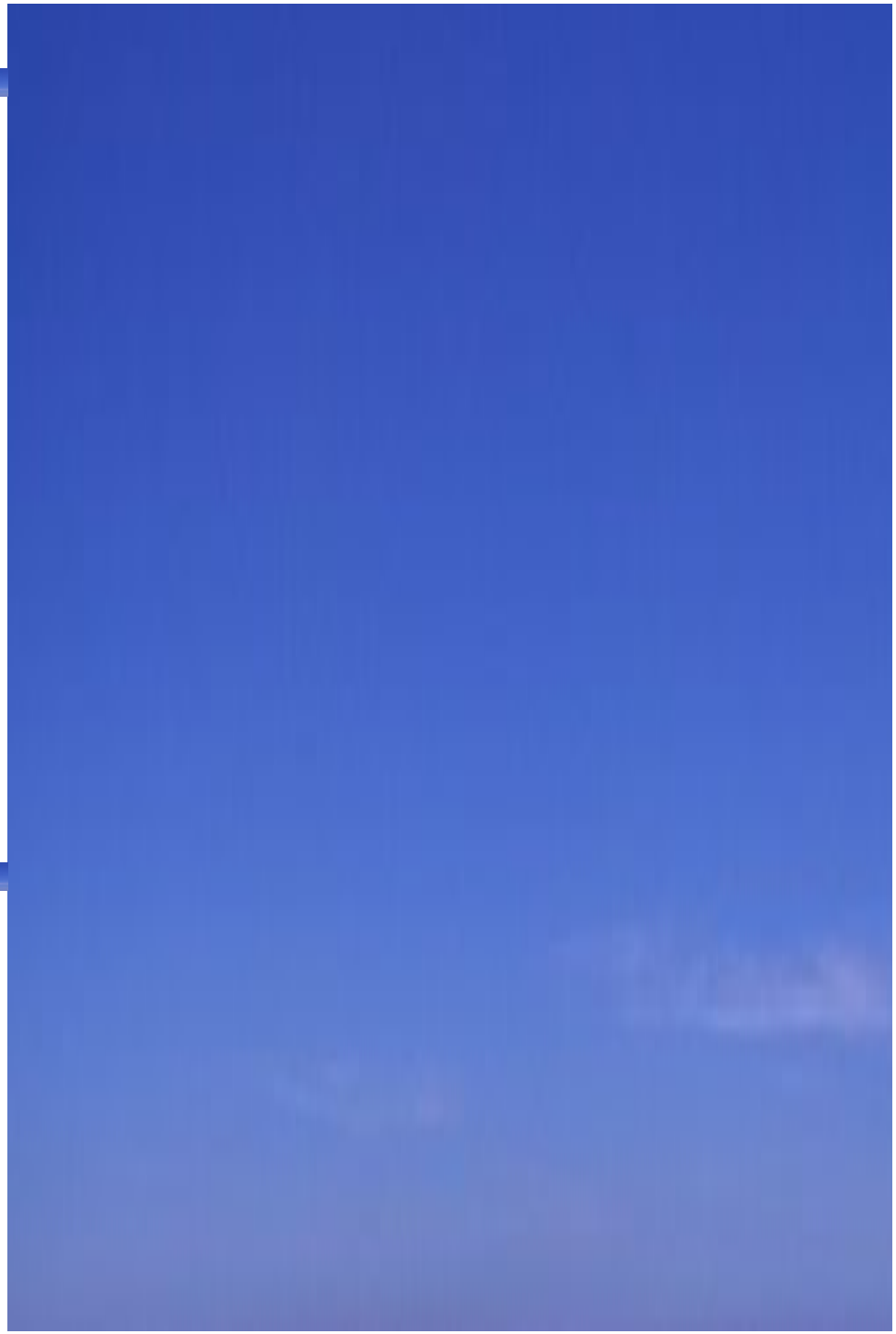
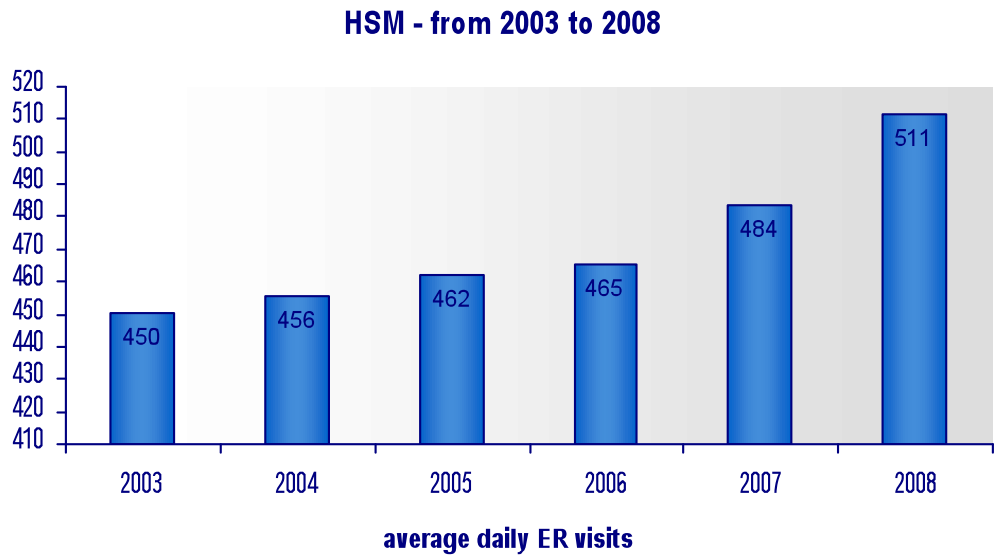
Sleepless nights?

The increase in Emergency Room cases at Hospital de Santa Maria



Why is there an increasing number of people who seek emergency care at HSM?

- Consistent increase in emergency cases (around 8% increase from 2007 to 2008)
- Particularly striking when compared to other ER services in Lisbon



General overview and motivation

Health Services

- Health sector – urgent need for reform; predominance of public services
- Reform – intense law production, namely in primary and emergency care

HSM

- Manchester triage (2006)
- "*Consulta de urgência*" (2007)
- Remodelling

Different patterns of demand/controversy

Possible increase of hospital visibility

Methodology and Data

Methodology

- Seriousness ∞ patient's characteristics
- Waiting times
- **Daily demand for ER visits**

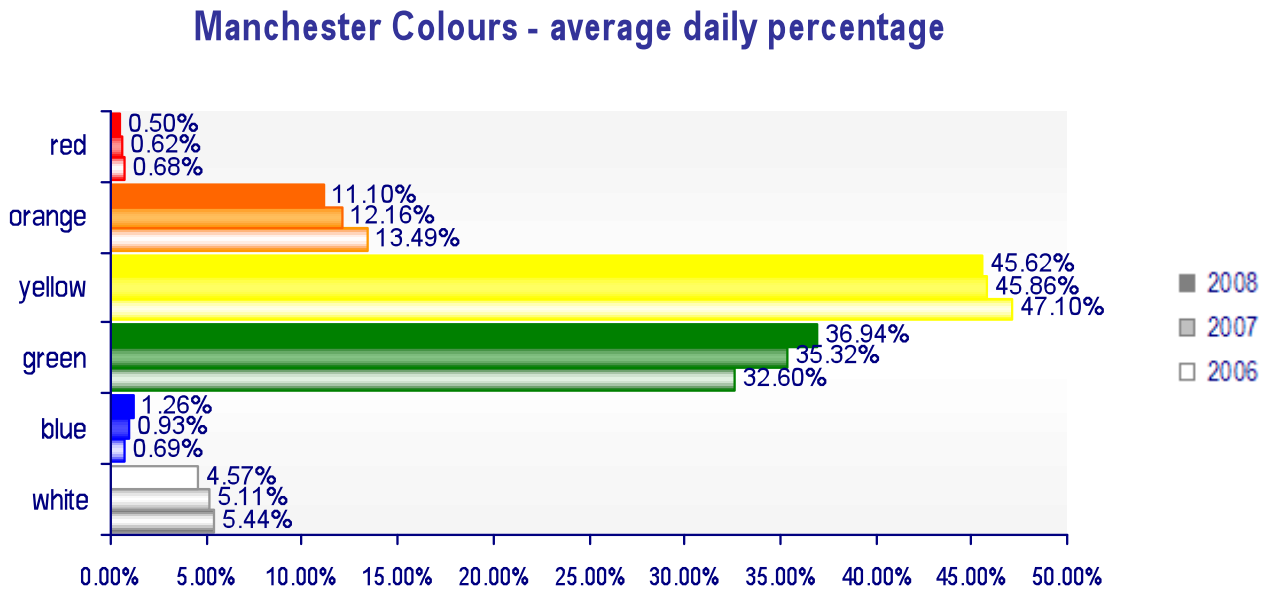
Data

- ALERT database (2006-08): HSM
- Hospital fees: *Diário da República*
- Distances: viamichelin

Methodology and Data

Methodology	Data
❖ Seriousness ∞ patient's characteristics ❖ Waiting times ❖ **Daily demand for ER visits**	❖ ALERT database (2006-08): HSM ❖ Hospital fees: *Diário da República* ❖ Distances: viamichelin
❖ Parishes: adding information ❖ Forecast: opening of a new primary emergency unit in Odivelas	❖ 2001 Census: INE ❖ Distances: viamichelin

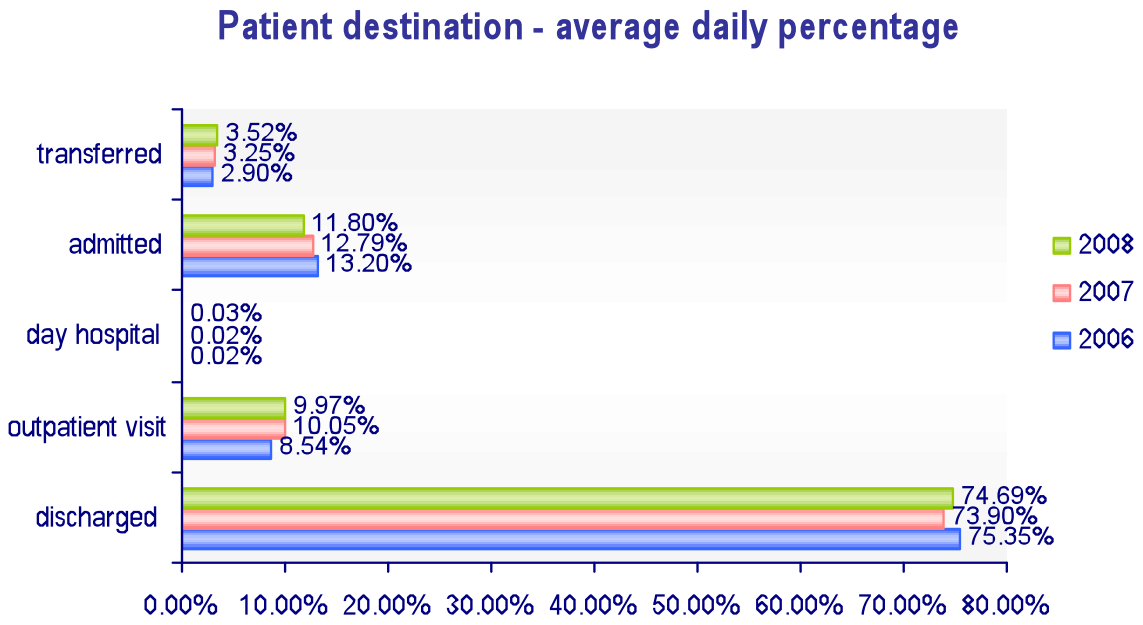
Descriptive Statistics



Proportion of “blue” and “green” increases – light cases

Proportion of “orange” and “red” decreases – serious cases

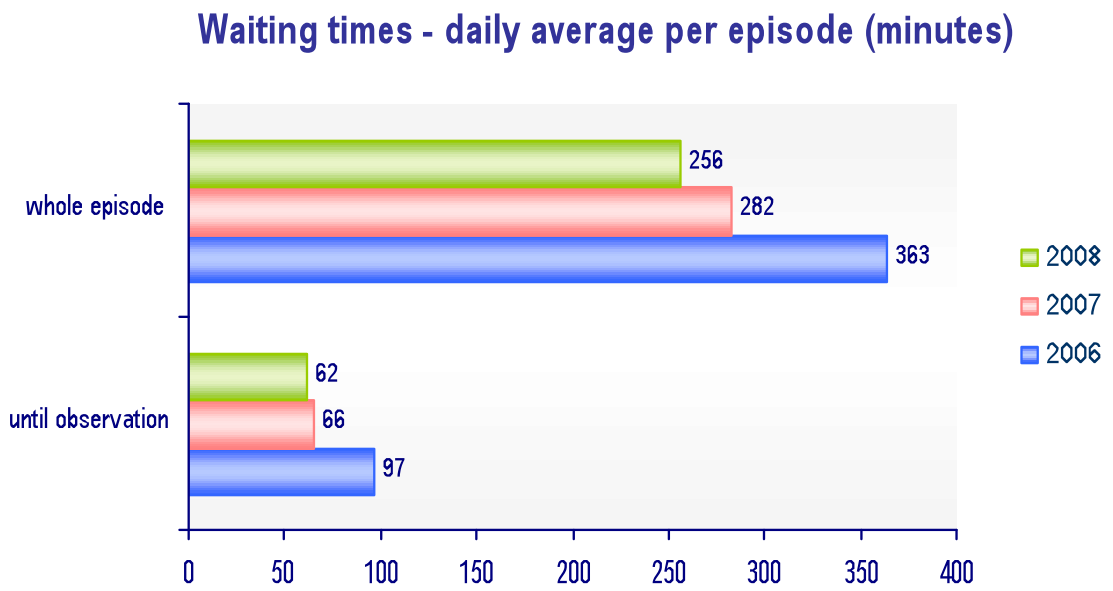
Descriptive Statistics



Proportion of “discharged” and “outpatient visit” increases

Hospital admission is relatively lower

Descriptive Statistics



Both waiting times and total episode spell have decreased significantly over the two years

Regression outputs – Time Trends

	2003 - 2008	
Independent variable	**Log of ER episodes per day**	**ER episodes per day**
Time trend (t)	0.0000396 (7.97)	0.0181535 (7.87)
2008 * t	0.00000333 (6.38)	0.00165 (6.81)
Note: t-ratios in parenthesis		

	2006 - 2008	
Independent variable	**Log of ER episodes per day**	**ER episodes per day**
Time trend (t)	0.000159 (4.51)	0.0763898 (4.46)
2008 * t	0.000000666 (0.79)	0.0003584 (0.87)
Note: t-ratios in parenthesis		

- Research strategy:
  - Look from different angles
  - Sometimes only associations can be found
  - Sometimes causal relations can be tested
- Includes:
  - Time series – number of episodes per day
  - Type of patients – “Manchester colors”
  - Repeated users – number of times each patient went to the ER
  - Waiting time to be seen – time in minute
  - Needs from population – cross-parish analysis

Roadmap to the models

Roadmap to the models

Regression outputs – Multinomial Logit Model

	Manchester colours - marginal effects											
Independent variable	**White**		**Blue**		**Green**		**Yellow**		**Orange**		**Red**	
2008	-0.0063274	(-8.33)	0.0036153	(9.81)	0.0228088	(13.14)	-0.0052354	(-2.93)	-0.0135423	(-12.41)	-0.001319	(-5.16)
Gender	-0.0025894	(-3.47)	-0.0022386	(-6.74)	-0.0072762	(-4.36)	0.03289	(19.00)	-0.018841	(-17.62)	-0.0019447	(-7.75)
Age below 1	-0.0325459	(-5.85)	-0.0083686	(-5.59)	-0.114844	(-6.79)	0.147708	(7.32)	0.0065293	(0.45)	0.0015212	(0.43)
Age between 1 and 5	-0.0218792	(-6.99)	-0.0092113	(-17.9)	-0.0610669	(-7.67)	0.1292958	(14.60)	-0.0356018	(-6.77)	-0.0015366	(-1.29)
Age between 5 and 18	-0.0173527	(-12.24)	-0.0048577	(-9.34)	0.0334027	(9.56)	0.0485845	(13.23)	-0.0576553	(-29.25)	-0.0021215	(-4.46)
Age between 55 and 65	0.0227867	(16.15)	-0.0004189	(-0.86)	-0.0668185	(-27.64)	-0.0018957	(-0.69)	0.0461733	(22.17)	0.000173	(0.40)
Age between 65 and 85	0.0187625	(18.07)	-0.0012264	(-3.21)	-0.1381397	(-73.59)	0.0210079	(9.73)	0.096537	(57.72)	0.0030588	(8.18)
Age above 85	-0.0016768	(-0.82)	-0.0070432	(-13.9)	-0.2207696	(-70.83)	0.020022	(4.22)	0.2024801	(44.41)	0.0069875	(6.46)

Note: z-ratios in parenthesis

	Patient destination after observation - marginal effects									
Independent variable	**Discharged**		**Outpatient visit**		**Day hospital**		**Admitted**		**Transferred**	
2008	-0.0014605	(-1.01)	0.0019438	(1.71)	0.0000318	(1.81)	-0.0035015	(-4.19)	0.0029864	(6.24)
Gender	0.0335634	(24.04)	0.0015922	(1.45)	-0.00000942	(-0.61)	-0.0230767	(-28.33)	-0.0120695	(-26.43)
Age below 1	0.0495404	(3.46)	-0.0283827	(-2.67)	-0.0000714	(-7.82)	-0.0174843	(-1.99)	-0.0036019	(-0.63)
Age between 1 and 5	0.0675533	(10.61)	-0.0238072	(-4.75)	-0.0000999	(-7.82)	-0.0376184	(-10.61)	-0.0060278	(-2.43)
Age between 5 and 18	0.0277208	(9.23)	0.0004769	(0.21)	0.0000528	(1.14)	-0.0254741	(-13.67)	-0.0027763	(-2.32)
Age between 55 and 65	-0.0870341	(-33.98)	0.0078716	(4.51)	0.0000354	(1.18)	0.0637322	(33.11)	0.0153949	(14.09)
Age between 65 and 85	-0.1607205	(-76.59)	0.0001743	(0.13)	0.00000427	(0.21)	0.1224486	(74.04)	0.0380933	(38.60)
Age above 85	-0.2857008	(-55.40)	-0.0390116	(-15.69)	-0.0000136	(-0.35)	0.2447243	(51.43)	0.0800017	(25.84)
Blue	0.0900518	(17.24)	0.0050445	(1.01)	-0.0001029	(-7.82)	-0.0763442	(-110.84)	-0.0186492	(-12.21)
Green	0.1846007	(72.98)	-0.036991	(-19.46)	-0.0000451	(-1.77)	-0.1421114	(-112.83)	-0.0054532	(-4.09)
Yellow	0.0827835	(29.40)	-0.0359835	(-17.58)	-0.0000194	(-0.69)	-0.0714232	(-54.58)	0.0246427	(15.22)
Orange	-0.1266055	(-23.01)	-0.0264438	(-12.07)	0.0000383	(0.83)	0.0483732	(23.54)	0.1046378	(17.95)
Red	-0.0665458	(-5.85)	-0.0933209	(-32.87)	-0.0000846	(-7.82)	0.119359	(15.15)	0.0405924	(4.67)

Note: z-ratios in parenthesis

Model – Multinomial Logit and Duration Analysis

Manchester colours

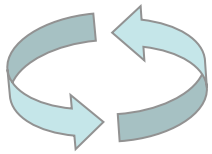
- 2008: greater likelihood of a light case ("blue" or "green")
- Age accentuates likelihood of a serious episode
- Adults register highest likelihood of "blue" and "green" episodes

Patient destination

- 2008: evidence of the "wrong door effect"
- "Blue" patients are more likely to be assigned to an outpatient visit

Duration

- Time: opportunity cost
- Decreasing time trend
- 2008: inversion
- Possible "attraction effect"



Roadmap to the models

Regression outputs – Demand for ER visits

	Log of ER episodes per day					
	700 daily observations					
Independent variable	**Complete**	**t-value**	**Step. 10%**	**t-value**	**Step. 15%**	**t-value**
Time trend (t)	0.0015143	(3.84)	**0.0015388**	(5.35)	0.0017602	(5.43)
2008 * t	-0.000000713	(-0.46)				
February	0.083547	(5.30)	**0.0602699**	(6.15)	0.0724027	(6.44)
March	0.0348343	(2.18)			0.0205853	(1.93)
Abril	0.0376873	(1.88)			0.0256666	(2.11)
May	0.032163	(1.87)			0.0198518	(1.73)
June	0.0391922	(2.23)			0.0256884	(2.36)
July	0.0506334	(2.84)	0.0227593	(2.35)	0.0356587	(3.38)
August	0.0139797	(0.75)				
September	0.0334288	(1.66)				
October	0.0573966	(3.29)	0.0250997	(2.42)	0.0358747	(3.18)
November	0.0484934	(2.77)	0.0189052	(1.84)	0.0257302	(2.33)
December	0.0231317	(1.38)				
Monday	0.2055812	(18.44)	**0.2043527**	(18.95)	0.2068962	(19.05)
Tuesday	0.1249947	(11.53)	0.1281706	(12.16)	0.12605	(11.85)
Wednesday	0.1030879	(9.57)	0.1055925	(10.03)	0.1052314	(10.01)
Thursday	0.0890775	(8.09)	0.0917436	(8.51)	0.0913237	(8.46)
Friday	0.0896398	(8.54)	0.0907484	(8.80)	0.0917606	(8.92)
Saturday	0.0339834	(3.43)	0.0361845	(3.69)	0.0355174	(3.63)
Gender	0.3013766	(2.60)	0.2804301	(2.51)	0.2948121	(2.65)
Age below 1	29.57204	(0.26)				
Age between 1 and 5	93.03565	(1.89)	**87.59985**	(1.85)	100.7621	(2.13)
Age between 5 and 18	-4.762461	(-0.35)				
Age between 55 and 65	-9.914869	(-0.68)				
Age between 65 and 85	23.17684	(2.05)	**30.50866**	(2.98)	27.22842	(2.64)
Age above 85	13.41092	(0.54)				
Age below 1 * t	-0.0018095	(-0.28)				
Age between 1 and 5 * t	-0.0053636	(-1.90)	-0.005054	(-1.86)	-0.0058079	(-2.13)
Age between 5 and 18 * t	0.0003405	(0.43)			0.0000634	(6.70)
Age between 55 and 65 * t	0.0005788	(0.69)	0.0000666	(7.30)		
Age between 65 and 85 * t	-0.0013246	(-2.04)	-0.0017486	(-2.97)	-0.0015603	(-2.63)
Age above 85 * t	-0.0007475	(-0.53)				
Blue	15.57395	(0.50)				
Green	16.50115	(2.49)	**16.97207**	(3.11)	19.93272	(3.23)
Yellow	18.53648	(2.83)	18.9342	(3.20)	19.29114	(3.17)
Orange	19.05594	(1.48)			17.89112	(1.51)
Red	-43.33763	(-0.67)				
Blue * t	-0.0008712	(-0.49)				
Green * t	-0.0009408	(-2.46)	-0.0009683	(-3.07)	-0.001138	(-3.19)
Yellow * t	-0.0010655	(-2.82)	-0.0010892	(-3.19)	-0.0011106	(-3.16)
Orange * t	-0.0010923	(-1.47)			-0.0010253	(-1.50)
Red * t	0.0024845	(0.66)				
Distance in minutes	0.0297241	(3.88)	**0.0315678**	(4.26)	0.0300871	(4.05)
Waiting time till observation	0.000258	(1.41)			**0.00026**	(1.60)
Hospital fees (HF)	-0.0563259	(-0.84)	**-0.0544302**	(-1.89)	-0.1049361	(-3.04)
30 days after 1st change (HF)	-0.0007268	(-0.30)				
30 days after 2nd change (HF)	0.0129057	(5.64)	**0.0096**	(6.02)	0.012157	(6.46)
Constant	-20.73767	(-3.07)	-21.06424	(-4.24)	-24.50961	(-4.38)
Adjusted R^2		**64.22%**		**64.11%**		**64.40%**

Note: t-ratios in parenthesis

Regression outputs – Duration Analysis/Poisson Model

	Log of waiting time	
	344,320 obs.	
Independent variable	**Step. 10%**	**t-value**
Time trend (t)	**-0.000709**	(-22.96)
Monday	0.2374504	(44.94)
Tuesday	0.1658209	(30.89)
Wednesday	0.1856807	(34.39)
Thursday	0.1155939	(21.39)
Friday	0.1260702	(23.28)
Saturday	0.0930781	(16.79)
Gender		
Age below 1	-0.6580028	(-20.66)
Age between 1 and 5	-0.6165752	(-42.67)
Age between 5 and 18	-0.2725686	(-45.90)
Age between 55 and 65	0.0407826	(9.17)
Age between 65 and 85	0.1045256	(29.52)
Age above 85	0.1375493	(17.93)
Blue	**-5.043527**	(-3.75)
Green	**2.772286**	(5.05)
Yellow	4.106439	(7.61)
Orange	3.698785	(5.99)
Red	-0.0000251	(-22.60)
Blue * t	**0.0003301**	(4.29)
Green * t	**-0.0001365**	(-4.33)
Yellow * t	**-0.0002199**	(-7.10)
Orange * t	**-0.0002236**	(-6.31)
2008	**0.1959846**	(37.91)
Constant	15.77149	(29.35)
Adjusted R^2		**8.66%**
Note: t-ratios in parenthesis		

	Repeated use	
	199,088 obs.	
Independent variable		**t-value**
Gender	0.1137282	(30.42)
Age below 1	0.9285222	(36.50)
Age between 1 and 5	0.7031313	(54.99)
Age between 5 and 18	0.0977864	(13.75)
Age between 55 and 65	0.0017966	(0.30)
Age between 65 and 85	**0.1024581**	(21.05)
Age above 85	**0.1136182**	(10.58)
Blue	**0.0091949**	(1.20)
Green	-0.1136999	(-12.05)
Yellow	-0.1232146	(-13.21)
Orange	-0.1169926	(-10.80)
Red	-0.3554317	(-12.40)
Distance in minutes	0.0113185	(47.35)
Waiting time till observation	**-0.0001561**	(-4.80)
2008	-0.1650858	(-29.29)
"Consulta de urgência"	**-0.3350359**	(-69.48)
Constant	0.6276415	(57.64)
Adjusted R^2		**N/A**
Note: t-ratios in parenthesis		

Model – Daily demand for ER visits (time series)

Time evolution

- Increasing time trend of around 5% per year
- Strong monthly seasonality in February, July, October and November
- Strong week-day seasonality, especially on Monday

Patients' features

- Greater inflow of senior citizens has contributed to the increase in ER cases
- Light colours (namely "green") also play a role

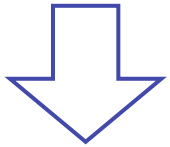
Price

- Change in hospital fees decreases daily inflow only in the first month (-4.48%)
- Waiting times have a timid and positive effect: "attraction effect"
- Distance has a positive effect: lack of substitutes?

Roadmap to the models

Model - Parishes

- 40 top parishes (82% of the cases) – Census information (schooling, workforce, age groups)
- Two dependent variables – Ratio (ER intensity) and Delta (ER increase)



- Senior citizens contribute to ER increase, but parishes with relatively more senior citizens have less ER intensity
- ER intensity higher in parishes with more people on retirement
- More people on GMI contributes to ER increase
- Higher participation and unemployment rates are associated with less ER intensity
- Higher education contributes to diminish ER cases

Regression outputs – Parishes/Forecast of *SUB*

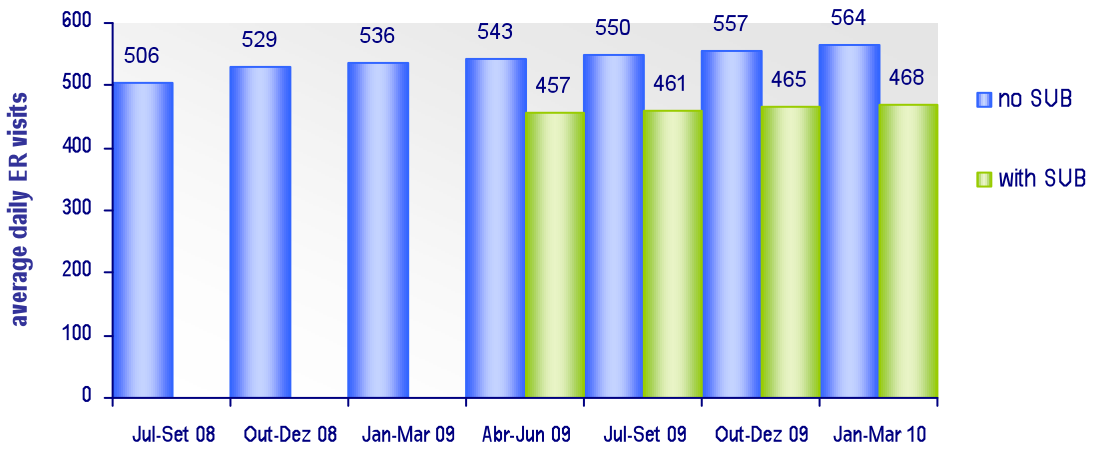
	Dependent variable			
Independent variable	**Ratio**	**t-value**	**Delta**	**t-value**
Total population	-0.00000778	(-3.11)	0.1724275	(4.69)
Age below 20			-0.3388516	(-4.47)
Age above 65	-0.0000595	(-4.07)	0.2037286	(1.72)
Nine years of schooling	0.0001016	(2.98)	0.9584833	(-3.00)
Bachelor degree	0.0000162	(2.51)		
PhD			-3.739369	(-3.65)
Unemployment rate	-1.059015	(-4.77)		
Participation rate	-0.5959817	(-4.45)		
Retired people	0.0000486	(3.73)	-0.3889104	(-2.90)
GMI			1.081603	(1.87)
Constant	0.4455045	(5.84)	6.144101	(0.15)
R^2		**75.92%**		**52.32%**
Note: t-ratios in parenthesis				

	2006 - 2010
Independent variable	**Blue and green cases per day**
Time trend (t)	0.0361119
2008 * t	-0.0001979
Concerning only the parishes covered by the new unit	

Model - Forecast

- Opening of a *SUB* in Odivelas, covering approximately 12 parishes
- Assumption: only “blue” and “green” will transfer (demand more elastic/no need for surgical care)
- Two step forecast based on time trends (all cases – “blue” and “green” cases from the *SUB* area)

Forecast - before and after *SUB*



Conclusions

Relevant determinants of demand

- Population characteristics
  - Old age explains part of the increase; so do the lighter cases
  - Evidence of the "wrong door effect"
- Health system
  - Possible "central hospital bias" in distant parishes
  - Distance and unemployment and do not seem to affect
- HSM action
  - Restructuring/new services – reduction in waiting times
  - Changes perceived indirectly ("*consulta de urgência*")

Effective measures

- Educating public in using the correct "door": hard task
- Opening of a *SUB:* considerable decrease

Conclusions

Data limitations

- Lack of information regarding other hospitals in the area (for comparison and even as independent variables)
- Census information from 2001

Areas of further research

- Comparison with other ER services
- Measuring these effects for the outpatient unit at HSM (link between ER and outpatient visits)
- Assess the impact of private health care
- Direct survey to patients