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Mental health inpatient care: how should services be organised in a NHS?

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Mental health inpatient care: how should services be organised in a NHS?*

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Abstract

Organisation of mental health care provided by hospitals can be done with concentration of services in a few units or with several hospitals providing them. The trade-off to be made is between being closer to patients having several units of low volume activity each or benefiting from economies of scale to obtain better outcomes. We address here the magnitude of the scale effects in mental health care. This provides important information to address the above-mentioned trade-off. We also analyse the importance of integrated continuous care services in mental health as a complement to inpatient care by computing the potential savings to the National Health Service (NHS). These services are a set of sequential interventions in mental health and/or social support, focusing on rehabilitation and recovery of patients with psychosocial disability. Analysing both economies of scale and integrated continuous care are relevant issues for mental health system financing.

We use a diagnosis related group (DRG) dataset from 2001 to 2013 considering only mental health inpatient discharges, from an European country with a case-mix based funding system (Portugal).

Using a conditional risk set model, we find a scale effect for each DRG that ranges between 0 and 1 day. The magnitude of the scale effect is not sufficiently high to justify the centralisation of psychiatric services in higher volume hospitals. We find potential savings for the NHS if integrated continuous care was in place.

The focus of mental health system redesign should be on promoting integrated mental health care, with concentration of hospital services not being particularly relevant.

Keywords: mental health; inpatient care; economies of scale; integrated continuous care; services organisation.

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1 Introduction

Mental or psychological well-being makes up a valuable part of an individuals' capacity to lead a fulfilling life (Chisholm, Saxena and Van Ommeren, 2006). The latest epidemiological research shows that psychiatric disorders and mental health problems have become one of the main causes for disability in societies nowadays (de Almeida, 2009).

According to Knapp et al. (2007), economic costs of mental health disorders are very high. The burden of mental disorders such as depression, alcohol addiction and schizophrenia has been seriously underestimated in the past due to the fact that traditional approaches only considered mortality figures, ignoring the number of years lived with the disability caused by illness.

One of the main challenges that European countries are facing is to ensure that mental health services receive a fair share of the available health funding (Europe, 2002). Mental health system financing has become a priority for almost all the European countries and the United States (US) (McDaid, Knapp and Curran, 2005; Garfield, 2011).

Before payment design can be discussed, the underlying economic properties of activity must be clarified. Suppose unit costs and outcomes of mental health care are largely independent of how much is done in each place treatment is provided. Then, a single payment value, applicable to all units, small and large, would be feasible. Moreover, the size of each unit could be left totally to patients' preferences or patients' geographic concentration. At the other extreme, in the presence of strong size (scale) effects, units of different size may need different unit payments and location of activities of hospitals providing mental health care services must be actively planned. Knowing the magnitude of the scale effect in mental health care as the first step to the discussion of mental health care organisation motivates this paper.

In addition, and since mental health services should be balanced between hospital and community-based services, Portuguese Government has been approving several decree-laws on integrated continuous care for patients with severe mental illness (SMI).[1] These facilities aim to provide recovery and deinstitutionalisation programmes for patients with SMI and serve as a complement to inpatient care. The rationale is to transfer patients with SMI to these facilities once they are clinically stable which allows, on average, a shorter hospital length of stay (LOS). As the implementation of these services has constantly been postponed, we analyse the potential savings that integrated continuous care can bring to the Portuguese National Health Service (NHS). Identifying the potential savings of these facilities, along with their clinical benefits, allows to discuss how mental health care organisation should be balanced between hospital and integrated care. This topic is relevant also for the payment design as it should

[1] Patients whose diagnosis is one of the following: schizophrenic, bipolar or severe depressive disorders.

reduce incentives for (re)institutionalisation and promote community-based care.[2]

Using individual data on inpatient discharges from the Portuguese NHS ranging over ten years, we investigate scale effects in mental health care. Since we want to model the length of time spent by each patient in a hospital before discharge (patient transition from “sick” to “healthy”), we use a duration model, specifically a conditional risk set model. We opt to use this model because it accounts for several specificities of our dataset, such as recurrent readmissions within 30 days of discharge (meaning that patients did not improve their health status) and repeated events for the same patient (he can improve his health status but after a period of time, more than 30 days, he gets sick again). Our results show that there is no advantage in centralisation of activities in high volume hospitals.

We also identify potential savings for the NHS that range between €4.5M and €13.4M if integrated continuous care facilities were part of the Portuguese mental health system as a support to inpatient care (about 26% of the initial cost). Transferring patients with SMI to these facilities will reduce, on average, the hospitals’ LOS. This implies an increase in hospitals’ bed capacity allowing hospitals to treat more patients. We determine that, if integrated continuous care was part of the Portuguese NHS, hospitals would have capacity to treat, on average, 10% to 27% more patients with severe mental disorders per year.

The remainder of this paper is as follows. The next section briefly describes the Portuguese health system, namely the mental health branch. Section 3 reviews the literature on services organisation. Section 4 presents the dataset used throughout our analysis and a descriptive statistics, while the methodological approach is described in Section 5. Section 6 presents the main results of our analysis, which are then discussed in Section 7. Finally, Section 8 concludes.

2 The Portuguese National Health Service

The Portuguese health system is organised around a NHS, which is managed by the Ministry of Health. The Portuguese NHS was set to comply with the Constitution disposition that establishes the right of all citizens to health protection, regardless of their economic and social background (Barros and de Almeida Simões, 2007).

The organisation of public infrastructures for healthcare provision has been restructured in the recent past. Most of the Portuguese hospitals are now administratively part of health units called hospital centers (Centros Hospitalares). In some regions of the country, Government has been grouping together the local health centers and the hospitals located in the same region in a single administrative unit known as local health units (Unidade Local de Saúde). The main idea behind this restructure was to promote

[2] One example is the England’s “Care Pathways and Packages Approaches”.

efficiency gains from economies of scale. This reorganisation did not imply a hospital merge, in general, as only in a few cases did duplicated services in several hospitals of the same center closed. So far, no study has analyse the scale effects if duplicated services were eliminated, stressing the need for empirical evidence.

As far as mental health is concerned, it has been discussed how these services should be financed and organised. According to the Portuguese Mental Health Plan 2007-2016 (de Almeida, 2009), the way that mental health care is funded creates barriers to the development of specialist (inpatient, outpatient and community-based) services. To what concerns organisation, this plan claims that mental health services should be decentralised. It is argued that services must be provided closer to the populations, meaning that, in terms of inpatient care, hospitals should provide community care services. Still, no empirical study was performed to sustain such statements, highlighting the need for evidence that can guide policy making.

Concerning mental health services organisation, Portugal is shifting from psychiatric hospitals to a network of services based on the community. The rationale is to keep patients in their respective residential communities instead of staying in psychiatric hospitals (de Almeida, 2009). Since 2007, Portugal closed two psychiatric hospitals which were replaced by community-based services and mental health units in general hospitals. According to de Almeida et al. (2015), despite the fact that the transition from psychiatric hospitals to general hospitals went well, Portugal still lacks of community care services, domiciliary services and primary care services oriented towards mental health care. Due to this service reorganisation, in 2004 the mental health referral network was modified and new psychiatric services within general hospitals were developed (DGS, 2004).

In order to solve a long-existing gap in social support and healthcare in Portugal, the Government established, in 2010, by the decree-law 8/2010,[3] the Portuguese National Network for Integrated Care (RNCCI) for mental health patients. These services are a set of sequential interventions in mental health and/or social support, focusing on rehabilitation and recovery of patients with psychosocial disability. In the light of family and social integration, integrated continuous care conducts an active and continuous process of rehabilitation and social support by promoting autonomy and improving patients' outcomes. The rationale is to transfer patients from inpatient care to these health care facilities, after they are clinically stabilised. The provision of these services includes three types of residential units (maximum support, intermediate support and minimum support), social integration facilities (day centres) and home support teams. In 2011,[4] Government defined the prices that should be paid to these integrated continuous care units.

[3] Updated version is given by the decree-law 22/2011.
[4] Decree-law 183/2011.

It has been argued that the development of RNCCI will improve the specific integrated continuous care responses in terms of mental health (de Almeida, 2009). However, the implementation of these services has been postponed. Despite there are several studies stating the clinical benefits of these facilities on patients' outcomes, there is no study that provides empirical evidence on savings for the NHS if integrated care was in place.

3 Services Organisation

Mental health care is characterised by diversity in provision, which covers long-term and acute care, and medical, mental, rehabilitative and social services (Mason and Goddard, 2009). Mental health has been a broad and current interest in health economics since the uncertainty and variations in treatments are likely to be greater than in other areas. Also the social consequences and external costs of mental illness are significant (Frank and McGuire, 2000).

A mental health care system assumes a multidisciplinary approach to psychiatric disorders (Knapp et al., 2007). Evidence points to a balanced care between community-based and modern hospital-based care (Thornicroft and Tansella, 2003). Frontline services are based in the community but hospitals play an important role as specialist providers. Organisation of inpatient care is an important issue for the system's efficiency.

Since a large debate about financing mental health is taking place in the literature, it is important to understand if there is any gain in terms of efficiency from centralisation of activities in higher volume hospitals. Due to economies of scale, larger hospitals may be more cost-effective than smaller ones. This catchy argument requires a clear empirical background which is currently absent. Policy makers need to account for the possibility of concentrating activities in some hospitals or at least accommodate the fact that some hospitals may receive proportionally less as they benefit from economies of scale.

The literature is vast in what concerns hospital efficiency since hospitals consume a significant share of health resources in most countries (OECD, 2012). Specifically, analysis on the economies of scale, stating whether larger hospitals are more or less efficient than smaller ones, has gained importance (Posnett, 1999; Weaver and Deolalikar, 2004; Morikawa, 2010). The empirical work performed on this topic not only focuses the analysis at a hospital-level (Morikawa, 2010) but also on specific medical treatments (Gaynor, Seider and Vogt, 2005). As far as hospital-level is concerned, the results are consistent among the studies on this topic.[5] Evidence points to a scale effect for small hospitals (less than 200 beds) and a constant scale effect for the average hospital with about 200-300 beds (Aletras, Jones and Sheldon,

[5] Most of the studies focus their analyses on a specific country and use different methodologies such as an estimation of the total factor productivity (Morikawa, 2010) or an estimation of the short-run cost function to determine the long-run scale economies (Kristensen et al., 2008).

1997; Kristensen et al., 2008).

The work performed on specific medical treatments reports a relation between hospital volume and outcomes such as mortality rates or other proxies (length of stay, physician volume) (Hamilton and Hamilton, 1997; Gaynor, Seider and Vogt, 2005). Logistic and probit regression models, accounting for fixed effects at hospital level, are the most common methodologies applied in these volume-outcome studies.

We did not find any study about services organisation at a medical speciality level, namely in terms of economies of scale. Hence, we propose to fill the gap in the literature by analysing the economies of scale of mental health departments within general hospitals by applying a duration model that accommodates data specificities such as recurrent readmissions within 30 days. We also add to the literature evidence on potential savings that integrated continuous care may bring to the mental health system (besides all the clinical benefits), which so far has not been done.

4 Data

We use the diagnosis related group (DRG) dataset of hospital discharges, which is organized by Administração Central do Sistema de Saúde, I.P. (ACSS). It includes all inpatient discharges at the NHS and the diseases are classified according to the International Classification of Diseases, Clinical Modification (ICD-9-CM). We only consider Mental Health diseases (i.e. DRGs 424 to 432) using observations from 2001 to 2013, excluding Psychiatric Hospitals. We excluded these hospitals from the analysis because not only they have more long-term care beds than general hospitals but also they have specialty units which cannot be fully compared with the services provided by general hospitals. Also, Government plans to exclude psychiatric hospitals form the mental health system.

This dataset comprises information about patients characteristics such as age and gender. We merge hospital level information data — case-mix index (*cmi*), beds, length of stay (*lstay*), discharged patients (*dp*) and total cost (*totalcost*)[6] — from ACSS and hospital reports, available at ACSS.[7] This information is only available since 2001. For 74 hospitals there is no complete information over these variables. To overcome this problem, we use information of the following year whenever a gap exists. In addition, we do not have information regarding the year 2013 on the hospital-level variables and, therefore, we use 2012 information as a *proxy*.

We found eleven cases of rehospitalisation, in the same DRGs, that had an admission date previous to the last discharge. These cases were removed from our dataset as they were a registration error. We also dropped 4,915 observations of patients aged 15 and younger since they are treated in Child and

[6]This cost comprises operational, financial and extraordinary costs gathered from the financial statements.
[7]In appendix A.1 we present the sources of information used.

Adolescent Psychiatric inpatient units.[8] The database, including all discharges from 2001 to 2013, has 155,678 observations.

Observations of some hospitals were combined due to the creation of hospital centers and local health units. Due to this merge, in 2011, the data of Centro Hospitalar e Universitário de Coimbra includes the discharges of the psychiatric hospital Sobral Cid. We are not able to disentangle the information of this psychiatric hospital. In appendix A.2 we present a summary of the hospital mergers occurred in the NHS.

4.1 Descriptive statistics

The number of mental health inpatient discharges increased by approximately 2.8% between 2001 and 2013. DRGs 426 (Depressive neuroses), 429 (Organic disturbances and mental retardation) and 430 (Psychoses) were the codes with more cases registered between 2001 and 2013, representing approximately 81% of all discharges. The histogram is presented in appendix A.3. DRG 430 is the most heterogeneous group within mental health DRGs since it comprises different diseases such as schizophrenic, schizo-affective and bipolar disorders. This DRG includes 98% of all inpatient discharges whose diagnoses are severe mental disorders. These disorders account for 46% of all mental health inpatient discharges.

Hospitals with less than 650 beds treated 69.4% of all inpatient discharges. More than half of these observations were treated in hospitals with a number of beds that ranges between 400 and 650.

Approximately 98.9% of all discharges have a length of stay (LOS) of less than 90 days (mean and standard deviation amount to 21.5 and 132.8 days, respectively) and within 90 days we have approximately 64.3% of cases with a LOS between 1 and 20 days.[9] In our data we have 100 cases with a LOS higher than 1,000 days. These cases concern chronic patients who were not transferred to another unit care facility, such as continuous care.

Considering the average length of stay (ALOS) by DRG, DRG 430 has the highest ALOS (26.3 days). The ALOS has decreased approximately 13% from 2009 to 2010 but has increased 12.9% from 2010 to 2011 and thereafter remained almost constant.

In this briefly statistical description, we cover the main variables that are included in our analysis. Special attention should be given to DRG 430 since it comprises approximately 54% of all mental health inpatient discharges. A description of all the variables included in the model, their respective designations and summary statistics for the main DRG (DRG 430 - Psychoses) is presented in appendix A.5. For the remaining DRGs, this information is presented in a web appendix.[10]

[8] Patients aged 16 and older may be treated in adult mental health inpatient units.

[9] In appendix A.4 we present the histogram of LOS of less than 90 days.

[10] `https://meocloud.pt/link/28843095-7089-400d-b320-5a26a6a528b7/Web_Appendix/`

5 Methodology

In this section we describe the methodology used to determine if organisation of mental health services should be done with concentration of services in a few hospitals or with several units providing them (subsection 5.1). We also describe the method used to estimate the potential savings that integrated continuous care can bring to NHS (subsection 5.2).

5.1 Economies of scale

Our dependent variable is LOS per episode, hospital, year and DRG. *Volume* and $volume^2$ are the independent variables of interest. As covariates we include patient characteristics (*age*, *gender*) and hospital characteristics (*cmi*, *beds*, *dp*, *lstay*, *totalcost*).[11] We perform the regression analysis *per* DRG since it classifies a patient under a particular group where those assigned are likely to need a similar level of hospital resources for their care.

To determine the scale effect we use a duration model as we want to model the length of time that patients spend in the hospital. Specifically, the model adopted is the conditional risk set model (Box-Steffensmeier and Jones, 2004; Cameron and Trivedi, 2005). We did not use the Ordinary Least Squares (OLS) because this method does not account for several specificities of our dataset which influence the results.

Since our dataset consists of discharged patients, the model needs to be an univariate duration model (transition from "sick" to "healthy"[12]) but with multiple spells (patients may be readmitted). We have recurrent/repeated events, which arises when several events of the same type are registered for each individual. Our data concerns to completed spells as we do not have individuals that stay "sick"[13] (Box-Steffensmeier and Zorn, 2002).[14] Spells for the same individual cannot be considered independent and therefore we need to account for correlated unobservables.

We assume that entry into the state being modelled is exogenous, meaning that there are no initial conditions problems. Otherwise the model of survival times in the current state would also have to take account of the differential chances of being found in the current state in the first place (Box-Steffensmeier and Zorn, 2002).

The survival time data is an outflow dataset in which data collection is based on those leaving the state of interest. We also have information on when the spell began. If one has information about the day, month, and year in which a spell began, and also the day, month, and year, at which subjects were

[11] We also introduce dummy variables to control for the procedure of using 2012 information for the year of 2013 and use information of the following year whenever a gap exists.

[12] We only have a single state.

[13] As mentioned before our data consists on inpatient discharges.

[14] This means that the likelihood function is simply the multiplication of the density function from period 1 to N.

last observed — so survival times are measured in days — and the typical spell length is months or years, then it is reasonable to treat survival times as observations on a continuous random variable (not grouped). But if spells length is typically only a few days long, then recording it in units of days implies substantial grouping. It would then make sense to use a specification that accounts for the interval censoring. In our data approximately 18% of all observations regarding DRG 430 (Psychoses) have a duration spell between 1 and 30 days. Therefore we can use days as the unit of LOS.

An important issue that we should take care of concerns "tied" survival times — more than one individual in the data set with the same recorded survival time. A relatively high prevalence of ties may indicate that the banding of survival times should be taken into account when choosing the model specification (Box-Steffensmeier and Zorn, 2002; Cleves and StataCorp, 2009).

Overall, the duration model that we have to consider must take into account the following items: continuous time; outflow sample; no time-varying characteristics (explanatory variables are fixed over time and have only cross-section variation); completed spells; recurrent events (multiple spells); correlated unobservables (state dependence); unobserved heterogeneity and "tied" survival times.

As our dependent variable is length of stay, we assume a continuous model since $\{T = t\}$ is interpreted as an observation from a continuous process, hence contributing a density function term to the likelihood. We do not have time-varying characteristics since our control variables are: gender, age, volume and hospital characteristics (which change between years but not within the same year and since we cannot follow a patient between years — due to *id* changes — this is not a concern. These variables are time-invariant within each spell.). We have to deal with "tied" survival times but first it is important to understand what model accounts for multiple spells and correlated unobservables.

There are two different approaches to deal with recurrent events: the Counting Process (CP) and the Stratified Cox (SC) model (Box-Steffensmeier and Zorn, 2002; Cleves and StataCorp, 2009). In the CP model, different lines of data are treated as independent even though several outcomes are from the same subject. In this model, it is used the standard Cox proportional hazard (PH) model to analyse the data. In the SC model, recurrent events are treated as not identical and the strata are the time interval numbers. Within this model we have three different approaches: Conditional 1, Conditional 2 and Marginal models.

Conditional means that a subject is assumed not to be at risk for a subsequent event until a prior event has occurred. The difference between these two conditional models is the time scale. Specifically, the Conditional 1 approach uses the same data layout as the CP approach, but a SC model is used instead of a standard Cox PH model. In this model the time until the first event influences the risk of the set for later events. The Conditional 2 model uses a different data layout: the start value is always 0 and the stop value is the time interval length. The time until the first event does not influence the following events since the clock determining who is at risk gets reset to zero after each event.

The Marginal approach uses the standard data layout. It considers each event as a separate process. Time for each event starts at the beginning of follow-up for each subject. There is no start time column but only a stop time column. All subjects are considered to be at risk for all events, regardless of how many events they actually had.

If the order of the events is not important then we should choose the CP model. Otherwise we need to decide between the three approaches of the SC model. If the time interval of interest is the time from the study entry than Conditional 1 approach is the correct choice. We should choose the Conditional 2 model if the time interval of interest is the time between two events. If there are different types of events than we should use the Marginal model.

In our case, the more suitable approach is the Conditional 2 model, as the time that a patient stays in the first episode influences the time that he stays in the second time, and so on (order matters). What we have seen from the descriptive analysis is that the length of stay of the first episode has been decreasing and the number of readmissions has been increasing with a length of stay higher when compared to the first episode.

Thus, the appropriate model is the conditional risk set model (variance-correction models) considering elapsed time, where estimates are provided for the effect of covariates on the hazard of the k^{th} event since the beginning of the observation period.

The Cox model is a proportional hazard model, its specification can be written as:

$$h_q(t) = h_{0q}(t) \times e^{X\beta} \tag{1}$$

where X is the vector of time-independent covariates (*volume*, *volume*^{2} *age*, *gender*, *cmi*, *beds*, *dp*, *lstay* and *totalcost* and the dummy variables) and $h_{0q}(t)$ is the baseline hazard function at time t for a subject in group q. That is, the coefficients are assumed to be the same, regardless of the group, but the baseline hazard can be group specific. There is a mathematical relationship between the hazard function and its corresponding survival function. The survival function is the baseline survival function, raised to the power of the exponent of the linear prediction (Clayton, 2012).[15]

Maximum likelihood estimates of β for the above model is obtained by maximizing the partial log-likelihood function:

$$logL = \sum_{j=1}^{D} \Big[\sum_{i \in D_j} \mathbf{x_i}\beta - d_j log \Big\{ \sum_{k \in R_j} exp(\mathbf{x_k}\beta) \Big\} \Big] \tag{2}$$

[15]The exponent of the linear prediction is the hazard ratio for that combination of covariates.

where $\mathbf{x_i}$ is the row vector of covariates mentioned before for the time interval $(t_{0i}, t_i]$ for the i^{th} observation in the dataset $i = 1, ..., N$. j indexes the ordered failure times $t(j)$, $j = 1, ..., D$; D_j is the set of d_j observations that fail at $t(j)$; d_j is the number of failures at $t(j)$; and R_j is the set of observations k that are at risk at time $t(j)$, that is, all k such that $t_{0k} < t(j) \leq t_k$. The estimator $\hat{\beta}$ has been shown to be a consistent estimator for β (Lin, 1994).

To estimate this model we consider the exit rate (event) as a variable that is 1 if the patient leaves the state and 0 otherwise. In addition, and in order to build a timeline, we create two variables: one for entry time and other for exit time. To adjust not only for repetitions but also for dependence of spells, we also generate a variable that stratifies our data and is based on episode sequences for each patient. Hence, the estimation of the partial log-likelihood function 2 is obtained by forming the ordered failure times $t(j)$, the failure sets D_j, and the risk sets R_j, using only those observations within that stratum. Finally, and in order to account for "tied" events, this model allows one to use the Efron method which takes consideration on how the risk set changes depending on the sequencing of tied events (Box-Steffensmeier and Jones, 2004).

To determine if there is a scale effect, we convert the estimation results in number of days by obtaining the adjusted survival curve for low and high volume hospitals for each DRG.[16] This is done by combining the baseline survivor function with the linear prediction of the covariates. It is worth recalling that the adjusted survival at time t is the baseline survival at time t, raised to the power of the exponent of the linear prediction.

The difference between these two curves is the predicted value of the variable *volume*. We consider that high/low volume hospitals are the ones with a volume greater/less than the median value. To obtain the adjusted survival curve for the high/low volume hospitals we then use the mean volume for each volume group.[17] For the remaining control variables (*age*, *gender* and hospital characteristics) we use their mean value for each DRG. We have a scale effect if $exp(X\beta)_{high\_volume} > exp(X\beta)_{low\_volume}$ has the baseline survivor function ranges between 0 and 1.

We estimate the scale effect for each DRG but since the DRG 430 comprises 54% of the total observations we pay special attention to the results for this DRG.

5.2 Potential savings for NHS from integrated continuous care

Our approach is to use the DRG dataset to analyse which inpatient stays of patients with SMI [18] are eligible to be transferred to these institutions and determine the potential savings (difference between

[16] The mean difference between these two curves gives the scale effect measured in number of days.

[17] For robustness purposes we perform this analysis considering different predicted values for *volume* using the percentile 75.

[18] As mentioned before only these patients are eligible for integrated continuous care facilities.

the current "cost" and the potential "cost" if integrated continuous care units were in place).

First we analyse the LOS. According to psychiatrists[19], and based on their clinical expertise, the LOS that on average a patient with SMI needs to stay in the hospital to be stabilised is approximately 24 days (Scenario 1). We claim that all inpatient discharges which had a LOS higher than this ALOS could have been transferred to these facilities.

To compute the hospital cost of treating these cases we compute the daily cost per patient (using the DRG prices) and multiply it by the ALOS. Since costs are not available at a patient level, the best thing we can do is to use the DRG prices as a *proxy* of the cost.[20] Since prices set for DRGs are not based on publicly available analytical cost we are assuming that these prices reflect costs.

The integrated continuous care cost is computed by multiplying the time that a patient needs to stay in those facilities (the difference between the total LOS and ALOS) by the daily price defined in the decree-law, which amounts to €26.62.[21] Since we have no information on the LOS that a patient, on average, need to stay in integrated care, we assume equal quality of treatment which is reflected in the same LOS, independently where the patient is treated.

Since psychiatrists claim that the ALOS for patients with SMI can range between 15 and 30 days we create two additional scenarios based on the lower and upper bound of this interval (Scenarios 2 and 3, respectively).

We perform this analysis for the period between 2011 and 2013 as the daily price paid per patient to these units was defined in 2011.

It is worth recalling that these facilities not only aim to support inpatient care but also to provide social integration of individuals with psychosocial disability. In our analysis we are not considering the benefits from social integration, due to lack of information.

6 Results

6.1 Economies of Scale

Tables 5 and 6 present the estimation results of the conditional risk set model for each DRG (please see appendix B). In each table, the first column presents the results of the full model, whereas the second column presents the results of a restricted model, in which the variables that were found not to be

[19]The auhtors would like to thank Ricardo Gusmão from Instituto Nacional de Saúde Pública do Porto and Teresa Reis from Nova Medical School.

[20]Briefly, we estimate the cost per patient using the prices of each DRG. We also consider the lower and upper limits of the LOS.

[21]This price can be considered as the "cost" of treating a patient in continuous care housing: "Residência de apoio moderado com complemento de unidade sócio-ocupacional". So far no changes have been made to the prices stipulated in 2011.

statistically significant were recursively eliminated.

Since we have a quadratic term in our regression model it is not straightforward to determine if we have a scale effect or not only by looking at the volume's marginal effects presented in tables 5 and 6. Hence, we convert the estimation results in potential days saved using the methodology described in subsection 5.1. The scale effect ranges between 0 and 6 days (Table 1).

Table 1: Economies of scale — Volume

	# days saved (pctl 50)	# days saved (pctl 75)
DRG425	-0.01	0
DRG426	-0.02	-0.02
DRG427	1.05	1.06
DRG428	0	0
DRG429	0	0.01
DRG430	0.08	0.08
DRG431	-1.1	-1.1
DRG432	6.33	6.33

For DRGs 427, 430 and 432 we identify a scale effect. DRGs 428 and 429 presents zero potential days saved. For the remaining DRGs we find diseconomies of scale.[22] The results are very similar if we consider the top 25% as the high volume hospitals.

It is worth highlighting the impact of the remaining covariates, namely *beds* and complexity of cases (*cmi*). Table 2 presents the marginal effects of both variables.

Table 2: Marginal effects — *beds* and *cmi*

	Marginal effect *beds*	Marginal effect (*cmi*)
DRG425	-0.0013	0426
DRG426	-0.0010	0.392
DRG427	-0.0011	NS
DRG428	-0.0016	-0.319
DRG429	-0.0003	0.361
DRG430	-0.0004	0.528
DRG431	-0.0004	NS
DRG432	NS	NS

NS: Not statistically significant

The coefficient of *beds* is statistically significant for almost all DRGs (except DRG 432). The negative sign indicates that those treated in hospitals with a high number of beds have a lower hazard rate *ceteris paribus* (i.e. lower conditional healthy rates and hence longer length of stay). Regarding *cmi*, the associated coefficients are positive and statistically different from zero for all DRGs, except for 427, 431 and 432. The positive coefficient estimates indicate that patients who are treated in high *cmi* hospitals have a smaller length of stay. Only for DRG 428 we find a negative relationship between *cmi* and LOS, suggesting diseconomies of scale.

[22] The results are very similar if we drop the variable $volume^2$.

6.2 Potential savings for NHS from integrated continuous care

The table below presents, for the three scenarios, the current "cost" (before transferring) of treating patients eligible to be transferred to integrated continuous care and the potential "cost" if these facilities were in place (after transferring). We also report the number of patients eligible to be transferred to continuous care and the ALOS in these health care facilities under the three scenarios.

	Scenario 1	Scenario 2	Scenario 3
# patients	6,149	11,382	3,978
ALOS_CC	23.03	19.50	27.79
Before transferring			
Cost hospital	€24,215,920	€41,109,184	€17,085,424
After transferring			
Cost hospital	€14,002,497	€21,783,754	€9,645,127
Cost CC	€3,770,430.3	€5,907,430.5	€2,942,628
Total cost	€17,772,927.3	€27,691,184.5	€12,587,755
Potential savings	€6,442,992.7	€13,417,999.5	€4,497,669
% of initial cost	26.6%	32.6%	26.3%

Under these scenarios it is expected potential savings that range between €4,497,669 and €13,418,000 (about 26% and 33% of the initial cost, respectively). If continuous care facilities were in place, hospitals would have capacity to treat, on average, 10% to 27% more patients with severe mental disorders per year.

7 Discussion

Our results show that there is a scale effect for DRGs 427 (Neuroses except depressive), 430 (Psychosis) and 432 (Other mental disorder diagnosis).

For DRG 430 the economic magnitude of the scale effect in number of days amounts to 0.08. This value is rather small to justify the centralisation of psychiatric services in high volume hospitals. For DRGs 427 and 432, we find potential gains of 1 and 6 days if patients were treated in high volume hospitals, respectively. The ALOS of both DRGs 427 and 432 is 14.85 and 7.87 days, respectively. Transferring treatments to high volume hospitals can only bring potential savings of 2.8% for the NHS as these two DRGs account for 5% of total hospital mental health discharges. For the remaining DRGs, the scale effect is negative suggesting diseconomies of scale.

One possible explanation for our findings is that DRG 427 comprises diagnoses that are more common and simple to deal with and therefore high volume hospitals are more effective in treating these type of diseases (e.g.: adjustment disorders and obsessive-compulsive disorders). To what concerns DRG 432, it comprises diagnoses that normally need special treatment such as sleep disorders. These treatments are often provided by high volume hospitals. Therefore, patients with these kind of disorders treated in these facilities need less inpatient care than the ones treated in hospitals with no such treatments.

When deciding on the centralisation of activities in high volume hospitals, policy-makers cannot rely only on potential savings. The literature has reported a negative relationship between utilisation of services and the distance of the patient from the hospital (the so-called *distance decay* effect) (Mungall, 2005). This effect is more pronounced for patients with low incomes, poor access to transport and the elderly and disable. Balancing the potential gains that we find against the arguments on access to care, we conjecture that the former argument is not strong enough to justify the centralisation of psychiatric services in high volume hospitals.

Since inpatient care for mental disorders is indicated specially for people with SMI our results may be reflecting the fact that this type of diseases has on average a length of treatment of 24 days in Portugal, despite the hospital volume. This value was provided by psychiatrists and is based on their clinical expertise since no formal study was performed on the average length of stay of patients with SMI in Portugal. In the literature there are several studies that focus on SMI inpatient average length of stay and they are namely based on evidence from the US. Lee, Rothbard and Noll (2014) found a confidence interval for the average length of stay of 10 ± 3 days. However, we need to be cautious when comparing these values between countries. This is due to the fact that inpatient length of stay is influenced by the availability of community health services (WHO, 2003*a*) and also by the increased pressure to discharge patients earlier (Auffarth et al., 2008). Systema, Burgess and Tansella (2002) found evidence of a shorter length of stay in a community-based system than in a hospital-based system. As for Portugal, it has been relying on inpatient care and the community services have not had the desirable progress (de Almeida, 2009). Therefore, and since the US is more community-based oriented than Portugal, the results provided by empirical evidence need to be read carefully.

It is worth highlighting that we find economies of scale for hospitals that treat more complex cases (cmi). One possible explanation is that this variable is capturing best practices, since larger hospitals get sicker and more expensive patients (Morikawa, 2010).

We also find diseconomies of scale for larger hospitals (with higher number of beds), which is in line with previous literature (Posnett, 1999). Our results may be reflecting the reorganisation of public infrastructure for healthcare provision which inserted the Portuguese hospitals into joint health units. This reorganisation did not imply a hospital merge but instead only administrative services were merged.

Our results show that integrated continuous care should be considered as part of the Portuguese mental health system. As evidence points out, this kind of facilities serves as a complement to inpatient care as many mental disorders are "better managed by services that adopt a continuing care model" (WHO, 2003*b*). The ability of inpatient care to help patients with SMI may depend on the availability of comprehensive continuous care services (WHO, 2003*b*). Additionally, and according to the literature, once these services are available, they may help reduce hospital readmissions (Systema, Burgess and Tansella, 2002), and also provide social integration for these patients (Wait and Harding, 2006) which can bring long-term gains.[23]

According to Porter and Lee (2013), the health care delivery system design can improve patient value. Organising care into Integrated Practice Units (IPUs) around patient medical conditions can efficiently maximise the patient's overall outcomes (Porter, 2012). As integrated continuous care facilities are patient-centered and bring together providers and staff who address severe mental disorders, they can improve patient outcomes at both medical care and social integration.

It should be highlighted that a recent Governmental report on mental health care delivery (ACSS, 2015) identifies as an urgent need the creation of continuous care facilities. It is the social sector[24] that has been the main provider of psychiatric rehabilitation but it cannot be considered as a substitute for these facilities. Moreover the social sector has been at almost full capacity (ACSS, 2015).

Given the current economic and financial situation, Portugal has launched several reforms in its health care sector not only to "introduce more efficiency into the health system" but also to reduce the costs regarding the NHS (Eurohealth, 2012). Hence, and since implementing continuous care facilities could bring potential savings to NHS, this measure should be considered by the policy-makers.

In terms of the methodology used and comparing with the main common methods used in the volume-outcome empirical works such as the logistic and probit regression models, we believe that our approach is more appropriate since it accommodates the fact that patients may leave the hospital not fully recovered, which is an important aspect in mental health (Zhang, Harvey and Andrew, 2011). We must refer that data on hospital characteristics specifically about mental health departments were not available.

For robustness purposes, we estimate the regression model described in subsection 5.1 using a multiple Ordinary Least Squares (OLS). In this analysis we create an unique observation for patients who were readmitted within 30 days by adding the length of stay. The results are different from the ones we obtain using a duration model, as in this case volume is not statistically significant, specifically for DRG 430.[25] Hence, for our analysis, it is crucial the way the data specificities are accommodated by each estimation method.

In terms of efficiency measures, some authors state that one should use the ALOS instead of LOS. The argument is that the LOS is influenced by patients' characteristics, but even after controlling for those covariates, there is still unexplained variations in the LOS between hospitals (Cooper et al., 2010).

[23]This social integration promotes greater personal autonomy and independence and also employement integration for patients with SMI.

[24]The social sector is financed by the Ministry of Labour and Social Security

[25]In the first chapter of the thesis entitled "Three essays on mental health" we present these results.

For robustness purposes, we estimate the regression model described in subsection 5.1, using ALOS as the dependent variable instead of LOS. We opt to use the OLS regression model since in this case the observation unit is the hospital and not the patient. The results are similar to the ones we obtain considering as the efficiency measure the LOS.[25]

Regarding the computation of potential savings, we assume a benchmark with an average LOS for all the patients with SMI but as mentioned before this ALOS is the number of days that a patient with severe mental disorder needs to stay at the hospital in order to be stable (which approximately coincides with the ALOS of these patients in our dataset — 23.5 days). The cases in which patients may need to stay longer in the hospital are the ones in which patients face co-morbidities. Since patients who were considered in the analysis have a severe mental disorder as the main diagnosis, we believe that these patients could have been transferred to the integrated continuous care facilities.

It is worth highlighting that transferring patients to these units will allow the average LOS to decrease mainly in DRG 430 (it comprises 98% of all mental health inpatient discharges whose diagnosis is severe mental disorders). As these cases are treated mostly in high volume hospitals we conjecture that potential scale effects could emerge from integrated continuous care, *ceteris paribus*. We suggest that scale effects should be reassessed after integration continuous care be implemented. If the magnitude of the scale effect is sufficiently high, Government should promote the centralisation of inpatient services in high volume hospitals. In this scenario, decentralisation is not affected, as integrated continuous care is provided closer to patients's geographic concentration.

As far as mental health financing is concerned, our results should be considered when designing a new mental health financing plan. Since we do not find any advantage in centralise inpatient services, the financing system does not need to induce concentration. Also it does not need to accommodate the fact that high volume hospitals could receive proportionally less because they benefit from economies of scale. However, the new financing mechanism should be designed in order to consider the integrated continuous care as part of the Portuguese mental health system as proposed in the Portuguese Mental Health Plan (de Almeida, 2009).

8 Conclusion

Our paper assesses the existence of a scale effect from concentrating activities in high volume hospitals. This study is performed for Portugal, a country with a case-mix based funding system, using a DRG dataset. Also, potential savings for NHS from continuous care were computed since these facilities can work as a complement to inpatient care. Both analysis are relevant issues to mental health system financing.

Using a conditional risk set model, we find a scale effect for some DRGs, specially DRG 430 which comprises about 54% of total mental health inpatient discharges. Despite this result, economic magnitude if the scale effects found is rather small to justify the centralisation of psychiatric services in high volume hospitals. The potential savings that this centralisation could bring is only about 2.8% of the total cost of mental health inpatient care.

We also find potential savings for inpatient care if integrated continuous care was in place that range between €4.5M and €13.4M (about 26% and 33% of the initial cost, respectively). Transferring patients to these facilities could allow inpatient care to treat, on average, 10% to 27% more patient with severe mental illness per year. Hence, we claim that continuous care should be part of the Portuguese mental health system.

Our results should be taken into account by the Portuguese policy-makers when designing a new mental health financing plan. The focus should be on promoting integrated mental healthcare with concentration of services not being relevant.

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Appendices

A Data

A.1 Sources of Information — Hospital characteristics

The following hospital reports were used to gather information on hospital characteristics:

- EPE hospitals: Relatórios e Contas from 2003 to 2012 — variables: cmi, beds, dp, lstay, cost.
- from Unidade Operacional de Financiamento e Contratualização: Relatórios Nacionais de Retorno 2007, 2008 and 2009 (EPE and SPA hospitals) — variables: cmi, dp, lstay.
- from Unidade Operacional de Gestão Financeira: Relatório e Contas 2006 and 2007 (SPA hospitals), 2008 (EPE and SPA hospitals) — variables: cmi, beds, dp, lstay, cost.
- from Instituto de Gestão Informática e Financeira da Saúde:
  - Departamento de Consolidação e Controlo da Gestão do SNS: Contas Globais 2001, 2002 and 2003 (SPA hospitals) — variables: cmi, beds, dp, lstay, cost (except for 2003).
  - Relatório e Contas 2004 and 2005 (SPA hospitals) — variables: cmi, beds, dp, lstay, cost.
- from ACSS: Tabela Hospitalar 2010, 2011, 2012 — variables: cmi, dp, lstay.
- from the report "Avaliação da experiência de gestão privada do Hospital Fernando Fonseca (1995-2008)" issued by Universidade Nova de Lisboa we collect information about Fernando Fonseca Hospital (Hospital Amadora-Sintra) from 2001 to 2007.

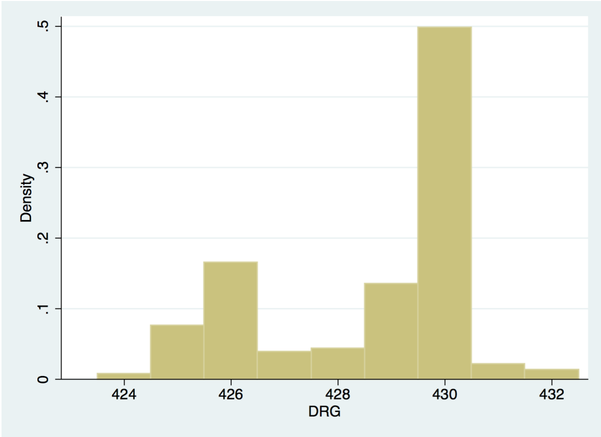
A.2 Hospital Mergers

Table 3: Hospital Mergers

ID before merge	ID after merge	Merge_year
COND VARZ	PVVC	2001
FUND COVI	CHCB	2001
REAL PESO	CHVR	2002
ABRA NOVA TOMA	CHMT	2003
VIAN LIMA	CHAM	2003
PMAO LAGO	CHBV	2004
SERP BEJA	CHBA	2005
EGAS XAVI CRUZ	CHLO	2006
SETU OUTA	CHSE	2006
BRAC MACE MIRA	CHNT	2006
JOSE ESTE MART CAPU	CHLC	2007
CHVR CHAV LAME	CHTA	2007
GAIA ESPI	CHGE	2007
FAMA TIRS	CHMA	2007
PLEG ELVA	ULNA	2007
GUIM FAFE	CHAA	2007
AMAR VALE	CHVS	2008
MARI PULI	CHLN	2008
ANTO MPIA DINI	CHPO	2008
ALCB PENI CALD	CHON	2009
FEIR MADE OLIV	CHDV	2009
GUAR SEIA	ULSG	2009
CHAM	ULAM	2009
CHBA	ULBA	2009
MONT BARR	CHBM	2010
CAST	ULCB	2010
JOAQ	CHPO	2011
HUCO CHCO	CHUC	2011
AVEI AGUE ESTA	CBVG	2011
POMB LEIR ALCB	CHLP	2011
JOAO VALO	CHSJ	2011
VISE TOND	CHTV	2011
CURR MACO	CHLC	2012
CHON VEDR	CHO	2012
CHBV FARO	CHAL	2012

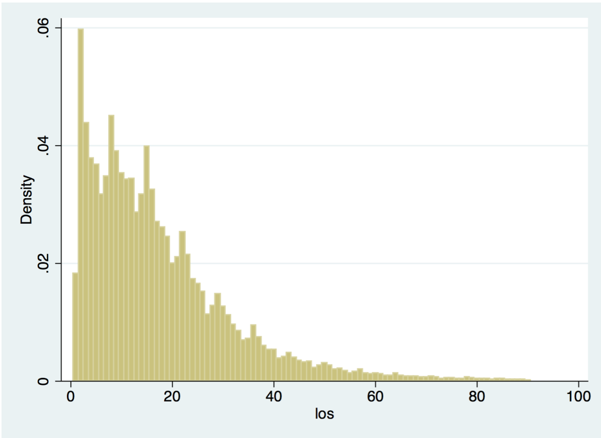
A.3 Histogram – DRG

Figure 1: Histogram – DRG



A.4 Histogram – LOS

Figure 2: Histogram – LOS less than 90 days



A.5 Summary statistics

Table 4: DRG 430

Variable	Description	Mean	Std. Dev.	Min	Max	N
los	period of time a patient remains in the hospital in days	25.39	136.09	1	16,675	82,612
volume	number of inpatient discharges per year per DRG	287.22	139.57	1	822	82,612
age	age in years	45.98	15.18	16	104	82,612
gender	binary variable (=1 if male)	0.47	0.50	0	1	82,612
cmi	average DRG relative weight for a hospital	1.05	0.21	0.61	2.71	82,612
beds	number of beds	641.61	415.29	20	2,279	82,612
dp	average number of patients discharged	24,065.01	13,893.77	518	71,159	82,612
lstay	average period of time a patient remains in the hospital in days	7.61	0.99	4	21	82,612
totalcost	operating, financial and extraordinary costs (in million €)	140.34	111.81	4.03	462.76	82,612
dum_cmi	binary variable (=1 if information used for *cmi* regards from previous/next year)	0.23	0.42	0	1	82,612
dum_totcost	binary variable (=1 if information used for *totcost* regards from previous/next year)	0.25	0.43	0	1	82,612
dum_lstay	binary variable (=1 if information used for *lstay* regards from previous/next year)	0.13	0.33	0	1	82,612
dum_dp	binary variable (=1 if information used for *dp* regards from previous/next year)	0.12	0.33	0	1	82,612
dum_beds	binary variable (=1 if information used for *beds* regards from previous/next year)	0.18	0.38	0	1	82,612

B Results

Table 5: Duration Model

	(1) DRG425	(2) DRG425	(1) DRG426	(2) DRG426	(1) DRG427	(2) DRG427	(1) DRG428	(2) DRG428
volume	-0.00468*	-0.00471**	-0.00666***	-0.00655***	0.00522**	0.00472***	0.00238	0.00207**
	(-2.55)	(-2.74)	(-13.05)	(-13.64)	(3.16)	(7.94)	(1.44)	(2.85)
$volume^2$	0.0000399*	0.0000362*	0.0000222***	0.0000216***	-0.00000412		-0.00000184	
	(2.05)	(2.07)	(10.65)	(11.55)	(-0.31)		(-0.11)	
age	-0.0000181		-0.00738***	-0.00738***	-0.00520***	-0.00531***	0.000851	
	(-0.04)		(-16.17)	(-16.14)	(-6.10)	(-6.24)	(0.91)	
gender	-0.0274		0.0287		-0.0780**	-0.0783**	0.0245	
	(-1.38)		(1.88)		(-2.71)	(-2.73)	(0.98)	
cmi	0.460***	0.426***	0.392***	0.392***	0.103		-0.277	-0.319**
	(7.33)	(7.36)	(5.60)	(5.79)	(0.76)		(-1.92)	(-2.61)
beds	-0.00117***	-0.00129***	-0.00104***	-0.00102***	-0.00104***	-0.00107***	-0.00163***	-0.00162***
	(-9.27)	(-12.09)	(-9.88)	(-10.05)	(-5.20)	(-11.80)	(-10.26)	(-11.08)
dp	0.0000215***	0.0000251***	0.0000219***	0.0000211***	-0.00000127		0.0000323***	0.0000325***
	(5.30)	(7.60)	(5.85)	(5.81)	(-0.19)		(6.31)	(6.56)
lstay	-0.0222		0.0235**	0.0239**	0.0354	0.0433**	0.0790***	0.0826***
	(-1.70)		(2.77)	(2.82)	(1.76)	(2.89)	(4.58)	(4.85)
totalcost	0.000694**	0.000635*	0.000553*	0.000556*	0.00245***	0.00252***	0.00155***	0.00156***
	(2.65)	(2.45)	(2.29)	(2.32)	(6.17)	(8.65)	(4.17)	(4.42)
N	11,029	11,029	24,626	24,626	6,102	6,102	7,305	7,305

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We omit the results for the dummy variables due to space restrictions.

Table 6: Duration Model

	(1) DRG429	(2) DRG429	(1) DRG430	(2) DRG430	(1) DRG431	(2) DRG431	(1) DRG432	(2) DRG432
volume	-0.00342***	-0.00340***	-0.000894***	-0.000891***	-0.0222***	-0.0218***	0.0325***	0.0340***
	(-5.47)	(-5.46)	(-9.05)	(-9.73)	(-4.66)	(-4.69)	(12.48)	(13.60)
volume2	0.0000256***	0.0000254***	0.00000172***	0.00000170***	0.000250***	0.000236***	-0.000130***	-0.000139***
	(6.99)	(6.99)	(12.70)	(13.32)	(3.52)	(3.39)	(-10.82)	(-12.09)
age	0.00877***	0.00877***	-0.00416***	-0.00416***	0.00168		0.00279*	0.00284*
	(21.68)	(21.69)	(-16.42)	(-16.45)	(1.23)		(2.08)	(2.19)
gender	-0.0424**	-0.0423**	-0.0740***	-0.0740***	0.0355		0.429***	0.424***
	(-2.73)	(-2.73)	(-9.81)	(-9.81)	(0.73)		(7.77)	(7.41)
cmi	0.361***	0.361***	0.527***	0.528***	0.0575		0.00487	
	(6.46)	(6.46)	(11.77)	(11.95)	(0.25)		(0.02)	
beds	-0.000279*	-0.000280*	-0.000378***	-0.000382***	-0.000293	-0.000393**	0.0000425	
	(-2.34)	(-2.34)	(-7.70)	(-15.31)	(-0.94)	(-2.78)	(0.13)	
dp	0.00000737*	0.00000741*	-0.000000221		-0.00000165		-0.0000106	-0.0000108***
	(2.14)	(2.15)	(-0.14)		(-0.15)		(-1.05)	(-5.68)
lstay	-0.0730***	-0.0733***	-0.0209***	-0.0204***	-0.0470		-0.0102	
	(-7.35)	(-7.41)	(-3.74)	(-4.36)	(-1.56)		(-0.27)	
totalcost	-0.000599*	-0.000599*	-0.000306**	-0.000316**	0.00165*	0.00165**	-0.0000576	
	(-2.56)	(-2.56)	(-2.74)	(-3.14)	(2.15)	(3.20)	(-0.08)	
N	18,227	18,227	82,612	82,612	1,837	1,837	1,758	1,758

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We omit the results for the dummy variables due to space restrictions.