

# “Does the Quality of Hospital Treatment Vary by Days of the Week?”

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# Introduction

## Objectives

- Show the effect of the time of admission on the quality of treatment
- Investigate the existence of premature discharge

## Rationale

- Introduction of the DRG system
- Reductions of length of stay

# Previous literature

## Empirical findings

- Worse health outcomes for admissions/discharges during the weekend/ at night (Kaiser et al. 2006, Bell and Redelmeier 2001, Goldfrad and Rowan 2000, Arias et al. 2004)
- Staffing capacity related to health outcomes (Lang et al. 2004, Lankshear et al. 2005)
- Outcomes depend on LOS
  - Hospitals with shorter LOS have higher emergency readmission rates (Heggestad 2002)
  - In-hospital mortality risk decreases with higher average LOS (Heggestad 2002)

# Methodological Issues

- Measures of quality of treatment
  - in-hospital mortality
  - emergency readmissions
- Risk adjustment
- Endogeneity of day of admission
  - elective vs. emergency admissions

# Emergency Admission

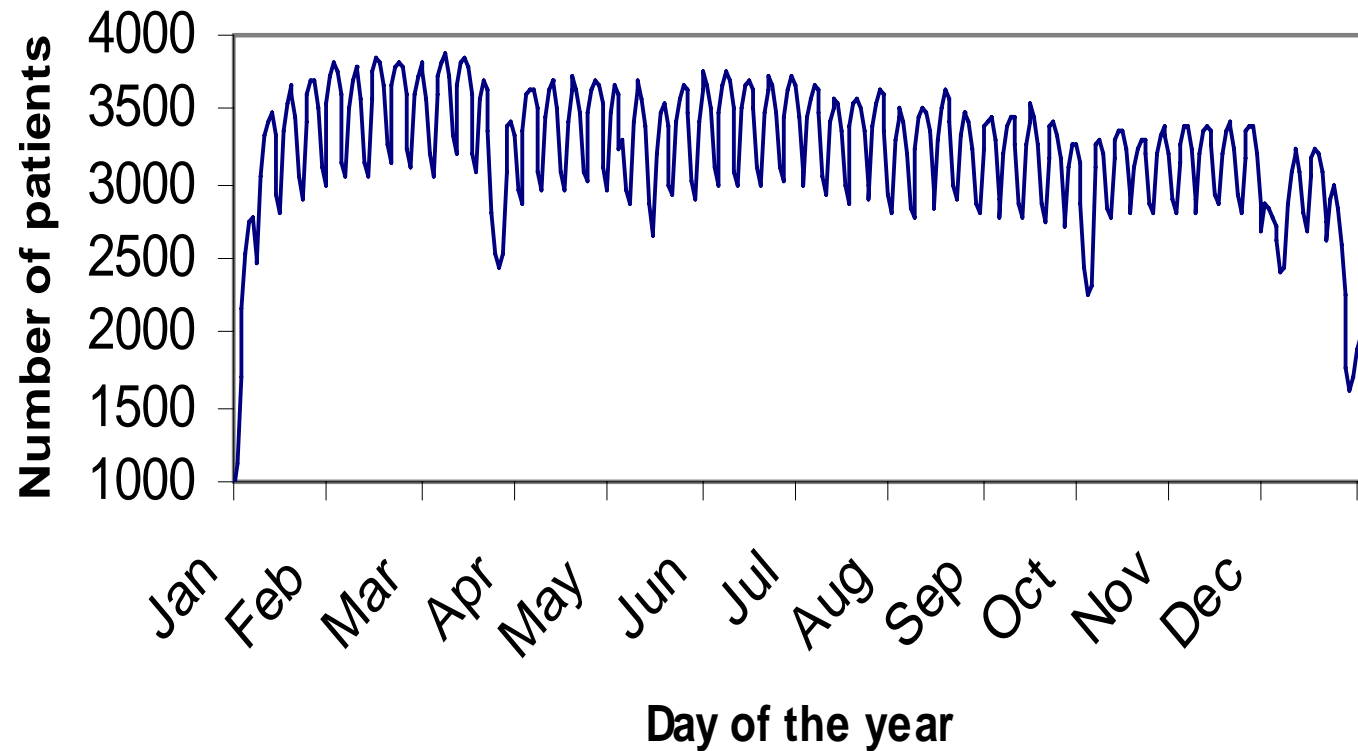
- Definition: Patients in **imminent danger of life**, or where danger of life is to be expected, if the **fastest possible medical treatment** is not provided (Law of emergency medical services)
  - No self-selection of patients
- Hospitals must admit all emergency cases, given their capacity and medical qualification
  - No selection of patients by admitting hospitals
- If admission of emergency patients is exogenous by days of the week and time of the day, we can single out the effect of quality of treatment by time of admission

# The Data

- **Source:** Administrative patient-level data from twelve German hospitals for the years 2004 and 2005
- **Health outcomes:** In-hospital mortality up to 30 days after admission, emergency readmissions up to 15 days after hospitalization
- **Sample size:**
  - 263 823 observations
  - 168 705 elective and 95 118 emergency admissions
- **Patient characteristics:** Age, sex, insurance status, distance to hospital
- **Characteristics of illness severity:** Relative diagnosis weight, PCCL, operative diagnosis, number of secondary diagnoses, dummies for MDC, hospital and department of admission

# Descriptive Analysis

## Admission and Discharge Policy

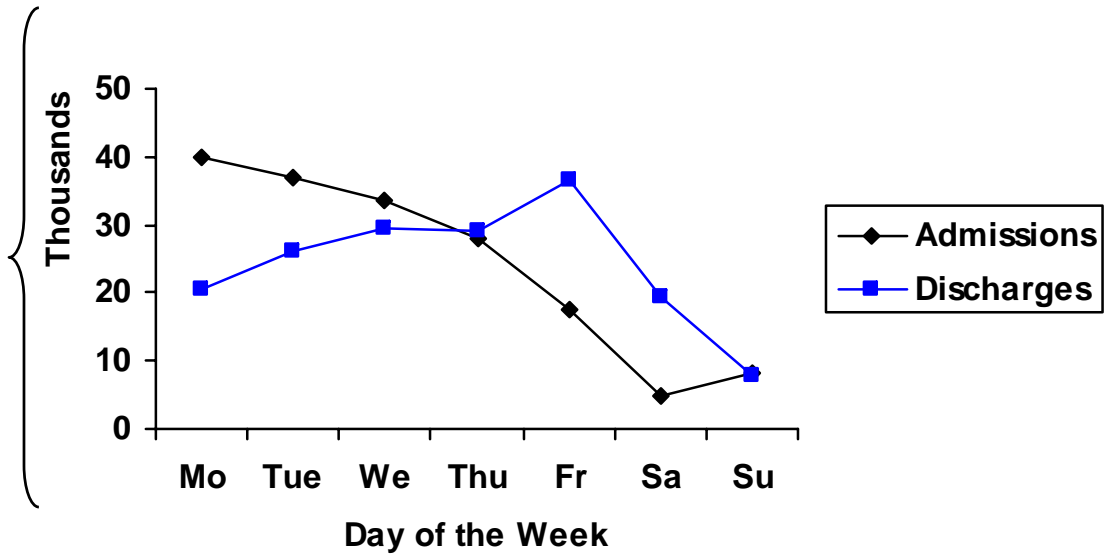


Typical pattern of rising and falling numbers of patients throughout the year

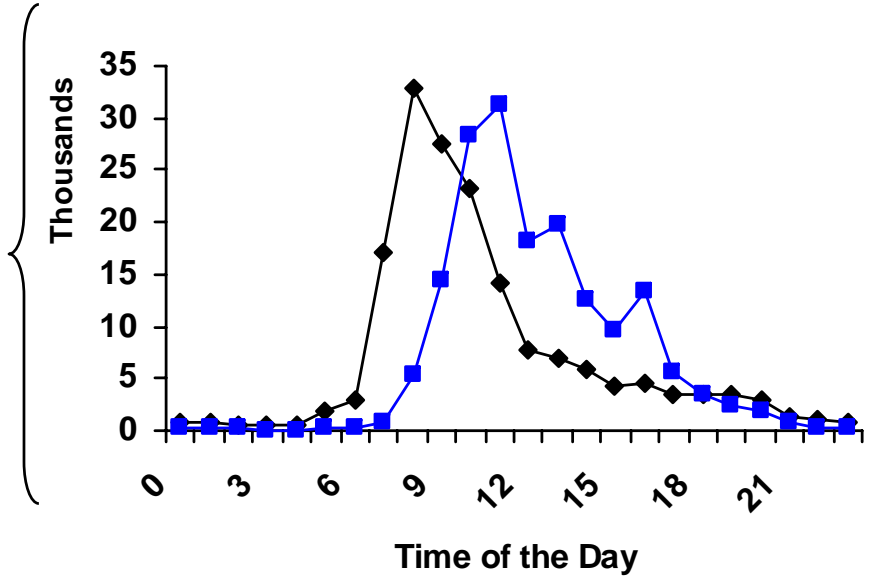
# Descriptive Analysis

## Admission and Discharge of Elective Patients

Many admissions on Mondays and many discharges before the weekend



Many admissions in the morning, discharges lagging

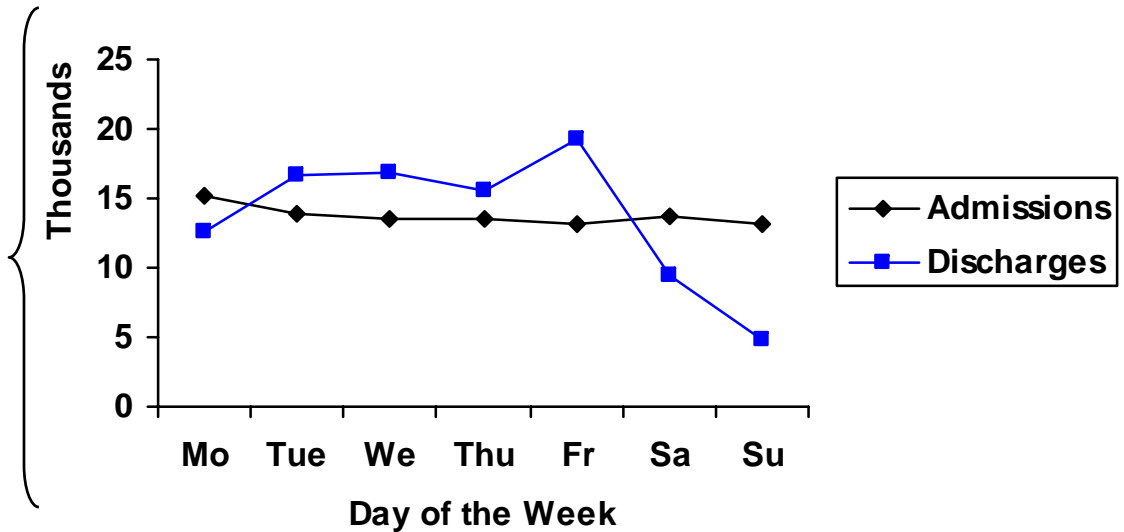




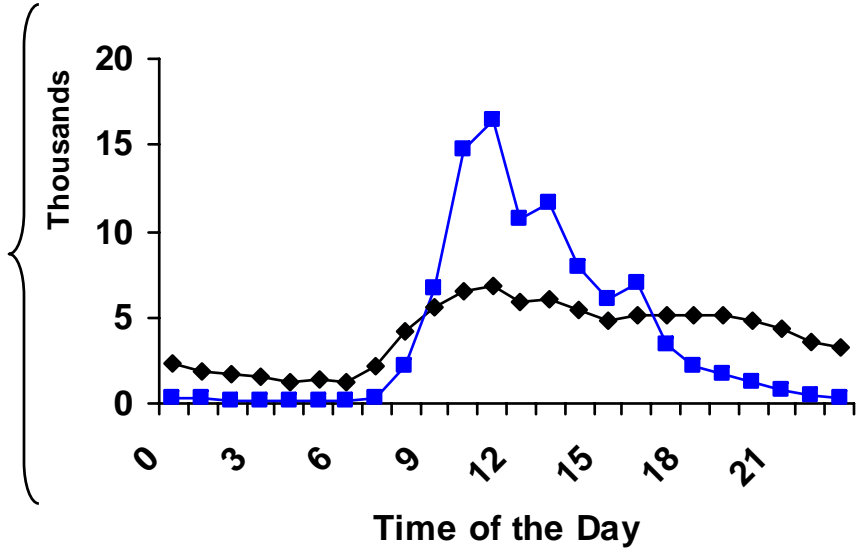
# Descriptive Analysis

## Admission and Discharge of **Emergency** Patients

Admissions constant throughout the week



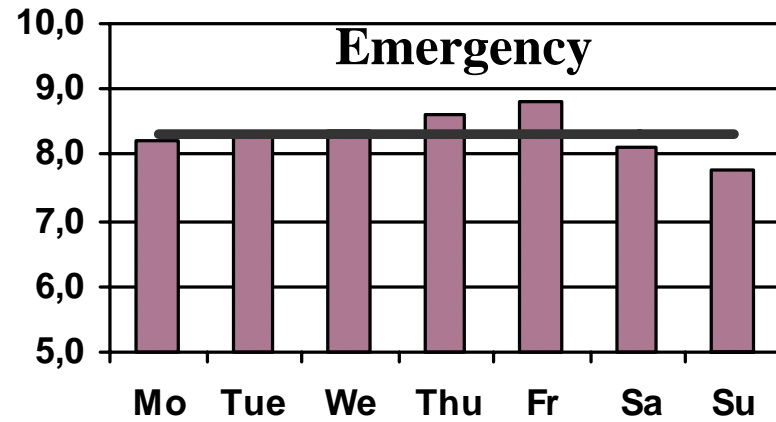
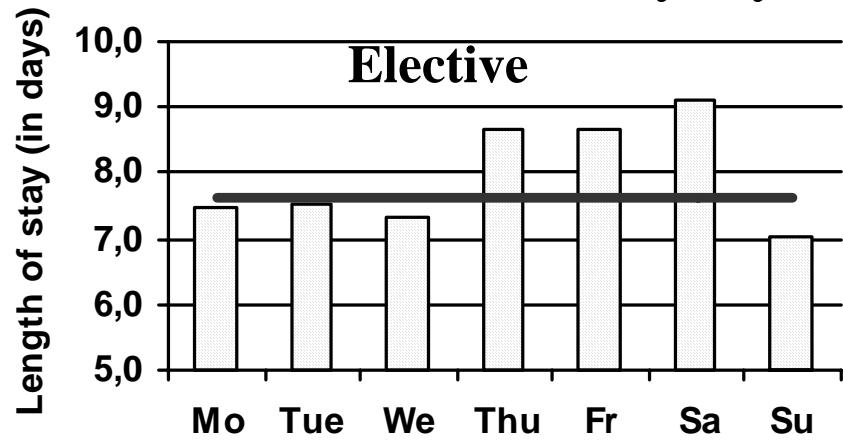
Admissions less variable than those of elective patients



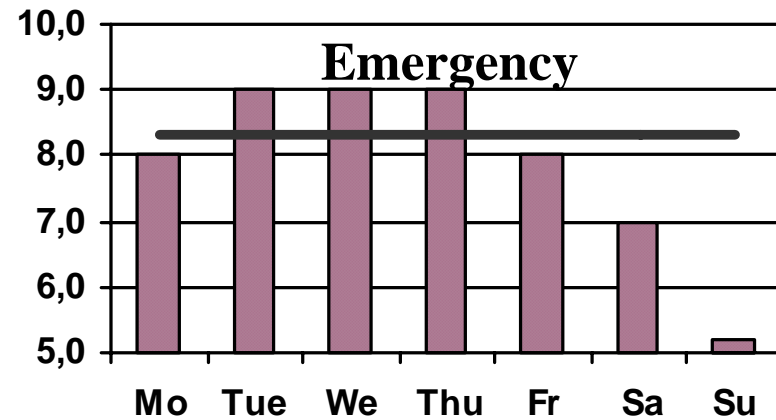
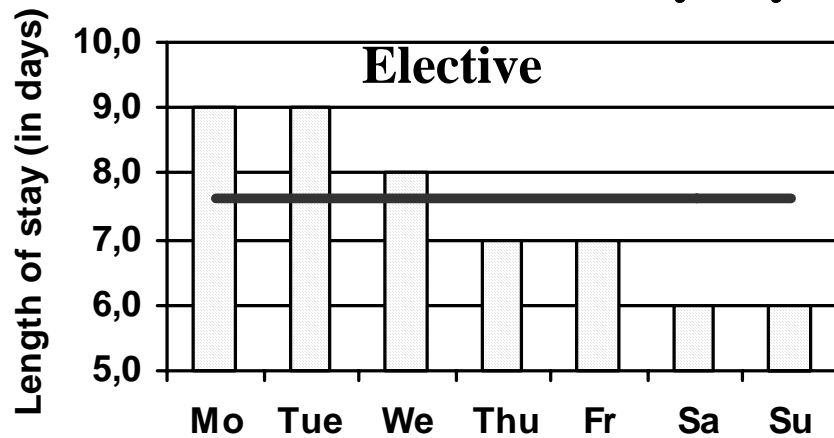
# Descriptive Analysis

## Length of Stay

By day of admission



By day of discharge



# Descriptive Analysis

## Unadjusted in-hospital mortality rates (in %)

	By day of admission*		Death-to-patients ratio*	
	Elective patients	Emergency patients	Elective patients	Emergency patients
<b>Mo-Su</b>	<b>1.36</b>	<b>3.81</b>	<b>0.125</b>	<b>0.187</b>
Mo-Fr	1.28	3.74	0.122	0.184
Mo	1.08	3.48	0.113	0.176
Tue	1.12	4.01	0.116	0.180
We	1.13	3.63	0.122	0.192
Thu	1.35	3.63	0.126	0.176
Fr	1.96	3.97	0.134	0.198
Sa	2.91	3.95	0.131	0.198
Su	1.62	4.08	0.137	0.191

Notes:

& In-hospital mortality within 30 days after admission

\* Number of deaths relative to patients

Relatively high mortality rates before/during the weekend

# Descriptive Analysis

## Unadjusted emergency readmission rates (in %)

	By day of admission		By day of discharge	
	Elective patients	Emergency patients	Elective patients	Emergency patients
<b>Mo-Su</b>	<b>0.67</b>	<b>1.02</b>	<b>0.67</b>	<b>1.02</b>
Mo-Fr	0.66	1.01	0.67	0.99
Mo	0.59	1.06	0.63	1.02
Tue	0.65	0.92	0.54	0.76
We	0.69	1.10	0.66	1.30
Thu	0.75	0.98	0.73	0.96
Fr	0.73	1.03	0.75	0.97
Sa	0.91	1.22	0.69	1.17
Su	0.63	0.87	0.64	1.14

Notes:

# Emergency readmissions within 15 days after previous discharge

Higher readmission rates for before weekend admissions

# Descriptive Analysis

## Unadjusted In-Hospital Mortality and Readmission Rates by time of the day (In %)

Hour	Elective patients		Emergency patients	
	In-Hospital Mortality <sup>&amp;</sup>	Readmission Rates <sup>*</sup>	In-Hospital Mortality	Readmission Rates
0-24	1.36	0.67	3.97	1.02
7-18	1.31	0.70	3.77	1.04
18-7	1.73	0.52	4.10	1.00

Notes:

& In-hospital mortality within 30 days after admission

# Emergency readmissions within 15 days after previous discharge

Higher mortality rates at night, lower readmission rates at night

# Descriptive Analysis

**Descriptive statistics of individual characteristics and main indicators of severity of illness by days of admission**

Variable	Elective patients		Emergency patients	
	Mo-Fr	Sa-Su	Mo-Fr	Sa-Su
Number of observations	155692	12944	69261	25857
Age	50.38 (25.33)	38.42 (31.24)	52.75 (25.74)	50.60 (27.11)
Fraction of males	0.52 (0.50)	0.54 (0.50)	0.52 (0.50)	0.52 (0.50)
Fraction of privately insured patients	0.08 (0.27)	0.09 (0.28)	0.09 (0.29)	0.09 (0.28)
Distance from patient's home to hospital	23.95 (55.94)	20.93 (53.79)	17.81 (53.65)	17.56 (54.25)
Effective case mix index	1.20 (2.20)	1.26 (2.69)	1.24 (2.40)	1.18 (2.16)
Clinical complexity level (PCCL)	1.48 (1.61)	1.30 (1.63)	1.89 (1.65)	1.82 (1.65)
Fraction of operative DRGs	0.35 (0.48)	0.27 (0.44)	0.21 (0.41)	0.19 (0.39)
Number of secondary diagnoses	3.05 (4.34)	2.94 (5.19)	3.16 (5.63)	2.90 (5.32)

Note: Standard deviations in parentheses.

# Descriptive Analysis

## Causes of in-hospital mortality and emergency readmissions for weekdays versus weekend admissions (in %)

Causes	Emergency admissions			
	Deaths		Readmissions	
	Mo-Fr %	Sa-Su %	Mo-Fr %	Sa-Su %
MDC 01 Mental disorders	15.99	16.17	12.58	11.02
MDC 03 Diseases of the sense organs	0.86	0.62	4.87	4.90
MDC 04 Diseases of the respiratory system	18.61	18.30	14.15	6.12
MDC 05 Diseases of the circulatory system	17.12	20.43	17.77	17.14
MDC 06 Diseases of the digestive system	9.03	8.70	12.74	29.80
MDC 07 Diseases of the hepatobiliary system and pancreas	5.44	5.60	2.20	2.04
MDC 08 Diseases of the musculoskeletal system	2.66	2.84	4.09	4.90
MDC 09 Diseases of the skin and subcutaneous tissue	1.90	1.51	2.99	2.45
MDC 10 Endocrine, nutritional and metabolic diseases	1.76	1.95	1.58	1.22
MDC 11 Diseases of the urinary system	2.14	2.31	8.49	7.75
MDC 12 Diseases of the male genitourinary system	0.55	0.35	0.94	0.41
MDC 13 Diseases of the female genitourinary system	1.10	0.98	2.67	1.63
MDC 15 Newborn	0.07	0.00	2.04	1.22
MDC 17 Hematological diseases and neoplasms	2.51	2.13	5.34	5.71
MDC 18B Infectious and parasitic diseases	4.00	3.55	2.52	1.23
MDC 21B Injury and poisoning	0.65	0.44	2.67	0.82
MDC 23 Symptoms, signs and ill-defined conditions	0.31	0.35	1.10	1.22
Ungroupable	15.30	13.76	1.26	0.41
<b>Total number</b>	<b>2902</b>	<b>1126</b>	<b>636</b>	<b>245</b>

# Estimation method

- Binary dependent variables
  - Above average length of stay
  - In-hospital mortality
  - Emergency readmission
- Two samples
  - Full sample (elective and emergency admissions)
  - Emergency sample only
- Main variables of interest
  - weekend vs. weekday admission
  - night vs. day admission
- 3 sets of explanatory variables
  - S1 = Raw (Treatment on outcome)
  - S2= S1 + exogenous individual characteristics
  - S3=S2 + mostly endogenous severity of illness indicators and dummies for diagnosis, department and hospital of admission



# Probit regression results

## Determinants of **above average LOS**

Explanatory Variables	Above average LOS							
	By day of admission				By day of discharge			
	Full sample		Emergency cases		Full sample		Emergency cases	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
<b>Tue</b>	0.054**	(6.30)	0.061**	(3.81)	-0.036**	(-3.59)	-0.004	(-0.24)
<b>We</b>	0.081**	(9.12)	0.097**	(6.02)	-0.113**	(-11.44)	-0.055**	(-3.48)
<b>Thu</b>	0.137**	(15.23)	0.148**	(9.25)	-0.206**	(-20.61)	-0.096**	(-5.97)
<b>Fr</b>	0.162**	(16.31)	0.146**	(9.13)	-0.268**	(-27.94)	-0.126**	(-8.15)
<b>Sa</b>	0.098**	(8.03)	0.057**	(3.44)	-0.311**	(-27.74)	-0.186**	(-10.00)
<b>Su</b>	0.004	(0.37)	-0.032*	(-1.99)	-0.306**	(-20.21)	-0.254**	(-10.47)
Died in hospital	-0.466**	(-23.35)	-0.557**	(-21.38)	-0.443**	(-22.03)	-0.530**	(-20.24)
Male	-0.048**	(-7.92)	-0.058**	(-6.14)	-0.049**	(-8.04)	-0.058**	(-6.13)
Age	-0.002*	(-2.47)	0.007**	(6.71)	-0.002*	(-2.42)	0.007**	(6.60)
Age <sup>2</sup>	0.005**	(7.24)	-0.002*	(-2.34)	0.005**	(7.09)	-0.002*	(-2.28)
Privately insured	-0.098**	(-9.46)	-0.143**	(-8.92)	-0.096**	(-9.19)	-0.140**	(-8.73)
Distance	-0.001**	(-3.85)	0.001	(1.55)	-0.001**	(-3.81)	0.001	(1.38)
Distance <sup>2</sup>	0.001*	(2.54)	0.001	(0.30)	0.001*	(2.49)	0.001	(0.19)
PCCL	0.064**	(29.02)	0.075**	(21.25)	0.064**	(28.62)	0.073**	(20.73)
DRG weight	-0.041**	(-12.40)	-0.064**	(-12.03)	-0.043**	(-12.59)	-0.065**	(-12.25)
Operative DRG	-0.096**	(-10.88)	0.048**	(3.13)	-0.105**	(-11.85)	0.047**	(3.06)
#Side diagnoses	0.095**	(53.97)	0.094**	(36.37)	0.096**	(53.86)	0.094**	(36.26)
Pseudo R2								

Notes:

§ 1 if positive individual deviation from the expected average length of stay from a diagnosis according to the official DRG catalogue, 0 otherwise.

# Probit regression results

**Weekend admission and in-hospital mortality:**  
**FULL SAMPLE**

Explanatory Variables	In-hospital mortality <sup>*</sup>					
	Raw		Adjusted <u>exog</u>		Adjusted <u>endog</u>	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
<b>Weekend admission</b>	<b>0.217**</b>	<b>(15.91)</b>	<b>0.237**</b>	<b>(16.15)</b>	<b>0.180**</b>	<b>(10.44)</b>
Male			0.085**	(7.23)	0.039**	(2.75)
Age			0.001	(0.22)	0.010**	(4.96)
Age <sup>2</sup>			0.017**	(16.56)	0.006**	(3.62)
Privately insured			-0.035	(-1.61)	0.03	(1.15)
Distance			-0.002**	(-3.56)	-0.002**	(4.43)
Distance <sup>2</sup>			3.3 E-04*	(2.29)	3.3 E-04**	(3.58)
PCCL					0.344**	(40.99)
Relative DRG weight					-0.159**	(-13.58)
Operative DRG					0.001	(1.01)
# Side diagnoses					0.015**	(8.89)
Artificially ventilated					0.001**	(4.59)
Pseudo R <sup>2</sup>	0.004		0.081		0.304	

# Probit regression results

## In-hospital Mortality

Explanatory Variables	In-Hospital Mortality			
	Full sample (263754 observations)		Emergency sample (95118 observations)	
Weekend admission	0.180**	-	0.061**	-
Night admission	-	0.139**	-	0.010
Male	0.039**	0.041**	0.046*	0.046*
Age	0.010**	0.011**	0.020**	0.020**
Age <sup>2</sup>	0.006**	0.005**	-0.001	-0.001
Privately insured	0.03	0.029	0.016	0.016
Distance	-0.002**	-0.002**	-0.002*	-0.002*
Distance <sup>2</sup>	3.3 E-04**	3.1 E-04**	0.000~	0.000~
PCCL	0.344**	0.324**	0.281**	0.281**
Relative DRG weight	-0.159**	-0.042**	-0.027**	-0.027**
Operative DRG	0.001	-0.089**	-0.037	-0.037
# Side diagnoses	0.015**	0.003*	0.002	0.002
Artificially ventilated	0.001**	-0.001**	-0.001**	-0.001**
Pseudo R2	0.30	0.31	0.29	0.29

Notes: \*\* significant at 1%; \* significant at 5%; ~ significant at 10%

# Probit regression results

## Emergency Readmission

Explanatory Variables	Emergency Readmission			
	Full sample (263754 observations)		Emergency sample (95118 observations)	
Weekend admission	0.052	-	0.010	-
Night admission	-	-0.057~	-	-0.068~
Above avg. length of stay	-0.302**	-0.301**	-0.274**	-0.276**
Male	-0.003	-0.002	-0.014	-0.014
Age	-0.003	-0.003	-0.003	-0.003
Age <sup>2</sup>	0.001	0.000	0.001	0.001
Privately insured	0.025	0.025	0.013	0.011
Distance	-0.003**	-0.003**	-0.001	-0.001
Distance <sup>2</sup>	0.001**	0.001**	0.000	0.000
PCCL	0.044**	0.044**	0.021~	0.021~
Relative DRG weight	-0.139**	-0.139**	-0.252**	-0.252**
Operative DRG	-0.032	-0.037	0.215*	0.210*
# Side diagnoses	-0.038**	-0.038**	-0.044**	-0.044**
Artificially ventilated	-0.001	-0.001	0.000	0.000
Pseudo R2	0.086	0.091	0.07	0.08

Notes: \*\* significant at 1%; \* significant at 5%; ~ significant at 10%

# Probit regression results

Selected partial effects from fully adjusted models

	Full sample		Emergency sample	
	Partial Effect	t-value	Partial Effect	t-value
<b>Weekend admission</b>	0.002279**	(10.60)	0.001508**	(3.05)
<b>Night admission</b>	0.001597**	(8.68)	0.000028	(0.06)
			<b>Emergency readmissions</b>	
<b>Weekend admission</b>	0.000714*	(2.28)	0.000161	(0.34)
<b>Above average LOS</b>	-0.003610**	(14.04)	-0.004248**	(8.81)
<b>Night admission</b>	-0.000201	(0.75)	-0.000249	(0.57)
<b>Above average LOS</b>	-0.003599**	(13.99)	-0.004246**	(8.81)

# Summary and Conclusion

- Mixed evidence of significance of time of admission on quality of treatment
  - In-hospital mortality significantly higher for weekend admissions
  - No significance of day of admission when emergency readmission is the outcome
  - No significant effect for day vs. night admissions
- Signs of premature discharge
  - Length of stay depends on day of admission and discharge
  - Above average length of stay is associated with fewer emergency readmissions
- **Probably:** Lower staffing capacity during the weekend might cause lower quality of outcome, but we do not know