Do hospitals react to random demand pressure by early discharges?

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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.

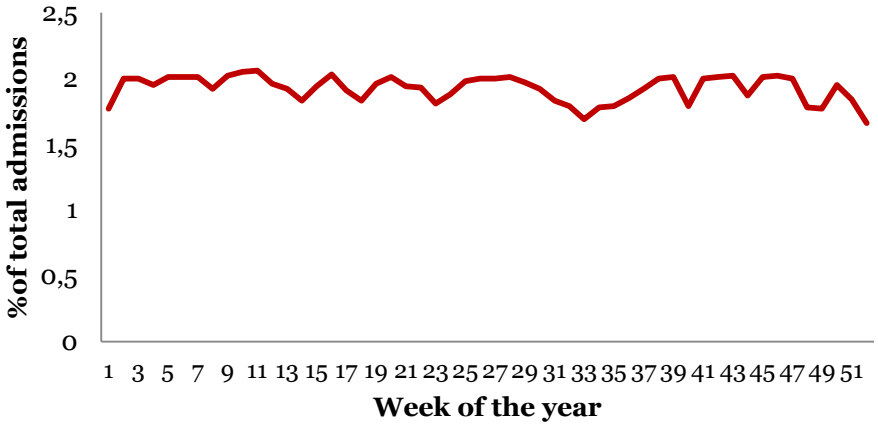
Hospital utilization: measured by the number of admissions occurring at a given hospital in a specific period of time.

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

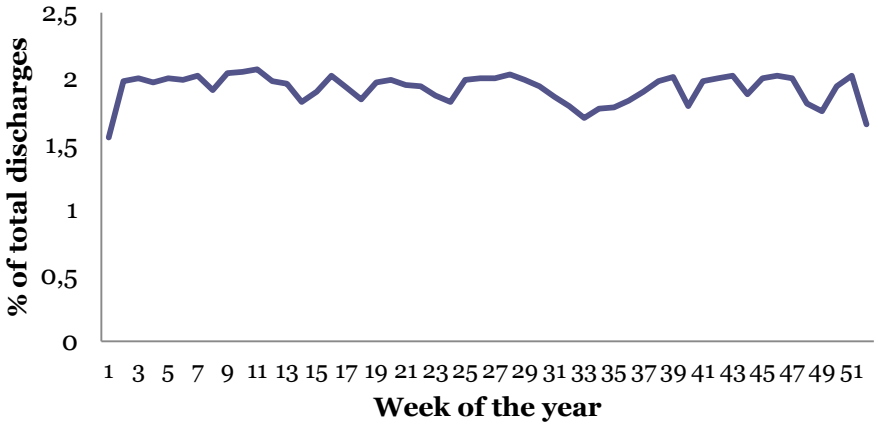
Motivation

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

Graph 1: Admissions per week



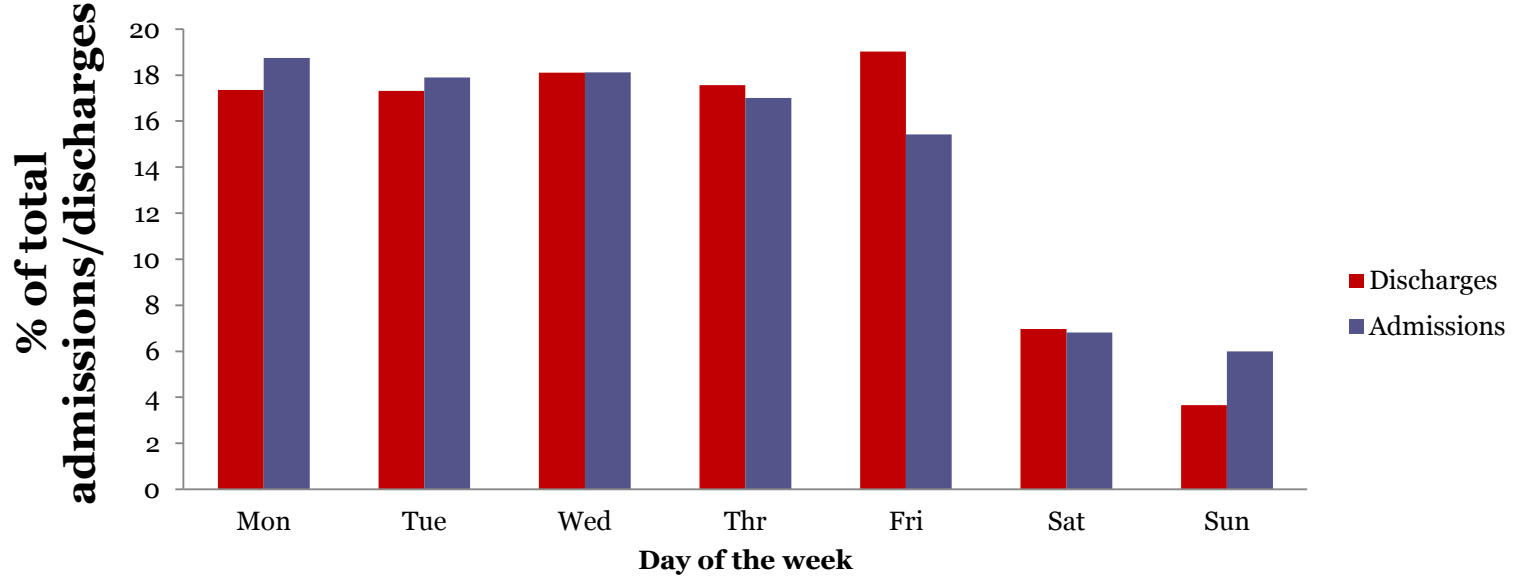
Graph 2: Discharges per week



Motivation

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

Graph 3: Admissions and Discharges per day of the week



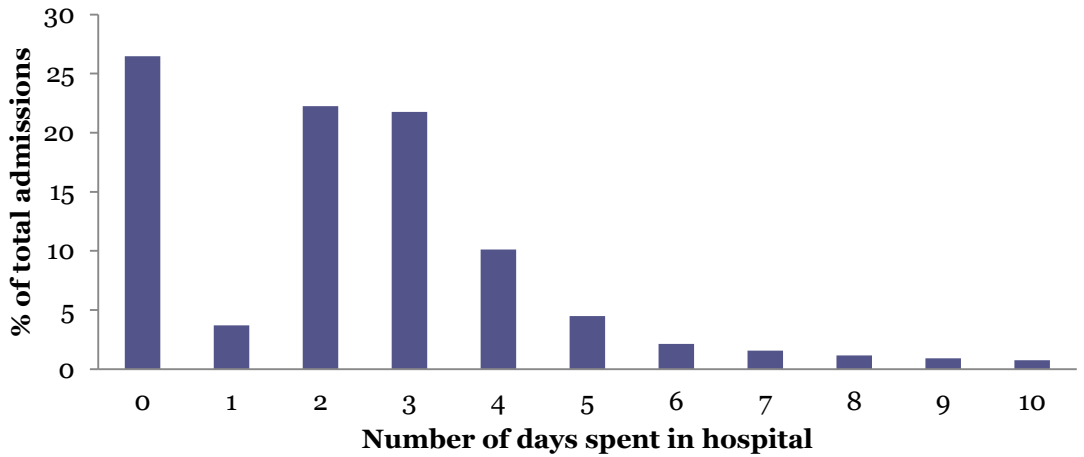
The Negative Binomial (NB) model

- 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



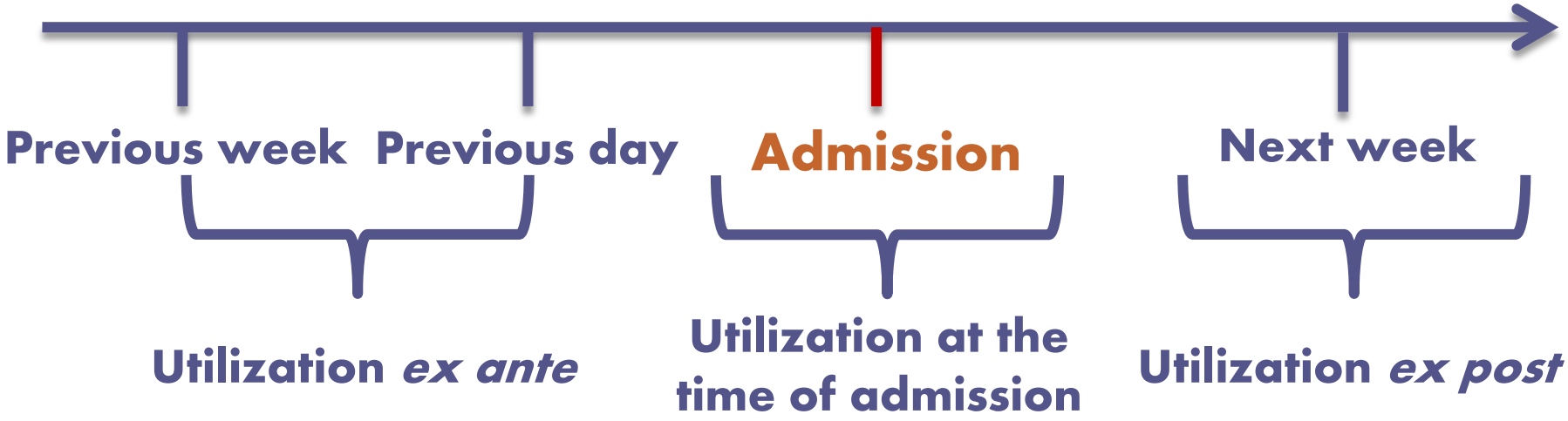
The Negative Binomial (NB) model

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

- **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;

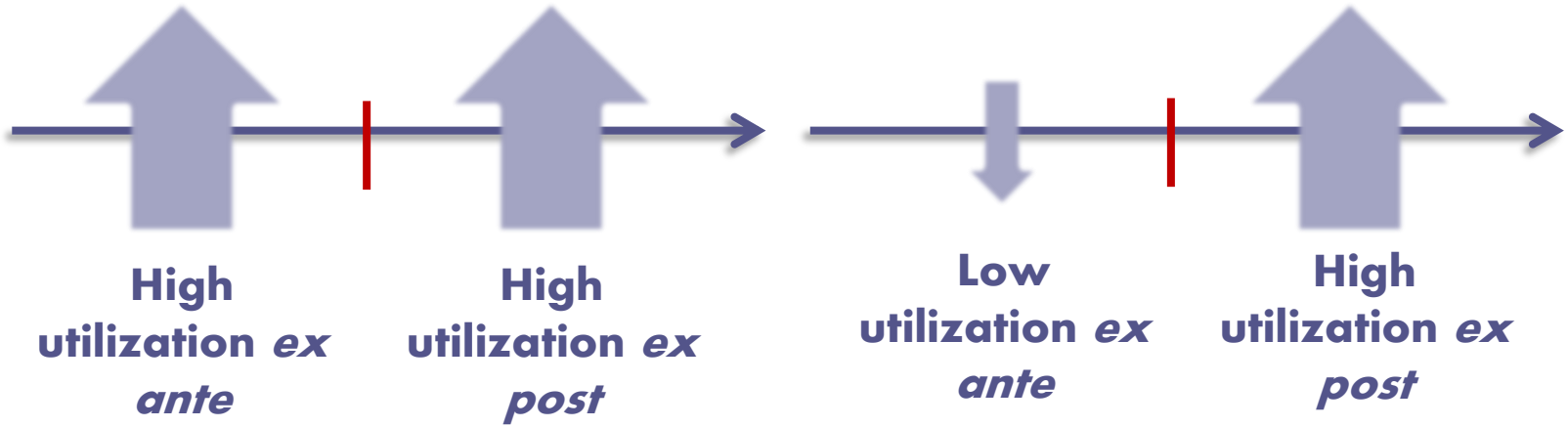


- Interaction term – continuous by continuous interaction;

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

$$z_{low} = z - \left(\bar{z} - \delta_z\right)$$
$$z_{high} = z - \left(\bar{z} + \delta_z\right)$$

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

Utilization levels *ex ante*		Coef.	P>|z|	IRR
	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