Institution: Aston University

Unit of Assessment: 17 Business and Management

Title of case study: Impacting regulatory methodology and revenues for gas and electricity transmission in Germany and the Netherlands

Period when the underpinning research was undertaken: Jan 2000 – Dec 2019

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Emmanuel Thanassoulis	Professor	Apr 1999 - Sep 2020
Dimitris Giraleas	Lecturer	Apr 2013 – present
Ozren Despic	Lecturer	Aug 2003 – present
Ali Emrouznejad	Professor	April 2002 - present

Period when the claimed impact occurred: 2016-2020

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact

Research and expert advice by Thanassoulis and Giraleas on productivity change was used to determine revenue caps for some 400 German and Dutch energy transmission and distribution companies over regulatory cycles spanning 2017-2023. Thanassoulis provided further scientific advice in two regional court submissions (2017, 2019), which challenged the German regulator's methods for computing efficiency and productivity gains for 2014-2023. The underlying research and advice impacted the regulated energy companies – with a combined regulated turnover of over Euros 18.5 billion per annum – consultancy companies and the regulators in Germany and the Netherlands, affecting a population of over 100 million people.

2. Underpinning research

Research into efficiency and productivity change by Thanassoulis (undertaken 2000-2019) and Giraleas (undertaken 2012-2017) has extended and enhanced Data Envelopment Analysis (DEA), and the application of econometric analysis and index number theory. Thanassoulis has over 70 refereed academic publications in this area, with more than 11,000 citations.

These approaches are used in Europe by regulators to assess the scope for efficiency and productivity savings. Economic regulation of monopoly utilities ensures that consumers pay a fair price for services. This objective is addressed – utilising these approaches – through periodic reviews during which regulators set price or revenue caps for utilities.

The *Malmquist Index* traditionally has been used as a way to measure productivity change over time. In 2004, Maniadakis and Thanassoulis (**R1**) enhanced and expanded the scope of the Malmquist Index, developing the *Cost Malmquist Index* which was ultimately used by the German regulator. Unlike the *Malmquist Index*, the *Cost Malmquist Index* also captures the effect of price changes on productivity. This means that productivity change calculations can now show separately the effect of changes in the quantity of inputs and outputs – as well as the effect of price changes of those inputs over time. This provides a clearer picture of the root sources of cost productivity change and is especially relevant in economic regulation where costs are the object of the regulation.

In 2006, Portela and Thanassoulis (**R2**) refined the *Malmquist Index*. This research improved the original *Malmquist index*, which calculated productivity change with reference to an estimated benchmark, which under some circumstances can lead to biased results. Thanassoulis' research did away with the need for a benchmark, calculating instead productivity change by using only observed levels of inputs and outputs.

In 2012, Giraleas, Thanassoulis and Emrouznejad, in (**R3**) reviewed, compared and assessed the various methods for computing productivity change in multi-input, multi-output contexts, including econometric methods, Data Envelopment Analysis (DEA) and index numbers. The research has a special focus on *Törnqvist productivity indices* – a type of index number, used frequently, including in Germany and The Netherlands, to determine regulated utility companies' revenue cap. The research allows for better-informed models to calculate industry-specific, long-run productivity growth estimates.

In other key work (**R4**) into Data Envelopment Analysis (DEA), the broad central method used by regulators, Thanassoulis has defined the "unit of assessment" and the process for setting up a DEA model in terms of the inputs and corresponding outputs of those units. These concepts – as well as the role of outliers – were expanded on by Thanassoulis, Portela and Despić (**R5**). The identification of suitable inputs and outputs, and the treatment of outliers, play a vital role in economic regulation. This is because the companies whose efficiencies and productivity change over time are to be assessed are large, with complex and interwoven activities which must all be suitably captured in the modelling process.

Overall, the research of Thanassoulis and Giraleas has expanded, enhanced and improved the modelling processes used in economic regulation.

3. References to the research

R1 N. Maniadakis and E. Thanassoulis (2004) A Cost Malmquist Productivity Index, European Journal of Operational Research. Volume 154, Issue 2, pp 396-409. (*227 citations*) - (https://doi.org/10.1016/S0377-2217(03)00177-2)

R2 Maria Conceição A. Silva Portela, Emmanuel Thanassoulis (2006) Malmquist Indexes Using a Geometric Distance Function (GDF): Application to a Sample of Portuguese Bank Branches, Journal of Productivity Analysis, Vol 25, 1-2, pp. 25-42 (239 downloads, 42 citations) (https://doi.org/10.1007/s11123-006-7124-z)

R3 Giraleas D., Thanassoulis E., Emrouznejad A. (2012) Productivity change using growth accounting and frontier-based approaches – Evidence from a Monte Carlo analysis- European Journal of Operational Research, Vol 222 pp673-683 (26 citations) (https://doi.org/10.1016/j.ejor.2012.05.015

R4 Thanassoulis (2001) *Introduction to the Theory and Application of Data Envelopment Analysis: A foundation text with integrated software*. Kluwer Academic Publishers, Boston, Hardbound, ISBN 0-7923-7429-0, 312 pp. – (1511 citations)

R5 Thanassoulis, E., Portela, M.C.S. and Despić, O. (2008), '*Data Envelopment Analysis: the mathematical programming approach to efficiency analysis',* in Fried, H.O., Knox Lovell, C.A. and Schmidt, S.S. (eds) *The measurement of productive efficiency and productivity growth*, New York, NY (US) Oxford University Press Book (1263 citations (book), 326 (chapter))

Research Funding : **ESRC, £60,000 (2005-2009) Project Title:** Developing Panel Based Methods for Assessing Relative Performance in the English and Welsh Water and Sewerage Industry – Collaborative Case award with the Office of Water Services (OFWAT), economic regulator of water and sewerage companies in England and Wales; **HEFCE, £269,000 (2000-2005), Project Title**: The assessment of productivity change over time in central administrative services in UK Higher Education Institutions.

Indicators of research quality: **R1, R3** published in a peer reviewed journal ranked 4 in the CABS Academic Journal Guide of 2015. **R2** published in a specialist efficiency and productivity analysis CABS rank 2 peer-reviewed journal. **R4** (book) and **R5** (book chapter) are published in established academic publishing imprints Kluwer Academic Publishers and Oxford University Press, respectively. All citations: Google Scholar, 21 December 2020.

4. Details of the impact

Aston research has had a material impact on the policy, practice and process of estimating efficiency and productivity changes at firm and sector level for regulatory purposes in Germany and the Netherlands. These two countries have a combined population of over 100 million and regulated expenditure of more than €18.5 billion per annum.

The research has changed the policy and practice of the economic regulation of electricity and gas transmission and distribution service operators (TSOs and DSOs) in Germany and the Netherlands, covering regulatory cycles between 2017 and 2023. The impacts were channeled via consultants to the regulators. The beneficiaries are consultancy companies Oxera and Polynomics and the regulators and regulated energy companies operating in Germany and The Netherlands, collectively influencing the energy prices for over 100m people.

We claim three main areas of impact:

1. Computing revenue caps for regulated TSOs and DSOs in Germany

This impact relates to the adoption and subsequent implementation of the Cost Malmquist and Tornquist methods (R1, R3 respectively) used by the German energy regulator BNetzA in 2017 to compute the "Xgen" (**S1**). The Xgen is the industry-specific annual productivity change benchmark figure and is critical component in determining revenue caps for 401 gas and electricity DSOs and TSOs serving a combined population of 80 million.

In preparation for the gas and electricity regulatory cycles covering 2017-2023, BNetzA requested energy companies to submit their responses to its proposed methodology for calculating the Xgen. One of these energy companies, the TSO Netze BW, commissioned a consultancy firm (Polynomics) to advise it on its response. Polynomics recommended (**S3**) to Netze BW the use of the Cost Malmquist, drawing extensively from research in (**R1**), and Tornqvist productivity indices (**R3)**. This advice was then included in Netze BW's submission to BNetzA. BNetzA subsequently commissioned its own consultant (WIK) to review the energy companies' submissions. WIK (**S2**), quoting Polynomics, found both the Cost Malmquist and the Tornqvist indices appropriate methodologies for calculating the Xgen. BNetzA then officially adopted them (**S1**) and opened the process to final consultation.

Bundesverband der Energie und Wasserwirtschaft (BDEW), an industry association which represents over 1,800 German energy and water companies, responded by commissioning a consultancy company (Oxera) to review BNetzA's final methodology. Oxera commissioned Thanassoulis and Giraleas as "renowned" (an official term in German law) academic experts, to advise BDEW on its response (**S4**) and they did so by drawing on their underpinning research (**R1, R3**). The impact is the adoption and subsequent implementation of the Cost Malmquist (pioneered in **R1**) and Törnqvist productivity (**R3**) indices by BNetzA (**S1**) for calculating Xgen for the regulatory cycles spanning 2017-2023.

2. Computing revenue caps for regulated TSOs in the Netherlands

This impact relates to development of the methodology (**R3**) used to calculate productivity change estimates and its subsequent implementation by Dutch TSOs to determine their revenue caps. In 2015, the Dutch energy regulator, the Authority for Consumers and Markets of the Netherlands (ACM), commissioned the consultancy Oxera to update the methodology used to calculate industry-specific productivity change, and produce estimates for the 2017-2021 regulatory period. Giraleas, as the academic lead of the project (**S7**), drew on regulatory precedent and the underpinning research (**R3**) to together with the Oxera team update and substantially change the methodology used to generate the required estimates of productivity change (**S5**).

ACM then invited TSOs to comment. Giraleas and the Oxera team analysed the TSOs' responses, and stood by their original findings (**S6**). The impact is the development of the methodology and the production of the estimates, which ultimately were adopted by the regulator.

This impacted the regulation of energy prices paid by 17M people over 5 years.

3. Impact on the revenue cap for German TSO Netze BW

The beneficiary of this impact – which draws on research by Thanassoulis (**R1, R2**, **R4** ch 3-5) and (**R5**, sections R6, R8) – is Netze BW, the largest TSO in the German state of Baden-Württemberg. It serves 2.32 million electricity and 147,000 gas customers. Thanassoulis, as academic expert, authored with a team from the consultancy Oxera two court submissions by Netze BW. These submissions appealed respectively the regulator BNetzA's determinations of the Xind (firm specific efficiency target) and Xgen (industry productivity target) factors relating to the 2014-2018 (Xind) and 2018-2022 (Xgen) regulatory cycles (**S7**). It was argued that the methods used by the regulator for computing Xind and Xgen above was not in line with scientific best practice to the detriment of Netze BW.

The Xind case was submitted to Oberlandesgericht Düsseldorf (Higher Regional Court of Düsseldorf) and settled out of court in 2017, resulting in a substantial financial benefit for Netze BW in terms of the revenue it would be permitted to raise within the regulatory framework. The Xgen appeal has been submitted for hearing. At the time of writing an outcome is still awaited. The combined financial impact for Netze BW of the two cases relates to in-scope expenditure of over €600 million across the five-year regulatory cycle.

The impact on the methodology and its implementation for computing the scope of productivity and efficiency gains in Germany and The Netherlands is set to have an enduring effect on regulatory policy and practice beyond Germany and the Netherlands. A 2018 study commissioned by the Council of European Energy Regulators to develop a methodology for cross-European performance assessment of TSOs is based upon the methodology adopted by the German regulator (**S8**).

5. Sources to corroborate the impact

S1) Final Determination published by The German Regulator (BNetzA) "BK4-17-093 – Ruling Chamber 4- 13-12-2017" (S1-Link to copy (in German)), **key passage on P.9-10 in para 1.3): "***In general, both of the described methods of Törnquist and Malmquist are suitable to determine the general sectoral productivity factor. Firstly, the regulator has already described the above methods as internationally renowned methods in its reasoning for the introduction of incentive-based regulation. Furthermore, after considering the WIK report on determining the general sectoral productivity factor, the court reaches the conclusion that both methods are generally suitable to determine XGEN.*"

S2) Report submitted to the German Regulator BNetzA by its Consultants (WIK) (S2-Link to copy (original in German)):**"WIK Study for BNetzA: Expert opinion on the determination of the general sectoral productivity factor - revised version after receipt of the comments"– 10-July 2017**: **Translated extracts – P.XII**: "*A particularity of the Malmquist is the possibility to calculate the index on the basis of nominal costs (Cost-Malmquist). As will be shown, changes in the sectoral factor prices are directly included in the Cost-Malmquist result when the costs are considered without an inflation adjustment. Therefore, a separate calculation of the changes in the sectoral factor prices is unnecessary, which helps to eliminate possible sources of error.*"; **P.54** "*In this chapter, the specific approach to determine the development of productivity via the Malmquist index is being introduced, based on the explanations in chapter 4.1. In addition to the available initial data, the preferred specification on the basis of the Cost-Malmquist will be introduced. This will focus on the distribution network operators for electricity and gas.*"

S3) Report submitted to the German Regulator BNetzA by Consultants (Polynomics) Polynomics (24/8/2016) (S3-Link to copy (original in German)) **"Determining technological progress based on company data - The use of the Malmquist method in the German regulatory framework:" Translated extracts: P.34** "*The Cost-Malmquist, as opposed to the Production-Malmquist, uses monetary values in the form of cost and price data in its calculations. Maniadakis & Thanassoulis (2004) demonstrate how the decomposition of the Malmquist index according to Färe et al (1989) can be applied to this Cost-Malmquist, in such a way that the effects of changes in the input prices on XGEN can be determined.*"; **P.48** "*Since the Cost-*

Malmquist employs the correct factor prices and therefore determines the efficient costs, it is not affected by the varying precision in determining the isoquant during both periods. Therefore, the (Cost-shift) ECC calculated on the basis of the Cost-Malmquist is correct."

S4) Report submitted to BNetzA by BDEW: Bundesverband der Energie- und Wasserwirtschaft e.V. (German Association of Energy and Water Industries), **"Opinion: Definition X General Gas BNetzA consultation (BK4-17-093) to determine the general sectoral productivity factor for gas network operators Berlin, November 17, 2017** (S4-Link to copy (original in German)) **"** *Stellungnahme - Festlegung X Generell Gas BNetzA-Konsultation (BK4-17-093) zur Festlegung des generellen sektoralen Produktivitätsfaktors für Gasnetzbetreiber* ": **key passages on pp3** "*BDEW has commissioned Oxera Consulting to produce a report on the scientific standard to calculate XGEN and to evaluate the draft document (BK4-17-093) by BNetzA. With the help of renowned international experts on the Törnquist and Malmquist methodology as well as on efficiency comparisons via DEA and SFA, a number of inconsistencies and methodological errors have been detected. The Oxera report is attached to this document as an appendix.*"; **and pp 8** "*Through Oxera, renowned international experts on the Törnquist and Malmquist methodology and on efficiency comparisons with DEA and SFA were involved: Prof. Emmanuel Thanassoulis, Prof. Subal Kumbhakar, Dr. Dimitris Giraleas, Dr. Srini Parthasarathy and Alan Horncastle. The BDEW brings the current Oxera opinion into the consultation procedure so that necessary adjustments to the draft definition can be implemented on an objective basis. The renowned experts have identified a number of inconsistencies and methodological errors.*"

S5 Study on ongoing efficiency for Dutch gas and electricity TSOs, by Oxera for Netherlands Authority for Consumers and Markets (ACM) (S5-link to report)
The study was commissioned by ACM from OXERA consultants authored by a team which included Dr Giraleas. It determines the annual productivity gain to be imposed on the TSOs ACM regulates over the regulatory cycle 2017-2021. Dr Giraleas based his contribution on underpinning research (**R3**) as referenced on pp 42 of the report.

S6 Response to GTS's and TenneT's comments on Oxera's ongoing efficiency study for ACM, prepared for ACM by Oxera (S6-link to report): The report considers the points raised by two Dutch TSOs **S5** above and concludes "*Having reviewed the six queries from GTS and TenneT on our report…that the arguments they put forward under these queries do not have an impact on our conclusions.*"

S7 Letter from Oxera consultants detailing the role of Professor Emmanuel Thanassoulis and Dr Dimitris Giraleas in S5 and S6

S8 Pan-European cost-efficiency benchmark for electricity transmission system operators Main Report, CEER & SUMICSID SPRL (2019) "*The outlier detection used in the final runs follows the German Ordinance for Incentive Regulation and the notion of DEA outliers herein (ARegV, annex 3). The invoked criteria are consistent with the method proposed and used in Agrell and Bogetoft (2007), representing a systematic and useful device to improve the reliability of regulatory benchmarking without resorting to ad hoc approaches.*" **P47- Para 4.92**