NATIONAL INSTITUTE FOR HEALTH AND WELFARE

Relationship of hospital costs and quality of care

Unto Häkkinen and EuroDRG teams in Finland, France, Germany, Spain and Sweden

Motivations

- Not much information on quality between countries and hospitals
- An important policy question: are costs and quality related to each other
  - If there is a positive correlation=> better quality can be provided only by increasing costs
  - If there is a non positive correlation => potential for improving performance by containing costs with no reduction in quality or improving quality without increasing costs

Aims

- To compare quality of hospital care using patient level data in treating acute myocardial infarction (AMI) patients in five European countries
- To examine whether cost-quality trade-off exists by comparing hospital level costs and survival rates

The approaches cost/quality relationship

- Cost functions with cost as the dependent variable: quality measures as explanatory variables (in given cost function)
- Quality as dependent variable, where hospital cost is one explanatory variable
- Estimation of cost and quality functions independently➔ aim to evaluate whether the joint evaluation of cost and quality affects ranking of hospitals relative to comparison based on costs alone.

How quality affects costs

- Much evidence that complications, hospital infections and medical errors increase the cost of hospital care (e.g. Carey and Stefos 2010) at individual patient level.
- At aggregate (department or hospital) level, it has been hypothesised that net cost form a U-shaped curve (Hvenegaard et al. 2010)

Hvenegaard et al. 2010

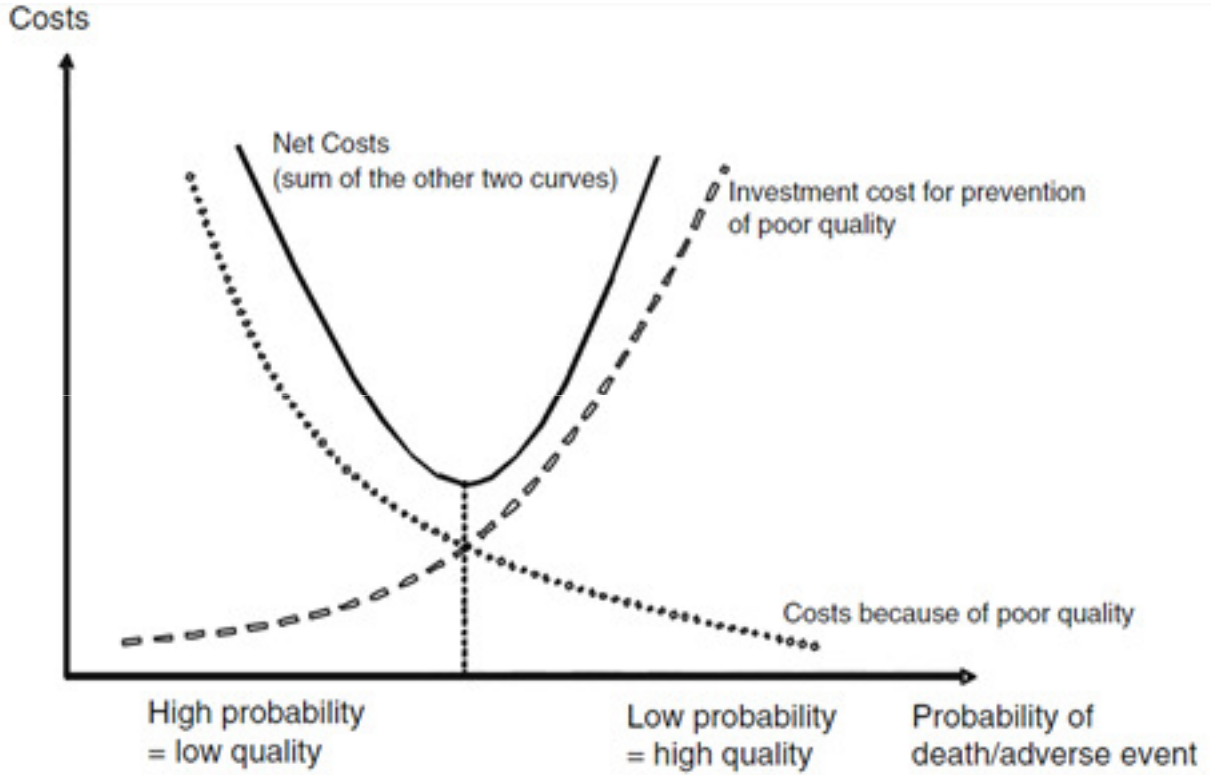


Fig. 1 The theoretical relationship between costs and quality

Measuring quality /outcome by mortality complicates the analysis

- Costs are low if patient dies at earlier days of admission
- Much of resources are allocated to patient during their last days before death

=>simultaneous relationship

We model both costs and quality. Quality is measured by a binary variable and costs are modelled with a logarithmic transformation

$$\ln(c_{ik}) = x'_{1ik}\beta_1 + \delta q_i + u_k + \epsilon_{1ik}$$

$$q^*_{ik} = x'_{2ik}\beta_2 + v_k + \epsilon_{2ik}$$

where c_{ik} are costs for patient i in hospital k, quality (discharged alive) is measured by the observed variable

$$q_{ik} = \begin{matrix} 1 \; if \; q^*_{ik} \geq 0 \\ 0 \; if \; q^*_{ik} < 0 \end{matrix}$$

Explanatory variables describing patients age, gender, co-morbidities etc. are contained in the given x-vectors, β_1 and β_2 are parameter vectors, u_k and v_k are hospital specific effects which are here treated as fixed, ε_{1jk} ε_{2jk} are individual error terms assumed to be bivariately normally distributed

Two steps in estimation of cost function

- Evaluating whether cost function should be estimated separately for patients who died during hospital stay and for patients discharged alive.
  - Chow F-test for similarity of the cost function between these two groups
- Evaluating whether the error terms of quality and cost function are correlated
  - The significance of sample selectivity is tested in terms of the inverse Mills ratio and included in the final model only if significant

Data

- Patient level data of hospital discharges linked with cost information collected for EuroDRG project from Finland, France, Germany, Spain and Sweden

AMI episodes

Hospital inpatient admission due to AMI (ICD-10: I21-I22) as main diagnosis

Excluded, if:

- bypass surgery
- LoS = 0
- LoS = 1 and patient transferred to another hospital
- Cost outlier (with a bilateral trim based on 3 times the standard deviation of the cost distribution)
- In a hospital with less than 50 cases

Description of AMI samples

			Cost/patient (€)			Lengtht of stay			In hospital mortality %		
Country	Number of cases	Number of hospitals	Average	Min hospital	Max hospital	Average	Min hospital	Max hospital	Average	Min hospital	Max hospital
Finland	1253	5	4684	2118	5826	5,5	4,6	5,7	6,4	5,2	11,7
France	8415	38	5197	2961	8010	6,0	3,5	8,1	4,9	1,2	16,9
Germany	5159	18	4274	2844	5411	8,3	5,1	15,1	11,8	1,2	23,5
Spain	2781	6	6705	2140	7334	7,7	5,9	10,5	6,7	4,6	16,6
Sweden	15305	33	5113*	2110*	7310*	5,5	4,3	7,3	7,1	3,3	13,5

*trasferred to € using exchange rate

Patient level variables used in estimations

- Age (classified)
- Gender
- Type of AMI
- Total number of different diagnoses coded in medical records
- Patients transferred to the hospital from other institutions
- Patients discharged from the hospital to another institution
- Emergency, describing if patient admitted from emergency department, ward or similar institution as relevant in each country
- Two variables of Charlson index describing single non severe comorbidity, and two comorbidities and more (or one single severe one), respectively

Estimation strategy in practice

Quality: Fixed effects probit model for survival (discharged alive). Estimated from a pooled data

Cost: Fixed effects OLS for (log) cost, Estimated separately for each country. Based on CHOW test separate models for survived and deceased patients. Inverse mills ratio significant in some cases

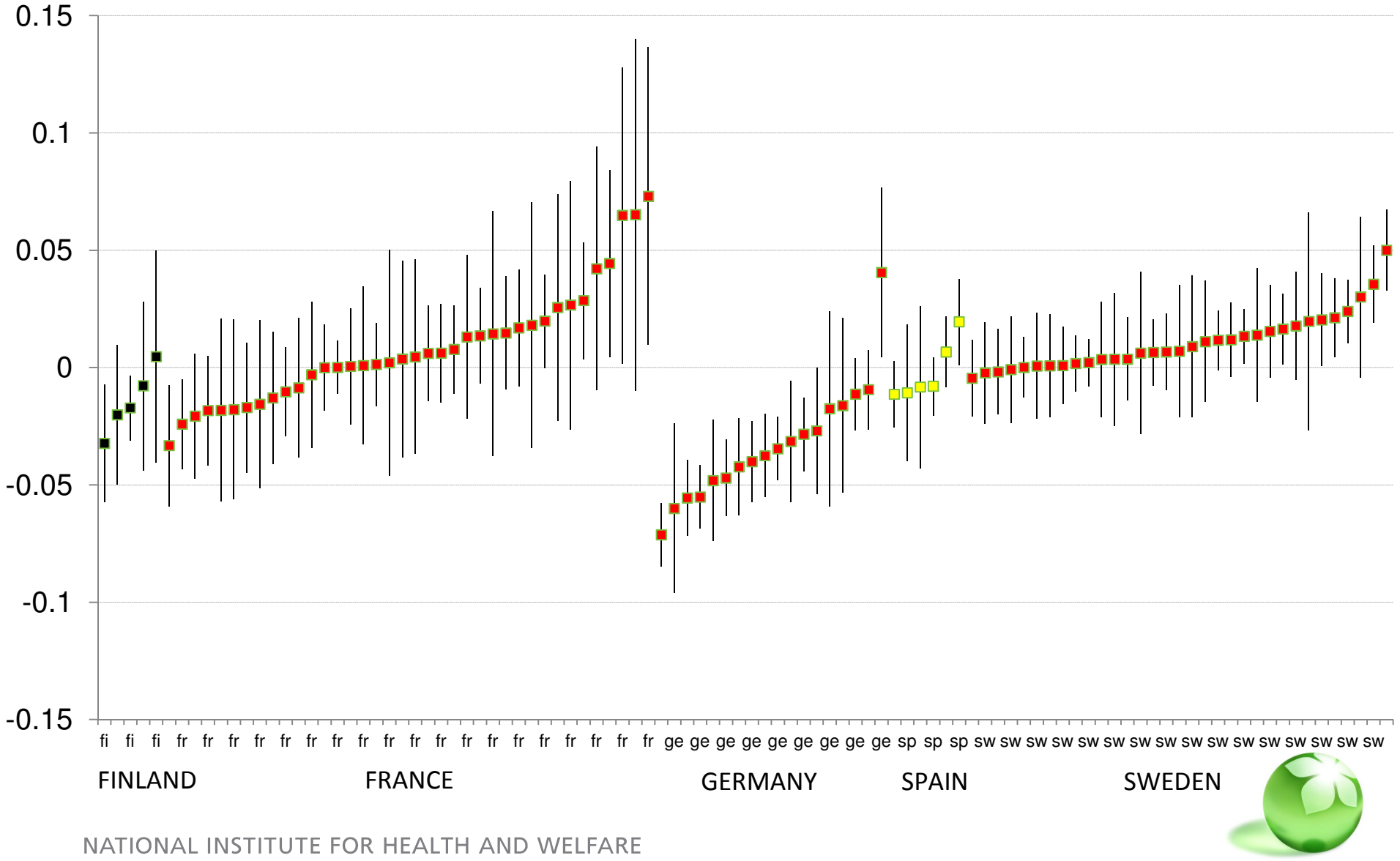
Describing the results

- Quality (discharged alive from the hospital stay): marginal effects (probit model) of hospital dummy variables (effect coding). The marginal effects describes how many percent points the survival differs from the average survival of all hospitals
- Cost level: weighted fixed effects scaled to country average. The fixed effects describes how many per cents the cost differs from the country average

Quality and cost models will be examined with correlation diagrams

Estimation results for survival (discharged alive from hospital) of AMI patients. Probit regression, marginal effects, hospital dummies not reported.	
	AMI
Age 1-60	0.028***
Age 71-80	-0.025***
Age 81-85	-0.070***
Age >85	-0.113***
Male	0.005*
Total number of different diagnoses coded in medical record	-0.002***
Patient admitted into hospital from other institution	0.004
Patient admitted from emergency department	-0.014***
ST-elevated MI	0.023***
Non-ST-elevated	0.064***
Subsequent MI	-0.010
One non-severe Charlson comorbidity	-0.011***
At least 1 severe or 2 non-severe Charlson comorbidities	-0.032***

Quality (discharged alive) of 100 European hospitals in care of AMI, marginal effects with confidence intervals



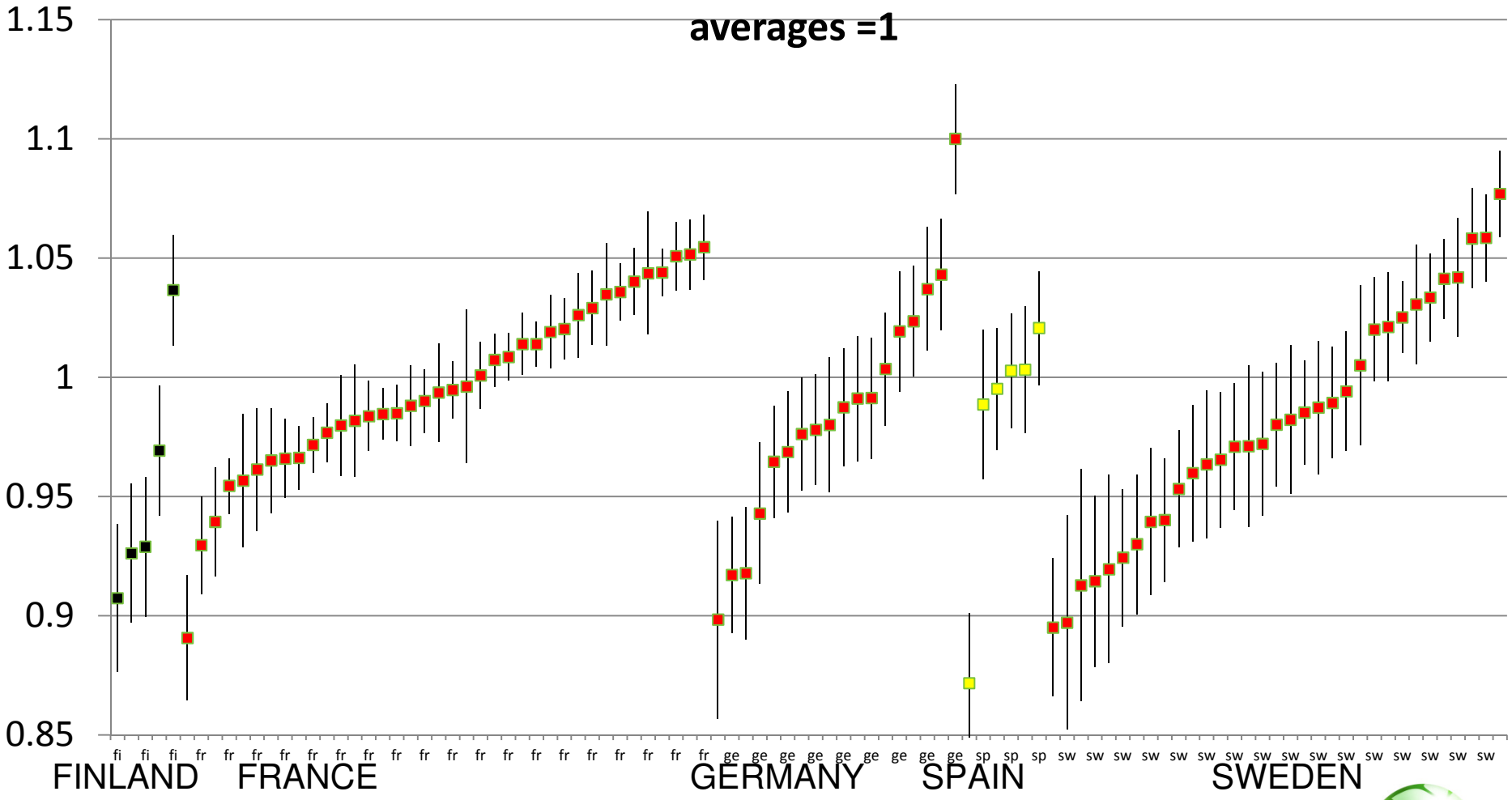
Cost

- The cost models were estimated separately for each country, since cost accounting methods varied between countries and we do not have data on price differences ➔we are not comparing cost between the countries
- The sign and value of coefficients of the independent variables and the explanatory power (R^2) varied between the models for survived and deceased as well as between the countries
- Inverse Millis Ratio variable was significant in model for the deceased in France and Sweden

Estimation results of cost functions for AMI patients

	Finland		France		Germany		Spain		Sweden	
	Survived	Deceased	Survived	Deceased	Survived	Deceased	Survived	Deceased	Survived	Deceased
Age 1-60	-0.087	-0.074	-0.021	0.830***	0.027	-0.185	-0.040	0.023	0.011	-0.606*
Age 71-80	0.056	-0.555	-0.004	-0.582***	-0.001	0.140	-0.020	-0.033	-0.030*	0.908***
Age 81-85	-0.011	-0.677	0.001	-1.565***	-0.050	-0.057	-0.200***	-0.512	-0.127***	1.583***
Age >85	-0.085	-1.253*	-0.106**	-2.257***	-0.214***	-0.227	-0.480***	-0.735*	-0.283***	2.371***
Male	0.004	-0.042	-0.001	0.504***	0.042**	0.125	0.030	0.249	0.014	-0.059
Total number of different diagnoses coded in medical record	0.057**	-0.094	0.070***		0.078***	0.146***	0.032***	0.044	0.035***	
Patient admitted into hospital from other institution	-0.330***	0.222	-0.197***	0.491**	-0.121***	-0.221	-0.210**	1.025**	-0.353***	0.188*
Patient discharged from hospital to another institution	0.156**		-0.005		-0.001		0.121**		0.090***	
Patient admitted from emergency department	0.111**	-0.484*	0.117***	-0.113	0.066**	-0.001	0.221***	0.109	0.219***	0.548***
ST-elevated MI	0.175*	0.075	0.023	0.861***	0.223**	0.616***	0.385***	0.314	0.204***	-0.137
Non-ST-elevated	-0.089	-0.035	-0.099**	1.535***	0.013	0.425**	0.121	0.169	0.009	-2.316***
Subsequent MI	0.239	0.516	-0.158*	0.017	0.258*	0.453	0.191	-1.580***	0.148**	0.815***
One non-severe Charlson comorbidity	0.111*	-0.255	-0.002	0.082	0.023	0.249	0.019	0.048	0.013	0.802***
At least 1 severe or 2 non-severe Charlson comorbidities	0.184	0.444	-0.037	-0.464**	-0.072**	0.020	-0.063	-0.059	-0.014	1.600***
Inverse Mills Ratio				-2.172***						3.964***
Constant	7.949***	9.274***	8.102***	12.124***	7.474***	5.650***	8.065***	7.645***	10.441***	1.351
N	1172	81	7973	407	4552	607	2594	185	14220	1085
r2	0.415	0.339	0.322	0.317	0.350	0.446	0.228	0.238	0.299	0.179

Cost level and their confidence intervals of 100 European hospitals. AMI patients. Based on country specific cost functions. Country averages =1



Relationship between quality and cost

- Hospitals marginal effects of survival were plotted against hospital level fixed effects of costs

Cost and quality among AMI patients