A Work Project, presented as part of the requirements for the Award of Masters Degree in Management from the Faculdade de Economia da Universidade Nova de Lisboa.

CONTRACT-PROGRAM EVALUATION: IMPACT OF THE DRG CLASSIFICATION SYSTEM ON HOSPITALS' OUTPUTS

Work project carried out on the Strategy Course, with the supervision of:

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Abstract

The present work project aims at evaluating the impact of contract-program implementation in 2003 and of incentives created in 2007 on hospital output, under the DRG inpatient classification system. A sample of five Portuguese acute public district hospitals was chosen as sample, between 2002 and 2007. Results of hypothesis testing shows positive significant effects on decreasing average lengths of stay, despite significant average age and case-mix increases verified after 2002. Increasing rates of elective outpatient surgeries were also proved significant. Effects of the introduction of 25 new medical outpatient DRG prices in 2007 were proven significant, even if a clear trend was not observable in terms of increases on outpatient discharges, exception made for DRG 410 (chemotherapy). Regression analysis, aiming at detecting upcoding effects in 109 DRG pairs, showed sensitiveness of fraction of the most complicated DRG on each pair to positive changes in DRG prices, for 3 out of 5 hospitals. However, average negative price changes verified for the considered timeframe cancelled expected upcoding effects.

Keywords: Contract-program; DRG Classification System; Outpatient Incentives; Upcoding.

1. Introduction

The present work project aims at evaluating the impact of contract-program implementation in 2003 and introduction of incentives in 2007 for outpatient discharges on the way hospitals classify their output, under the DRG[1] classification system.

A non-representative sample of five Portuguese public district hospitals was selected, by suggestion of ACSS,[2] given their bed capacity, variety of location and wide array of acute healthcare services provided.

Hypothesis testing was performed to several key indicator variables - such as lengths of stay, age, case-mix[3], ratio of elective outpatient surgeries, types of admission, discharge and transfer and MDG[4] output concentration - in order to identify relevant effects of policy changes on output efficiency and productivity. Regression analysis of upcoding aimed at detecting effects of changes in DRG prices and age on complexity of 109 DRG pairs, from 2003 to 2007. Tests of hypothesis were also performed to detect significant changes in DRG coding of 25 new medical outpatient DRGs.

Results point out to significant reductions in average lengths of stay despite increases on average age and average case-mix complexity, as well as increases in shares of outpatient elective surgeries. Three out of five hospitals were found to significantly respond to changes in DRG prices by coding up patients to diagnosis which had suffered higher price increases. However, due to negative average price changes verified for this period, upcoding had not induced actual changes in DRG pairs' complexity. Evidence of effects of new medical outpatient incentives was found in 14 out of 25 DRGs, namely a strong increase in DRG 410 (chemotherapy).

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[1] Diagnosis Related Groups.

[2] *"Administração Central do Sistema de Saúde" – Health System's Centra Administration.*

[3] The case-mix index reflects a hospital's relativity in comparison to other hospitals, in terms of its output complexity.

[4] Major Diagnosis Groups.

Hence, the present work project aims at monitoring if policies undertaken to increase output efficiency and classification are in fact achieving its purposes, namely in terms of cost reduction and productivity enhancement, while maintaining quality standards in healthcare provision.

A brief literature review will support theoretical background concerning issues such as the healthcare contracting process, the DRG classification system and DRG upcoding incentives. The methodological section describes data, sample and statistical methods adopted to answer to the stated research questions. Results, discussion, as well as relevant conclusions will comprise the remainder of the work project.

2. Literature Review

2.1. The Healthcare Contracting Process

Portuguese national health service's current benchmarking of corporate management practices, such as the use of contract-programs, is an example of efforts taken in place at improving its financial efficiency and inverting the increasing trend in total health expenditure verified in Portugal (5,9% in 1990 to 9,9% in 2006)[5], in the past sixteen years (Saltman and Mossaialos, 2002, quoted by OPSS, 2009; OECD, 2009).

In generic terms, the healthcare contract model might be defined *"as a system of direct payments, under contract, from the insurers or third parties to the providers for services rendered to insured patients, who receive benefits in kind"* (OECD, 1992).

The contract model concerns the negotiation of a prospective buying agreement established between three counterparts - users, insurers and providers - regarding healthcare services to be rendered. Contracts might be defined on the basis of quantity,

[5] Total health expenditure expressed in percentage of gross domestic product.

effectiveness, price and quality criteria, where monitoring[6] and evaluation[7] are also important dimensions to be considered for its proper implementation (Escoval, 2003).

The contract-program concept plays an important role on changing the way health institutions are managed, resetting its focus from resource to results based management. As a financing tool, it allows for more equity on resource allocation, adjusting it to each hospital's output. Separation of responsibilities between funders/insurers and providers has also given incentives for increased competition as well as helped developing quality and efficiency indicators. The introduction of efficiency weights on price calculation was decisive to establish contract-programs' its necessary credibility and to qualitatively improve incentives provided to hospitals (OPSS, 2009).

Nevertheless, several flaws might be pointed out to contract-programs, which are due specifically to lack of governmental focus on fixing and planning clear contracting objectives and lack of fit between contracted and produced outputs, allowing rewards for inefficiency. Information asymmetries caused by deficient monitoring capabilities and the weak penalties provided for managerial inefficiencies, decreasing incentives for rigorous accountability, are also relevant factors with potential to undermine contract-programs' main premises (Escoval, 2003).

Types of contract-programs range from global contracts, in which the funder/insurer pays for a set of clearly defined services, without setting quantities or unitary prices, to contracts which optimize health outcomes and value creation to healthcare users, hence the latter requiring more complex monitoring and evaluation systems, higher risk partition and *soft*, long term relationships, among counterparts (Escoval, 2003; OPSS, 2009).

[6] The contract-program encompasses the creation of planning systems and increments competition between providers.

[7] Evaluation of available resources, financing alternatives, expected outcomes and users' needs.

According to OPSS (2009), the contracting process in the Portuguese National Health Service has evolved into a cost/volume contract, based on payments by acts with pre-determined volumes, set for each line of production[8]. Priority has been given to cost and volume reduction, despite quality and equity incentives recently introduced. However, notwithstanding efforts undertaken to improve the contracting process, improvements are still necessary to produce effective/expected health gains to its users.

Due to its predominant prospective nature, the concept of contract-program implies that hospitals having to adjust their output classification to the terms included in the contract, if providers aim achieving contracted goals and avoid the premature depletion of its budget, prior to established deadlines.

2.2. The DRG Classification System

Contract-program output adjustment for prospective price calculations should be performed through the application of a classification system for acute inpatients capable of clearly defining a hospital's products, thus allowing for equity in healthcare financing (Urbano and Bentes, 1994).

All Payer Severity-adjusted DRGs is the current inpatient classification system in use by the Portuguese National Health Service's acute hospitals. It contains 26 major diagnosis groups (MDG), grouped according to clinically coherence and resource consumption criteria, and divided on medical and surgical DRGs. Each one of the approximately 700 DRGs is on its hand classified according to similarities in etiology, system or apparatus and on similarity of healthcare provision to all patients included on that particular DRG. DRGs are formed according to variables contained in hospitals' discharge reports and

[8] E.g. inpatients, outpatients and emergency service.

are mutually exclusive and exhaustive groups[9]. Several DRGs are grouped in pairs, taking into account differences in age and presence of complications or comorbidities, implying higher resource consumption (Urbano and Bentes, 1994).

A hospital's output price calculation under the contract-program methodology includes clarifying variables such as number of equivalent patients, adjusted case-mix index, number of inpatient days over pre-designated thresholds and its unitary base price (Bentes *et al.*, 1996, quoted by Santana, 2005).

Case-mix index reflects a hospital's relativity in comparison to the hospitals' national average, in terms of DRG complexity, thus being an essential variable for price definition under the contract-program work frame. The case-mix index is calculated by the following formula (Ordinance nr.839-A/2009, 31st July):

$$ICM = \frac{\sum(equivalent\ patients\ DRG_i\ x\ DRG_i\ relative\ weight)}{\sum equivalent\ patients\ DRG_i}$$

In which a weight is attributed to each DRG, reflecting its relative level of resource consumption in comparison to the average patient intensity of resource consumption - being weights calculated from variables contained in historical clinical records - and fixed at the national level, being also convertible to prices (Santana, 2005).

The number of equivalent patients is another important adjustment variable for correcting price estimations, being defined as the total number of inpatient episodes obtained after converting short term inpatient days[10] and transferred patients into equivalent sets of each DRG's normal inpatient days (Ordinance nr.839-A/2009, 31st July).

[9] Necessary variables for DRG definition include main diagnosis, other diagnosis, surgical interventions, age, gender and type of discharge.

[10] Short term inpatient days concerns episodes presenting inpatient days equal or inferior to the lower threshold of its corresponding DRG.

Taking into account its relevance for price calculation, lengths of stay should be maintained within each DRG's predetermined thresholds, minimizing marginal costs and thus maximizing its adjustment to contracted prices.

Despite being a valid measure to contain costs and introduce incentives for efficiency and equity under a prospective payment scheme, the DRG classification system has also its drawbacks. It creates incentives for patient selection, potentially harmful for healthcare access and equity, mostly caused by problems related to DRGs' weight structure. These problems arise from existing lags between calculated weights and real costs attributable to each DRG, either caused by political intervention, inefficient DRG weight determination methods[11], or exogenous causes such as case severity, price compression or coding process issues[12] (Santana, 2005).

2.3. Upcoding Incentives

Actually, one of the most relevant hazards to prospective healthcare financing under DRGs is connected with potential upcoding practices. Hospitals might engage in DRG upcoding, namely in DRG pairs (e.g. grouped by complications or age criteria) which otherwise would be set to the less expensive DRG in that pair, hence incurring in marginal gains. Dafny (2005) studied American hospitals' responses to the age criteria abolition in 1988 and its impact on DRG coding practices, thus finding evidence of upcoding, namely in patients whose diagnosis had suffered the largest price increases after the reform, this effect being stronger among for-profit hospitals. Silverman and Skinner (2004) also found evidence of upcoding in American hospitals. Between 1989 and 1996, the most expensive DRG in the pneumonia DRG pair had rose by 10 percentage points among not-for-profit hospitals, 23 percentage points among for-profit

[12] E.g. upcoding.

hospitals and 37 percentage points in hospitals converting from non-profit to for-profit status. This study also concluded that more active upcoding practices from for-profit hospitals are rather a reflection of concerted efforts of administrators and physicians to share the risks of incurring in upcoding practices than of improved financial efficiency through reduced downcoding or case-mix increases.

According to Dafny (2005), *"the increase in the average case weight is the single largest source of increased hospital spending by Medicare"*. *DRG creep* concerns the systematic upcoding of patients´ diagnosis in order to maximize hospital reimbursement (Grimaldi, 1985). It is consequence of possible aggressive upcoding strategies adopted by some hospitals trying to incur in marginal gains (e.g., by taking advantage of flaws on DRG coding monitoring), thus increasing discrepancies between actual costs incurred by the hospitals and contracted resources under a prospective payment system (Silverman and Skinner, 2004).

Therefore, it is relevant to test the hypothesis of upcoding practices in Portuguese hospitals, namely in identifying possible significant effects of DRG price changes on case-mix complexity increases across time and hospitals, as well as the effect of other important variables, such as patients' average age.

2.4. Contract-program's Incentives

Recent incentives have been introduced under the contract-program scheme, aiming to improve output efficiency, such as the introduction of incentives to enhance outpatient outputs, e.g., by introducing new medical and surgical DRGs, as well as by increasing outpatient prices for some preexisting outpatient DRGs in 2007 (ordinance nr.110-A/2007). SIGIC[13] introduction in 2005 is another example of incentives undertaken to

[13] *"Sistema Informático de Gestão de Intervenções Cirúrgicas"* – Computerized Management System for Surgical Interventions.

increase output and quality within the system, being its adherence included as a clause in hospitals' contract-programs. However, it is necessary to monitor into what extent these incentives have in fact produced positive or negative effects on output, (inducing a more efficient allocation of resources) in a period in which the Portuguese National Health Service aims at shifting a considerable amount of its outputs towards outpatient DRGs.

3. Methodology

3.1. Data

Primary data sources comprised annual DRG database tables provided by ACSS's *"Unidade Operacional de Financiamento e Contratualização"*[14], belonging to five Portuguese acute district hospitals, between 2002 and 2007. Each table contained all clinical episodes coded for each hospital in the given time span, as well as several variables used for price setting purposes, such as length of stay, DRG codes, types of admission, discharge and transfer, number of equivalent patients and billing validity status. Data from ordinances nr.123/2003 and nr.110-A/2007 was also included in the tables, concerning types of DRGs, DRG weights and prices, as well as length of stay thresholds. Secondary data was gathered from *"Centros de Saúde e Hospitais – Recursos e Produção do SNS"* reports (2002-2007), concerning yearly variables such as average length of stay, occupancy rates and number of discharged patients, which were used to compare hospitals in the sample to the national aggregate. Stata[15] and Microsoft Office Excel[16] were the data analyses software used in the present work project.

[14] Operational Unit of Contracting and Financing.
[15] Version 10.
[16] Office Excel 2007.

3.2. Problem Definition

Main objectives:

- To identify upcoding trends in DRG coding practices between 2003 and 2007;
- Identify changes in DRG coding variables from 2002 to 2007, related to contract-program implementation in 2003 and outpatient incentives introduction in 2007.

Specific objectives:

- Identify upcoding effects on fraction of 109 DRG pairs for each hospital in the sample, from 2003 to 2007;
- Identify changes in length of stay, case-mix, age, nature of discharges (inpatient/outpatient), types of admission, discharge and transfer, following contract-program implementation in 2003 and introduction of new outpatient incentives in 2007, from 2002 to 2007;
- Identify changes in coding following new medical outpatient incentives in 2007.

Research Questions:

- Are there significant upcoding effects on fraction of 109 DRG pairs explained by variations in DRG prices and age for each sampled hospital, between 2003 and 2007?
- Are there significant changes in yearly averages for length of stay, average age, case-mix, ratio of elective outpatient surgeries, types of admission, discharge and transfer, after contract-program implementation in 2003 and outpatient incentives in 2007?
- Are there significant changes in the number of medical outpatient discharges after new outpatient incentives introduction in 2007?

3.3. Sample Description

The sample in question includes all inpatients and outpatients discharged from five Portuguese acute public district hospitals, between 2002 and 2007. The sample is not statistically representative of countrywide inpatient and outpatient DRG outputs during the designated timeframe; generalization of inferences made is thus not possible for the population in question. District hospitals were selected given their major representativeness in terms of aggregated capacity, the highest among the five hospital divisions, as well as the highest rates of inpatients treated and inpatient days. Moreover, district hospitals are spread countrywide, providing a wide array of healthcare services with a relatively complex case-mix, close to the national average.

In order to draw some means of comparison between data from hospitals in the sample and the district hospital's group[17], averages concerning three key performance indicators are shown in the table below:

Table1. Comparison between the five hospitals' and district hospitals' inpatient averages, in terms of length of stay, patients treated, inpatient days and case mix index, 2002-2007 period.

Hospital	1	2	3	4	5	District Hospitals
Average Length of Stay (Days)	5	5	5	6	5	7
	(5,23)	(5,01)	(5,03)	(5,26)	(5,13)	n.a.
Average Inpatients Treated	14692	11169	20329	12907	20673	12634
	(245)	(399)	(751)	(171)	(1270)	(694)
Average Inpatient Days	106588	78363	135598	101249	172994	86333
	(3943)	(4907)	(4980)	(3637)	(11077)	(4890)
Case Mix Index (%)	0,85	0,90	0,97	0,90	0,91	n.a.

Note: Standard deviations are presented in parenthesis.

From figures stated in table 1, it is possible to briefly characterize all hospitals as midsized at the national level. Nevertheless, hospitals 3 and 5 could be considered as slightly more relevant hospitals, given both of them being above district hospitals' averages, either in terms of patients treated per year and inpatient days, either by their case-mix index values, close to the national standard, especially in case of hospital 3

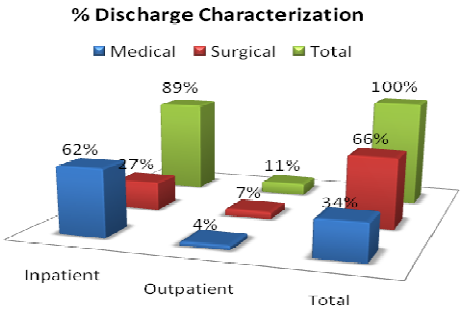
[17] Provided by DGS's annual reports (2002-2007).

(0,97%). The remaining three hospitals might be considered as standard at the national level, given their lower average values in terms of patients treated, inpatient days and CMI[18], when compared to the other two hospitals and to district hospitals' averages.

Taking into account several characterization variables, it is feasible to describe the sample in terms of nature of discharge (inpatient/outpatient) and type of DRG (medical/surgical) shares, as well as gender, age and types of admission, discharge and transfer.

The sample in question comprises a total number of 537.247 discharges, 66,1% of them medical and 89,1% inpatient. Graph 1 characterizes the sample in terms of nature and type of discharges.

Graph1: Discharge variables percentage rates characterization for the total sample, period 2002-2007.



Concerning gender, the sample comprises approximately 54% female and 46% male. Average ages for inpatients display means of 49 years and medians of 54 years for the 2002-2007 timeframe, with rightward skewness in accordance with a proportional increase of healthcare needs verified with aging. As for outpatients, means and medians of 56 years seems to suggest that a majority of elective surgical discharges might explain the average age inflation in outpatients between 2002 and 2007, when compared to inpatients' averages.

Concerning type of admission, urgent admissions are the most common among inpatients, with averages close to 77% shares of urgent admissions. On average, 20% of

[18] Case-mix index.

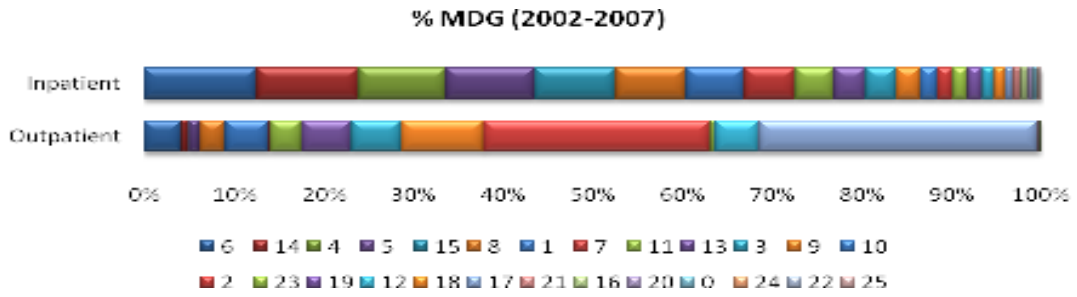
admissions are elective whereas the remainder is divided mostly by program related admissions destined to decrease surgical waiting times (PECLEC and SIGIC)[19]. As for outpatients, the large majority (84%) of admissions is elective, whilst the rest of admissions are allocated to SIGIC.

Concerning SIGIC implementation, 2005 was a transitional year from PECLEC to SIGIC, thereafter PECLEC being fully replaced by SIGIC admissions. However, the rate of admissions has maintained similar levels to those verified in the previous program for inpatient admissions, whereas for outpatients more encouraging rates are observable, with a positive variation of 10% in averages between rates for both programs, with averages of 4,7% admission rates for PECLEC, against averages of 14,8% for SIGIC, for the period 2002-2007.

Concerning type of discharge, approximately 91% of inpatients and 87% of outpatients were discharged to their households. Discharges against medical opinion, an indicator with potential influence on budgeting[20], is not considered to be relevant, given rates below 1% for both discharge types.

Deceased rates, as a possible descriptive measure of healthcare quality, are quite stable throughout the analyzed timeframe, averaging 5% for inpatients. Concerning type of transfer, solely 2,5% inpatients and 0,3% were transferred. Consequently, transfer rates for the considered sample might be considered as being irrelevant.

Graph2: MDG shares for inpatient and outpatients between 2002 and 2007, for all hospitals.



[19] PECLEC – *" Programa de Combate às Listas de Espera Cirúrgicas"* – Reduction Program for Surgical Waiting Lists.

[20] Considered for equivalent patients' weight formulations, concerning short inpatient stays.

In terms of DRG output concentration description, 53% of inpatient's DRG outputs between 2002 and 2007 are attributable to only 5 out of the 26 groups, meaning approximately 20% of the total output. A relatively high MDG concentration rate is thus verified for the sample in question, despite output stability in relative terms. Regarding outpatient MDG's, output concentration is even greater, since only 18 MDGs comprised outpatient output, of which two MDG's were accountable for 56% of total output (MDGs 17[21] and 2[22], with 31% and 25% shares respectively).

3.4. Data Analysis

In order to estimate upcoding effects for DRG pairs in the sample, estimation using grouped data procedures was selected, thus allowing for more conservative standard errors, further corrected for heteroskedasticity by clustered robust standard errors calculations.

Pair selection took into account two requisites: the presence of complications in one of the pair's DRG and each pair being included both in 2003 and 2007 DRG tables[23]. According to these assumptions, 112 pairs were included for estimation. However, three pairs were dropped due to lack of observations.

A pair's fraction[24] variation across time and hospital serves as a proxy to identify possible upcoding trends in pairs (Dafny, 2005).

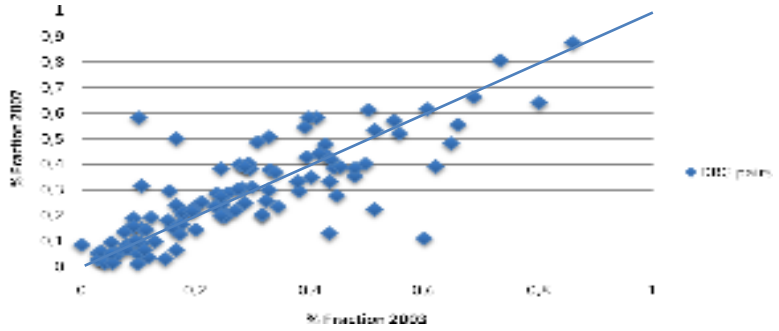
The following linear regression equation was set up to test for effects on fraction:

$$fraction_{pth} = \alpha + \varsigma\, pair_p + \delta\, year_t + \mu\, hospital_h + \gamma\, age_{pth} + \psi \Delta\, spread_{pth} + \varepsilon_{pth} \qquad (1)$$

[21] Weakly differentiated myeloproliferative diseases and disturbances.
[22] Eye diseases and disturbances.
[23] DRG tables included in ordinances nr.123/2003, 5th February, and nr.110-A/2007, 23rd January.
[24] Share of the most expensive DRG within each DRG pair.

Where fraction is the dependent variable, which is the share of admissions to a pair in a certain year and hospital belonging to the top code for that pair.

Graph3. Differences in fraction for 109 DRG pairs, 2003-2007.



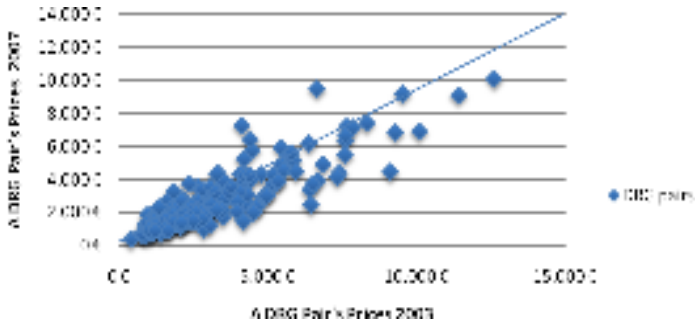
The aforementioned graph displays differences in percentages of the most expensive DRG for a given pair in two distinct years, 2003 and 2007, in which is not possible to distinguish a clear trend in terms of increases in fraction. Nonetheless, it is possible to observe a higher concentration of pairs below the 20% most expensive DRGs coded for both years, confirmed by 2003 and 2007 fraction medians (0,248 and 0,238, respectively).

Spread, pair, year, hospital and average age are the independent variables of interest, being the dimensions of its coefficient vectors: ς (1 x 109), δ (1 x 5), μ (1 x 5), γ (1 x 1) and ψ (1 x 1).

The variable spread addresses differences in DRG prices in top codes and DRG prices in bottom codes, for each pair, in a given hospital and year. The measure of interest is the difference of spreads for each pair between 2003 and 2007, for a given hospital, allowing its coefficient to capture any marginal effects of differential upcoding incentives (if $\psi > 0$, hospitals upcoded more in pairs where the incentive to do so increased more).

The following graph displays differences in spread for each pair, between 2003 and 2007.

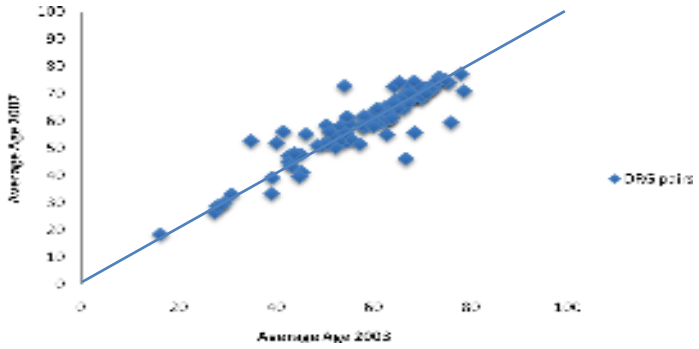
Graph4. Differences in spread for 109 DRG pairs, 2003-2007.



By looking at graph 4 a decreasing trend in spread is apparent, in which approximately 83% of the pairs have presented decreases in prices, with a 95% confidence interval for average spread between -769€ and -412€, which might be interpreted as a dissuasive incentive to upcoding practices.

The year coefficient captures the average impact of price changes on all pairs, whereas the hospital coefficient captures effects of price changes in each hospital. Age coefficient captures average age effects of price changes for each pair, for each given year and hospital.

Graph5. Differences in average age for 109 DRG pairs, 2003-2007.



Graph 5 allows observing that the majority of average ages does not vary considerably between 2003 and 2007; even so, average age has increased by approximately 64% of the sampled pairs. Medians for 2003 and 2007 are of 63 and 61 years old respectively.

Table3. Fraction, spread and average age variables' means, by hospital and year.

N=2700	Fraction		Spread		Average Age	
	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$
Hospital 1	547	0,222	547	-0,326	547	58
Hospital 2	535	0,305	535	-0,322	535	60
Hospital 3	544	0,302	544	-0,328	544	59
Hospital 4	533	0,295	533	-0,315	533	60
Hospital 5	541	0,267	541	-0,325	541	58
Total	2700	0,278	2700	-0,323	2700	59
2003	539	0,279	539	-0,324	539	59
2004	539	0,277	539	-0,330	539	59
2005	539	0,274	539	-0,325	539	59
2006	544	0,273	544	-0,324	544	60
2007	539	0,286	539	-0,313	539	60
Total	2700	0,278	2700	-0,323	2700	59

Table 3 displays means for both dependent and independent variables. It is relevant to outline the negative spread means across all hospitals and years, evidence that measures undertaken to decrease price differentiation had been the most relevant for the pairs in study.

In order to assure estimations' validity, fixed effects were considered for DRG pairs, thus correcting for endogeneity and ruling out the possibility that changes in spread could be correlated to omitted variables affecting changes in fraction (Dafny, 2005).

Descriptive and inferential statistical techniques in the form of two sample tests of hypothesis, assuming equal variances, were applied in order to test for differences in DRG coding between 2002 and 2003-2007 period, as well as between 2002-2006 period and 2007, aiming at testing any significant differences in means regarding characterization variables such as length of stay, case-mix, age, ratio of elective outpatient surgeries and types of admission, discharge and transfer, both for inpatients as for outpatients, for each hospital. Outliers were excluded for length of stay and case-mix estimations[25].

[25] Outliers were excluded beyond inferior and superior thresholds, comprising mean values plus three times inter-quartile difference.

Tests of hypothesis were also applied to test if the introduction of new medical outpatient DRGs with ordinance 110-A/2007, 5th February, induced changes in coding for the DRGs in question. Tests of hypothesis were run considering differences occurring between 2002-2006 period and 2007, for each hospital.

4. Results and Discussion

4.1. Are there significant upcoding effects on fraction of 109 DRG pairs explained by variations in DRG prices and age for each sampled hospital, between 2003 and 2007?

Linear regression estimates for the 5 hospitals in the sample are presented in the following table.

Table4. Effects of variations in spread, average age and years on upcoding of 109 DRG pairs.

N=2700	Hospitals		Std Errors
Δ Spread	0,104	***	0,020
Average Age	0,005	***	0,000
2004	-0,006		0,014
2005	-0,008		0,013
2006	-0,014		0,014
2007	-0,005		0,013
Hospital 2	0,074	***	0,012
Hospital 3	0,068	***	0,014
Hospital 4	0,057	***	0,014
Hospital 5	0,043	*	0,016
Overall R-squared	0,145		

Note: Robust standard errors; p-value<0,001*, p-value<0,01**, p-value<0,05*. Unit of observation is the DRG pair per year, per hospital.**

Estimates displayed allow inferring that fraction appears to be positively sensible to changes in spread, as well as to average age changes, being those coefficients statistically significant. Concerning hospital dummies, it appears that all hospitals seem to present significantly positive variations in fraction, compared to hospital 1. Time effects appear not to be statistically significant to explain upcoding trends for the DRG pairs contained in the sample.

Concerning spread effects on DRG pairs' complexity, despite a positive effect in spread verified by an expected change of 0,104 in fraction for each 2342,38€[26] increase in spread, when remaining variables are held fixed, negative average changes in spread occurring from 2003 to 2007 reduced attractiveness to upcode. The verified decrease in price differentiation reduced sampled DRG pairs' average complexity, despite a positive reaction to upcode more in pairs where higher price increases had been verified.

Average age coefficient is also significant: an expected change of 0,005 in fraction is expected for each 1 year increase in average age for sampled hospitals. Fact which is in line with verified increases in average age across the sampled timeframe. Due to increasing intensity of healthcare stock fulfillments arising with aging, related for instance to comorbidities, aging tends to naturally increase DRG pair complexity.

In order to capture hospital level effects and to determine potential differences in responses to upcoding incentives, the same regression analysis was applied to each of the five hospitals. Estimates are presented in the following table:

Table5. Effects of variations in spread, average age and years on upcoding of 109 DRG pairs, by hospital.

Hospitals	1	2	3	4	5
Δ Spread	0,012	0,119 **	0,070 *	0,147 ***	0,057
	(0,044)	(0,041)	(0,027)	(0,029)	(0,036)
Average Age	0,005 ***	0,006 ***	0,005 ***	0,005 ***	0,005 ***
	(0,001)	(0,001)	(0,001)	(0,001)	(0,001)
2004	0,004	-0,026	-0,013	0,047	-0,036
	(0,045)	(0,041)	(0,035)	(0,029)	(0,028)
2005	0,017	-0,032	0,027	-0,005	-0,028
	(0,036)	(0,034)	(0,027)	(0,031)	(0,034)
2006	0,013	-0,070	0,025	-0,002	-0,029
	(0,030)	(0,042)	(0,035)	(0,033)	(0,032)
2007	0,033	-0,043	-0,019	0,015	0,014
	(0,033)	(0,037)	(0,028)	(0,033)	(0,034)
Overall R-squared	0,085	0,148	0,157	0,137	0,129

Note: Robust standard errors are presented in parenthesis; p-value<0,001*, p-value<0,01**, p-value<0,05*. Unit of observation is the DRG pair per year, per hospital.**

[26] 2342,38€ is the standard equivalent to a DRG weight of value equal to 1.

Table 2 allows inferring positive and significant effects of variations in spread, from 2003 to 2007, for hospitals 2, 3 and 4, as well as significant average age effects across all hospitals in general, while time effects do not present any statistical significance for the sampled hospitals.

Variable fraction is sensitive to changes in spread for hospitals 2, 3 and 4, meaning those hospitals apparently tended to upcoded more in pairs with higher positive changes in spread.

Hence, for hospital 2 the expected change in fraction is of 0,119 per each 2342,38€ increase in DRG prices, whilst for hospitals 3 and 4 there are changes of 0,07 and 0,147 per each 2342,38€ increase in DRG prices, when remaining variables are held fixed.

Concerning average age coefficients, it is evident a statistically significant effect of average age on fraction across all hospitals. An increase of 0,005 in upcoding for each additional 1 year is verified for hospitals, exception made for hospital 2 which presents a 0,006 increase, when remaining variables are held fixed.

Given results obtained, it is possible to infer positive variations in fraction with changes in prices and average age, thus confirming upcoding practices in 3 out of the 5 hospitals. Aging also plays a significant part on the increase in fraction of most complicated diagnosis for the sampled DRG pairs. Price changes, despite inducing positive effects on fraction, do not induce higher expenditure since their variations are negative on average for this sample, a fact which cancels the incentive to engage in upcoding practices. However, awareness seems to exist concerning rewards for upcoding, since three hospitals seem to present tendency to upcode more in pairs where differences in prices between non complicated and complicated diagnosis are larger.

4.2. Are there significant changes in yearly averages for length of stay, average age, case-mix, ratio of elective outpatient surgeries, types of admission, discharge and transfer, after contract-program implementation in 2003 and outpatient incentives in 2007?

Test of hypothesis' outcomes, concerning average age for both contract-program and outpatient incentives' introduction, are displayed in the following table.

Table6. Two sample t-test estimates for average age between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge[27], per hospital.

		Δ 2002				Δ 2007			
Hospital	Discharge	N	T-test	P-value		N	T-test	P-value	
1	Inpatients	88153	0,568	0,285		88153	-1,436	0,076	
	Outpatients	14467	-11,439	0,000	***	14467	14,975	0,000	***
2	Inpatients	67015	-0,043	0,483		67015	-0,050	0,480	
	Outpatients	10230	-17,675	0,000	***	10230	24,853	0,000	***
3	Inpatients	121974	-6,454	0,000	***	121974	8,041	0,000	***
	Outpatients	15018	-13,969	0,000	***	15018	44,974	0,000	***
4	Inpatients	77442	-8,093	0,000	***	77442	7,750	0,000	***
	Outpatients	4470	-6,971	0,000	***	4470	15,036	0,000	***
5	Inpatients	124035	-10,387	0,000	***	124035	8,972	0,000	***
	Outpatients	14443	-6,456	0,000	***	14443	20,719	0,000	

Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05.**

Negative significant differences are visible for both inpatients and outpatients after 2002, followed by predominant positive significant differences for 2007, thus confirming that average age had in fact increased during this period, as expected, with potential positive impact on both lengths of stay and resource intensity outcomes. Similar results were found for both medical and surgical DRGs.

Concerning average length of stay, estimates are presented in the table below.

[27] Inpatient or outpatient discharges.

Table7. Two sample t-test estimates for average length of stay between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge, per hospital.

		Δ 2002				Δ 2007			
Hospital	Discharge	N	T-test	P-value		N	T-test	P-value	
1	Inpatients	84325	2,729	0,003	**	84325	-1,383	0,083	
	Outpatients	13328	-5,042	0,000	***	14467	-8,137	0,000	***
2	Inpatients	64627	-0,653	0,257		64627	-5,200	0,000	***
	Outpatients	10230	-2,734	0,003	**	10230	-1,245	0,107	
3	Inpatients	118138	3,386	0,000	***	118138	-1,857	0,032	*
	Outpatients	15018	-3,575	0,000	***	15018	-7,573	0,000	***
4	Inpatients	74170	-0,787	0,216		74170	-2,357	0,009	**
	Outpatients	4470	-0,912	0,181		4470	-0,609	0,271	
5	Inpatients	118807	8,867	0,000	***	118807	-7,101	0,000	***
	Outpatients	14443	16,443	0,000	***	14443	-10,687	0,000	***

Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05*.**

Considering the nature of discharges it is possible to infer, for the period after contract-program implementation, that there are positive significant differences in average length of stay for inpatients in 3 out of 5 hospitals, whereas for outpatients negative significant differences are found also for 3 out of 5 hospitals. These outcomes signify a decrease in average length of stay for inpatients, possibly indicative of more efficiency in DRG output, hence a possible positive response to contract-program implementation. On the other hand, for outpatients this increase might indicate an opposite effect, in which less discharge efficiency within the 24 hours' timeframe might grant marginal losses for each extra inpatient day paid as outpatient diagnosis. For the time period after outpatient incentives' implementation there are also significant and negative changes in averages for 4 out of 5 hospitals for inpatients, and in 3 out of 5 hospitals for outpatients, which might also reflect an increase in healthcare provision efficiency after introduction of new incentives for outpatient output enhancement.

In terms of type of DRG, for both implementation periods it is observable a significant decrease in average length of stay, common to medical and surgical DRGs across all

hospitals in general. Positive results are found in terms of decreasing length of stay, despite the confirmed increase on average age verified for this timeframe.

Estimates for both inpatients' and outpatients' case-mix are presented in the following table.

Table8. Two sample t-test estimates for case-mix between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge, per hospital.

			Δ 2002				Δ 2007		
Hospital	Discharge	N	T-test	P-value		N	T-test	P-value	
1	Inpatients	84618	3,283	0,001	***	84618	-4,438	0,000	***
1	Outpatients	14467	11,770	0,000	***	14467	-71,392	0,000	***
2	Inpatients	64179	-3,159	0,001	***	64179	1,804	0,036	*
2	Outpatients	10230	6,077	0,000	***	10230	-62,394	0,000	***
3	Inpatients	115405	-3,839	0,000	***	115405	0,919	0,179	
3	Outpatients	15018	9,744	0,000	***	15018	-67,778	0,000	***
4	Inpatients	74714	-7,759	0,000	***	74714	5,619	0,000	***
4	Outpatients	4470	-0,687	0,246		4470	-33,830	0,000	***
5	Inpatients	117742	-3,771	0,000	***	117742	4,814	0,000	***
5	Outpatients	14443	1,514	0,065		14443	-52,068	0,000	***

Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05*.**

Significant outcomes for inpatients and outpatients case-mix allow to infer, in general, an increase in inpatient case-mix complexity throughout the whole timeframe, verified through negative changes after 2002 and positive changes in 2007. Opposite outcomes are observable for outpatients' case-mix, which had suffered a decrease in complexity of throughout the sampled timeframe, for all hospitals in general. This behavior might confirm a positive relationship between average age and increasing case-mix complexity despite verified decreases in length of stay for inpatients, whilst for outpatients this change might be related with the high concentration of DRG outputs, namely after 2006.

Another relevant indicator of greater DRG output efficiency, under the contract-program scheme, regards the ratio of elective outpatient surgeries per year, over the

total number of elective surgeries. The following table displays estimates for each hospital's ratio differences, for both periods.

Table9. Two sample t-test estimates for ratio of elective outpatient surgeries between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge, per hospital.

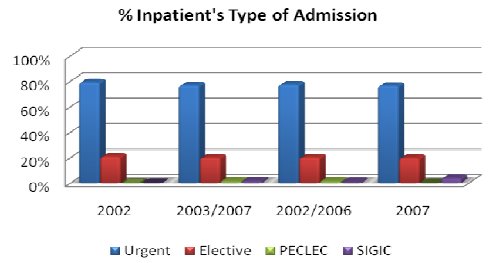
Hospital	Δ 2002				Δ 2007				% Ratio
	N	t-test	p-value		N	t-test	p-value		
1	17378	-14,023	0,000	***	17378	20,958	0,000	***	0,39
2	14435	-21,684	0,000	***	14435	3,410	0,000	***	0,37
3	29986	-21,759	0,000	***	29986	32,778	0,000	***	0,21
4	11555	-17,006	0,000	***	11555	15,429	0,000	***	0,27
5	26933	19,529	0,000	***	26933	-22,146	0,000	***	0,30

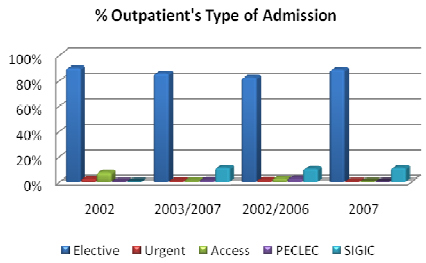
Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05*.**

In 4 out of 5 hospitals significant differences are verified for both periods, demonstrating an apparently strong increase in ratio of elective outpatient surgeries, in line with efficiency incentives provided by contract-program introduction and outpatient incentives provided. Exception made for hospital 5, which seems to present an opposite behavior in comparison to the remaining sample.

Regarding type of admission, the following graphs allow to compare differences prior and after contract-program and outpatient incentives introduction, both for inpatients and outpatients, for all hospitals.

Graphs6&7: Inpatient and outpatient differences in type of admissions, prior and post contract-program implementation (2003) and outpatient incentives (2007), for all hospitals.



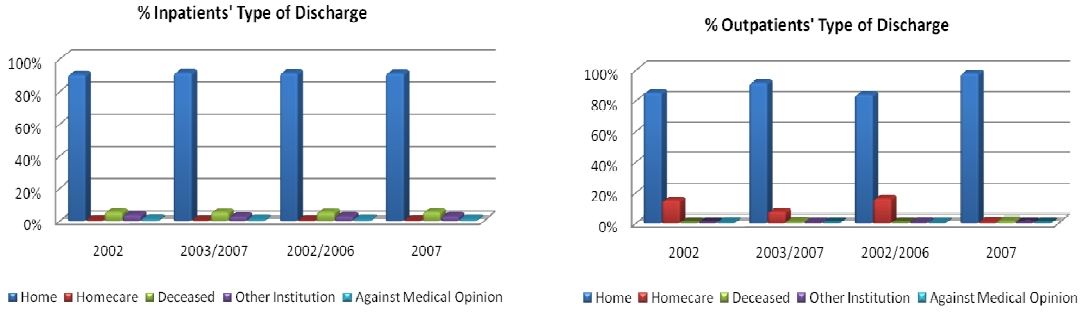


Despite graphs 6 and 7 apparently showing little changes in type of admission, two sample t-tests assuming equal variances outcomes[28] performed show significant changes

[28] Annex 1.

for all hospitals, for both periods. Exception made for hospital 4, in which t-test results are not as clear about changes after contract-program introduction, though overall[29] results are significant. However, in global terms, it is clear the predominance of urgent admissions over elective for inpatients and of elective over urgent admissions for outpatients for the period in analysis. A reference concerning SIGIC admissions for outpatients should be made, since it varies considerably across hospitals, ranging from zero SIGIC admissions in hospital 4 to 31% average SIGIC admissions since 2005 in hospital 1, thus putting on evidence the heterogeneity of admission rates related to patients incorporated in this system, across the hospitals in the sample.

Graphs8&9: Inpatient and outpatient differences in type of discharge, prior and post contract-program implementation (2003) and outpatient incentives (2007), for all hospitals.



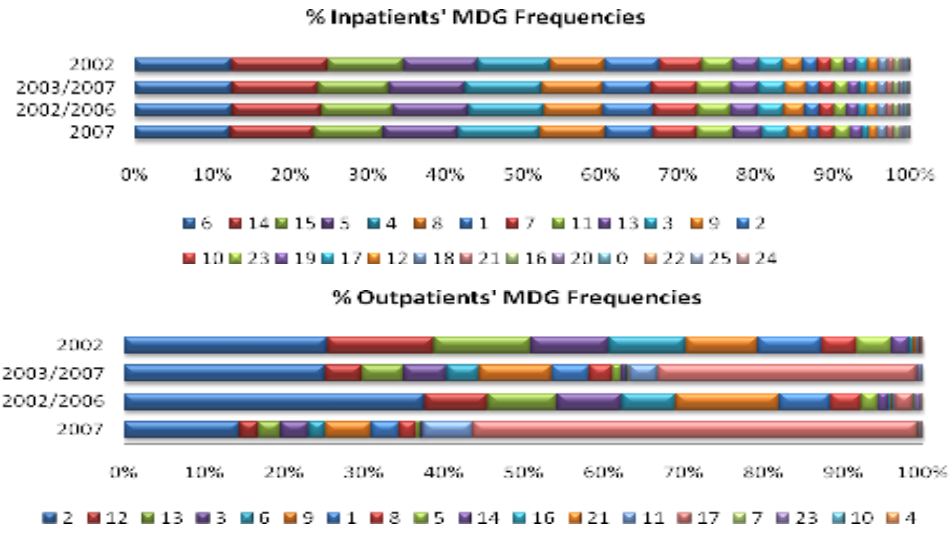
In terms of type of discharge, t-test outcomes[30] allow to infer significant changes for the total sample for both periods, except for hospital 4, concerning t-test outcomes for overall changes after 2002.

Regarding type of transfer t-test outcomes[31], significant overall changes are also verified for the total sample, however, only for hospitals 1, 3 and 4 significant changes are verified for both periods, not being verified significant changes for the remainder in any period.

[29] "Overall" - Differences in means without considering type of discharge or type of transfer.
[30] Annex 2.
[31] Annex 3.

Major diagnosis groups' (MDG) analysis allows for a descriptive outlook on both inpatient and outpatient outputs for the sample, as well as for differences prior and post contract program implementation and outpatient incentives:

Graphs10&11: Inpatient and outpatient differences in MDG' relative frequencies, prior and post contract-program implementation (2003) and outpatient incentives (2007), for all hospitals.



Considerable differences seem only to be evident for outpatient discharges, in which a considerable reduction is observable for MDG 2 relative output (-23%), after outpatients' incentives introduction, whereas a big increase was verified for MDG 17 (+53,4%). These responses in outpatient output are mainly due to a large increase in coding of DRG 410 (chemotherapy), to which a new outpatient price had been attributed in 2007. Despite a relative reduction, MDG 2 (lens surgery), has also benefited from a considerable increase in output in absolute terms, starting in 2006, which might be interpreted as an outcome of health system's efforts to rapidly increase output on this specific DRG, due perhaps to political reasons.

4.3. Are there significant changes in the number of medical outpatient discharges after new outpatient incentives introduction in 2007?

In order to identify changes in coding following new medical outpatient incentives implemented in 2007, two sample t-tests assuming equal variances were performed to 25 medical DRG's to which had been added new outpatient incentives in 2007.

The following table presents estimates for the 14 DRGs presenting significant differences in average outpatient discharges, prior and after price introduction, and also its corresponding fractions of outpatients in 2007:

Table10. Two sample t-test estimates for statistically significant differences in average outpatient discharges, concerning medical DRGs with new outpatient prices, prior and after 2007.

GDH	t-test	p-value		Fraction%
35	-5,383	0,000	***	74,65
82	-3,430	0,000	***	0,00
100	2,968	0,002	**	19,44
125	3,619	0,000	***	3,23
183	-2,936	0,002	**	0,00
323	3,082	0,001	**	44,31
338	-2,180	0,015	*	0,00
351	2,835	0,002	**	83,33
409	4,740	0,000	***	97,18
410	13,728	0,000	***	99,29
465	2,427	0,008	**	67,35
466	-5,003	0,000	***	5,21
467	-9,760	0,000	***	0,34
777	-4,250	0,000	***	0,00

Note: t-test (α=0,05); p-value<0,001*, p-value<0,01**, p-value<0,05*; fraction percentages in 2007.**

It appears that approximately 56% of medical DRGs with new outpatient incentives have presented significant changes in inpatient averages, and from these 14 medical DRG's, 7 had experienced a decrease in inpatient discharges. However, merely 5 DRGs (20%) presented fractions of outpatient discharges above 50%. On the other hand, 4 DRGs with significant differences in inpatient averages have not presented any outpatient discharges in 2007 for the sample in question. A mention should still be made

to DRG 410, which solely was responsible for a boost in outpatient output in 2007, in absolute values, being responsible for an increase of approximately 17.000 outpatient discharges, accounting for nearly 30% of total outpatient discharges for the total sample. Nevertheless, it is not yet possible to observe a clear trend on medical outpatients' incentives' effectiveness for this sample, in terms of the set of DRGs considered, since several kinds of responses to incentives have been verified.

5. Conclusions

Contract-program implementation has been considered an important step forward in what respects to efficiency, accountability, and in the future, health gains.

However, the Portuguese National Health Service needs to be capable of monitoring and evaluating the effectiveness of measures undertaken within its output centers/providers, in order to proceed with the necessary adjustments to measures implemented and thus justify the investment made on its implementation.

The present work project aimed at somewhat unveiling possible effects occurred after contract-program implementation in 2003 and subsequent outpatient incentives introduced in 2007.

Short note for the limitations of work project, related to the non-representativeness of the sample, which does not allow generalizing results obtained, as well relating to the undisclosed identity of the hospitals in the sample, at least concerning its status as EPE or SPA, in order to allow for further comparisons.

As for the first research question, which addresses upcoding detection in 109 DRG pairs, results obtained should raise awareness for the possibility of upcoding practices being engaged in Portugal, and also to its negative impact on expenditure in a future

scenario of positive average changes in prices within DRG pairs, taking into account the relevant negative impact caused by *DRG creep* overseas.

Regarding the research question on changes in several quality and performance indicators, prior and after contract-program and incentives' introduction, significant positive effects were found in general. Significant decreases on average lengths of stay were found, despite average increases on average age and case-mix, which might be interpreted as an outcome of efficiency and productivity measures induced by contract-program clauses. Significant positive outcomes were also achieved for the ratio of outpatient elective surgeries, as a possible sign of effectiveness on outpatient incentives implemented with contract-program's inception. Mention also to variations on SIGIC adherence shares for outpatients across the 5 hospitals, ranging from 0 to 31%, thus reflecting some heterogeneity in its adoption, at least at outpatient level.

In terms of MDG concentration, relevant outcomes were obtained, namely related to high concentration of discharges for outpatients, in which a high increase in the share of discharges was observable for DRG 410 (chemotherapy), in 2007. These results thus apparently show the potential reach of outpatient incentives in inducing increases in volume within a relatively short timeframe.

Concerning outcomes of new outpatient prices created for 25 medical DRGs in 2007, a clear significant trend is not yet clearly defined for the set of DRGs in question, mainly in terms of generic increases on fraction of outpatient discharges for the majority of DRGs. However, discharges due to DRG 410 have accounted for a considerable increase in the number of outpatient discharges in 2007, enforcing evidence in favor of the actual effectiveness of outpatient incentives created in 2007, at least for the sample in question.

Further studies should deepen the impact of contract-program implementation and incentives in a representative sample, able to generalize results at the national level, as well as to increase knowledge about upcoding practices in Portugal.

Hence, it is possible to affirm that in generic terms the impact of contract-programs on hospitals' DRG output seems to be positive for the considered sample. Decreasing lengths of stay were verified despite increases in average age and case-mix. Attention should be paid though to upcoding, as well as to high concentration levels of DRG output, which might indicate needs for further adjustments, namely concerning the reinforcement of an apparently successful outpatient incentives plan implementation.

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7. ANNEXES

Annex1. Two sample t-test estimates average type of admission, between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge, per hospital.

Hospital		Δ 2002			Δ 2007		
		N	T-test	P-value	N	T-test	P-value
1	Overall	102620	-25,117	0,000	102620	-0,346	0,365
	Inpatient	88153	-23,777	0,000	88153	5,024	0,000
	Outpatient	14467	-14,441	0,000	14467	-10,006	0,000
2	Overall	77245	-8,418	0,000	77245	14,487	0,000
	Inpatient	67015	-14,164	0,000	67015	17,964	0,000
	Outpatient	10230	-6,939	0,000	10230	15,274	0,000
3	Overall	136992	-4,106	0,000	136992	-14,445	0,000
	Inpatient	121974	-16,357	0,000	121974	23,466	0,000
	Outpatient	15018	-3,000	0,001	15018	5,861	0,000
4	Overall	81912	10,116	0,000	81912	-33,643	0,000
	Inpatient	77442	-0,638	0,262	77442	-9,159	0,000
	Outpatient	4470	0,955	0,170	4470	-7,026	0,000
5	Overall	138478	-21,930	0,000	138478	8,721	0,000
	Inpatient	124035	-25,956	0,000	124035	22,288	0,000
	Outpatient	14443	-8,948	0,000	14443	-2,983	0,001

Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05*.**

Annex2. Two sample t-test estimates average type of discharge, between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge, per hospital.

Hospital		Δ 2002			Δ 2007		
		N	T-test	P-value	N	T-test	P-value
1	Overall	102620	-3,586	0,000	102620	17,057	0,000
	Inpatient	88153	-3,031	0,001	88153	12,134	0,000
	Outpatient	14467	-6,541	0,000	14467	24,586	0,000
2	Overall	77245	3,517	0,000	77245	-9,376	0,000
	Inpatient	67015	0,057	0,477	67015	-1,524	0,064
	Outpatient	10230	-0,779	0,218	10230	0,457	0,324
3	Overall	136992	8,147	0,000	136992	-15,292	0,000
	Inpatient	121974	4,086	0,000	121974	-3,487	0,000
	Outpatient	15018	2,064	0,020	15018	-0,638	0,262
4	Overall	81912	0,413	0,340	81912	-2,732	0,000
	Inpatient	77442	-1,006	0,157	77442	0,576	0,282
	Outpatient	4470	-0,224	0,411	4470	0,048	0,481
5	Overall	138478	1,662	0,048	138478	-14,027	0,000
	Inpatient	124035	1,728	0,042	124035	-1,114	0,133
	Outpatient	14443	18,755	0,000	14443	-89,720	0,000

Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05.**

Annex3. Two sample t-test estimates average type of transfer, between 2002 and 2003-2007 period; between 2002-2006 period and 2007, by nature of discharge, per hospital.

Hospital		Δ 2002			Δ 2007		
		N	T-test	P-value	N	T-test	P-value
1	Overall	102620	-4,068	0,000	102620	2,419	0,008
	Inpatient	88153	-5,604	0,000	88153	9,492	0,000
	Outpatient	14467	-2,450	0,007	14467	-6,444	0,000
2	Overall	77245	-0,371	0,355	77245	0,992	0,161
	Inpatient	67015	-1,768	0,039	67015	4,731	0,000
	Outpatient	10230	-1,016	0,155	10230	1,769	0,039
3	Overall	136992	21,709	0,000	136992	-15,115	0,000
	Inpatient	121974	18,627	0,000	121974	-8,765	0,000
	Outpatient	15018	1,498	0,067	15018	-1,712	0,044
4	Overall	81912	5,614	0,000	81912	-1,758	0,039
	Inpatient	77442	4,704	0,000	77442	0,097	0,461
	Outpatient	4470	-0,147	0,441	4470	0,955	0,170
5	Overall	138478	0,275	0,392	138478	-1,635	0,051
	Inpatient	124035	-1,151	0,125	124035	1,863	0,031
	Outpatient	14443	-0,323	0,373	14443	-1,637	0,051

Note: Δ2002 equals the difference between year 2002 and 2003-2007 period; Δ2007 equals the difference between year 2007 and 2002-2006 period; t-test (α=0,05); -value<0,001*, p-value<0,01**, p-value<0,05*.**