ECONOMIES OF SCOPE

Economies of scope and scale in the electricity industry

Ørjan Mydland*
Faculty of Economics and Organization Science, Lillehammer University College, Lillehammer, Norway
and Department of Business and Management Science, Norwegian School of Economics, Bergen, Norway. Postal address: Lillehammer University College Lillehammer, Faculty of Economics and Organization Science, Pb 952, NO-2604 Lillehammer, Norway, Email: orjan.mydland@hil.no / orjan.mydland@nhh.no, Phone: +47 909 35 042

Subal C. Kumbhakar
Department of Economics, State University of New York – Binghamton, Binghamton, NY 13902, United States, kkar@binghamton.edu

Gudbrand Lien
Faculty of Economics and Organization Science, Lillehammer University College, Lillehammer, Norway, gudbrand.lien@hil.no

Roar Amundsveen
The Norwegian Water Resources and Energy Directorate, Oslo, Norway, roam@nve.no

Hilde Marit Kvile
The Norwegian Water Resources and Energy Directorate, Oslo, Norway, hkv@nve.no

Economies of scope

- Positive economies of scope means that the costs of producing two outputs are lower compared to at situation where two seperate firms produce one output each.
- Distribution and Generation of electricity.
- **Research question:** What are the costs and/or benefits of strict separation of the integrated firms?

BACKGROUND

- The electricity industry has undergone changes in Norway as in the rest of the world.
  - Policy makers whish to unbundle vertical integrated firms, and the main motivations are:
    - Increase competition in the market
    - Avoid cross-subsidization
    - Make distribution system operators (DSOs) focus on network operations only

- In 2016, the Norwegian Parliament amended the Energy Act, with changes taking effect from 2019. Strict separation of all *generation*- and *distribution* companies.
- This policy comes with a cost of not utilize economies of scope (if present)
  - How high are these costs?
- New data from Norway makes it possible to answer this question

Generation → Distribution

Different opinions

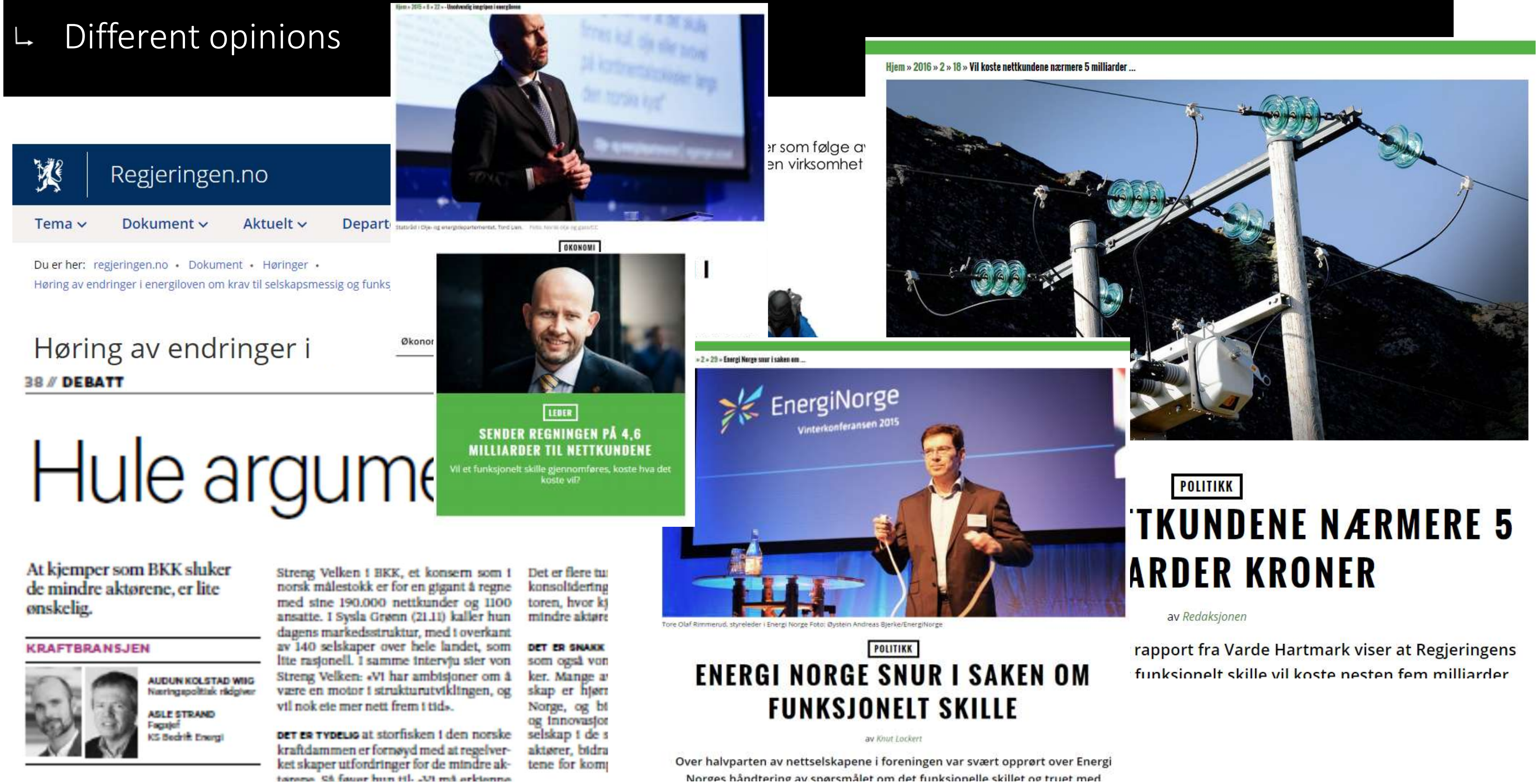


Table 1. *Summary of previous empirical scope- and scale studies of the combined generation and transmission/distribution electricity companies.*

Author(s)	Data	Functional form	Est. method	Economies of scope and scale*
Kaserman and Mayo (1991)	Cross-section (1981, US)	Quadratic cost function	OLS	Economies of scope (EOS) = 0.12 (at mean)
Kwoka (2002)	Cross-section (1989, US)	Quadratic cost function	OLS	EOS = 0.27 (at median). Reports substantial costs of vertical integration and highest for the smallest utilities
Jara-Diaz *et al.* (2004)	Panel-data (1985-1996, Spain)	Quadratic cost function together with cost share equations	Seemingly Unrelated Regressions (SUR)	EOS = 0.065 – 0.28. Economies of Scale Returns to scale (RTS) = 1.07.
Piacenza and Vannoni (2009)	Panel-data (1994-2000, Italy)	Multi-product & multi stage Box-Cox transformed cost function	Non-linear SUR	EOS = 0.24. RTS = 0.96. Reports findings of both vertical integration gains and horizontal scope economies
Fetz and Filippini (2010)	Panel-data (1997-2005, Switzerland)	Quadratic cost function	Random effects GLS and Random Coefficient model	EOS = 0.50 – 0.60 (at median). RTS = 1.40 - 1.70 (at median). Presence of considerable economies of vertical integration and economies of scale for most companies
Arocena *et al.* (2012)	Cross-section 2001, US)	Quadratic cost function together with cost share equations	SUR	EOS = 0.04 – 0.10. RTS = 1.01 - 1.03. Reports positive sample mean estimates of both vertical and horizontal economies
Meyer (2012a)	Panel-data (2001-2008, US)	Quadratic cost function	OLS	EOS = 0.19 – 0.26, when separating generation from distribution and retail. Reports that if generation and transmission remain integrated but are separated from distribution and retail, EOS = 0.08 – 0.10.
Triebs *et al.* (2016)	Panel-data (2000-2003, US)	Flexible technology translog cost functions with different specifications	SUR	EOS = 0.04 (0.40 when zeros are replaced by small numbers in the common cost function model). RTS = 1.10 – 1.13. Reports evidence of scale and vertical economies of scope.

*Estimates of economies of scale (measured by returns to scale (RTS)) are for integrated firms.

↳ DATA

- The data comprise economic and technical information on Norwegian electricity firms from 2004 to 2014
- Data collected by the Norwegian Water Resources and Energy Directorate (NVE)
- Paneldata 2004 – 2014, 1 883 observations, 261 firms.
- Model specifications:
    - Two outputs/products: Distribution (D) km network and Generation (G) in Mwh
    - One input: Total costs (C)

Variable	Mean	St. Dev.	Min	Median	Max
Total costs (1,000 NOK):					
Integrated firms (*distribution* and *generation)*	31,231	31,663	2,235	20,677	199,678
Specialized firms (*distribution*)	30,262	36,520	4,125	16,399	274,822
Specialized firms *(generation)*	17,395	21,480	27	10,504	175,552
Outputs:					
Distribution, *km network*	307	439	0 (31)	172	2,949
Generation, *Mwh*	103,850	203,767	0 (2,319)	14,640	1,081,649
Year			2004		2014

Time dummies:	All firms	Integrated	Distribution	Generation
Td1 (2004–2005)	371	104	142	125
Td2 (2006–2007)	377	102	138	137
Td3 (2008–2009)	386	101	138	147
Td4 (2010–2011)	384	94	142	148
Td5 (2012–2013)	300	94	134	72

Firm type observations:	
Integrated firms (*distribution* and *generation)*	515 observations, 55 firms
Specialized firms (*distribution*)	707 observations, 80 firms
Specialized firms *(generation)*	661 observations, 126 firms
Total firms	1,883 observations, 261 firms

Note: Numbers in parentheses are the minimum positive outputs for *distribution* and *generation.*

-MODELL SPECIFICATION

Vi estimate three different random effects models in our analysis

- Modell 1: «Normal» specification of a quadratic cost function
  - All firm types; specialized in generation, specialized in distribution and integrated firm with both generation and distribution are assumed to have equal technology.
  - Not possible to test.

- Modell 2: Dummy variable specification of quadratic cost function that allows different types of technology
  - Possible to test.

- Modell 3: Same as Modell 2, but with translog cost function.

↳ Scope measure

Total costs specialized firms in *generation*

$$Scope = \frac{(C_D(D,0) + C_G(0,G)) - C_I(D,G)}{C_I(D,G)}$$

Total costs specialized firms in *distribution*

Total costs integrated firms

> 0, Economies of scope from *integrated* firms

< 0, Diseconomies of scope from *integrated* firms

↳ RESULTS
-Scope and Scale

- All actual output combinations for the 515 firm observations from the 55 integrated firms over an eleven-year period in our panel data are used.

$$Scope = \frac{(C_D(D,0) + C_G(0,G)) - C_I(D,G)}{C_I(D,G)}$$

- Total costs increases by 3% if we separate *distribution* and *generation.*

- *Increase the cost for integrated firms with 3% →31,231*0.03*55 firms =51,531 → NPV (10 year) = 372,187*
- *Increase the cost for integrated firms with 23% →31,231*0.23*55 firms =395,072 → NPV (10 year) = 2,831,776*

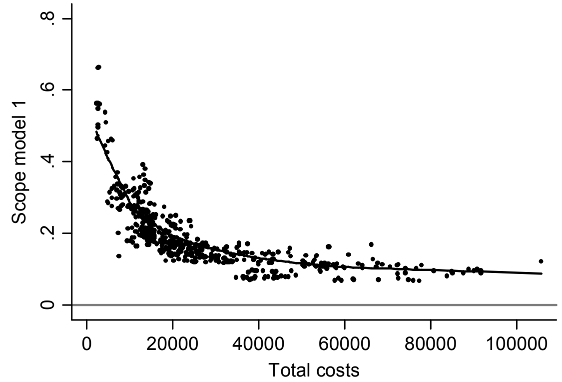
- Economies of scale estimates correspond to earlier results on Norwegian data Mydland et al. (2016) and Kumbhakar et al. (2015)

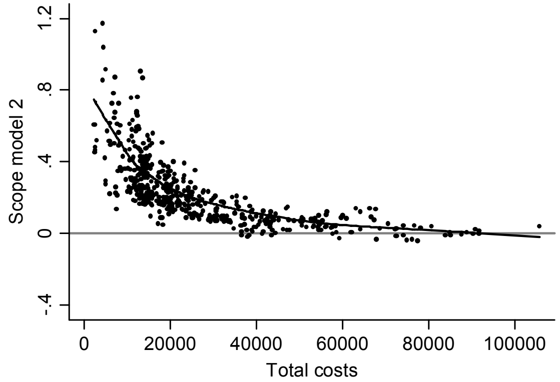
Table 4. *Economies of scope and scale results from the three models*

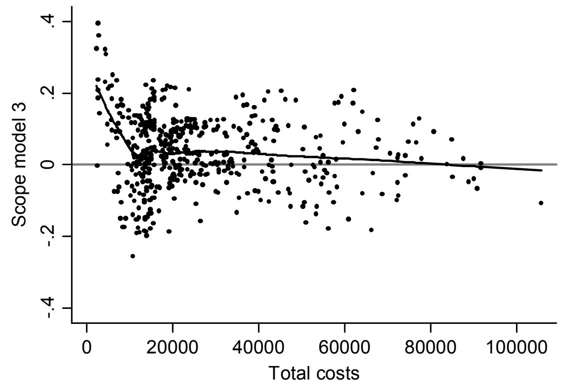
	Economies of scope			Economies of scale		
Percentiles	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
1%	0.09	–0.02	–0.19	0.99	0.82	0.97
5%	0.10	0.01	–0.15	1.01	0.86	1.01
10%	0.12	0.03	–0.10	1.10	0.93	1.04
25%	0.16	0.09	–0.03	1.16	1.03	1.18
Median	0.23	0.18	0.03	1.26	1.16	1.36
75%	0.30	0.32	0.11	1.42	1.34	1.52
90%	0.40	0.48	0.17	1.63	1.57	1.76
95%	0.46	0.61	0.21	1.95	1.84	1.86
99%	0.74	0.92	0.31	3.10	2.99	1.95

↳ COMPARING RESULTS

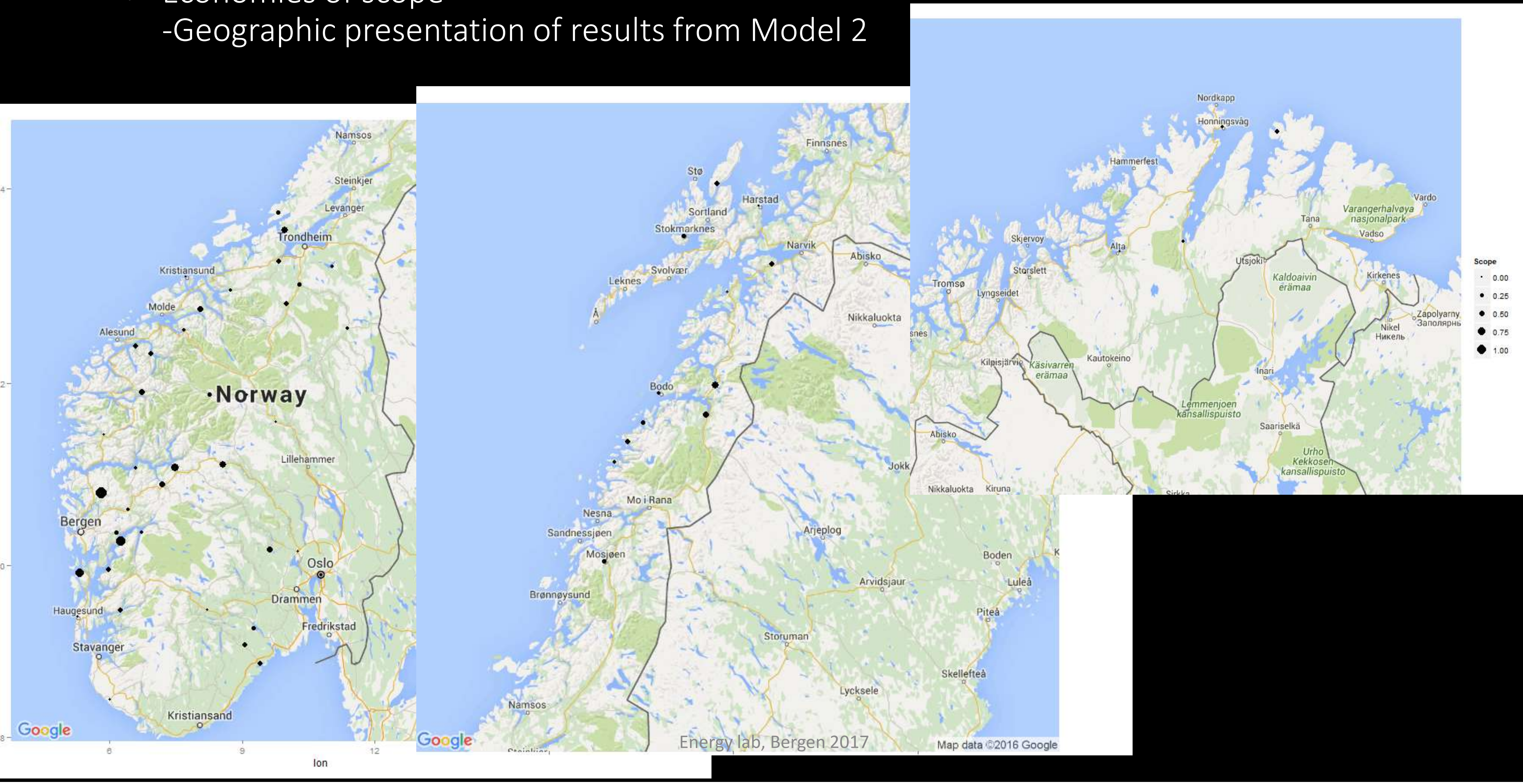
- Plots of economies of scope related to firm size (measured as total costs) for each of the *integrated firms.*
- For Model 1 and Model 2, there is a clear relationship between firm size and economies of scope.
- Model 3: negative, but no clear trend.







↳ Economies of scope
-Geographic presentation of results from Model 2



↳ CONCLUSIONS

- Overall we find economies of scope from integrated firms

- The economies of scope are highest for the smallest firms and is decreasing with firm size. Some of the bigger firms have diseconomies of scope.

- In Model 1 and Model 2 we find a clear relationship between economies of scope and firm size. In Model 3 there are no clear relationship. We see a negative trend but even for the smallest companies (low total costs) we find both economies- and diseconomies of scope.

- Idea for further work
    - Will the cost of unexploited economies of scope be offset by gains from economies of scale?
        - Combine scope and merger analysis.
            - Merge companies with high scope estimates …

↳ Economies of scope
-Furter work

- So far our findings show evidence of economies of scope and economies of scale.

- The amendment of the Norwegian Energy act (Energiloven § 4-6 og § 4-7) which ensure strict separation of the firm types will increase costs by not utilize economies of scope.

- New analyze / research question:
  - New scope-study, with some adjustments
  - Include merger gains i analysen

- Research question:
  - Can the merger gains offset the increase in total cost from not utilizing economies of scope?
    - Merger analyze:
      - Geographical?
      - Based on scope results?
      - Who keeps the gains/winnings?

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THANK YOU!

Questions