Impact of Hospital Provider Payment Reforms in Croatia

Martina Bogut
Luka Voncina
Ethan Yeh

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Abstract

Croatia began to implement case-based provider payment reforms in hospitals beginning in 2002, starting with broad-based categories according to therapeutic procedures. In 2009, formal diagnostic related groups were introduced, known locally as dijagnostičko terapijske skupine. This study examines the efficiency and quality impacts of these provider payment reforms globally on the Croatian health system by analyzing data on five procedures in acute health care for 10 years, between January 2000 and December 2009. The five procedures are cataracts, pneumonia, coronary bypass, appendectomy, and hip replacement. Using data from the Croatian Institute for Health Insurance, this study finds that both broad-based and detailed case-based payment systems have improved efficiency as measured by a reduction in average length of stay, with little impact on the number of cases. These provider payment reforms have had no adverse impact on quality as measured by readmissions. While it is still too early to quantify the impact of Croatia’s introduction of formal diagnostic related groups, it appears that the introduction of both broad and detailed case-based payment systems has improved efficiency in acute hospital care.

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Impact of Hospital Provider Payment Reforms in Croatia

Martina Bogut\textsuperscript{a}, Luka Voncina\textsuperscript{b}, and Ethan Yeh\textsuperscript{c}

\textsuperscript{a} Croatian Institute for Health Insurance, \textsuperscript{b} Ministry of Health, Croatia, \textsuperscript{c} The World Bank

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Introduction

Over the last decade, the Croatian health care system has undergone a series of health reforms that have helped to transform the once fragmented and highly decentralized health system into one that maintains the principles of universality and solidarity. The Croatian health system today has adequate financial resources (total health spending is 7.8% of GDP), a well-trained health workforce, an established system of public health programmes and service delivery, and good health outcomes relative to countries at comparable income levels.

The main bodies in the health care system are the Ministry of Health and Social Welfare, the Ministry of Finance, and the Croatian Institute for Health Insurance, known locally as Hrvatski zavod za zdravstveno osiguranje (HZZO). The HZZO is a public, non-profit institution that is the main third party payer in Croatia. HZZO administers mandatory health insurance, which provides universal coverage to the population (Table 1).

The hospital system in Croatia, with a network of 66 public institutions (3 clinical hospital centers, 4 clinical hospitals, 7 clinics, 23 general hospitals, 27 special hospitals, and 2 health resorts) accounts for over 50% of total public health care costs. Like most countries in former Yugoslavia, Croatia inherited a fee-for-service (FFS) hospital payment system, where hospitals were reimbursed on the basis of inputs used for each procedure. The payment system consisted of three separate components: (1) hospital hotel services, paid via a flat rate per diem; (2) medical services provided; and (3) pharmaceuticals and other supplies that were paid for separately, depending on the cost of each item. Under the FFS schedule, hospitals had incentives to maintain high bed occupancy rates and extend length of stay. High occupancy rates resulted in stable hospital funding through per diem payments, while the majority of costs tended to be concentrated in the first few days of hospital stays. Low occupancy rates also increased the risk that the HZZO would lower the global budget ceiling for hospitals.

Several reforms were introduced beginning in 2002 to increase efficiency in the hospital system (see Figure 1 and the Appendix for more information). First, broad case-based groupings called payment according to the therapeutic procedure (PPTP) were introduced in Croatia in 2002. Initially introduced only for a select number of procedures, the PPTP system expanded over time with a large expansion in 2005. By then, the number of services reimbursed via the PPTP system had grown to 118 selected diagnoses with the remainder still being paid for through FFS. Although the PPTP system was intended to provide hospitals with incentives to increase technical efficiency in service provision, in reality, the broad-based groupings were quite unpopular with providers as interventions for
the case groupings were often more costly. Providers believed that the intensity of resource use was underestimated for more complicated medical cases.

In 2009, PPTP groups were abandoned and formal diagnosis-related groups (DRGs) were introduced, known locally as *dijagnostičko terapijske skupine* (DTS). DRGs, which have much more refined case-groupings, are the most effective system of classification in health care and are used in most European countries, the United States, and Australia. DRG classifies cases of acute care into groups requiring similar consumption of hospital resources and that have similar clinical characteristics. Unlike PPTP, DTS has 671 groups of therapeutic-diagnostic procedures, which means that it is much more accurate in the pricing process. An example of the groups for cataract procedures is shown in Figure 2. Croatia’s DTS system is based on the Australian Refined Diagnosis Related Groups (AR-DRG) version 5.1, but modified for the Croatian context.¹

DTS was first piloted in four hospitals beginning in February 2006. As of April 2007, it was introduced in all Croatian hospitals, initially running in tandem with the existing billing system. During this period, HZZO actively worked with hospitals to ensure the appropriateness and quality of coding. One of the greatest challenges with the introduction of the Australian system in Croatia was the difference in DRG/DTS costing between the two countries. The original AR-DRG system used Australian data on resource use, clinical practice, and hospital billing. A second challenge was related to a form of “gaming” known as “code creep” in DRG systems, i.e. coding patients as having more serious or complicated conditions than they actually have. In Australia six different mechanisms are now employed to reduce this risk of upcoding².

Using data over 10 years, this study examines the efficiency and quality impacts across three provider payment systems in Croatia: (1) the original fee-for-service (FFS); (2) broad case-based groupings under the PPTP system, and (3) DRG case-based groupings under DTS, which are in effect today.³ The main objective is to examine the impact of introducing case-based payment systems, both broad (PPTP) and more detailed (DTS). Since

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¹ Like Croatia, several other European countries (e.g., Ireland, Romania, Germany and Slovenia) also have decided to import and modify the AR-DRG system, and not to develop their own. There are different versions of the DRG system in the world, namely: NorDRG (Denmark, Finland, Iceland, Norway, Sweden); AR-DRG (Australia); DPC (Japan); CMG (Canada); HCFA/CMS (USA); HBCs (Hungary); DBC (Netherlands); HRG (UK); G-DRG (Germany); T-DRG (Turkey); GHM (France); LDF (Austria)
² Steinbusch PJ, Oostenbrink JB, Zuurbier JJ, Schaeakens FJ. The risk of upcoding in casemix systems: A comparative study. Health Policy 2007; 81(2-3):289-99
³ Through the rest of the paper, the term DRG will be used to refer to detailed case-based groupings such as DTS or other DRG systems in the world. The term case-based payment systems will refer to both PPTP and DTS.
DTS has only been implemented for one year, it is difficult to fully compare the impact between PPTP and DTS.

Theoretically, case-based payment systems should lead to greater efficiency in hospital services as hospitals are no longer able to earn additional revenue by conducting more diagnostic tests, performing more procedures, or extending patient stay for a particular case. Hospitals should have incentives to treat a case in the most efficient and cost-effective manner, and a substantial amount of research has found that length of stay and costs declined with the introduction of case-based payment systems (Serra and Wagstaff 2010, Shmueli et al. 2002, Cutler 1990, Kahn et al. 1990).

At the same time, since hospitals are able to earn revenue for each additional case, it is possible that the number of hospital admissions (and possible readmissions) may increase. Empirical research suggests that volume of activity does not increase, although there are some mixed results (Serra and Wagstaff 2010, Dafny 2005, Shmueli et al. 2002, Kroneman and Nagy 2001, Cutler 1990).

From a quality perspective, theoretically there may be negative effects on patient health outcomes if hospitals use less costly and less effective tests or procedures. This potential negative effect should be balanced, however, by the incentive to fully treat a patient so that additional costs are not incurred under the same “case”. Empirically, most evidence suggests that introduction of case-based payment systems have had no effect (and even positive in some cases) on health outcomes (Serra and Wagstaff 2010, Cutler 1995, Feinglass and Holloway, 1991; Kahn et al., 1990).

An initial comparison of the first year of DTS implementation shows that detailed groupings appear to have lowered average length of stay (ALOS) and lowered bed occupancy. Both Figures 3 and 4 show data from 2008 and 2009 across all acute services by different types of hospitals in Croatia. There is a consistent decline in ALOS across all hospital types, but especially for clinics (0.9 days). Bed occupancy declined in the majority of hospitals, except for in clinical hospital centers. While it may be counterintuitive to think that increasing efficiency has led to decreasing bed occupancy rates, this result makes sense as hospitals now have incentives to discharge patients earlier, on average resulting in lower bed occupancy. This simple comparison of before and after cannot account for pre-existing trends, however. For example, ALOS or bed occupancy may have already been declining over time due to changes in clinical practices or technology. The rest of the paper conducts a more robust analysis to examine whether these changes can be attributed to the introduction of PPTP and/or DTS.
Methodology

Ideally, one would examine the introduction of case-based payment systems by comparing outcomes between valid treatment and comparison groups. Since case-based payment systems are often introduced by policy across all hospital providers in a country at the same time, it is difficult to identify a scientifically valid comparison group. In the United States, DRGs were introduced first under Medicare, which made it possible to compare certain types of hospitals. In Croatia, however, case-based payment systems (PPTP and DTS) were introduced across the whole system at the same time, with the same payment scheme for all hospitals.

This study uses a time series approach to examine the impact of case-based payment systems. Building on the work by Kahn et al. (1990) and Shmueli et al. (2002), we select five procedures to examine outcomes at the hospital level. Unlike those studies, however, which use a before and after comparison of the average level effect from the prior year compared to the post year, we use an interrupted time series (ITS) approach to examine changes in both the level and slope (see Shadish et al. 2002). The benefit of capturing the change in the slope is to examine changes over time due to the introduction of case-based payment systems—hospitals are likely to adapt and learn about efficiency improvements incentivized by case-based payment systems over time, and focusing only on the average change from one year to the next would not accurately quantify the improvements over months or years. For example, the ITS approach allows us to quantify the effect of DTS over a full 12 month implementation period, rather than estimating only the level effect of 2008 average compared to 2009 average.

The 5 procedures selected are cataracts, pneumonia, coronary bypass, appendectomy, and hip replacement. These 5 procedures were selected because they were common procedures, a mix of different types of cases, and the procedure codes existed through all the different payment methods. Four are surgical, and pneumonia is a medical procedure. Table 2 shows how the procedural codes correspond across the different payment systems from 2000-2009. Hospitalization claims data over 10 years (2000-2009) were collected from HZZO for

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4 A few studies have used a differences-in-differences approach between treatment and comparison providers such as Yipp and Eggleston (2001) and Dafny (2005). Serra and Wagstaff (2010) use a differences-in-differences approach to examine treatment and comparison countries.

5 Pneumonia did not have a code in the 2002-2005 PPTP period, so codes for pneumonia were based on the World Health Organization International Classification of Diseases and Related Health Problems (ICD). Fortunately, our analysis focuses on the impact of the PPTP period beginning in 2005, when all five procedures had PPTP codes.
these 5 procedures from all 68 hospitals in Croatia. The final dataset consists of 352,618 records (number of cases). Each record contained data concerning patient age, facility, treatment dates, length of stay, and amount billed to HZZO. The main outcomes of interest are: i) volume of activity, ii) average length of stay (ALOS).

The interrupted time series approach requires data to be in equally spaced intervals over time, so the data was aggregated to each month for each hospital. A fixed-effects, first-order autoregressive model was estimated as specified in Equation (1) to analyze the effect of: i) the full introduction of PPTP in 2005, and ii) the introduction of DTS in 2009:

\[
Y_{ht} = \beta_0 + \beta_1 Month_t + \beta_2 DTS_t + \beta_3 (Month_{DTS_t}) + \beta_4 PPTP_t + \beta_5 (Month_{PPTP_t}) + \beta_6 X_{ht} + \beta_7 \gamma_{month} + \mu_h + \epsilon_{ht}
\]

In Equation (1), \(Y_{ht}\) are various outcomes of interest (admissions, length of stay) for each hospital \(h\) and month \(t\), \(Month_t\) is a time trend, \(\gamma_{month}\) is a vector of dummy month variables to correct for seasonality, and \(\mu_h\) is a fixed-effect controlling for time-invariant unobservables for each hospital. \(DTS_t\) and \(Month_{DTS_t}\) are variables associated with the introduction of DTS—\(DTS_t\) is a binary dummy variable that captures the level effect at time 0 when DTS is introduced, and \(Month_{DTS_t}\) is a time variable starting when DTS is introduced to capture the change over time due to DTS. A linear combination of \(\beta_2 + \beta_3 * 12\) is used to estimate the impact of introducing DTS by December 2009. Similarly, \(PPTP_t\) and \(Month_{PPTP_t}\) are dummy and time variables associated with introduction of PPTP, and a linear combination of \(\beta_4 + \beta_5 * 48\) is used to estimate the impact of PPTP. Here we focus on the major expansion of PPTP and the introduction of new PPTP codes beginning Jan 1, 2005. \(X_{ht}\) are observable covariates within hospitals over time such as patient age, condition at hospitalization entry, and type of health insurance. \(\epsilon_{ht}\) are first-order autoregressive standard errors to account for serial correlation.

**System-level Descriptive Statistics**

Table 3 presents annual summary statistics for each of the procedures from 2000-2009. Over the ten year period, cataract procedures accounted for the greatest proportion of these five procedures when counting by absolute numbers of cases (39%), but in terms of total billed costs, hip replacements accounted for the highest percentage (28%). Considerable variation can be seen in both the number of cases and the length of stay for each procedure;

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6 Total number of hospitals across the observed period.
however, there appears to be strong reversion to mean (declining variance as measured by standard deviation) for length of stay. The standard deviations (reported in parentheses in Table 2) decline over time—for example, the ALOS standard deviation for cataracts declined from about 4 to 2.4 days, for bypass from a little over 10 to less than 9 days, and for hip replacements from 11 to 6.7 days. In a well-functioning case-based payment system, this is what we would expect as less efficient hospitals catch-up to the more efficient hospitals.

Figure 5 graphs the numbers of cases by each procedure type to make the trends more evident. Cases for most procedures are increasing over time, which is what we would expect from an aging population, and one with increasing resources for health care. In particular, the number of cataracts and hip replacements are increasing over time, which is also partly due to Croatian health policy to reduce waiting lists and increase cases for both procedures. As we would expect, appendectomy cases remain constant, although there is an interesting decline in 2009.

Average length of stay (ALOS) by year is graphed in Figure 6. Overall, ALOS is steadily declining over the 10 year period for all 5 procedures, although more so for hip replacement and cataracts. Figure 7 shows the average billed amount for the 5 periods, and the variation generally follows changes in reimbursed amounts established by HZZO. It is worth noting that substantial changes in reimbursed amounts—such as for pneumonia, appendix, and bypass, all in 2009, are associated with corresponding increases or decreases in number of cases. For example, reimbursed amounts for pneumonia increased dramatically under DTS, almost double what it had been in 2005, providing hospitals with a large incentive to increase the number of pneumonia cases. Indeed, hospitals did increase their pneumonia cases as shown in Figure 5.

**Interrupted Time Series Results**

The introduction of case-based payment systems from the 2005-2009 period (an expanded PPTP from 2005-2008 and DTS in 2009) appears to have increased efficiency as measured by a steady decline in ALOS, however it is unclear whether these changes can be attributable to the payment reforms. To control for time trends and examine the impact of the reforms at the hospital level, we estimate ITS regressions following Equation (1). Since a pilot PPTP was first introduced in 2002, we begin the analysis with all data from 2002 to

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7 There is also strong reversion to mean for average billed cost, but this may be more of a mechanical result due to changes in HZZO reimbursements.
8 Coronary bypass is graphed separately because of the Y-axis scale.
2009, aggregating the case-level data to each hospital-month-level. Only hospitals with enough month-level observations over the 2002-2009 period were kept, resulting in a total sample of 11,861 hospital-month-level observations across all 5 procedures.

The ITS regressions confirm some of the descriptive statistic results (see Table 3). Each column of each panel represents one regression, and the reported coefficients and standard errors are for the linear combinations of PPTP ($\beta_4 + \beta_5*48$) and DTS ($\beta_2 + \beta_3*12$) described earlier. The most significant results are for pneumonia and appendectomy. For pneumonia (Col 2), there is a statistically significant reduction in ALOS of 3 days associated with the PPTP period (2005-2008), and a significant increase of almost 1.5 days associated with the DTS period (2009). At the same time, there was a reduction of almost 9 cases for the average Croatian hospital performing pneumonia procedures under the PPTP period, and an increase of ~13 cases under the DTS period. Similarly, there was a substantial reduction in ALOS for appendectomy (Col 4) by ~1.3 days under PPTP and a continued decline of about 1 day under DTS. Under PPTP, the volume of cases actually increased for appendectomy but decreased under DTS. Taking the PPTP and DTS results together (Total effect of DRG reforms), the results suggest that the introduction of case-based payment systems from 2005-2009 reduced ALOS for pneumonia and appendectomy procedures by over 2 days, and led to little change in the volume of cases. ALOS also declined for bypass, although the complexity of bypass surgeries results in less precision for this estimate. There was little change in ALOS from 2005-2009 for cataracts or hip replacement as both were already experience declining ALOS.

Quality – Readmissions

Although attribution to the introduction of PPTP or DTS is difficult, efficiency has improved in hospitals as Table 3 shows declining ALOS over time for all five procedures. Given that efficiency has improved, it is important to prevent any unintended consequences of decreasing quality. To examine any effects on hospital quality, we collected additional data on readmissions within 2 weeks of the original procedure over the 2008-2009 period for two procedures: appendectomy and hip replacement. Readmissions can reflect hospital

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9 The estimated coefficients are similar if the full 10 year period is used. Since PPTP was first introduced in 2002, using the full 10 year period of data requires estimating the impact separately of the 2002-2004 initial PPTP period as well. Beginning the data analysis at 2002 increases the precision of the analysis, but the results are similar with either approach.

10 The actual regression coefficients are available from the authors upon request.
quality because the original procedures may have been performed with lower quality, resulting in infections or complications that require readmission.

We compare whether there was any difference in readmission rates under PPTP in 2008 compared to DTS in 2009. Figure 8 shows that for both appendectomy and hip replacement, there was little change in readmission rates. For appendectomy, the annual readmission rate in 2008 was 3.0% whereas in 2009 it was 2.5%. For hip replacement, the annual readmission rate in 2008 was 14.8% whereas in 2009 it was 15.2%. Unlike Shmueli et al. (2002), we do not find that readmission rates increase, suggesting that either quality stayed constant or hospitals did not increase readmissions to earn greater revenue. The fact that hospital budgets stayed relatively constant during this period may account for hospitals not changing their readmissions drastically, but the results do provide suggestive evidence that there were no unintended consequences, either on quality or efficiency.

To get a sense of whether hospitals are “purposely” increasing readmissions in order to earn more revenue, we examine the length of stay of readmissions. Under a DRG system, a readmission (like an additional case) results in an additional payment, so hospitals may be incentivized to readmit high cost cases as opposed to extending a patient’s stay under the original case code. Under this scenario, readmissions would increase under a DRG system even if quality remained high. As a robustness check, we examine the length of stay of the readmissions to get a sense of whether reported readmissions are “real” readmissions.

Table 4 shows that ALOS for readmissions for both appendectomy and hip replacement are slightly longer under DTS in 2009 than under PPTP in 2008. If it were true that hospitals were “purposely” increasing readmissions, we might expect readmission lengths of stay to be shorter under DTS, a full DRG system, because hospitals have little incentive to keep patients longer once they have been admitted. Yet, the ALOS is longer in 2009, suggesting that perhaps hospitals are not gaming readmissions, and that the readmission rate is a valid proxy for quality.

Finally, did hospitals with greater improvements in efficiency also have poorer quality? Figure 9 examines this hypothesis by examining the percent change in ALOS (efficiency) from 2008 to 2009 against the percent change in readmission rate (quality). Each dot represents one hospital observation. No clear pattern emerges for either procedure as the observations are scattered throughout, suggesting that increasing efficiency was not
associated with poorer quality.\textsuperscript{11} It is worth noting two outliers in the hip replacement figure—these two hospitals had substantial increases in hip replacement readmissions.

Discussion

Overall, the introduction of case-based payments appears to have improved efficiency of these five acute services in hospitals. Efficiency has increased as measured by declines in ALOS, although the results are only significant for pneumonia and appendectomy. Still, the magnitude for most of the procedures is negatives, suggesting that case-based payments have improved efficiency in Croatia. The efficiency gains (attributed to case-based payments), are smaller for hip replacement and cataracts, suggesting that the ALOS declines may be more likely the result of changes in technology, clinical practices, or other factors.

It is worth noting that the volume of cases has increased for almost all procedures, except for appendectomies, but that the increase in cases is generally not attributable to the introduction of PPTP nor DTS. Hospitals do not seem to have been “incentivized” to increase volume, except in the unique case of pneumonia. Instead the increase in cases appears to be the result of changes in health policies and demographics. Quality does not appear to have been adversely affected as well, as readmission rates remained similar for appendectomy and hip replacement.

What impact did all of these provider payment reforms have on HZZO expenditures? Figure 10 graphs the total annual costs to HZZO by each of these procedures. Costs increased for some of the procedures (hip replacement, pneumonia, cataracts), and decreased for others (bypass and appendectomy). The declines in overall costs make sense for bypass and appendectomy since laparoscopic surgeries have become more commonplace and technology has improved (although the appendectomy results for 2009 may be biased due to the decline in number of cases). The increasing costs for cataracts and hip replacement are also reasonable given the increase in the number of cases described earlier. Pneumonia is the major outlier, however, as total costs have more than doubled since 2008, and almost doubled from the 2005 cost.

Overall these results suggest that Croatia’s introduction of case-based payment systems is having its intended effect of improving efficiency and reducing ALOS, while maintaining patient quality. What is somewhat worrisome, however, is the responsiveness of hospitals to changes in coding, most evident in pneumonia cases. As the implementation of

\textsuperscript{11} An alternative explanation could be that increasing efficiency in ALOS was not associated with gaming of readmissions by discharging patients sooner and then readmitting them to increase revenues.
DTS continues, it will be important to continue to actively monitor the volume of all procedures separately to ensure that hospitals are accurately reporting their cases. Only with available and transparent data can accountability increase and improvements be made. For example, it would be useful to undertake a similar study in future years to examine impacts on efficiency, volume, and quality.

Particular attention needs to be given to pneumonia cases, for which there has been a remarkable one year increase in cases from 2008 to 2009. Although the number of pneumonia cases seems to be back to 2005-levels, pneumonia had the highest increase in price under the DTS system—287% from the case-based price under PPTP in 2008 to DTS in 2009. This substantial increase likely provides a strong incentive for hospitals to code cases as pneumonia, and evidence from the United States and Bulgaria suggest that pneumonia codes are prone to upcoding and gaming (Silverman and Skinner 2004, Thomson 2006). It will be important for HZZO and Croatia to continue to monitor pneumonia cases to prevent any future upcoding or gaming.

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Figure 1. The costs of hospital health care from 2000-2009

Source: HZZO

Figure 2. PPTP and DRG codes for cataract procedures

| PPTP          | DTS                                      |
|---------------|------------------------------------------|
| 02K02 Cataract surgery | C15A Glaucom and Complex Cataract Procedures |
| 02K03 Cataract surgery - ultrasound | C15B Glaucom and Complex Cataract Procedures, Sameday |
|               | C16A Lens Procedures                      |
|               | C16B Lens Procedures, Sameday             |

Source: HZZO

Figure 3. Average length of stay for different types of Croatian hospitals

Source: HZZO
Figure 4. Bed occupancy

Source: HZZO

Figure 5. Number of cases for 5 Selected Procedures

Source: HZZO
Figure 6. Average Length of Stay for 5 Selected Procedures

Source: HZZO

Figure 7. Average Billed Cost for 5 Selected Procedures

Source: HZZO
Figure 8. Readmission rates for PPTP (2008) and DTS (2009) by month

Source: HZZO
Figure 9. Relationship between changes in ALOS and changes in readmission rates

Appendix

Hip Replacement

Source: HZZO
Figure 10. Total HZZO Costs for 5 Selected Procedures

Source: HZZO
Table 1. The share of persons insured by the mandatory health insurance in the total population

|                     | 1998 | 2000 | 2001 | 2003 | 2005 | 2007 | 2008 | 2009 |
|---------------------|------|------|------|------|------|------|------|------|
| Share of population |      |      |      |      |      |      |      |      |
| covered by          |      |      |      |      |      |      |      |      |
| mandatory health    | 90.5 | 91.5 | 95.0 | 96.7 | 97.4 | 98.3 | 98.4 | 98.0 |
| insurance           |      |      |      |      |      |      |      |      |

Source: HZZO
## Table 2. Definitions of procedures

| FFS | Code* | Definition | PPTP | Code (from 07/2002.) | Code (from 01/2005.) | Code (from 01/2009) | DTS |
|-----|-------|------------|------|----------------------|----------------------|----------------------|-----|
|     | 51440; 51450; 51470; 51480 | Cataract surgery | OF001 02K02 | Cataract surgery | C16A Lens Procedures | C15A Glaucoma and Complex Cataract Procedures |
|     | 51440; 51450; 51470; 51480 | Cataract surgery - ultrasound | OF003 02K03 | Cataract surgery - ultrasound | C16B Lens Procedures, Sameday | C15B Glaucoma and Complex Cataract Procedures, Sameday |
|     | J10.0, J11.0, J12.0, J13.0, J14.0, J15.0, J15.1, J15.2, J15.3, J15.4, J15.5, J15.6, J15.7, J15.8, J15.9, J16.0, J16.8, J18.0, J18.1, J18.2, J18.8, J18.9 | Pneumonia | None 04M01 | Pneumonia | E62A Respiratory Infections/Inflammations W Catastrophic CC | E62B Respiratory Infections/Inflammations W Severe or Moderate CC | E62C Respiratory Infections/Inflammations W/O CC |
|     | 53601, 53611, 53612, 53613, 53614, 53620, 53630 | Coronary Bypass | OK010 05K01 | Coronary Bypass | F05A Coronary Bypass W Invasive Cardiac Inves W Catastrophic CC | F05B Coronary Bypass W Invasive Cardiac Inves W/O Catastrophic CC | F06A Coronary Bypass W/O Invasive Cardiac Inves W Catastrophic or Severe CC | F06B Coronary Bypass W/O Invasive Cardiac Inves W/O Catastrophic or Severe CC |
|     | 54701 | Appendicectomy | OK003 06K01 | Appendicectomy | G07A Appendicectomy W Catastrophic or Severe CC | G07B Appendicectomy W/O Catastrophic or Severe CC |
|     | 58150 | Total Hip Replacement - nocement | OD003 08K01 | Total Hip Replacement - nocement | I03A Hip Revision W Catastrophic or Severe CC | I03B Hip Revision W Catastrophic or Severe CC or Hip Revision W/O Catastrophic or Severe CC | I03C Hip Revision W/O Catastrophic or Severe CC |
|     | 58150 | Total Hip Replacement - cement | OD004 08K02 | Total Hip Replacement - cement | I03A Hip Revision W Catastrophic or Severe CC | I03B Hip Revision W Catastrophic or Severe CC or Hip Revision W/O Catastrophic or Severe CC | I03C Hip Revision W/O Catastrophic or Severe CC |
|     | 58152 | Parcial Hip Replacement | OD005 08K04 | Parcial Hip Replacement | I03A Hip Revision W Catastrophic or Severe CC | I03B Hip Revision W Catastrophic or Severe CC or Hip Revision W/O Catastrophic or Severe CC | I03C Hip Revision W/O Catastrophic or Severe CC |
|     | 58151 | Unstrung Hip Replacement | OD006 08K03 | Unstrung Hip Replacement | I03A Hip Revision W Catastrophic or Severe CC | I03B Hip Revision W Catastrophic or Severe CC or Hip Revision W/O Catastrophic or Severe CC | I03C Hip Revision W/O Catastrophic or Severe CC |
### Table 3. Descriptive statistics by procedure

| Procedure | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|-----------|------|------|------|------|------|------|------|------|------|------|
| Cataract  |      |      |      |      |      |      |      |      |      |      |
| Number of Cases | 10,339 | 11,818 | 12,876 | 12,394 | 13,898 | 13,305 | 15,042 | 16,135 | 15,685 | 17,213 |
| ALOS      | 7.73 | 6.68 | 5.42 | 4.65 | 4.29 | 4.13 | 3.76 | 3.59 | 3.34 | 3.04 |
| Billed cost | 4,527.25 | 3,897.48 | 3,724.67 | 4,312.12 | 4,357.56 | 4,231.32 | 4,303.75 | 4,457.74 | 4,602.92 | 5,347.49 |
| (2,004.26) | (1,696.58) | (2,857.89) | (1,317.61) | (1,186.67) | (1,141.06) | (1,081.05) | (1,110.55) | (3,243.59) | (643.45) |
| Pneumonia |      |      |      |      |      |      |      |      |      |      |
| Number of Cases | 7,812 | 8,352 | 10,837 | 10,610 | 11,296 | 12,338 | 11,232 | 11,599 | 9,165 | 12,708 |
| ALOS      | 12.28 | 11.93 | 11.54 | 11.28 | 11.30 | 10.31 | 9.43 | 9.74 | 9.76 | 10.37 |
| Billed cost | 7,403.71 | 6,755.29 | 5,933.24 | 6,615.81 | 7,047.26 | 5,800.21 | 5,020.06 | 5,348.36 | 5,792.38 | 10,389.82 |
| (7,861.07) | (7,645.65) | (7,699.26) | (7,569.68) | (8,269.46) | (6,733.79) | (5,918.92) | (6,453.00) | (6,406.05) | (4,773.01) |
| Bypass    |      |      |      |      |      |      |      |      |      |      |
| Number of Cases | 948 | 1,070 | 1,159 | 1,087 | 1,157 | 1,187 | 1,124 | 1,073 | 1,341 | 1,121 |
| ALOS      | 19.96 | 19.06 | 16.73 | 17.67 | 18.79 | 18.20 | 18.23 | 17.98 | 17.25 | 14.32 |
| Billed cost | 96,366.47 | 84,694.70 | 72,916.11 | 82,977.79 | 79,514.63 | 72,557.86 | 75,473.32 | 82,277.51 | 77,908.81 | 52,681.00 |
| (50,289.59) | (40,502.29) | (48,549.58) | (58,324.53) | (50,146.27) | (34,677.38) | (27,504.72) | (33,549.20) | (26,673.42) | (8,909.82) |
| Appendix  |      |      |      |      |      |      |      |      |      |      |
| Number of Cases | 6,072 | 5,814 | 6,071 | 5,288 | 5,494 | 5,712 | 5,581 | 5,712 | 5,374 | 3,529 |
| ALOS      | 8.73 | 8.50 | 8.41 | 8.66 | 8.76 | 8.68 | 7.86 | 7.82 | 7.49 | 5.94 |
| Billed cost | 8,034.42 | 7,842.01 | 7,700.66 | 8,258.29 | 8,552.36 | 8,327.99 | 7,511.08 | 8,161.01 | 8,306.01 | 6,611.98 |
| (12,292.65) | (10,759.79) | (22,140.78) | (13,368.33) | (15,638.14) | (19,310.63) | (13,458.14) | (11,407.54) | (12,136.14) | (2,373.94) |
| Hip       |      |      |      |      |      |      |      |      |      |      |
| Number of Cases | 2,977 | 3,552 | 3,985 | 4,144 | 4,645 | 4,812 | 4,736 | 4,753 | 5,053 | 4,969 |
| ALOS      | 21.96 | 20.24 | 18.50 | 18.38 | 17.69 | 16.87 | 16.12 | 15.75 | 15.94 | 15.05 |
| Billed cost | 22,972.53 | 20,027.55 | 18,821.90 | 19,813.85 | 22,298.34 | 23,112.27 | 23,147.84 | 23,965.13 | 24,457.92 | 27,907.63 |
| (11,255.93) | (8,386.85) | (9,096.25) | (8,153.39) | (11,038.18) | (6,387.67) | (5,958.30) | (5,902.31) | (6,754.01) | (4,878.44) |

Notes: HZZO data. Price in 2005 kuna, adjusted for inflation by Consumer Price Index from Croatian National Bank.
Table 4. Interrupted Time Series Regression Results of PPTP and DTS Impact

| Panel A: ALOS | | | | | |
|-------------|-------------|-------------|-------------|-------------|-------------|
| Cataracts | Pneumonia | Bypass | Appendix | Hip |
| Total effect of New PPTP (2006-2008) | 0.664* | -3.195*** | -3.983 | -1.348*** | -1.624 |
| (0.385) | (0.828) | (3.439) | (0.494) | (1.415) |
| Total effect of DTS by end 2009 | -0.143 | 1.455*** | -1.706 | -1.076*** | 1.654** |
| (0.207) | (0.471) | (1.595) | (0.290) | (0.782) |
| Total effect of DRG reforms (2006-2009) | 0.716 | -2.242*** | -6.660 | -2.698*** | -0.0924 |
| (0.463) | (1.001) | (4.071) | (0.603) | (1.707) |

| Panel B: Cases | | | | | |
|-------------|-------------|-------------|-------------|-------------|-------------|
| Total effect of New PPTP (2006-2008) | 5.066 | -8.863** | -2.293 | 3.397** | -1.331 |
| (8.072) | (3.920) | (6.016) | (1.496) | (2.112) |
| Total effect of DTS by end 2009 | -0.0991 | 13.91*** | 0.294 | -4.111*** | -0.170 |
| (4.293) | (2.153) | (2.837) | (0.860) | (1.184) |
| Total effect of DRG reforms (2006-2009) | 6.907 | 2.469 | -2.848 | -0.198 | -1.924 |
| (9.676) | (4.648) | (7.157) | (1.186) | (2.561) |

| Panel C: Reported cost per case | | | | | |
|-------------|-------------|-------------|-------------|-------------|-------------|
| Total effect of New PPTP (2006-2008) | 8.711 | -4295*** | -65593 | -2819*** | -6531*** |
| (394.7) | (794.1) | (96370.0) | (1075.0) | (1504.0) |
| Total effect of DTS by end 2009 | -1401*** | -4525*** | 87156* | -5035*** | -8312*** |
| (219.6) | (455.8) | (44657.0) | (643.0) | (830.2) |
| Total effect of DRG reforms (2006-2009) | -1331*** | -9410*** | 8529*** | -8270*** | 15964*** |
| (480.7) | (964.2) | (114076.0) | (1319.0) | (1814.0) |

| Panel D: Drug cost per case | | | | | |
|-------------|-------------|-------------|-------------|-------------|-------------|
| Total effect of New PPTP (2006-2008) | -131.6 | -1277*** | -52105 | -1394* | -4891*** |
| (341.6) | (376.2) | (96386.0) | (779.1) | (1056.0) |
| Total effect of DTS by end 2009 | 584.4*** | 88.00 | 122998*** | 476.5 | 1521*** |
| (191.9) | (221.3) | (44612.0) | (468.5) | (580.4) |
| Total effect of DRG reforms (2006-2009) | 437.4 | -1358*** | 59971 | -1120 | -4354*** |
| (417.3) | (461.7) | (114055.0) | (957.7) | (1271.0) |

| Observations | 2,158 | 3,687 | 437 | 2,833 | 2,746 |
| Number of Hospitals | 24 | 48 | 6 | 31 | 31 |

Standard errors in parentheses. All specifications include hospital fixed effects, time trend, and controls for age, condition at entry, type of insurance, and seasonality. HZZO data

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Readmission ALOS (in days)

| | PPTP | DTS |
|---|---|---|
| App | 7.15 | 8.38 |
| Hip | 16.29 | 16.61 |

Source: HZZO
Appendix. Background on the Croatian Health Care System

Croatia is a Central European country, which gained its independence and sovereignty in May 1991. Health care is provided through health care institutions, which have contracts with the HZZO. Health care in Croatia is carried at three levels – primary, secondary and tertiary. Hospital health care at the secondary level includes diagnosis, treatment and medical rehabilitation, medical care and boarding in a hospital. The tertiary level provides care, but also conducts more complex activities in specific branches of medicine, medical education, and research.

Hospital providers at the secondary level include general hospitals, special hospitals and health resorts (sanatoria). All general hospitals and the majority of special hospitals are public county-owned. While general hospitals primarily serve the population of their respective county, special hospitals serve the entire population of Croatia. General hospitals perform small procedures in surgery, internal medicine, pediatrics, gynecology and obstetrics, and emergency medicine. Special hospitals are for specialist, consultative, and inpatient treatment for certain illnesses or age groups. Health resorts provide health care, specialist, and hospital rehabilitation through natural health sources.

Tertiary care is provided in state-owned institutions: clinical hospital centers, clinical hospitals and clinics. A clinical hospital center is a general hospital where apart from the title clinic for internal medicine, surgery, pediatrics, gynecology and obstetrics, more than half of other specialties and more than half of teaching programs of the School of Medicine, School of Dental Medicine, and Faculty of Pharmacy and Biochemistry are performed. A clinical hospital is a general hospital where at least two of the specialties (internal medicine, surgery, pediatrics, gynecology and obstetrics) bear the title of the clinic and at least two other activities of other specialties, such as diagnostics, are provided. A clinic is a health institution or a part of health institution, which provides regular secondary and more complex specialist and consultative and inpatient care. Clinic activities also include teaching for universities and conducting scientific work.

The Minister of Health determines which institutions are classified as clinics, clinical hospitals or clinical hospital centers according to the Health Care Law that specifies the criteria that hospitals have to attain in order to be granted special status. The National Health Council accredits hospitals that meet certain normative standards set by the medical associations.
In Croatia classification of hospitals and organization of the health system has been regulated by the Healthcare Act and Network of Public Health Services (Network). In 2009 there were 66 public institutions in hospital health system, of which there were 3 clinical hospital centers, 4 clinical hospitals, 7 clinics, 23 general hospitals, 27 special hospitals, and 2 health resorts. In these hospitals a total 21,945 beds have been contracted. Of the total number of beds, 15,978 are for acute care, 653 beds for prolonged, sub-acute treatment, 3,344 for chronic disease (chronic mental illnesses, chronic diseases in children, chronic lung diseases) and 1,970 for acute and chronic treatment.

Hospitals as participants in health system are the most significant "consumers" of health care resources, accounting for 50% of total health care costs. Hospital resources are regulated through hard budgets. If a hospital exceeds its annual budget it will not receive additional funding for any bills levied for further services provided. Conversely if hospitals do not provide enough services to account for all of their budgets in a given year, then, in accordance with their contracts with the HZZO, in the subsequent fiscal year their budgets should be reduced by an amount equal to these unspent funds.