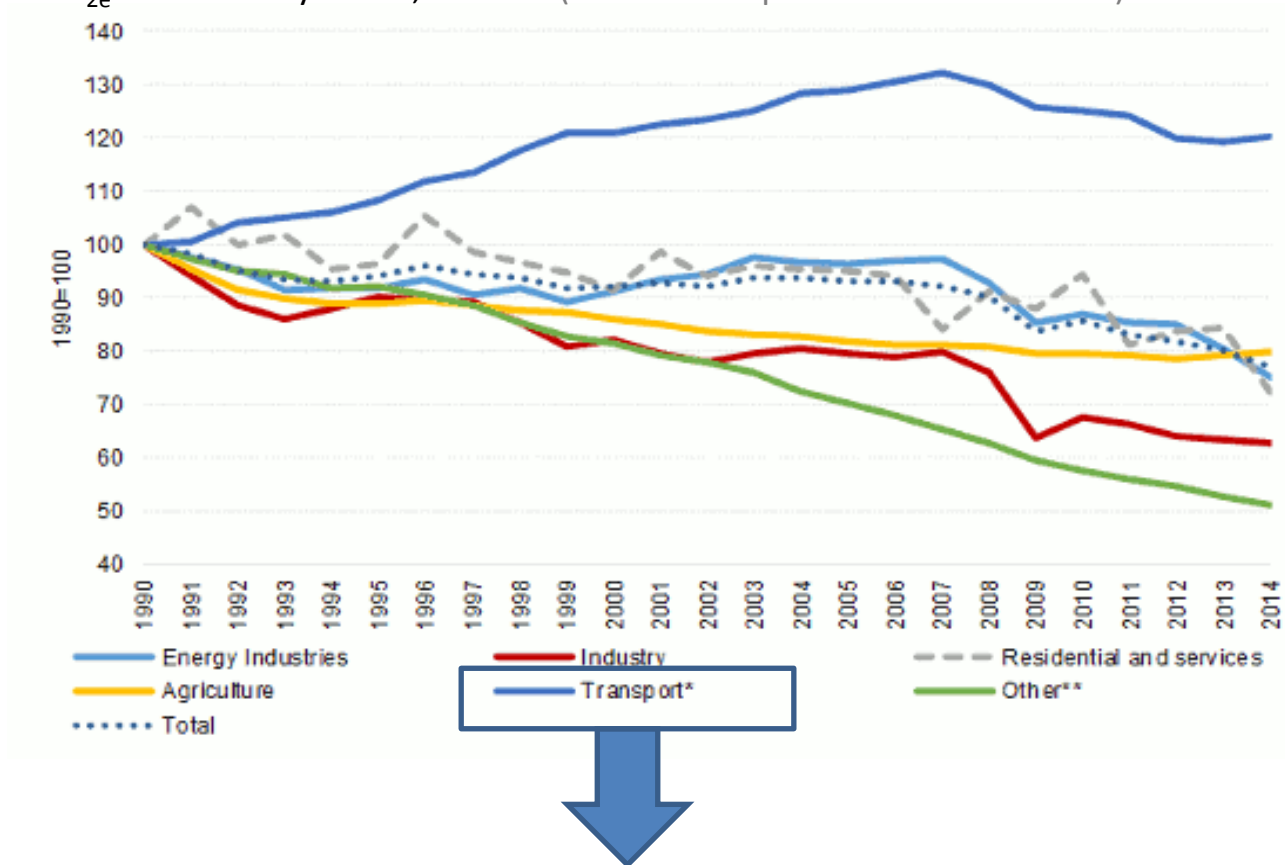


(European Commission 2017)

Existing:
Method of DEA
Malmquist Index
calculation for
longitudinal efficiency
evaluation.

2. Sustainability Measures

CO_{2e} emissions by sector, indexed (Source: European Commission 2017)



Necessity for action / improvement, esp. in SCM/logistics

2. Sustainability Measures

- **Sustainability** definition (von Carlowitz 1712)
- “Limits to Growth”
(Meadows et al. 1972, Kates et al. 2001)
- State of the art definition: Brundtland 1987 (p. 16)
- Triple bottom line (TBL) concept
(Elkington 1997, Akhtar et al. 2016, Formentini & Taticchi 2016, Hansen & Coenen 2015)
- Logistics: No “de-growth” option
(Levallois 2010, European Commission White Paper Transportation 2011)

ECONOMIC



WHAT WE HAVE ACHIEVED

- › Seized the opportunities offered by digitalization ✓
- › Increased the robustness of our fleet and infrastructure ✓
- › Secured our long-term capital expenditures plans with the agreement of LuFV II ✓
- › Implemented initial measures to improve our service orientation ✓

WHAT WE ARE WORKING ON

- › Improving punctuality
- › Improving customer and passenger information
- › Improving service and product quality
- › Achieving our financial targets



SOCIAL



WHAT WE HAVE ACHIEVED

- › Organized nearly 13,000 follow-up workshops to our 2014 employee survey ✓
- › Persisted in conveying our new understanding of leadership ✓
- › Signed a collective bargaining agreement that is economically reasonable ✓
- › Put an early warning reporting system in place to avoid staff shortages ✓

WHAT WE ARE WORKING ON

- › Transformation process to Group restructuring
- › Increasing our employer attractiveness
- › Our 2016 employee survey
- › Implementing "Working Environments 4.0"
- › Collective bargaining agreement "Work 4.0"
- › Further increasing the share of women
- › Developing the HR division

ENVIRONMENTAL



WHAT WE HAVE ACHIEVED

- › Reduced specific CO₂ emissions ✓
- › Highest ratio of green power in the transport sector through the share of renewable energy in the traction current mix ✓
- › Expanded our noise reduction program ✓
- › Reduced the particle emissions of our proprietary fleet ✓

WHAT WE ARE WORKING ON

- › New climate protection target for 2020
- › Complying with the Federal Government's targets for conversion to quiet brake shoes
- › Implementing noise remediation program
- › Developing environmental protection targets that extend beyond 2020
- › Technical solutions on overhead lines to protect birds

› Development of the top targets

Top targets economic	2014	2015	2020
Customer satisfaction – passengers (SI)	76.1	76.4	≥ 79
Customer satisfaction – freight transport and logistics (SI) ¹⁾	-	67.5	≥ 73
Product quality – punctuality of DB Group (rail) in Germany (%)	94.3	93.6	> 95
Market position – revenues (€ billion)	39.7	40.5	> 50
Profitability – ROCE (%)	6.3	5.3	≥ 9.0
Financial stability – redemption coverage (%)	20.9	18.5	≥ 30

¹⁾ Survey every two years.

- › Differentiated developments in customer satisfaction.
- › Deteriorating punctuality.
- › Weak performance of financial figures.

Top targets social	2014	2015	2020
Employee satisfaction – index ¹⁾	3.7	-	4.0
Employer attractiveness – rank	13	24	≤ 10
Demographic preparedness – share of women in Germany as of Dec 31 (%)	22.8	22.8	25.0
Demographic preparedness – health rate in Germany (%)	94.1	93.6	94.3
Demographic preparedness – percentage of staffing needs covered in Germany as of Dec 31 (%)	-	97.3	95.0

¹⁾ Survey every two years.

- › Employee satisfaction is measured every two years.
- › Employer attractiveness has suffered as a result of the strikes.

Top targets environmental	2014	2015	2020
Climate protection – specific CO ₂ emissions compared to 2006 (%)	-22.7	-24.5	-20 ¹⁾
Climate protection – share of renewable energy in the traction current mix (%)	39.6	42.0	35 ¹⁾
Noise reduction – track kilometers noise remediated in total (km) as of Dec 31	1,400	1,495	≥ 2,000
Noise reduction – freight cars refitted with whisper brakes in total (as of Dec 31)	6,665	12,703	60,000
Material/resource efficiency – recycling rate (%)	95.6	97.2	≥ 95

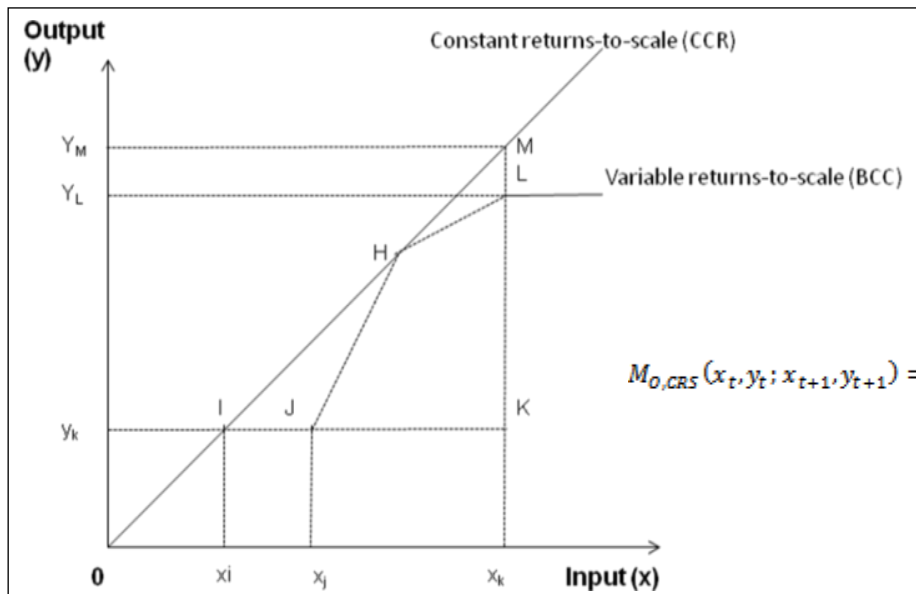
¹⁾ Target in revision.

- › Positive progress on environmental target
- › Climate protection target already exceeded
- › Further progress in noise reduction.

3. DEA Malmquist Index Method

- Data envelopment analysis as non-parametric technique (Charnes, Cooper & Rhodes 1978, Banker, Charnes & Cooper 1984)
- Malmquist index as longitudinal extension (Malmquist 1953)

Caves, Christensen & Diewert 1982)



$$M_{O,CRS}(x_t, y_t; x_{t+1}, y_{t+1}) = \frac{D_{O,CRS}^{t+1}(x_{t+1}, y_{t+1})}{D_{O,CRS}^t(x_t, y_t)} * \left[\frac{D_{O,CRS}^t(x_t, y_t)}{D_{O,CRS}^{t+1}(x_t, y_t)} * \frac{D_{O,CRS}^t(x_{t+1}, y_{t+1})}{D_{O,CRS}^{t+1}(x_{t+1}, y_{t+1})} \right]^{1/2}$$

4. Sustainability Data

E

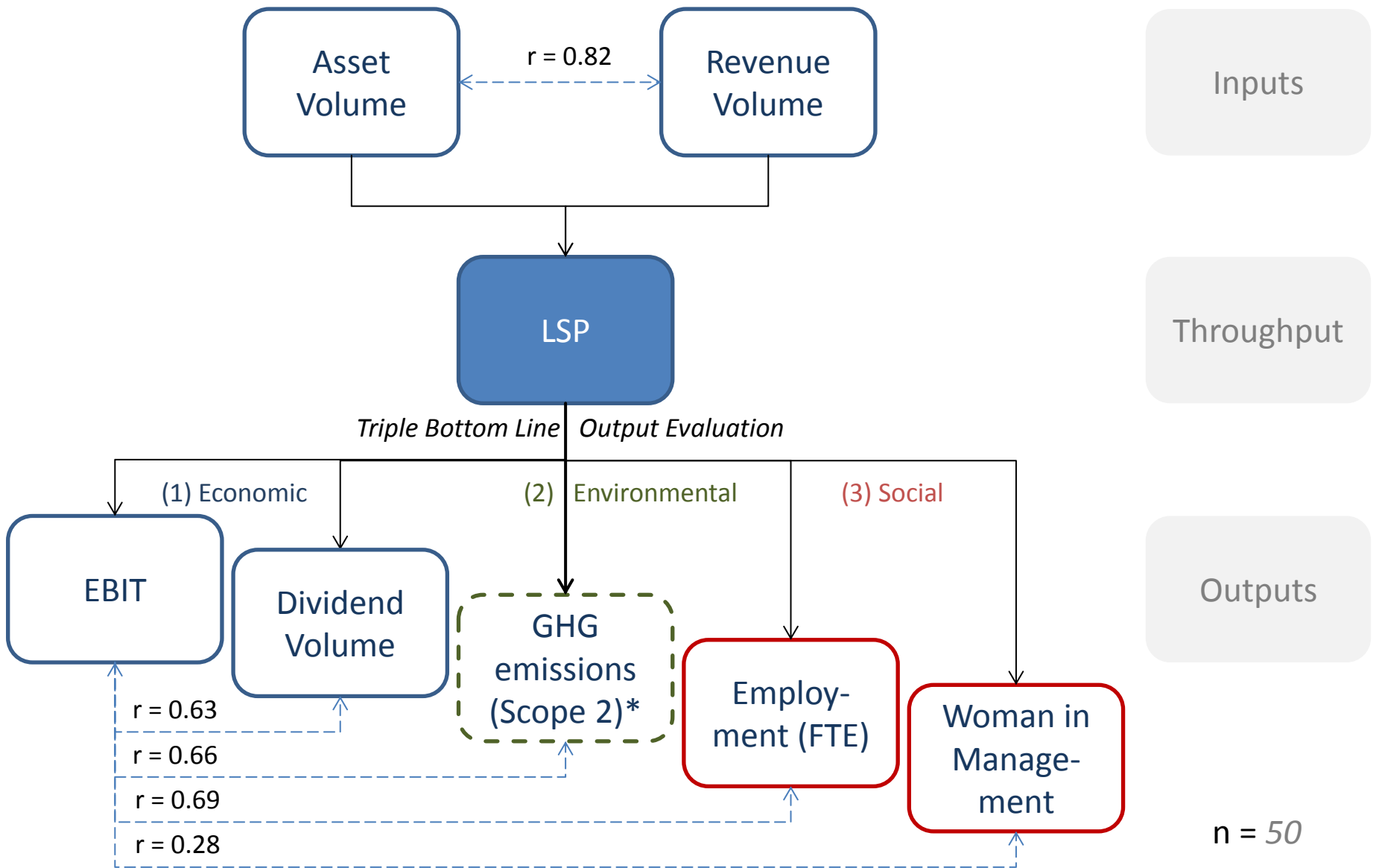
- GHG (CO₂-equivalent) emission volume – scope 2
(Manjunath & Gross 2017, Reichert, Holz-Rau & Scheiner 2016, World Resources Institute & World Business Council for Sustainable Development 2004)

S

- Employment – full time equivalent (FTE) figure
- Gender equality and woman participation in management – share of women in management

E

- Yearly corporate profit – earnings before interest and tax = EBIT (Wilford 2016, Jones & Finley 2011)
- Total dividend volume paid to shareholders



* Due to input optimization nature (objective: reduction of GHG emission), in the DEA calculation GHG emissions are defined as inputs.

5. Calculation Results

- DEA CRS and VRS models calculated
- Weightings introduced for enh. discrimination
- VRS with 5*15% weighting (Run 13) used further

Weighting for Inputs and Outputs where applicable ^[1]	Variable Returns to Scale (VRS)		Constant Returns to Scale (CRS)	
	2 Inputs	1 Input	2 Inputs	1 Input
<i>0% Weighting</i>	(I)	(II)	(III)	(IV)
Arithm. Mean	99.75%	99.75%	99.36%	98.87%
Median	100.00%	100.00%	100.00%	100.00%
Minimum	87.60%	87.60%	74.20%	71.50%
St. Dev.	1.74%	1.74%	3.68%	4.62%
<i>5% Weighting</i>	(V)	(VI)	(VII)	(VIII)
Arithm. Mean	99.49%	99.56%	98.01%	97.76%
Median	100.00%	100.00%	100.00%	100.00%
Minimum	79.10%	79.30%	71.40%	69.10%
St. Dev.	2.97%	2.90%	5.42%	5.89%
<i>10% Weighting</i>	(IX)	(X)	(XI)	(XII)
Arithm. Mean	98.80%	99.09%	85.49%	87.09%
Median	100.00%	100.00%	194.75%	94.00%
Minimum	72.90%	72.80%	43.30%	45.80%
St. Dev.	4.35%	4.10%	17.14%	15.41%
<i>15% Weighting</i>	(XIII)	(XIV)	(XV)	(XVI)
Arithm. Mean	97.57%	98.31%	72.12%	73.93%
Median	100.00%	100.00%	78.60%	76.50%
Minimum	66.60%	67.70%	28.30%	31.00%
St. Dev.	6.30%	5.50%	24.93%	22.18%

^[1] The applied weightings are not applicable to the output types EBIT and dividend volume as in these cases zero values are experienced. Cumulated minimum weightings may not be exceeding 100%. The maximum weighting applied for the five feasible indicators (assets, revenue, GHG emissions, employment and women participation in management) is 15%.

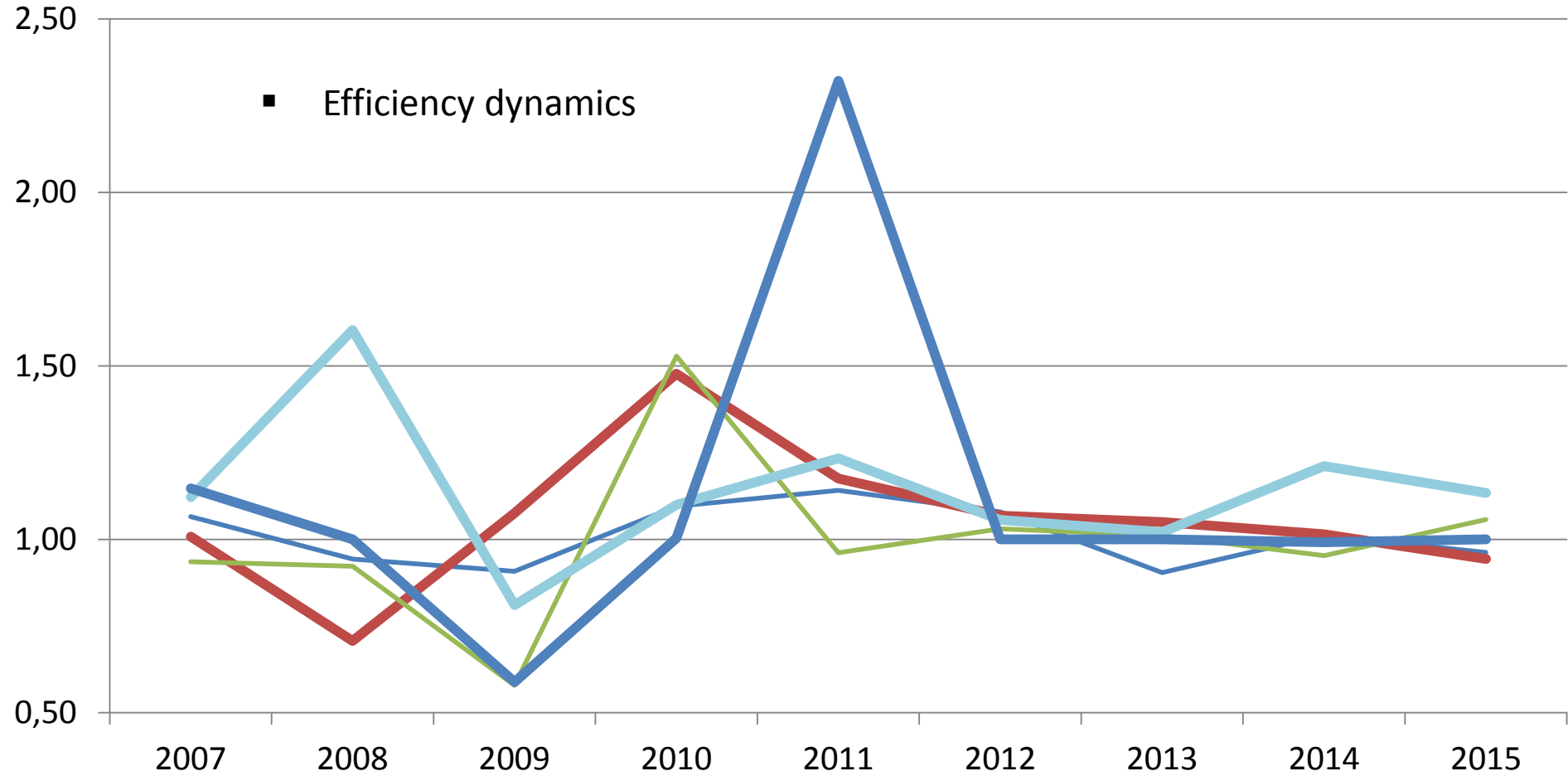
5. Calculation Results

Year	Deutsche Bahn Score	Deutsche Bahn Scale	Deutsche Post DHL Score	Deutsche Post DHL Scale	DSV Score	DSV Scale	Kühne + Nagel Score	Kühne + Nagel Scale	Panalpina Score	Panalpina Scale
2006	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant
2007	1.00	Constant	1.00	Constant	0.93	<i>Decreasing</i>	1.00	Constant	1.00	Constant
2008	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant
2009	1.00	Constant	1.00	Constant	0.67	<i>Increasing</i>	1.00	Constant	1.00	Constant
2010	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant
2011	0.99	<i>Decreasing</i>	1.00	Constant	0.81	<i>Increasing</i>	1.00	Constant	1.00	Constant
2012	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant
2013	0.86	<i>Decreasing</i>	1.00	Constant	1.00	Constant	1.00	Constant	1.00	Constant
2014	0.88	<i>Decreasing</i>	1.00	Constant	0.87	<i>Increasing</i>	1.00	Constant	1.00	Constant
2015	0.87	<i>Decreasing</i>	1.00	Constant	0.91	<i>Increasing</i>	1.00	Constant	1.00	Constant

- Efficiency leaders Panalpina, Kühne + Nagel & Deutsche Post DHL
- Interesting decreasing scale case for Deutsche Bahn Schenker

— DB — DHL — DSV — KUEHNE — PANALPINA

■ Efficiency dynamics

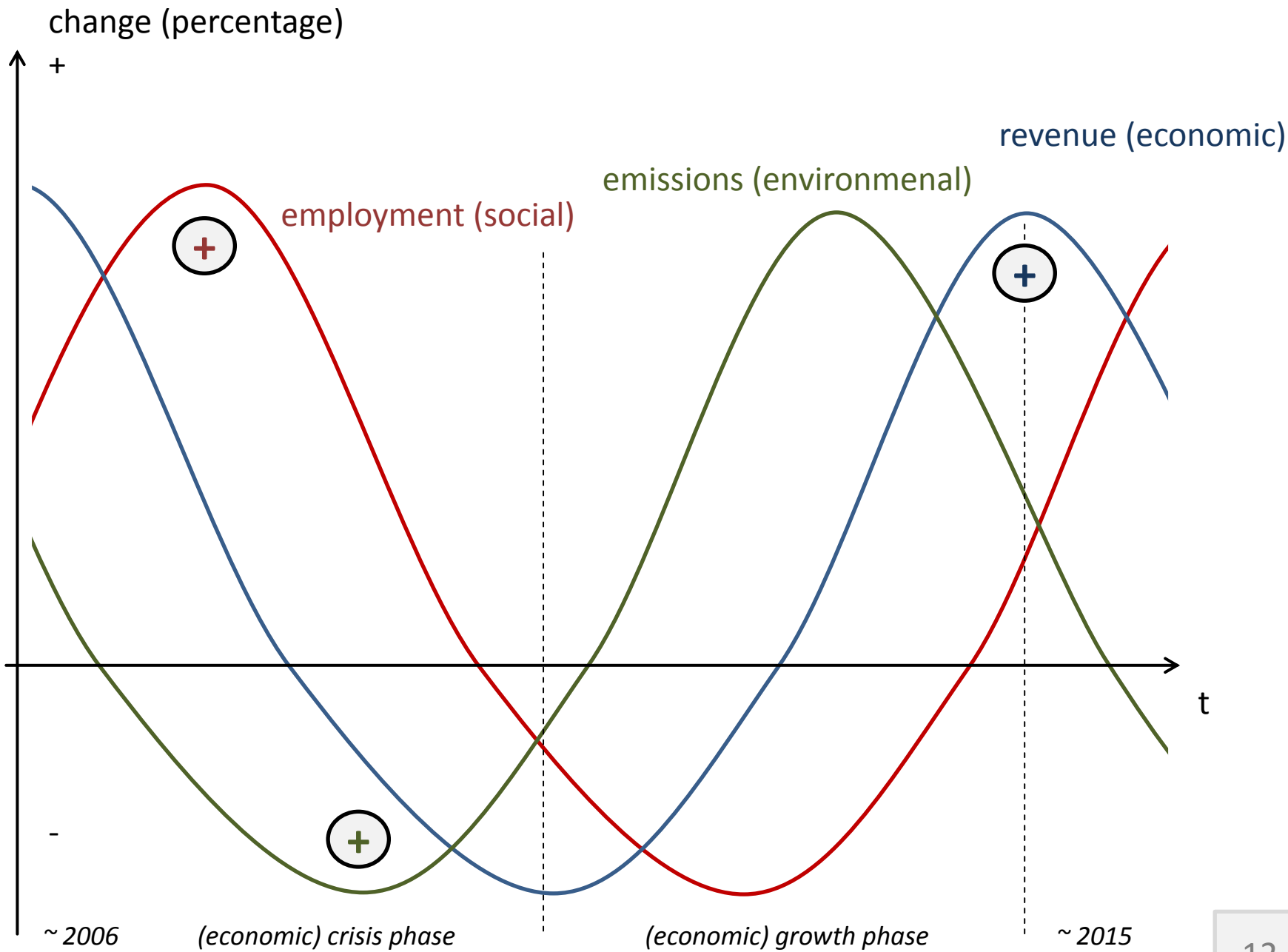


6. Discussion

- Indicators: (i) revenue, (ii) scope 2 GHG → assets, (iii) employment, (iv) further e.g. accidents
- DSV the least resilient and performing
- Leaders: medium-size, no government control
→ discussion regarding Deutsche Bahn

(Dolinayova, Loch & Camaj 2016, Bundesnetzagentur 2015, Nikitinas & Dailydka 2016, Bundesnetzagentur 2015, European Commission 2013).

- “Shaky dynamics” recognized: Proposition of a triple separation business cycle model



7. Outlook

- RQ: Sustained – MI for TBL testing
- Indicator discourse – employment, GHG
- “The wobbly triangle of TBL” & Business Cycle
- New RQ: LSP size, asset strategy, ownership
- “Cousins” S & E

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✓ **Thank you** very much for your kind attention.