

Do hospitals react to random demand pressure by early discharges?

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STATA User Group Meeting

Lisbon 2012



Outline

- ▶ Motivation;
- ▶ The Negative Binomial model;
 - ▶ The simple slopes approach;
- ▶ The Multinomial Logit model;
- ▶ Main conclusions.



Motivation

- ▶ Limited and fixed hospital resources may provide incentives to discharge patients earlier than expected when demand is high;
- ▶ An early discharge is problematic in the sense that it increases the risk of readmission and reduces the benefit each patient gets from treatment.

Main question: Is there a relationship between hospital utilization and discharge decisions in Portuguese hospitals?

Motivation

- ▶ *Diagnosis Related Groups* (DRGs) database;
- ▶ Years 2007,2008,2009 and 2010;
- ▶ 1 171 763 observations – 10 more relevant DRGs.

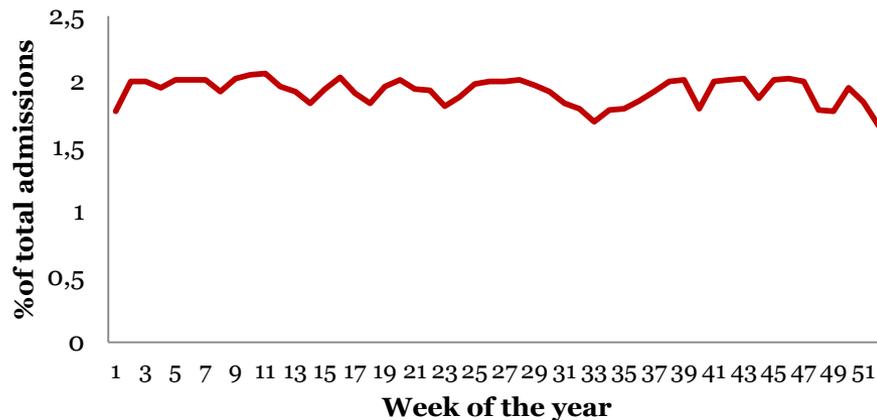
Hospital utilization: measured by the number of admissions occurring at a given hospital in a specific period of time.

Some regularities were found the evolution of hospital utilization both across the year and within each week.

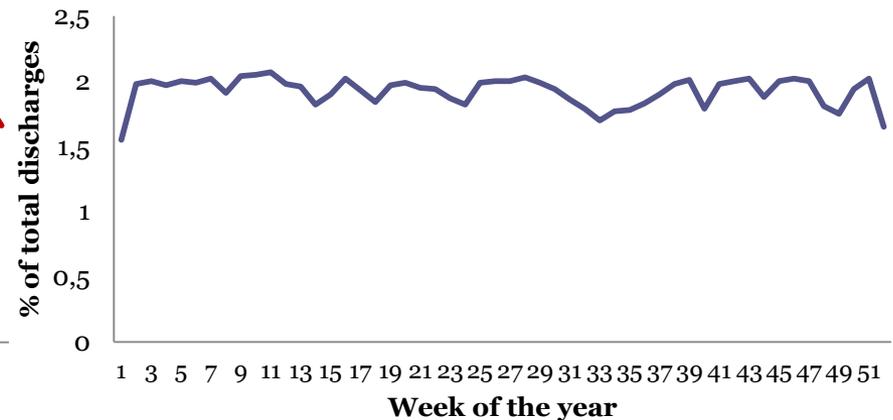
Motivation

Both admissions and discharges display a cyclical pattern closely related to vacation periods and climate changes.

Graph 1: Admissions per week



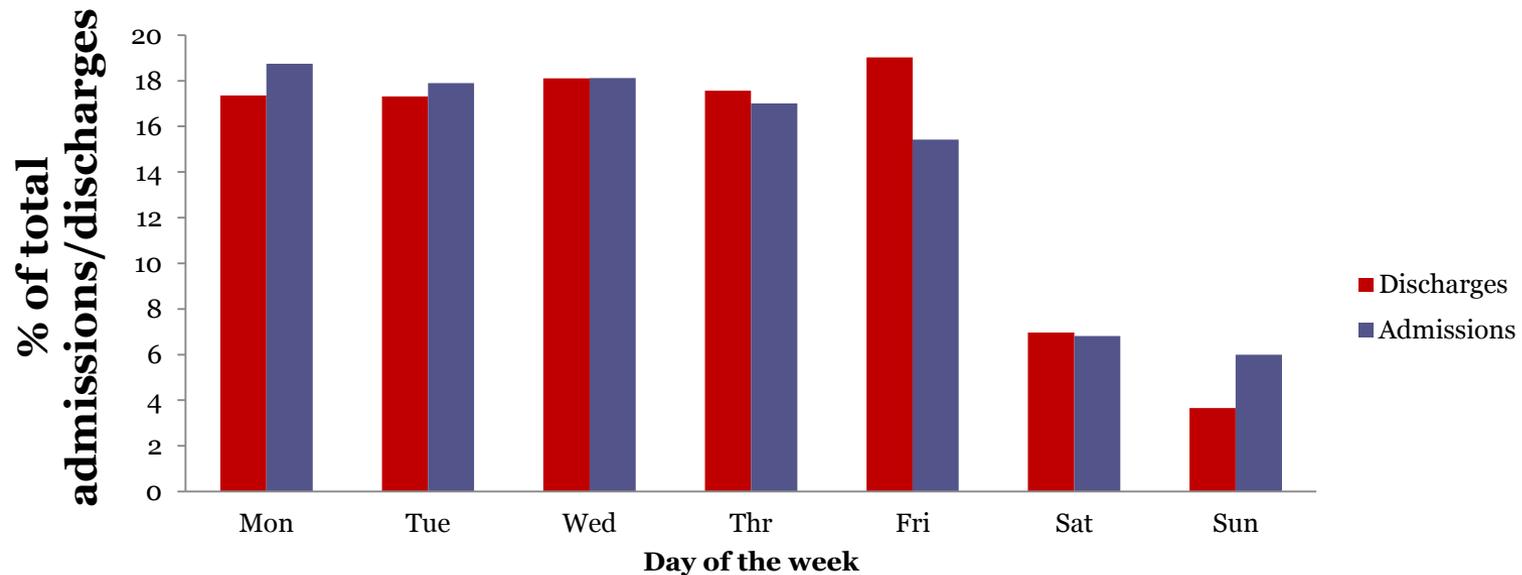
Graph 2: Discharges per week



Motivation

There is strong evidence in favour of the 'weekend effect'.

Graph 3: Admissions and Discharges per day of the week



The Negative Binomial (NB) model

- ▶ Why was the NB model used?
 - ▶ Evidence in favor of overdispersion in the data.

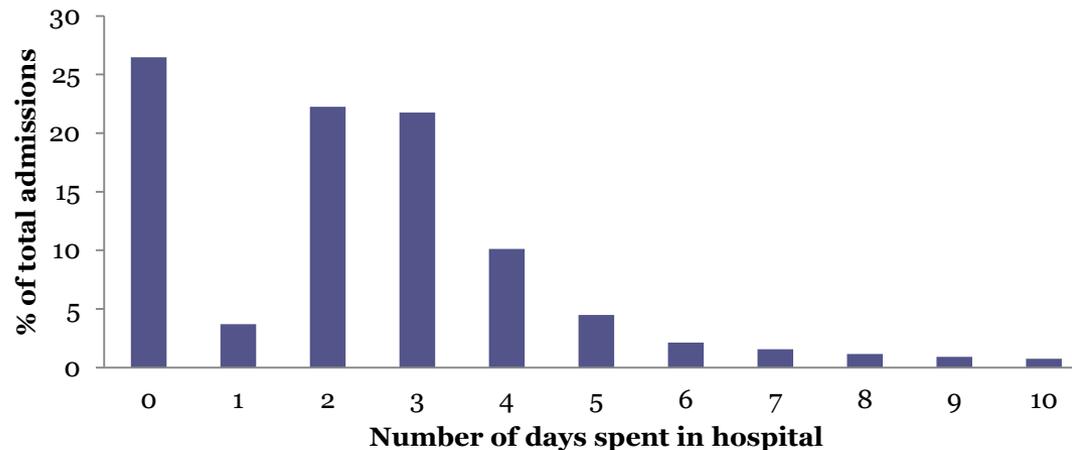
Table 1.

Overdispersion Parameter estimate			
Coef.	Std. Dev.	95% Conf. Int.	
0,1678	0,00052	0,1668	0,1689

Table 2.

Length	
Mean	Variance
3,188	28,106

Graph 4: Length of stay distribution



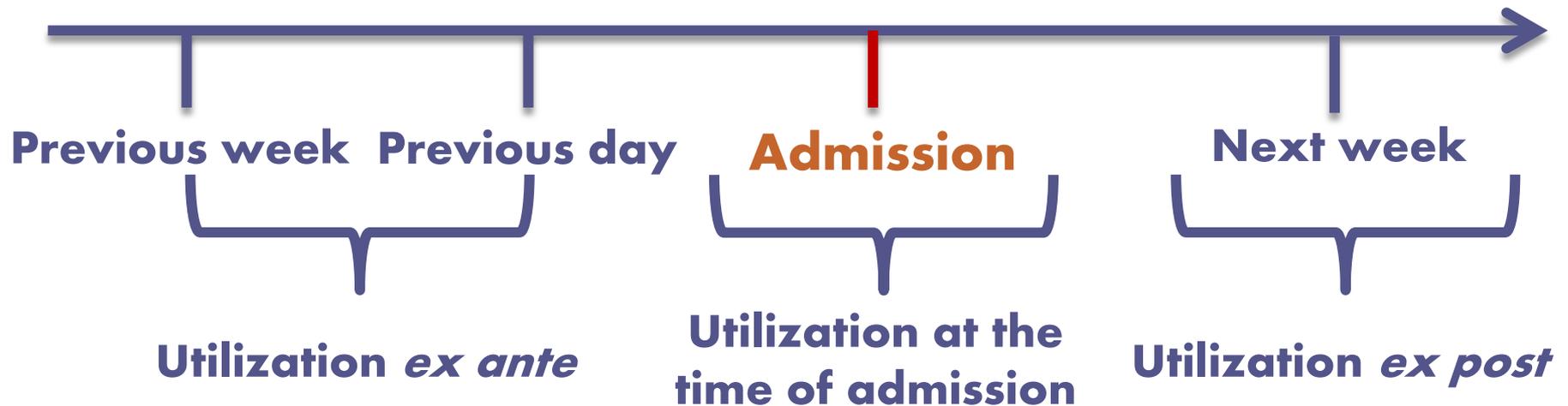
The Negative Binomial (NB) model

$$Y_{ijt} = c + \beta X_{ijt} + \alpha Z_{ijt} + \gamma (\text{Utilization})_{tj} + \mu (\text{Hospital FE})_j + \text{YEAR}_t + \text{DRG}_i + \varepsilon_{ijt}$$

- ▶ **Y:** Length of stay in hospital;
- ▶ **X:** Patient specific factors;
- ▶ **Z:** Variables that account for the admission/discharge date;
- ▶ **Hospital Fixed Effects:** One dummy variable for each hospital;
- ▶ **YEAR:** One dummy variable for each year;
- ▶ **DRG:** One dummy variable for each DRG included in the sample.

The Negative Binomial (NB) model

► Utilization Variables;

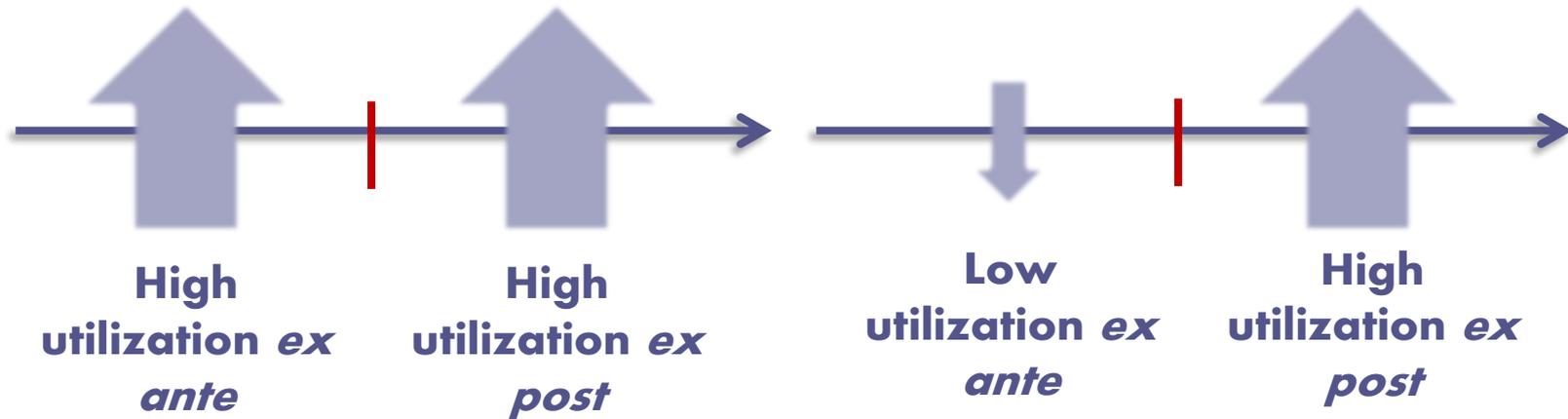


► Interaction term – continuous by continuous interaction;

Previous week admissions × Next week admissions

The Negative Binomial (NB) model

- Why is the interaction term necessary?



The hospital will probably be capacity constrained.

The hospital may not be capacity constrained.

The NB model (Results)

Tabel 3. NB model estimates

length	Coef.	Z	p> z 	IRR
summer	-0,015848	-9,54	0,000	0,9842
weekend	-0,01802	-7,8	0,000	0,9821
monday	0,060849	31,9	0,000	1,0627
admissions same week	-3,78E-05	-4,1	0,000	0,9999
admissions previous day	-1,45E-06	-5,3	0,000	0,9999
admissions previous week	-7,08E-05	-8,32	0,000	0,9999
admissions next week	-5,44E-05	-6,21	0,000	0,9999
Interaction term	6,59E-08	19,06	0,000	1,0000

Interpreting the interaction term (Simple Slopes Approach)

- ▶ Assume the following model

$$y = \beta_0 + \beta_1 x + \beta_2 z + \beta_3 xz$$

- ▶ This can be rearranged into

$$y = \beta_0 + \beta_2 z + (\beta_1 + \beta_3 z)x$$

The moderator variable z influences the relationship between the predictor variable x and the dependent variable y .

One can determine this marginal impact for different values of the moderator z .

Interpreting the interaction term (Simple Slopes Approach)

- In order to do that, one needs to create two new variables

$$\left. \begin{aligned} z_{low} &= z - \left(\bar{z} - \delta_z \right) \\ z_{high} &= z - \left(\bar{z} + \delta_z \right) \end{aligned} \right\} \text{Re-centering method}$$

- And, then, estimate two different models

$$y = \lambda_0 + \lambda_1 x + \lambda_2 z_{high} + \lambda_3 x z_{high}$$

$$y = \alpha_0 + \alpha_1 x + \alpha_2 z_{low} + \alpha_3 x z_{low}$$

Simple Slopes Approach (Results)

Table 4. Simple slopes approach assuming utilization *ex ante* as moderator

		Coef.	P> z	IRR
Utilization levels <i>ex ante</i>	Average	-5,44E-05	0,000	0,999946
	Below average	-9,21E-05	0,000	0,999908
	Above average	-1,67E-05	0,000	0,999983

An admissions surge after admission has a quantitatively irrelevant impact over hospital length of stay, independently of utilization levels *ex ante*.

Simple Slopes Approach (Results)

Table 5. Simple slopes approach assuming utilization *ex post* as moderator

Expected Future Utilization levels		Coef.	P> z	IRR
	Average	-7,1E-05	0,000	0,999929
	Below average	-1,08E-04	0,000	0,999892
	Above average	-3,31E-05	0,000	0,999967

An admissions surge prior to admission has a quantitatively irrelevant impact over hospital length of stay, independently of expected future utilization levels.

The Multinomial Logit (ML) model

Computes the relative probability of being discharged at a given day of the week.

- ▶ **Base outcome:** Wednesday;
- ▶ Uses the same control variables as the NB model;
 - ▶ Except for the hospital fixed effects;
 - ▶ Introduces length as covariate;
- ▶ Includes the same utilization variables;
 - ▶ Except for the interaction term;
- ▶ Includes dummy variables that indicate the day of admission.

The ML model (Results)

Table 6. ML average predicted probabilities

Day of the week	Probability	Std. Dev.
Monday	0,1579	0,110948
Tuesday	0,1512	0,121639
Wednesday	0,1555	0,124056
Thursday	0,1549	0,104269
Friday	0,1696	0,10084
Saturday	0,1282	0,096301
Sunday	0,0828	0,0965

Patients have a large probability of being discharged Friday and a low probability of being discharged during the weekend.

The ML model (Results)

Table 7. ML Model Marginal Effects

Variable	Friday		Saturday		Sunday	
	dy/dx	P> z	dy/dx	P> z	dy/dx	P> z
Admissions same week	-4,81E-06	0,36	3,72E-05	0,000	1,74E-05	0,000
admissions same day	-3,24E-06	0,000	7,82E-09	0,968	-2,57E-06	0,000
admissions previous day	7,38E-07	0,003	-3,12E-06	0,000	-2,33E-06	0,000
admissions next week	-1,11E-06	0,797	-6,21E-06	0,077	1,62E-05	0,000
admissions previous week	1,62E-05	0,000	-1,7E-05	0,000	8,85E-06	0,000
length	0,001573	0,000	-0,00411	0,000	-0,00068	0,000

Higher utilization levels increase the probability of being discharged Sunday.

Main Conclusions

Is there a relationship between hospital utilization and discharge decisions in Portuguese hospitals?

Utilization levels do have a negative impact over hospital length of stay, although this impact is quantitatively irrelevant.

However, patients have a larger probability of being discharged Friday and a lower probability of being discharged during weekend days.

Questions