A multilevel approach to explain variation in costs and quality of treatment after AMI in German and US Veterans Health Administration Hospitals

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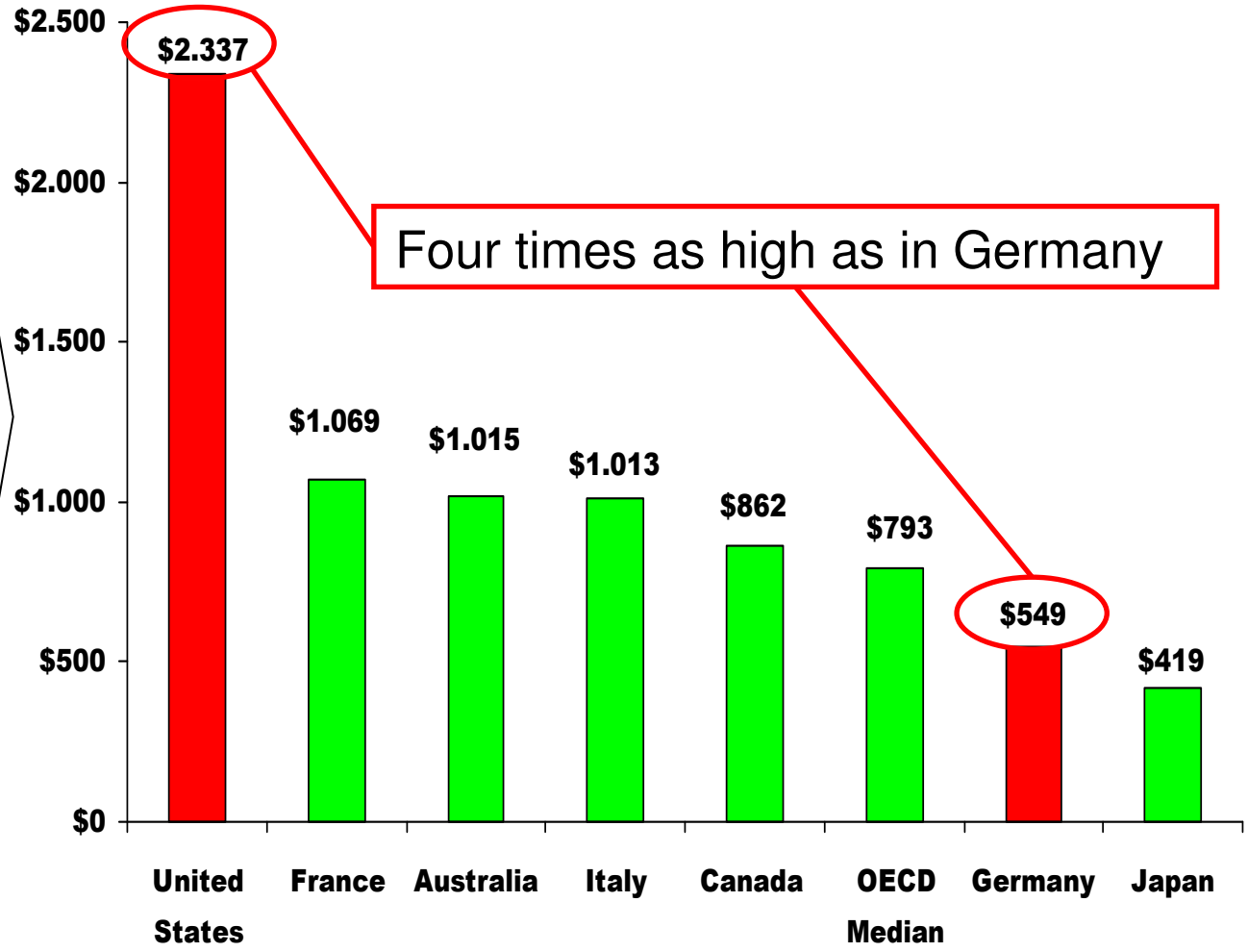
Introduction

- Efficiency has become a major objective in most health care systems of the world
- Hospitals and health care systems are increasingly benchmarked according to a number of efficiency criteria (e.g. WHO 2000 report)

Average hospital spending per Inpatient Care Day 2004
(adjusted for PPP)



Source: OECD Health Data 2006

Background

- Country variables (e.g. country-specific price levels) can have an important impact for studies in multinational settings
- Studies focussing on the public sector additionally have to account for the regulatory environment and the corresponding incentives
- In the health care sector it is of crucial importance to adequately control for the heterogeneity of patient characteristics (so called patient co-morbidities or case-mix)
- Drawbacks of most studies:
  - High level of aggregation (precludes adequate control of case-mix)
  - Quality of efficiency parameters (detailed cost data rarely available)
  - Often no indicators for quality included

Selection of Episode of Care

- We selected Acute Myocardial Infarction (AMI) as a major care episode to control for case-mix adequately
- A large number of studies have measured hospital performance based on AMI
- Advantages of AMI over other care episodes:
  - Requires immediate medical attention; no patient selection
  - High incidence and leading cause of death in the elderly
  - Quality of care provided by hospitals can substantially avoid mortality
  - Reflects level of technology utilization, which are characterized by large differences in resource use

Objectives

1) to explain variation in **costs as a measure of efficiency** and

2) to explain variation in **hospital mortality as a measure of clinical quality**

... using micro-level data at the episode level

... between hospitals of the Veteran Health Administration and Germany

⇒ **to explore new ways of hospital benchmarking!**

Veterans Health Administration (VA)

- Third largest healthcare delivery system in the US after Medicare and Medicaid
- provides care to 7.6 million predominantly low-income veterans
- VA is divided into 22 Veterans Integrated Service Networks, which receive capitation payments based on patient-related information
- reimbursement systems within the VISNs show considerable differences
- VA hospitals operate within a system of integrated delivery and face little competition

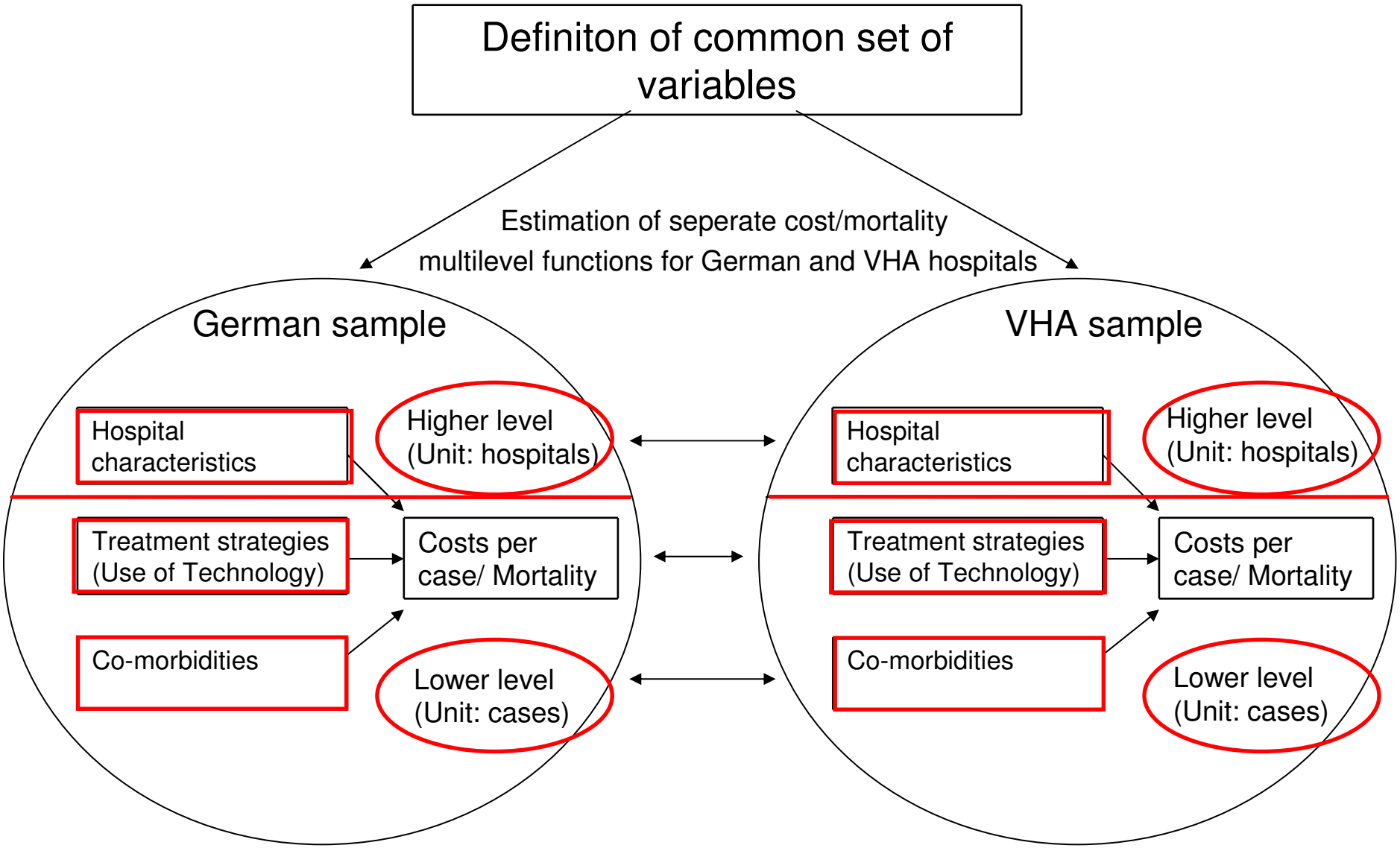
Hospital care in Germany

- Hospitals operate in fragmented health care system;
  usually no outpatient clinics in hospitals
- Since 2004 hospitals receive DRG payments from social health insurance funds and private health insurance companies
- DRG-system applies to all hospital services apart from psychiatry
- 1770 hospitals with public, non-for-profit or for-profit status

Data

- Data for year 2005 were obtained from the German national cost data study and the administrative databases of the VA
- both settings have a very similar data structure and follow a similar cost accounting approach
- modular accounting approach allowed to separate costs according to diagnostic services, laboratory, drugs, ward costs, and overhead costs
- patients classified as having severe complications and who had undergone coronary artery bypass graft surgery were excluded
- 130 VA hospitals with 6,598 patients and 18 German hospitals with 585 patients remained in the two samples

Methodology I



Methodology II

1. Multilevel regression is performed

   ⇒ What determines costs and mortality in both samples?

2. Imposing VA prediction functions on German sample and imposing German prediction functions on the VA sample

   ⇒ How would VA hospitals perform with German patients and vice versa?

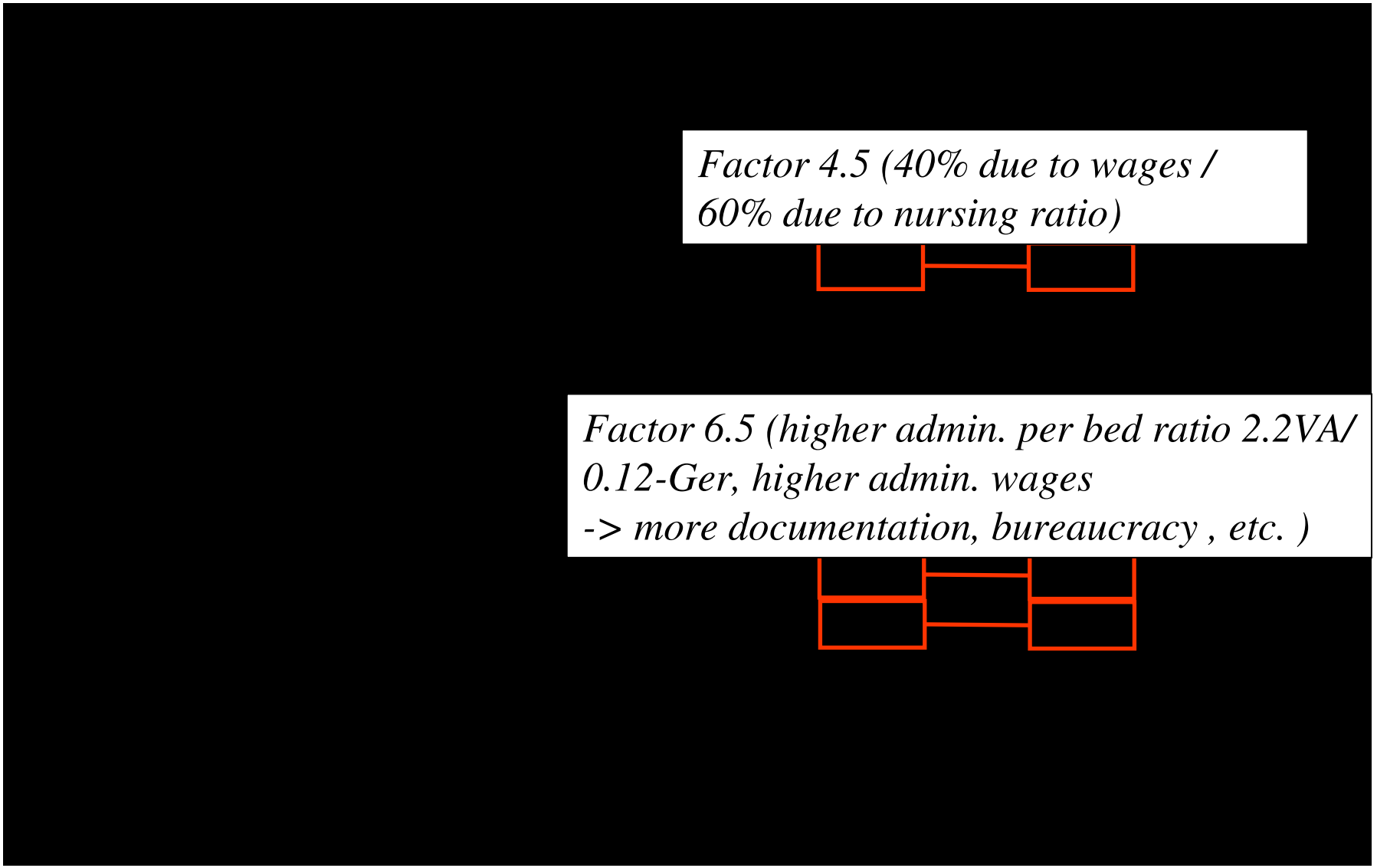
3. Applying a propensity matching score approach to match VA and German patients

   ⇒ How would hospitals from both samples perform with the same patient co-morbidities/treatment strategies?

Sample Characteristics

	VA	Gemany	p-value
No. of cases in the sample	6598	585	
No. of hospital in the sample	130	18	
Length of stay	5.5	8.0	<0.0001
Mortality rate	6.3%	1.5%	<0.0001
Treatment Strategies			
No procedure	29%	27%	0,034
Catheterization/NOPCI	17%	14%	0,0046
PTCA received	22%	36%	<0.0001
STENTS received	9%	20%	<0.0001
DRUGSTENTS received	23%	3%	<0.0001
Hospital Characteristics			
Selected AMI cases	48	35.6	0.59
Nurses per bed	2.8	0.59	<0.0001
Physicians per bed	0.7	0.2	<0.0001
Adminstrative staff per bed	2.2	0.1	<0.0001
Number of beds	137.8	503.3	<0.0001
Member of the council of teaching hospitals	35%	50%	0.63
Located in urban area	38%	22%	0.55

Median costs by cost category in US$



Regression with dependent "ln costs per case"

	VA	Germany
Intercept	7.8666***	7.5635***
Co-morbidities	included	included
Catheterization/NOPCI	0.4007***	0.1693*
PTCA received	0.1613***	0.6401***
STENTS received	0.4463***	0.6644***
Selected AMI cases	0.001763*	-0.00205
Member of the council of teaching hospitals	0,1076	-0.2968
Located in urban area	0.1781***	0.4841**
Nursing per bed	0.04304	-0.3056
Number of beds	0.001209**	0.000961*

* P<0.05, ** P<0.01, *** P<0.001

How do VA hospitals perform with German patients and vice versa?

	Predicted mean values based on German function		Predicted mean values based on VA function	
	VA	Germany	VA	Germany
Based on comorbidities				
Total costs (in $)	3,675	3,953	14,909	15,565
Hospital mortality (in %)	2.5	1.5	6.3	6.4
Based on comorbidities and treatment strategies				
Total costs (in $)	3,498	3,953	14,909	15,488
Hospital mortality (in %)	2.0	1.5	6.3	6.0
Based on comorbidities, treatment strategies and hospital characteristics				
Total costs (in $)	3,748	3,953	14,909	15,686
Hospital mortality (in %)	2.9	1.5	6.3	6.8

How do hospitals from both systems perform with the same co-morbidities/treatment strategies?

	Whole samples	Matched on propensity scores for co-morbidities[a]	Matched on propensity scores for co-morbidities and treatment strategies[b]
Ln_cost			
Coefficient for Germany	-1.3513 (0.1344)***	-1.4967 (0.1554)***	-1.3434 (0.1649)***
Hospital Mortality			
Coefficient for Germany	-0.0973 (0.0491)***	-0.1007 (0.0736)***	-0.0979 (0.0957)***

*** P<0.0001

S.E. in parenthesis

[a] PSM matched samples for co-morbidities include n = 2840 for VHA and n = 568 for Germany

[b] PSM matched samples for co-morbidities and treatment strategies include n = 1592 for VHA and n = 530 for Germany

Conclusion

- The analysis demonstrates the potential of micro-level analysis for hospital benchmarking

- Main prerequisites are to adequately control for heterogeneity in patient characteristics and to standardize costing information

- Differences in cost-efficiency can be explained by a combination of differences in input mix:
  - **Utilization:** VA likely to perform a greater number of procedures and to use costly drug-eluting stents instead of bare-metal stents; and had much higher staffing ratios than German hospitals
  - **Unit costs**: example of nursing costs showed that wages are nearly of equal importance as staffing ratios

- More research on optimal staffing ratio is needed

- Role of unmeasured health characteristics

BACK UP

Explanatory variables

- Co-morbidities:
  - Ontario AMI prediction rules and Charlson Co-morbidity Index were used
  - ICD-9 for VHA and ICD-10 for Germany – crosswalk tables usedTreatment Strategies
- Treatment Strategies
  - Cardiac cath. w/o. PCI
  - Cardiac cath. w. PTCA
  - Cardiac cath. w. bare-metal stent
  - Cardiac cath. w. drug-eluting stent.

  } If cardiac catheter was performed during same stay
  - PTCA w/o. cardiac cath.
  - Bare-metal stent w/o. cardiac cath.
  - Drug-eluting stent w/o. cardiac cat

  } If cardiac catheter was performed before the stay
- Length of stay:
  - was transformed by natural log
- Hospital characteristics:
  - Number of selected AMI cases: economies of scale
  - Beds: proxy for capital input/ size
  - Urban status: hospitals located in metropolitan area with pop. > 200,000
  - Teaching status: if member of the council of teaching hospitals
  - Nursing ratio: proxy for labor intensity

Methodology

Multilevel regression model with random intercept is performed

$$y_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + u_j + \varepsilon_{ij}$$

y_{ij} = outcome variable for the *ith case* -> costs per case/ mortality

β_0 = Fixed intercept

x_{ij} = Vector at the patient level for co-morbidities or treatment strategies

z_j = Vector at the hospital level for hospital characteristics

u_j = Random intercept representing the unexplained variation for the *jth* hospital

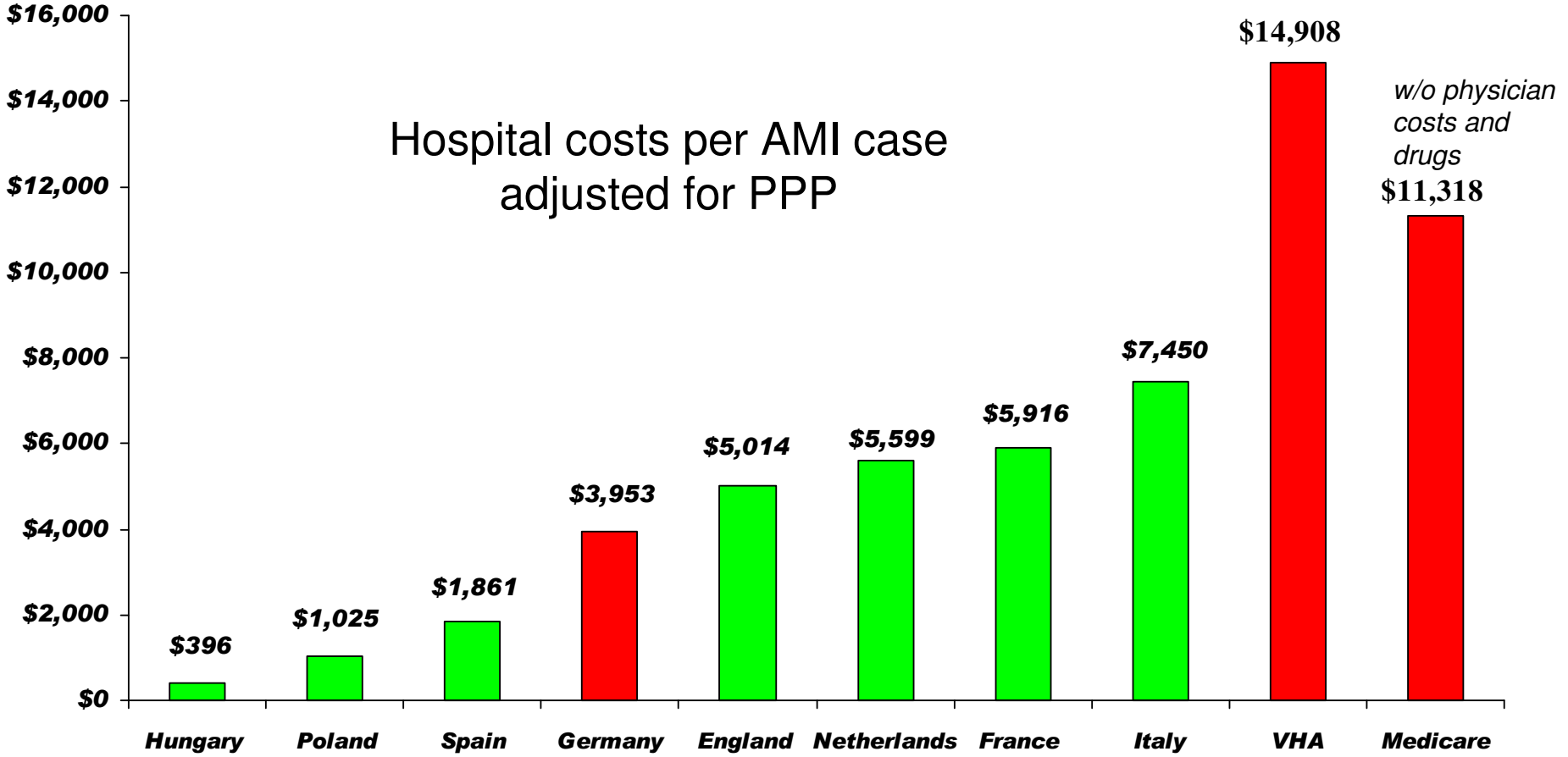
ε_{ij} = Random error term representing the unexplained variation for the *ith* case within the *jth* hospital

Regression with dependent “hospital mortality”

	VA	Germany
Intercept	-2.1132***	-4.1002***
Co-morbidities	included	included
Catheter + NOPCI	-0.00537	-0.3913**
PTCA received	-0.3589***	-0.3153*
STENTS received	0,04042	-0.2010
Selected AMI cases	-0.00286	-0.00095
Member of the council of teaching hospitals	-0.07425	-0.3128
Located in urban area	0,07042	-0.01648
Nurses per bed	0,09391	0,455
Number of beds	0,001401	0,000827

* P<0.05, ** P<0.01, *** P<0.001

How do AMI costs compare to Medicare and other European countries?

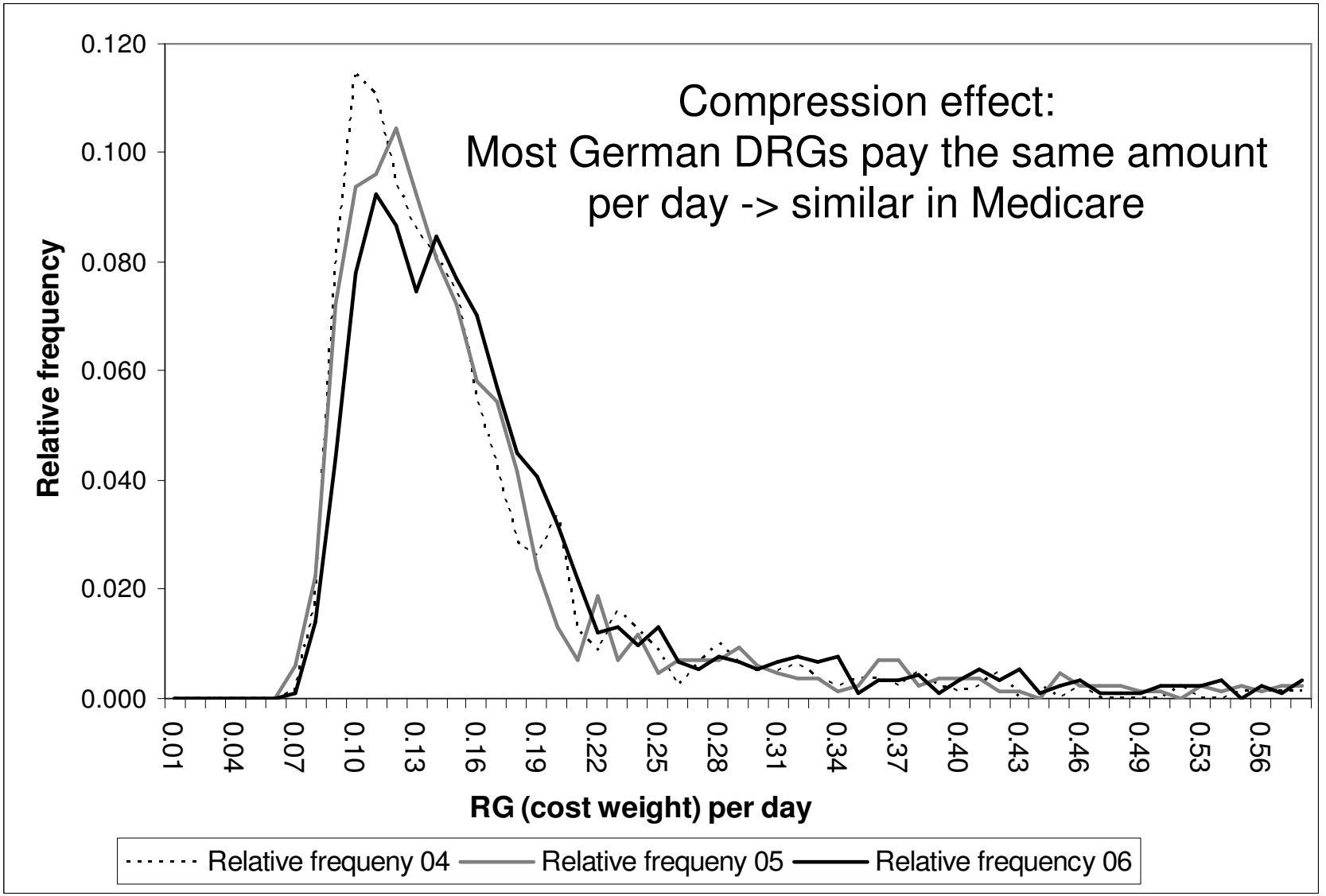


Comparison of VHA to Medicare hospitals (results from other studies):

- costs for Medicare tend to be higher/ increase with complexity of procedure
- Medicare hospitals perform more procedures
- Mortality in Medicare hospitals is lower

Source: data for other European countries based on findings of EU Health*Basket* Project; data for Medicare based on estimates for Medicare part A from MEDPAR Inpatient Hospital National Data for Fiscal Year 2005, Centers for Medicare and Medicaid Services.

Why can‘t we just take reimbursement rates?



Schreyögg J, Tiemann O, Busse R (2006) Cost accounting to determine prices: how well do prices reflect costs in the German DRG-system? *Health Care Management Science 9 (3): 269-280*

Sample definition

Cases:

- Male patients admitted with AMI
- Exclusion of cases with severe complications
- Exclusion of cases where admit-day = discharge-day -> transferred, died or ‘ruled out’ AMIs

Hospitals:

- Excluded VHA hospitals outside of continental US
- Excluded German university hospitals -> separation of hospital care from teaching and research questionable

-> 130 VHA hospitals with 6,598 cases remained

-> 18 German hospitals with 585 cases remained

Patient characteristics

Age (mean)	65,7	62,3
Acute renal failure	3%	4%
Cancer	4%	1%
Chronic renal failure	8%	5%
Congestive heart failure	9%	18%
Diabetes	24%	16%
Diabetes complications	4%	2%
Peripheral vascular disease	4%	2%
Pulmonary disease	15%	7%
Severe liver disease	<1%	0%
Angina pectoris	1%	3%
Cerebrovascular disease	2%	1%
Cardiac dysrhythmias	9%	13%
Chronic ischemic heart disease	66%	80%
Hypertensive heart disease	<1%	<1%
Shock	<1%	<1%