

Gabriele, Roberto; Tundis, Enrico

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Assessing the effect of longitudinal multiple subsidies on firm performance in the presence of neighbour interactions: A case study in the hotel industry^{*}

Roberto Gabriele[†]

Department of Economics and Management, University of Trento

Enrico Tundis[‡]

Department of Economics and Management, University of Trento

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Abstract

A Structural Marginal Model and Inverse Probability of Treatment Weighting (IPTW) estimation strategy is proposed in a dynamic 2-dimensional treatment setting in order to identify and estimate both the direct and the indirect average treatment effects of a policy over time. This approach is used to assess the effect of public capital subsidisation on the competitiveness of firms in the hotel sector in a place-based subsidisation public policy. A positive effect of the policy is estimated on several hotel performance indicators. Moreover, we found that a hotel's performance depend on whether many or few hotels in its own destination are subsidised.

Keywords: longitudinal multiple treatments; counterfactual methods; IPTW estimation; policy evaluation; hotel industry.

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[†] Email: roberto.gabriele@unitn.it

[‡] Email: enrico.tundis@gmail.com

1. Introduction

The Rubin's Causal Model (1974) is now the standard framework for quantitative evaluation studies (Imbens and Wooldridge, 2009). This model, based on the concepts of potential outcomes and assignment to a treatment mechanism, focuses on two fundamental assumptions: the Conditional Independence Assumption (CIA) to control for confounding factors which drive both assignment to treatment and potential outcomes, and the Stable Unit Treatment Value Assumption (SUTVA), which rules out any influence of a unit's treatment status on another individual's potential outcomes (Rubin, 1986). The need to account for interactions between units, i.e., relaxing the SUTVA assumption, however, is increasingly viewed as a serious problem in economics applications. In the case of public policies directed to firms, in particular, the intervention is expected to be beneficial for firms directly supported, but it may generate both positive and negative externalities, which extend the effect of the policy.

Authors dealing with spillovers generated by policies generally considered as their unit of analysis aggregated areas, such as census areas (e.g., Hanson and Rohlin, 2013) or local labour systems (e.g., De Castris and Pellegrini, 2012). Cerqua and Pellegrini (2013) made one of the first attempts to address the issue of SUTVA and spillover estimation when the firm is the unit of analysis. These authors discuss taxonomy of strategies to estimate spillover, centered on assumptions regarding the scope of the spillover and the selection of proper control firms. Instead, in a different emerging strand of literature, mostly in the fields of epidemiology and social science, the standard SUTVA is relaxed by incorporating agents' interactions directly in the models. Papers in this literature have modelled unit outcomes as depending not only on individually received treatments, but also on treatments received by other units, in a two-stage randomisation approach in which interference occurs within pre-specified groups and interference between groups is ruled out (Hong and Raudenbush, 2006; Rosenbaum, 2007). Grounded on this two-stage setting Hudgens and Halloran (2008) developed general modelling under randomisation when interference is present. Tchetgen-Tchetgen and VanderWeele (2010) presented an inferential approach for observational studies assuming independence across groups. Differently, Cerulli (2014) moves along the line traced by econometric studies normally dealing with non-experimental settings where sample selection is the rule. He draws from the works dealing with treatment effect identification in the presence of externalities and in particular from Manski's (1993, 2013) approach.

All these approaches, however, are not directly applicable in contexts where firms are subjected to multiple treatment over time, for instance to such policies that allow firms to receive more than one subsidy over time.

In this paper, we consider the case of time-varying treatments, i.e., we examined the firms' history of treatments. In this setting, the treatment is no longer the receipt of a single

treatment, but is a history of treatment, i.e. a sequence of 0s and 1s of the treatment status over the years. Accordingly the counterfactual is a differing sequence of 0s and 1s of the treatment status.

Drawing on previous literature (Hogan and Lancaster, 2004; Azoulay et al., 2009), we consider a Marginal Structural Model and Inverse Probability of Treatment Weighting (IPTW) estimators. Under this framework of analysis, we allow subsidisation to interfere across units. In particular, the potential outcomes of a firm is allowed to change when the treatment status of its neighbours change. Building on contributions in the emerging strand of research that relaxes SUTVA in analysis (Hong and Raudenbush, 2006; Hudgens and Halloran, 2008; Ferracci et al., 2013), we defined a framework which allows not only the identification and estimation of the direct average treatment effect but also estimation of the indirect effect of a policy. Suarez et al. (2008) extended the static IPTW estimation to multiple treatment settings, i.e. when subjects in a given time receipt more than one type of treatment. We propose an extension of the framework in a two-level longitudinal multiple treatment setting in which at each time t a unit receives two treatments: one at unit level and the other at cluster (group) level. Specifically, we implement an extended IPTW estimator to the dynamic 2-dimensional treatment setting.

Although general, our framework appears to be particularly appropriate for tourism-related industries. For hotels, in particular, the relevant interactions are expected to be local, that is, among hotels within relatively compact, well-defined geographic areas or destinations (Baum and Mezias, 1992). In the hotel industry geographical proximity generates demand-side agglomeration externalities that may exist even without interconnections among hotels. For instance, a group of hotels whose managers never speak to each other and who share no information among themselves still receive the effect of demand-side agglomeration externalities generated by heightened demand (McCann and Folta, 2009).

Production enhancements can create better quality products and services, which will in turn heighten demand once consumers are aware of them. For example, Baum and Ingram (1998) describe improved hotel labor practices that would enhance the quality of service experienced by visitors. Also improved capital endowment is a good indicator of higher quality of services delivered (Israely, 2002), and the room features and availability of a hotel's amenities and facilities play an important role in tourists' purchasing decisions (Kashyap and Bojanic, 2000; Choi and Chu, 1999). Renewed physical capital may thus enhance a hotel's competitiveness by achieving lower costs and higher-quality output (Orfila-Sintes and Mattsson, 2009). The quality improvement of a certain hotel can affect that of its neighbours (Calveras and Vera-Hernández, 2005). If in a certain neighbourhood, one hotel varies its quality, for instance, by restructuring its building and adding new facilities to its accommodation, this action by one hotel also changes the value of the neighbourhood: it may affect the quality of tourists' experience, their length of stay and likelihood of return, and may

eventually have an effect on all providers of services and goods – including other hotels – in the neighbourhood. Therefore, if we considered hotels embedded in their own tourist destinations within a region and defined hotel outcomes as a function of hotel treatment and of that of other hotels in the same destination, thus we should be able to estimate the direct effect of hotel's history of treatment and the indirect effect at the destination level.

A positive effect of subsidies on hotel performance is expected. Investment in physical capital plays an important role in augmenting the productivity and competitiveness of tourist firms (Blake et al., 2006). The reduced cost of capital then makes subsidised hotels more competitive by increasing the demand for their services. Being close to subsidised hotels will be beneficial also for non-subsidised ones, which can gain from enhanced demand due to the increased quality and attractiveness of the destination.

On the other hand, subsidisation can increase market product rivalry. In this case, subsidisation increases competition among hotels: if destinations compete in attracting tourists (Buhalis, 2000; Murphy et al., 2000), once those tourists have selected a destination, hotels within it will compete to become the tourists' first choice (Molina-Azorin et al., 2010; Zirulia, 2009). Therefore, if two hotels in the same destination are direct competitors but only one of them receives public aid, this will negatively affect the unsubsidised hotel's future competitiveness. This argument even gains strength when applied to micro and small family-owned firms. Small firms often have limited resources which may restrict their ability of access to information, particularly as regards new technologies and opportunities in the market. In addition, small firms find it difficult to obtain capital or credit (Carreira and Silva, 2010) and internal resources become the real way of financing their investments (Carpenter and Petersen 2002).

In the end, the bias in the estimated effect potentially introduced by considering the outcome of hotels to be independent of the support given to other hotels may act in both ways: the overall effect of the policy will be under-estimated (i.e., indirect effects will be positive) if positive spillovers stem from subsidies in supported hotels, but it will be over-estimated (i.e., the indirect effect will be negative) if unsubsidised firms are damaged as they lose relative competitiveness with subsidised hotels.

In this paper we provide an attempt to evaluate the direct and indirect effect of public subsidies to micro and small hotels in the context of a regional law. Tourism is a clear example where the place-based approach to the regional development (Barca et al., 2012; Neumark and Simpson, 2014) can be successful, although evidence in this sense is still scarce. Quantitative analysis on the efficacy of subsidisation policies to tourism firms is still scant and do not refer to small firms in a regional context (see e.g., Bernini and Pellegrini, 2013).

The empirical domain of analysis is the hotel industry in the province of Trento (Trentino), where almost all economic activity is run by micro and small independent tourist

firms. Policies to tourism are implemented under the umbrella of the Provincial Law 6/99 (PL 6/99) which is a tool of intervention active in Trentino since the 1999 and directed to several sectors. Subsidies are categorized by objectives and include environmental and energy-saving, investment in fixed capital, research and development, entrepreneurship promotion, firms' internationalization to foster firms' quality and productivity. The form of intervention directed to tourism firms consists in co-financing firm investment in fixed capital and environmental investments. Importantly, firms can receive one or more subsidies over time.

We exploit a detailed and unique dataset on a large, representative sample of eligible hotels operating in the province over the period 2002-2006, obtained by integration of several data sources. The empirical domain of analysis has two important advantages: the local dimension of the context of analysis and the focus on a single narrowly defined sector reduce the *ex ante* heterogeneity of the firms analysed, and the firms in the region cannot receive grants from other institutions other than the Trentino province. This is because, in 2002, provincial law 6/99 was the only tool of intervention in the economic activities of the local government and therefore the only source of subsidies available to firms in the region. We considered several measures of hotel performance.

Our results highlight the direct positive effects of subsidies on hotel performance. We also found empirical evidence of SUTVA violation and indirect subsidy effects. Specifically, our results are consistent with heightened competition among hotels within destinations as a result of policy intervention.

The remainder of the paper is organised as follows. The next section presents the econometric framework. Section 3 describes the context in which the analysis was carried out, the details on the data, and the variables used. Section 4 presents the results of the estimations. Section 5 concludes.

2. The econometric model

The reference econometric method is the Rubin's causal model (Rubin, 1974). Based on the concept of the counterfactual, two structures form the basis for this model: the theory of potential outcomes and the concept of a treatment assignment mechanism.

Let $z \in \{0,1\}$ indicates receipt of treatment: $z = 1$ if received and $z = 0$ if not. Accordingly, each unit i has two potential outcomes, $Y_i(1)$ under receipt of treatment, and $Y_i(0)$ under non-receipt. Given the two potential outcomes, the within-individual causal effect of treatment is obtained by contrasting the two outcomes: $\delta_i = Y_i(1) - Y_i(0)$. The difficulty with inferring a within-individual causal effect from observed data is that only one of the potential

outcomes can be observed (the “fundamental problem of causal inference” (Holland, 1986)). In particular, for binary treatment, the observed data on individual i consists of (Z, Y) , where $Z \in \{0, 1\}$ is the observed treatment status and:

$$Y_i = Z \cdot Y_i(1) + (1 - Z) \cdot Y_i(0) \quad (1)$$

is the observed response. The causal effects of interest here is the Average Treatment Effect (ATE) for the overall sample:

$$ATE = E(Y_i(1) - Y_i(0)) = E(Y_i(1)) - E(Y_i(0)) \quad (2)$$

Since only one of the two potential outcomes can actually be observed, we can only obtain the expected treatment outcomes for treated,

$$E(Y_i | Z_i = 1) = E(Y_i(1) | Z_i = 1) \quad (4)$$

and the expected control outcomes for the non-treated,

$$E(Y_i | Z_i = 0) = E(Y_i(0) | Z_i = 0) \quad (5)$$

In general, the conditional expectations in (4) and (5) differ from unconditional averages, due to differential selection of units in the treatment and control conditions, leading to biased estimates from observed outcomes.

One way of establishing an ignorable selection mechanism is to randomize units into treatment and control conditions. Randomisation ensures that potential outcomes are independent of treatment assignment Z . However, in practice, randomisation is often not possible. In *ex post* evaluations in particular, selection in treatment mechanism is not under the control of the analyst and selection bias problems arise. In our context, some hotels were more likely to apply for public subsidies than others, given certain *ex ante* characteristics. Thus, potential outcomes cannot be considered as independent of treatment status. In the standard Rubin’s model the identification and estimation of treatment effect are possible under the following assumptions:

Assumption 1: Stable Unit Treatment Value Assumption (SUTVA)

- a. Potential outcomes are fixed and one-dimensional, i.e., the potential outcomes of one unit should be unaffected by the particular assignment of treatments to the other units (no interference).
- b. Each treated unit receives the same type of treatment from the policy.

Assumption 2: Conditional independence (CIA) (or selection on observables)

$Y(Z) \perp\!\!\!\perp Z | X$, i.e. Z is independent of $Y(Z)$, $Z = 0,1$ conditional on $X = x$;

Assumption 3: Overlap

$c < \Pr(Z = 1 | X = x) < 1 - c$, for some $c > 0$.

2.1 Inverse Probability of Treatment Weighting (IPTW) estimation

The potential outcomes can be defined in terms of a linear model (Hogan and Lancaster, 2004):

$$E[Y(z)] = \alpha^* + \delta^* z \quad (8)$$

where δ^* is the average treatment effect (i.e., z changes from 0 to 1). The empirical counterpart of model M.4.1 can be specified as a regression model, so that:

$$E(Y | Z) = \alpha + \delta Z \quad (9)$$

Because of nonrandom selection to receipt of treatment, regression parameter δ generally not equal to the causal parameter δ^* : estimation of δ under the empirical model (9) will yield inconsistent estimates of causal parameter δ^* . In order to improve estimation in presence of selection, the Inverse Probability of Treatment Weighting (IPTW) estimator can be used. As for matching techniques the IPTW estimator relies on the CIA assumption. The idea of IPTW is that units which are underrepresented in the treated or control group are up-weighted and units which are over-represented in one of the groups are down-weighted.

When the estimate of interest is the average treatment effect, the inverse probability of treatment weight for the treated units is given by $w_i = 1/\hat{p}_i$, and for the control units is $w_i = 1/(1 - \hat{p}_i)$, where $\hat{p}_i = \Pr(Z_i = 1 | X_i)$ is the estimated propensity score for hotel i . For both group together we may write the weights as a function of treatment status and the propensity score:

$$w_i = \frac{Z_i}{\hat{p}_i} + \frac{(1 - Z_i)}{(1 - \hat{p}_i)} \quad (10)$$

The average treatment effect can be estimated by estimating model (9) by weighted least square with weights w_i . If all the relevant confounders are observed and included in X , weighting by w_i effectively creates a pseudo population in which X no longer predicts selection into subsidizing and the causal association between subsidy and outcome is the same as in the original population¹.

It is possible to extend model (9) to longitudinal multiple treatments. Let us again consider treatment (i.e. the receipt of subsidies) as binary variable. The set of potential treatments for unit i is now defined in terms of treatment histories $\bar{z}_{it} = \{z_{i0}, z_{i1}, \dots, z_{it}\}$ where $\bar{z}_{it} \in H_t$ represents the treatment histories of hotel i up to time t and H_t is the set of all possible t -sequences of 0s and 1s. Clearly, there are 2^t possible counterfactuals, only one of which is observed for each hotel. The average treatment effect of subsidy history \bar{z}_{it} on outcome y of hotel i is thus defined as $E\hat{y}(\bar{z}_{it}) - E\hat{y}(0)$, the average difference between outcomes when i follows the treatment history \bar{z}_{it} and outcomes when never receiving subsidies.

Let us assume that, at each point in time $t = 1, \dots, T$, for each hotel i we observe (Y, Z, X) where Y, Z and X represent the outcome, treatment status and a vector of hotel characteristics, respectively. In order to reduce the complexity of the problem, we can model the mean of the outcome variable as conditional on control covariates X and treatment history \bar{Z} as (Hogan and Lancaster, 2004):

$$E\hat{y}(\bar{z}_{it}) | \bar{Z}_{it}, X_{it} = b_0 + b_1'X_{it} + dg(\bar{Z}_{it}) \quad (11)$$

where $g(\cdot)$ is a known function of treatment history.

To estimate the causal effect consistently, we use an extension of the IPTW estimator. Its reliability depends on the validity of the Sequential Conditional Independence Assumption (SCIA), which provides a formal way of extending the assumption of selection on observables

¹ The model described in this section is a Marginal Structural Model (MSM). MSM is a regression model for the relationship between the outcome and the treatment assignments: the confounders are not included in the model, but by weighting each observation with the inverse of the probability of the observed treatments, the distorting effect of confounders is neutralized. Two models must be specified: an outcome model and a model for estimating the weights. However, as suggested in Hogan and Lancaster (2004), variables (X) used as confounders in the treatment model and variables used as control in the outcome model may overlap.

to the case of dynamic treatment (Robins et al., 2000; Hogan and Lancaster, 2004):

Assumption 4: Sequential Conditional Independence (SCIA)

$$Y(z_{it}) \perp\!\!\!\perp Z_{it} \mid \bar{Z}_{it-1}, \bar{X}_{it-1}^{TVC}, \bar{X}_{it} \quad (12)$$

where \bar{X}_{it} is the history of hotel-level variables and \bar{X}_{it}^{TVC} the history of time-varying confounder that is defined in the IPTW literature (see Azoulay et al., 2009) as a time-varying variable that (i) is correlated with future values of the dependent variable in question, (ii) predicts selection into treatment, and (iii) is itself predicted by past treatment history. Under SCIA the average treatment effect δ is identified and can be recovered by estimating:

$$y_{it} = b_0 + b_1 X_{it} + dg(\bar{Z}_{it}) + e_{it} \quad (13)$$

by weighted least squares, where the weights correspond to the inverse probability of following the actual treatment history of subsidies up to time t for hotel i . (Hogan and Lancaster, 2004; Azoulay et al., 2009)

The weights (w_{it}) for the IPTW estimation procedure for each firm i at time t are computed as follows:

$$w_{it} = \prod_{t=0}^t \frac{1}{\Pr(Z_{it} \mid \bar{Z}_{it-1}, \bar{X}_{it-1}^{TVC}, \bar{X}_{it})} \quad (14)$$

Each element in the denominator of equation (14) represents the probability that the hotel i received its own observed treatment (either subsidized or not subsidized) at time t , conditional on past treatment history and its past history of confounder variables. Therefore, the denominator of w_{it} represents the conditional probability that an hotel followed its own treatment history up to time t .

The probabilities in the denominator of equation (14) may vary significantly when time-varying confounders are strongly associated with the receipt of a subsidy, and the resulting IPTW estimator will have a very large variance. Thus we replace the weights with a ‘‘stabilised weights’’ ($sw_{i,t}$) computed, as follows:

$$sw_{it} = \prod_{t=0}^t \frac{\Pr(Z_{it} | \bar{Z}_{it-1}, \bar{X}_{it})}{\Pr(Z_{it} | \bar{Z}_{it-1}, \bar{X}_{it-1}^{TVC}, \bar{X}_{it})} \quad (15)$$

The use of stabilized weights increases IPTW efficiency without influencing its consistency (Hernan et al, 2000).

Let T_1 denote the set of years in which the hotel received at least one subsidy and T_2 the set of years during which the hotel i receives no subsidies. The denominator of sw_{it} is then estimated as:

$$\prod_{t \in T_1} \hat{p}_{it}^{den} \prod_{t \in T_2} (1 - \hat{p}_{it}^{den}) \quad (16)$$

where \hat{p}_{it}^{den} is the probability of being subsidised at time t , conditional on past treatment history and its past history of confounder variables. This probability are obtained by estimating a pooled cross-sectional logistic regression on the whole dataset as follows:

$$\hat{p}_{it}^{den} = \Pr(Z_{it} = 1) = g_0 + g_1 Z_{it-1} + g_2 Z_{it-2} + g_3 X_{it-1}^{TVC} + g_4 X_{it} + Z_t \quad (17)$$

The numerator of sw_{it} is defined in a similar way, except that the time-varying confounders are omitted from the list of covariates in model (17).

2.2 The extended framework for causal inference in presence of neighbour interference

2.2.1 Notation and definitions

Let z_t denote the vector of treatment assignment to hotels in a given period t :

$$z_t = (z_{1t}, z_{2t}, \dots, z_{Nt}) = (z_{it}, z_{-it}), \quad (18)$$

where z_{-it} is the vector of treatment assignment when that of hotel i , z_{it} , is removed. In this setting, hotel i has 2^N potential outcomes, $Y_{it}(z_t)$, corresponding to all possible treatment assignment combinations of N hotels. A contrast between any two of the possible 2^N outcomes is a causal effect. Clearly, the case in which SUTVA is satisfied is special, and:

$$Y_{it}(z_t) = Y_{it}(z_{it}, z_{-it}) = Y_{it}(z_{it}). \quad (19)$$

The effect of z_t on the hotel's potential outcome may be viewed as operating through z_{it} and a many-to-one function $v(z_t)$ (Hong and Raudenbush, 2006). The N -dimensional space is thus reduced to a 2-dimensional space. Hence:

$$Y_{it}(z_t) = Y_{it}(z_{it}, z_{-it}) = Y_{it}[z_{it}, v(z_{-it})]. \quad (20)$$

Two causal effects can be defined (Tchetgen and VanderWeele, 2010): a direct causal effect:

$$DE_{it} = Y_{it}[z_{it} = 1, v(z_{-it})] - Y_{it}[z_{it} = 0, v(z_{-it})] \quad (21)$$

as the causal effect of the treatment on a hotel given the treatment status of other hotels; an indirect causal effect or “spillover effect”:

$$IE_{it} = Y_{it}[z_{it}, v(z_{-it})] - Y_{it}[z_{it}, v(z_{-it}')] \quad (22)$$

as the causal effect on one hotel of the treatment received by other hotels in the destination.

The setting can be extended in order to account for the fact that hotels are located in different intra-regional tourist destinations (TDs). Accordingly, we introduce an assignment vector, $S = (s_1, \dots, s_b, \dots, s_N)$ where s_i can take values $j: j = 1, \dots, J$, where J is the number of tourist destinations. The potential outcome becomes $Y_{it}[z_{it}, v(z_{-it}), s_i]$. In the end, the causal estimand of interest is given by:

$$E\{Y_{it}[z_{it}, v(z_{-it}), s_i] - Y_{it}[z_{it}', v(z_{-it}'), s_i']\}. \quad (23)$$

In order to identify and estimate the average effect of treatment assignment z_t and $v(z_t)$ we assume²:

Assumption 5:

Let be $s_t = s_t' = s^*$, where s^* the observed assignment of hotels in the destinations. Therefore, given the current localization of hotels in the destinations, the estimand becomes:

$$E\{[Y_{it}(z_{it}, v(z_{-it}), s^*) - Y_{it}(z_{it}', v(z_{-it}'), s^*)] \mid S = s^*\}. \quad (24)$$

² Assumptions 1-4 stated in previous sections are still valid.

This assumption means that no hotel changed its location as a result of receiving or not receiving subsidies³.

Assumption 6: Neighbor-level SUTVA

The potential outcome of a hotel i belonging to TD j is dependent only on its treatment status and that of other hotels within TD j . In other words, treatment assignment of hotels in other destinations does not affect the potential outcome of the hotel in question. From the non-interference between destinations we have: $Y_{it}(z_{it}, v(z_{it}), s^*) = Y_{ijt}(z_{ijt}, v(z_{ijt}))$.

We also assume that each hotel's subsidy has the same effect on the potential outcome of hotel i . Hence, we define $v(z)$ as a function of the share of treated hotels in a destination. Formally, $v(z)$ is as follows:

$$v(z_{-it}) = v = \begin{cases} 1 & \text{if } n^{-1}(\mathbf{z}_{-it}^T \mathbf{z}_{-it}) \geq Me \\ 0 & \text{otherwise} \end{cases} \quad (25)$$

where Me is the median of the distribution of the intensity of treatment across destinations.

Assumption 7: Strongly ignorable treatment assignment

Let X_i be a hotel-level vector of covariates and W_i a destination-level vector of covariates. Causal inference is possible if treatment assignments are strongly ignorable within the levels of covariates:

$$\begin{aligned} E[Y_{it}(z_{it}, v_{it}) | Z_{it} = z_{it}, V_{it} = v_{it}, X_{it} = x_{it}, W_{it} = w_{it}] &= \\ &= E[Y_{it}(z_{it}, v_{it}) | X_{it} = x_{it}, W_{it} = w_{it}]. \end{aligned} \quad (26)$$

Under the above assumptions, we have a framework with a cluster-level randomised block design, followed by a hotel-level randomized block design within each cluster (i.e. destination). The probability that a TD is assigned to $V = 1$ (highly subsidised TD) given W , is:

$$\Pr(V = 1 | W = w) \quad (27)$$

³ The policy allows the re-location of firms. However, this possibility is empirically irrelevant in the case of hotels.

Given a TD assignment to high or low subsidized TD, hotels are assigned at random to $Z = 1$ (subsidy granted). Therefore, the probability for a hotel of receiving a certain treatment is given by:

$$\Pr(Z = z, V = v \mid X = x, W = w) \quad (28)$$

Using the law of probability, (28) can be decomposed into the product of two conditional probabilities as follows:

$$\begin{aligned} \Pr(Z = z, V = v \mid X = x, W = w) &= \\ &= \Pr(V = v \mid W = w) \cdot \Pr(Z = z \mid V = v, X = x, W = w) \end{aligned} \quad (29)$$

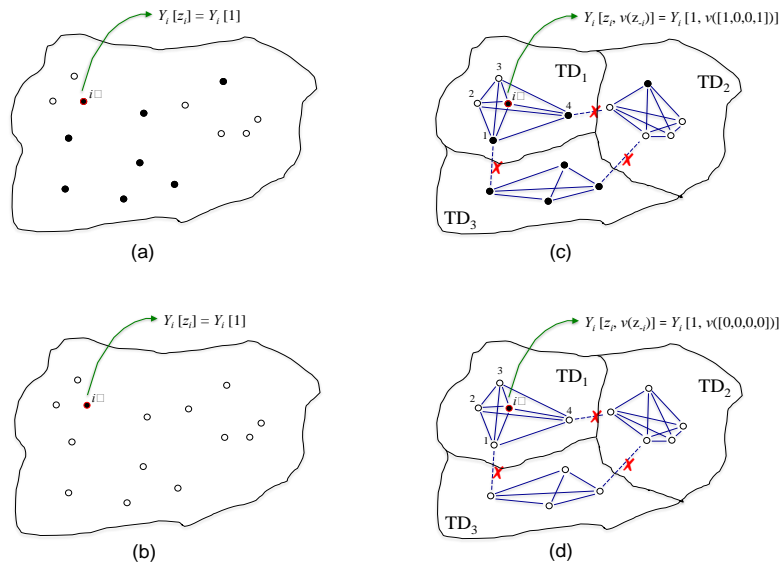


Figure 1. Graphical sequence of implications of SUTVA. Black circles: hotels receiving subsidies; white circles: hotels not receiving subsidies. When SUTVA is satisfied (panels (a) and (b)), no influence among units is assumed; outcomes of unit i do not vary if treatment status of other hotels varies (e.g., from (a) to (b)); Panels (c) and (d): how SUTVA is relaxed in our framework: hotels in a given destination (TD) are assumed to be connected and outcomes depend on treatment status of all other hotels in same destination. Outcomes of hotel i change when treatment status of other hotels changes, although its own treatment status is not changed.

2.2.2 IPTW estimation in a 2-level longitudinal setting and neighbours interference

We aimed to estimate the average treatment effect of subsidies on hotel performance, given the effect of TD exposure to subsidies over time. We, therefore, also had take into account the treatment history at TD level. Although the econometric considerations developed considering longitudinal history of treatment at the hotel level remained applicable to the case of two dichotomous treatments (both at the destination and at the hotel level), the estimation of the final weights was different. Suarez et al. (2008) proposes an extension of the static IPTW estimation to multiple treatment settings, i.e. when subjects in a given time receipt more than one type of treatment. We extended the framework in a two-level longitudinal multiple treatment setting in which at each time t a hotel receives two treatment: one at destination level and the other at hotel level. Specifically, we use the probability of receiving a 2-dimensional treatment defined in equation (29) to implement the extended IPTW estimator to the dynamic 2-dimensional treatment setting. Accordingly, we defined stabilized weights as follows:

$$\begin{aligned}
 SW_{it}^{2-level} &= \prod_{t=0}^L \frac{\Pr(Z_{it}, V_{it} | \bar{Z}_{it-1}, \bar{V}_{it-1}, \bar{X}_{it}, \bar{W}_{it})}{\Pr(Z_{it}, V_{it} | \bar{Z}_{it-1}, \bar{V}_{it-1}, \bar{X}_{it-1}^{TVC}, \bar{W}_{it-1}^{TVC}, \bar{X}_{it}, \bar{W}_{it})} \\
 &= \prod_{t=0}^L \frac{\Pr(V_{it} | \bar{V}_{it-1}, \bar{W}_{it}) \times \Pr(Z_{it} | \bar{Z}_{it-1}, \bar{V}_{it-1}, \bar{X}_{it}, \bar{W}_{it})}{\Pr(V_{it} | \bar{V}_{it-1}, \bar{W}_{it-1}^{TVC}, \bar{W}_{it}) \times \Pr(Z_{it} | \bar{Z}_{it-1}, \bar{V}_{it-1}, \bar{X}_{it-1}^{TVC}, \bar{W}_{it-1}^{TVC}, \bar{X}_{it}, \bar{W}_{it})}
 \end{aligned} \tag{30}$$

where \bar{X}_{it} and \bar{X}_{it}^{TVC} are hotel-level covariates and time-varying confounder histories up to time t , respectively. Similarly, \bar{W}_{it} and \bar{W}_{it}^{TVC} are TD-level covariates and time-varying confounder histories up to time t , respectively.

Each element in the denominator in (30) is the conditional probability that the hotel i received the 2-dimensional treatment, which is composed by its own observed treatment (either subsidised or not-subsidised) and the treatment received by the destination (either high or low intensity of subsidisation) at time t . Moreover, each element is decomposed as the product of two probabilities. The first, $\hat{p}_{it}^D = \Pr(V_{it} | \bar{V}_{it-1}, \bar{W}_{it-1}^{TVC}, \bar{W}_{it})$, is the probability that the destination where the hotel i is located received its own observed treatment (either high or low intensity of subsidisation) at time t conditional on its past treatment history and past history of destination level confounders; the second, $\hat{p}_{it}^Z = \Pr(Z_{it} | \bar{Z}_{it-1}, \bar{V}_{it-1}, \bar{X}_{it-1}^{TVC}, \bar{W}_{it-1}^{TVC}, \bar{X}_{it}, \bar{W}_{it})$, is the probability that the hotel i received its own observed treatment (either subsidised or non-subsidised) at time t conditional on its own past treatment history and its past history of confounder variables, and the past treatment history and past history of destination confounders.

The aim was to estimate for each hotel the probability of being treated according to one of the four possible treatment statuses in each period: $(Z_t = 1, V_t = 1)$, $(Z_t = 1, V_t = 0)$, $(Z_t = 0, V_t = 1)$, and $(Z_t = 0, V_t = 0)$. Table 4.9 lists the individual contemporaneous numerator and denominator components for calculating stabilised weights.

Table 1. Numerator and denominator for calculating stabilised weights.

<i>Treatment status</i>	<i>Numerator</i>	<i>Denominator</i>
$(Z_t = 1, V_t = 1)$	$\hat{p}Z_{it}^N \times \hat{p}V_{jt}^N$	$\hat{p}Z_{it}^D \times \hat{p}V_{jt}^D$
$(Z_t = 1, V_t = 0)$	$\hat{p}Z_{it}^N \times (1 - \hat{p}V_{jt}^N)$	$\hat{p}Z_{it}^D \times (1 - \hat{p}V_{jt}^D)$
$(Z_t = 0, V_t = 1)$	$(1 - \hat{p}Z_{it}^N) \times \hat{p}V_{jt}^N$	$(1 - \hat{p}Z_{it}^D) \times \hat{p}V_{jt}^D$
$(Z_t = 0, V_t = 0)$	$(1 - \hat{p}Z_{it}^N) \times (1 - \hat{p}V_{jt}^N)$	$(1 - \hat{p}Z_{it}^D) \times (1 - \hat{p}V_{jt}^D)$

Let T_1 be the set of periods in which the hotel received a subsidy in a destination with high intensity of treatment, T_2 the set of periods in which the hotel received a subsidy in a destination with low intensity of treatment, T_3 the set of periods in which it did not receive any subsidy in a destination with high intensity of treatment, and T_4 the set of periods in which it did not receive any subsidy in a destination with low intensity of treatment. The calculation denominator and denominator for obtaining stabilised weights is reached by multiplying the quantities of interest at time t by their lagged values. Formally, for the denominator we have:

$$\prod_{i \in T_1} \tilde{p}Z_{it}^D \times pV_{jt}^D \prod_{i \in T_2} \tilde{p}Z_{it}^D \times (1 - pV_{jt}^D) \prod_{i \in T_3} \tilde{(1 - pZ_{it}^D)} \times pV_{jt}^D \prod_{i \in T_4} \tilde{(1 - pZ_{it}^D)} \times (1 - pV_{jt}^D) \quad (31)$$

The probabilities in the above equation were estimated through a logit models as follow:

$$\hat{p}V_{jt}^D = \Pr(V_{jt} = 1) = g_0 + g_1V_{jt-1} + g_2V_{jt-2} + g_3W_{jt-1}^{TVC} + g_4W_{jt} + Z_t \quad (32)$$

$$\hat{p}Z_{it}^D = \Pr(Z_{it} = 1) = g_0 + \sum_{q=1}^2 \hat{\alpha}_q g_q Z_{it-q} + \sum_{p=1}^2 \hat{\alpha}_p j_p V_{jt-1} + W_1 X_{it-1}^{TVC} + W_2 X_{it} + W_3 W_{jt-1}^{TVC} + W_4 W_{jt} + Z_t \quad (33)$$

The numerator of $sw_{it}^{2-level}$ is defined in a similar way, except that one omits the time-varying confounders from the list of covariates.

After having obtained the weights, a weighted regression was performed as follows:

$$y_{it} = b_0 + b_1'X_{it} + b_2'W_{it} + dg(\bar{Z}_{it}) + lh(\bar{V}_{it}) + e_{it} \quad (34)$$

In the empirical estimation we also extended the two parameterisation used in the previous section to function $h(\cdot)$. Specifically, under parameterisation 1 we have:

$$dg(\bar{Z}_{it}) = d(Z_{it} + Z_{it-1} + Z_{it-2}) \quad (35)$$

$$lh(\bar{V}_{it}) = l(V_{it} + V_{it-1} + V_{it-2}) \quad (36)$$

and under parameterisation 2:

$$lh(\bar{V}_{it}) = l_1V_{it} + l_2V_{it-1} + l_3V_{it-2} \quad (37)$$

$$dg(\bar{Z}_{it}) = d_1Z_{it} + d_2Z_{it-1} + d_3Z_{it-2} \quad (38)$$

The estimated causal parameter δ under parameterisation 1 quantifies the direct causal benefit of receiving additional subsidies, regardless of the timing with which subsidies are assigned. For instance, if only one subsidy was received over period $t-2$ to t , the relative benefit is equivalent, regardless of when it was received. Under parameterisation 2, the timing of subsidisation affects outcomes. In addition, cumulative subsidisation is not assumed to have a linear effect on the current value of the outcome variable analysed. Under both parameterisations, we assume that subsidies received before time $t-2$ have no causal effect on outcomes.

3. The case study: the policy, data and variables

The Trentino is an Alpine province in north-east Italy, with nearly 500,000 inhabitants. Thanks to the variety of attractions – Lake Garda and its surroundings, the Dolomites, and many historic towns and cities – about 2,300,000 tourists visited the region in 2006, spending more than 11,000,000 nights there. The contribution of the hotel and restaurant industry to the local value added ranged between 6.7% and 6.9% in the period 2004-2006.

The Trentino spans more than 14 tourist districts with quite different environmental conditions: a number of districts enjoy a mild climate most of the year and a long peak season (Lake Garda); the districts in the best Alpine resorts are characterised by full winter and summer

seasons, and have a two-peak tourist season; other districts only have a short summer peak season. Lastly, ancient towns enjoy a fairly constant arrival of tourists throughout the year.

Differences among tourist districts are not only due to their endowment in natural resources, because they are community-type destinations (Beritelli et al., 2007; Franch et al., 2010), i.e., areas with a variety of autonomous tourist operators, in which destination marketing is managed by several local agencies (*Aziende di Promozione Turistica*). In these areas, destination management – in which hotels are predominant - plays a fundamental role in coordinating tourist operators to achieve an overall image and increase destination package tours.

In 2006, 1600 hotels were registered, for a total number of more than 47,000 rooms. The hotels are unevenly distributed in the tourist districts. There are very many in Valle di Fassa (18.31% of the total in 2006), near Lake Garda (9.75%) and in the high mountain resorts. As regards class, measured as one to five stars, the majority of which (more than 60%) are three-star hotels. The Trentino hotel industry is characterised by the widespread presence of small family firms. In 2006, its hotels had an average of 30 rooms with 6.2 employees; only 15% were owned by limited liability companies.

3.1 The policy: Provincial Law 6/99

A distinguishing feature of this institutional setting is that firms operating in the province of Trento can apply only for subsidies awarded by the local government. In this setting, Provincial Law 6/99 (hereafter, PL6) provides guidelines on the economic incentives to firms operating in the province. It comprises a large set of incentive schemes which are meant to foster fixed investments, research and development expenditure, firm restructuring, the adoption of production processes to safeguard the environment, and re-location of firms within the province.

All firms operating in the province of Trento can apply for PL6 grants by submitting a project to the local authority. Although there is no deadline for submission during the calendar year, since a first-in-first-out criterion is used to assign financial resources, some firms may be refused once the budget is exhausted. There are two types of evaluation mechanism, basically determined by the magnitude of the investment: selective and automatic. Through the selective mechanism, once a hotel applies for a grant, its application is examined for its economic viability and financial sustainability. Only if the project receives a positive assessment can it be co-financed by the local government. Instead, automatic subsidies are granted only after examination of applications.

3.2 Database

We relied on several sources to construct the database. Administrative archives, held by the local government, are the primary source of information on hotels receiving grants. In particular, primary data on firms' applications for public subsidies come from the APIAE (*Agenzia provinciale per l'incentivazione attività economiche*), the administrative body that manages the subsidisation programme on behalf of the local government. The APIAE archives (DBA_{apiae} database) allowed us to recover all the applications (2774) filed from 1999 to 2011 concerning tourism-related industries: accommodation (hotels, camp-sites, etc.), restaurants, travel agencies and other recreational activities. For each application it was possible to retrieve information on: name of the applicant (*ragione sociale*), tax code, address of the applicant (*sede legale*), description of economic activity, date of submission and of assessment/approval of application, type of subsidization procedure (selective or automatic), final outcome of the application assessment (obtained, rejected, other outcomes). We consider subsidies granted through both selective and automatic procedure.

Data collected through subsidy applications are not sufficient for conducting an impact evaluation, mainly because they do not comprise information on firm characteristics and their financial performance. In our context, only about 15% of hotels are limited liability firms. In fact, only limited liability firms are obliged to make publicly available their annual balance sheet, the main source of information at firm level. Therefore, in order to obtain information on hotels in the province we could not rely on publicly available databases.

We overcome this limitations using the DB_{hotelTN} database, an extensive repertoire built in partnership with the Statistical Office of the Trentino province and already used in previous analysis of the hotel sector in the Trentino province (see Corsino et al., 2011). The database contains information on hotel characteristics (e.g., revenue and cost figures, legal form, structural characteristics, location, etc.) for a representative sample of the population of hotels operating in the province. Because of constraints on the time span over which hotel-level data are available in the DB_{hotelTN} database, we focus our analyses on the period from 2002 to 2006. The final database (BDevalHTN) contains data for 426 subsidised and 410 non subsidised hotels over the period 2002-2006.⁴

The hotels can receive one or more subsidy during the observed period (2002-2006). We consider also 372 non-subsidised hotels.⁵ Figure 2 plots the distribution of number of subsidies for the hotels in our sample.

⁴ For further details on the construction of the database see the Appendix.

⁵ We do not consider non-subsidised hotels that show very low propensity to invest, i.e. we discarded those non-subsidised hotels with negative changes of amortization cost on tangible assets over the entire period under analysis.

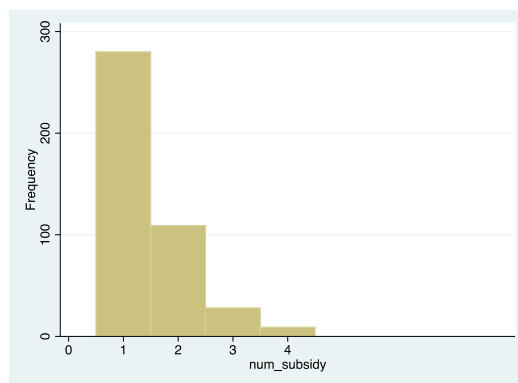


Figure 2 Subsidies for hotel in the DBevalHTN database

The figure shows that most of the treated hotels received one subsidy throughout the observed period. However, the number of hotels which obtained two or three was not negligible. In a few cases, more than three subsidies were even granted.

3.3 Outcome variables

Mapping the expected effects of public subsidies with observed variables, which properly measure firm outcome, is not always straightforward. Competitiveness is ultimately related to the perceived quality of services and goods, and to how resources and competences are combined to produce them. At firm level, as far as subsidies to physical capital investment are concerned, productivity growth is one of the most direct outcomes studied (Bergstrom, 2000; Harris and Trainor, 2005; Skuras et al., 2006; Tzelepis and Skuras, 2004; Bernini and Pellegrini 2011). In tourism, the effective and efficient use of available resources is a major concern in establishing, raising and sustaining the competitiveness of tourist firms and destinations (Tsai et al., 2009), so that hotel productivity is the preferred measure of hotel competitiveness.

A desirable complementary aim of a public policy should be that of achieving sustainable growth (Schwab, 2012). As argued by scholars in this field (Ritchie and Crouch, 2000), the competitiveness of tourist destinations is in fact illusory without sustainability. Smoothing demand variability over time (i.e., reducing seasonality), especially when tourist demand increases, is one of the main challenges in achieving the policy objective of overall sustainability in this sector (see, for instance, the “Agenda for a sustainable and competitive European tourism”, Commission of the European Communities, 2007).

As the hotel industry faces high fixed costs, which make the occupancy break-even level quite high, demand fluctuation becomes very problematic for hotel management. Hotels can partly benefit from destination management policies aimed at promoting the destination by adding new services or attractions during off-peak seasons (Baum and Hagen, 1999). Despite

this, hotels which invest in renewing their buildings still face challenges of increased capital intensity. Therefore, receiving subsidies is linked to reduced demand variability, to the extent that the investment increases the attractiveness of the hotel during off-peak months, allowing better use of installed capacity.

We used the following outcome variables:

- Labour productivity, measured as the ratio of total deflated revenue to total employment (*lab_prod*). A second proxy of labour productivity was obtained as the ratio of value added to total employment (*lab_prod_2*).
- Occupancy rate (*occ_rate*), defined as the ratio of total guest nights spent in a year to the number of beds available, multiplied by the number of days the hotel was operative. The occupancy rate is an index of the hotel's level of activity. This measure has the advantage of being widely used among hotels. It is also regarded as a performance indicator in the hotel industry (Orfila-Sintes and Mattsson, 2009; Sainaghi, 2010) and performance heterogeneity among hotels stems from the different ability of hotels to transform a given capacity into sold nights and services (Yu and Lee, 2009).
- The revenue per available room (*revpar*), obtained as the ratio of the (deflated) yearly revenue to the number of rooms, multiplied by the number of days the hotel was operative; it is considered as a proxy of capital productivity and is widely used as measure of performance in the hotel industry.
- A measure of variability of the level of activity over time (*occ_var*), defined as the coefficient of variation of the number of monthly arrivals over the year. An increase in this variable (i.e., increased demand variability) may be highly detrimental to productivity in services (Morikawa, 2012).

3.4 Covariates: Confounders and exogenous variables

We consider the following set of confounders::

- The legal form, which indicates the attitude of the firm towards risk and also the chance of entering public subsidisation programmes (Almus and Czarnitzki, 2003). By using a limited liability legal form, for instance, owners can minimise their risk up to a certain amount and thus have higher incentives to pursue more risky projects. In addition, legal forms may signal the varying quality of firms. Hence, we used a categorical variable *legal_form*, which classifies hotels into sole proprietorship, partnership, and limited liability forms.
- Both different levels of subsidies and different performance may depend on firm size. Firm size is also a useful predictor of financial constraints (Hadlock and Pierce, 2010), and the capacity of receiving external finance (e.g., bank loans) is correlated with firm

size. In accordance with the literature on hotels (De Jorge and Suárez, 2013), we used hotel size (*size*) as a proxy for the number of available beds.

- Hotel category indicates the level and complexity of services provided. Higher categories comprise more services, equipment complexities and organisational aspects. In our context, hotel category is informative about the “type” of hotelier. In fact there is a sharp polarization of the distribution of “active” and “passive” entrepreneurs across hotel categories: only 7% to 12% of active entrepreneurs belong to 1 and 2 star categories, while only 8% to 12 % of passive entrepreneurs belong to 3 and 4 stars categories (see PAT – Servizio Statistica, 2006). Category cross-comparison can thus explain an important part of the unobserved differences in entrepreneurial behaviour and hotel performance. We defined a variable (*category*) with two values: high for three- and four-star hotels, and low for one- and two-star ones.
- Hotels which are attractive to international tourists are expected to be more productive (Assaf and Cvelbar, 2011). The international trade literature also supports this claim, arguing that firms which can sell their products to foreign customers are more productive than domestically oriented ones. Hotels operating in foreign markets are also able to generate new knowledge from international tourists and may be more interested in restructuring and improving their equipment and facilities than hotels mainly operating in the domestic market. A high percentage of international sales may also be considered as an indirect measure of quality of management and employment: hosting foreign customers requires higher skills and competences (e.g., knowledge of foreign languages). We defined a measure of internationalisation (*int*) for each hotel as the ratio of the number of nights spent by foreign guests to the total number of nights over the year.
- Hotels may have different investing propensity as well as profitability. Firms with smaller capital intensity are expected to have smaller ‘operating leverage’, and therefore smaller volatility of earnings, given the same demand fluctuations (Lev, 1983; Baginski et al, 1999). We used as a proxy of capital intensity (*cap*), the ratio of amortisation of tangible capital to revenue (Baginski et al, 1999; Cheng, 2005; Asthana and Zhang, 2006).

Moreover, we use in the following set of exogenous variables:

- We also account for fine-grained effects of unevenly distributed spatial demand densities. Here, it is reasonable to consider that proximity to physical and natural amenities makes hotels differently attractive to tourists. We used a measure of “proximity” (*prox*), so that the impact of attraction points decreases with distance from the hotel, like the market-potential function (Harris, 1954). As attraction points we

considered ski areas, touristic lakes and well-known beauty spots. Formally, our measure of market potential was defined as the decreasing function of the distance from the selected attraction points, as follows:

$$prox_i = \hat{\alpha} \left(\sum_{j=1, \dots, n} d_{ij} \right)^{-1} \quad (39)$$

where d_{ij} is the (Euclidean) distance between hotel i and attraction point j , $j = 1, \dots, n$.

- Co-location may affect hotel performance as well as hotel managers' choice to apply for subsidies. Firms may benefit from positive externalities accruing from agglomeration economies. Several studies have addressed the role of agglomeration in the hotel industry (Baum and Mezias, 1992; Baum and Haveman, 1997; Ingram and Baum, 1997; Chung and Kalnins, 2001; Kalnins and Chung 2004). Co-location may provide opportunities for frequent interactions, exchanges of information among hotel managers and reduced monitoring costs (Gan and Hernandez, 2011). As a consequence, co-location may increase the chances that hotel behaviour, with respect to subsidy opportunities, may be influenced by other existing hotels which are planning to apply for subsidies. We controlled for the co-location effect by using an index (co_loc), which is a decreasing function of the distance of a hotel from all other hotels (as in the case of the $prox$ variable):

$$co_loc_i = \hat{\alpha} \left(\sum_{j=1, \dots, m} q_{ij} \right)^{-1} \quad (41)$$

where q_{ij} is the (Euclidean) distance between hotel i and hotel j , $j = 1, \dots, m$.

4. Results

This section reports the results of estimating model (34). We considered time-variant confounders to be the pre-treatment value of the hotel size ($size$), capital intensity index (cap_int), legal form ($legal_form$), hotel category (cat) and degree of internationalization (int). As control variables in the outcome model we considered the co-location index (co_loc), proximity index ($prox$), contemporaneous category, legal form, size, internationalization, and capital intensity. Variables at level 2 (i.e. at destination level) may be cluster level variables or cluster aggregates of individual level variables (Hong and Raudenbush, 2006). Here, we used the aggregate value of hotel-level variables at the destination level. In particular, as time varying-confounders we used the aggregated nights spent, the aggregated revenue, the

aggregated employment, and the average touristic rate of the destination. As control variables we used the total amount of beds, the average proximity of hotels to attraction points and the average distance among hotels in the destinations. The analysis was carried out on the several outcome variables defined in section 3.3, i.e., the varying level of capacity utilisation (*occ_var*), average occupation rate (*occ_ratio*), revenue per available room (*revpar*), and the two proxies of labour productivity (*lab_prod* and *lab_prod_2*). Results were obtained under the two parameterisations of functions $g(\cdot)$ and $h(\cdot)$ for each outcome variable considered.

The interpretation of δ is the average direct effect of the receipt of a subsidy on hotel outcome, λ s represent the indirect average effect on hotel outcome linked to belonging to a touristic destination with high instead of low intensity of subsidization. Therefore, if the value of λ s differs from zero, violation of SUTVA is indicated. In particular, positive values of λ would be consistent with the hypothesis of positive externality, meaning that the hotels enjoy the positive externalities stemming from being located in a destination, the quality and attractiveness of which is increased by the public subsidisation policy. In this case, hotels enjoy the benefits due to the overall increased quality of the destination even without improving their own quality. Instead, negative values of λ are consistent with the hypothesis that subsidization activates competition among hotels and negative externalities are generated.

Table 3 lists the results when parameterisation 1 of both functions $g(\cdot)$ and $h(\cdot)$ is applied. As discussed previously, in this case, it is not the timing but only the cumulative subsidisation which is assumed to play a role. The direct effect of subsidies is still positive and significant. Likewise, there is evidence of SUTVA violation consistent with the competition hypothesis, according to which subsidisation has indirect negative effects on non-subsidised hotels

Estimated coefficients when parameterization 2 is assumed are listed in table 4. Now λ_1 represents the contemporaneous effect on the hotel outcome of belonging to a destination where a high proportion of hotels receive subsidies, λ_2 represents the additive indirect effect of the hotel being in a context with high intensity of subsidization during the year prior to outcome evaluation, and λ_3 has the same meaning, but when two time lags are considered.

Table 3. Weighted least square estimates. Model (34), parameterisation 1

<i>Variables</i>	<i>Treatment history parameterisation</i>	<i>occ_var</i>	<i>occ_ratio</i>	<i>revpar</i>	<i>lab_prod</i>	<i>lab_prod_2</i>
<i>g(Z)</i>	$\delta(Z_t+Z_{t-1}+Z_{t-2})$	(δ) -0.081*** (0.019)	0.039*** (0.007)	5.205*** (0.811)	1,098.480 (1,135.456)	608.719 (575.548)
<i>h(V)</i>	$\lambda(V_t+V_{t-1}+V_{t-2})$	(λ) 0.034* (0.020)	-0.019** (0.008)	-1.718** (0.871)	-729.757 (1,220.335)	-174.052 (618.572)
Controls						
<i>co-loc</i>		0.004 (0.003)	0.001 (0.001)	-0.202 (0.134)	-297.484 (187.479)	-59.890 (95.031)
<i>prox</i>		0.071 (0.049)	0.036* (0.019)	3.622* (2.050)	3,982.847 (2,870.403)	3,947.330*** (1,454.970)
<i>Legal_form_2</i>		-0.130*** (0.029)	0.042*** (0.011)	5.926*** (1.200)	5,645.511*** (1,680.105)	1,926.547** (851.623)
<i>Legal_form_3</i>		-0.040 (0.044)	0.074*** (0.017)	15.408*** (1.844)	9,795.078*** (2,582.132)	3,070.663** (1,308.849)
<i>cat</i>		-0.149*** (0.031)	0.059*** (0.012)	5.094*** (1.282)	7,073.073*** (1,794.543)	3,366.029*** (909.631)
<i>size</i>		-0.016 (0.026)	0.027*** (0.010)	-1.978* (1.081)	3,356.654** (1,513.446)	3,670.209*** (767.146)
<i>ext</i>		-0.054 (0.058)	0.055** (0.022)	-6.298*** (2.397)	-1,092.897 (3,356.775)	146.158 (1,701.505)
<i>cap</i>		0.264** (0.117)	-0.160*** (0.045)	-19.103*** (4.880)	9,548.197 (6,833.681)	12,783.280*** (3,463.903)
<i>tot_beds</i>		-0.000*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.857** (0.391)	0.976*** (0.198)
<i>ave_attr</i>		-0.106 (0.133)	-0.129** (0.050)	1.622 (5.526)	6,495.994 (7,738.465)	5,713.596 (3,922.527)
<i>ave_alb</i>		-0.017 (0.022)	0.024*** (0.009)	1.170 (0.935)	-1,576.950 (1,309.071)	-909.040 (663.551)
<i>ave_tur</i>		0.220*** (0.067)	-0.007 (0.025)	-6.564** (2.789)	2,789.114 (3,905.761)	-1,237.334 (1,979.779)
Observations		798	798	798	798	798
R-squared		0.147	0.336	0.249	0.142	0.234
R_adj		0.132	0.324	0.236	0.127	0.221
F		9.639	28.30	18.58	9.287	17.11

Table 4. Weighted least square estimates. Model (34), parameterization 2

<i>Variables</i>	<i>Treatment history parameterization</i>	<i>occ_var</i>	<i>occ_ratio</i>	<i>revpar</i>	<i>lab_prod</i>	<i>lab_prod_2</i>
<i>g(Z)</i>	$\delta_1 Z_t + \delta_2 Z_{t-1} + \delta_3 Z_{t-2}$					
	(δ_1)	-0.019 (0.035)	0.039*** (0.013)	5.279*** (1.463)	338.961 (2,055.437)	503.717 (1,040.697)
	(δ_2)	-0.119*** (0.033)	0.036*** (0.013)	5.019*** (1.391)	1,752.395 (1,954.737)	874.968 (989.711)
	(δ_3)	-0.105*** (0.034)	0.043*** (0.013)	5.424*** (1.409)	1,217.246 (1,978.697)	454.374 (1,001.843)
<i>h(V)</i>	$\lambda_1 V_t + \lambda_2 V_{t-1} + \lambda_3 V_{t-2}$					
	(λ_1)	-0.087** (0.041)	0.045*** (0.016)	1.761 (1.725)	1,395.224 (2,423.160)	490.217 (1,226.881)
	(λ_2)	0.033 (0.039)	0.007 (0.015)	-2.684 (1.641)	-2,681.575 (2,305.189)	-1,942.913* (1,167.150)
	(λ_3)	0.125*** (0.033)	-0.065*** (0.013)	-4.383*** (1.389)	-2,504.492 (1,951.464)	-825.611 (988.054)
Controls						
<i>co-loc</i>		0.004 (0.003)	0.001 (0.001)	-0.216 (0.134)	-315.163* (187.943)	-72.454 (95.158)
<i>prox</i>		0.068 (0.049)	0.035* (0.019)	3.501* (2.049)	3,957.926 (2,877.748)	3,893.919*** (1,457.045)
<i>Legal_form_2</i>		-0.110*** (0.029)	0.032*** (0.011)	5.408*** (1.223)	5,353.317*** (1,717.399)	1,869.987** (869.544)
<i>Legal_form_3</i>		-0.031 (0.044)	0.065*** (0.017)	15.207*** (1.861)	9,916.745*** (2,613.887)	3,270.803** (1,323.448)
<i>cat</i>		-0.147*** (0.031)	0.055*** (0.012)	5.057*** (1.288)	7,126.378*** (1,809.163)	3,435.639*** (916.005)
<i>size</i>		-0.014 (0.026)	0.028*** (0.010)	-1.985* (1.078)	3,320.082** (1,515.024)	3,648.710*** (767.078)
<i>ext</i>		-0.111* (0.060)	0.079*** (0.023)	-4.319* (2.494)	477.906 (3,503.377)	972.710 (1,773.810)
<i>cap</i>		0.269** (0.116)	-0.159*** (0.044)	-18.962*** (4.876)	9,513.090 (6,850.025)	12,781.818*** (3,468.265)
<i>tot_beds</i>		-0.000** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.675* (0.406)	0.856*** (0.206)
<i>ave_attr</i>		-0.080 (0.162)	-0.067 (0.061)	-1.940 (6.767)	380.025 (9,506.790)	473.900 (4,813.423)
<i>ave_alb</i>		0.002 (0.026)	0.005 (0.010)	0.928 (1.088)	-1,294.442 (1,528.437)	-459.882 (773.870)
<i>ave_tur</i>		0.164** (0.070)	0.029 (0.026)	-5.088* (2.911)	3,391.988 (4,089.850)	-1,272.604 (2,070.749)
Observations		798	798	798	798	798
R-squared		0.164	0.355	0.257	0.146	0.239
R_adj		0.145	0.340	0.240	0.126	0.222
F		8.510	23.83	14.99	7.391	13.60

The results indicate that the contemporaneous (i.e. at time t) indirect effect of being in a destination where many instead of few hotels in are subsidized is positive and statistically significant when *occ_var* and *occ_ratio* are considered as outcomes, and is but not statistically significant for the other outcomes. This evidence is consistent with the hypothesis that the

policy activates a process of quality improvement which generates positive externalities. However, the additional effect attributable to past exposure at time $t-1$ to high density of subsidization is in general lower than the contemporaneous one. This effect become in general negative, and for *occ_var*, *occ_ratio*, and *revpar* also statistically significant, at time $t-2$. Moreover, the magnitude of λ_3 generally more than counterbalances the positive direct effect (δ_3) on hotel outcomes, leading to a negative net effect of subsidization at time $t-2$. Instead, for *revpar*, the net effect is positive. Overall, This evidence is consistent with the hypothesis of heightened competition.

In summary, it seems that the policy had a positive direct impact on hotel outcomes. The only exception is for labour productivity, in which the sign of the causal parameter is positive but not statistically significant. Less clear is the effect due to potential externalities generated by the different intensity of subsidization of hotel's neighbours in the destination. However, the trend of the indirect effect over time, which is negative at time $t-2$, is consistent with a process in which the policy first generates positive externalities, but after that increases competition among hotels over time.

5. Concluding remarks

Whether or not industrial public policies have an effect on private firm performance and eventually on aggregate economic growth is still an open question. The main purpose of this paper was to contribute to the debate on policy evaluation by assessing the direct as well as the indirect effect of capital subsidies on firms' performance, especially micro and small firms in the hotel industry.

Evaluation with non-experimental data usually relies on two critical assumptions: the similarity of treated and control units (except for their treatment status; the Conditional Independence Assumption), and no interference between unit outcomes, i.e., an individual's outcome should not depend on other individuals' treatment status (the SUTVA assumption).

However, the most important consequence of the SUTVA assumption was that, if the policy generates externalities, their effect on hotel performance cannot be measured and the estimation is therefore biased. We tackled this issue by defining a new estimation framework which allowed for interference between hotels in the dynamic treatment setting. We found that SUTVA may be violated, since a hotel's potential outcomes depend on whether many or few hotels in its own destination are subsidised. In particular, when the proportion of subsidised firms is high, the effect on the potential outcomes of the focal hotel is negative, consistent with increased competition within destinations.

Our empirical results clearly indicate the need to focus research on interactions and spillovers in industrial public policies directed to private firms.

Some final remarks are necessary. The use of a dichotomous variable to measure the indirect effect of the policy has some limitations. For instance, it can lead to considering as equivalent a TD with treated firms only and a TD with a treated/non-treated ratio slightly above the median. In future works, the framework could be improved by considering continuous variable. Also, it remains open the issue of how to separate the effect due to spatial proximity of the hotels from the spillover effect associated with the subsidies. What should be done is then to clearly identify the net spatial effect of subsidies considering spillover effect that cannot be attributed to policy intervention (see e.g. De Castris and Pellegrini, 2012). Lastly, the analysis showed that the effect of time seems to be important: the longer is the period after which the effect is evaluated, the higher is the effect observed. In this regard widening the time-span of the analysis would be beneficial.

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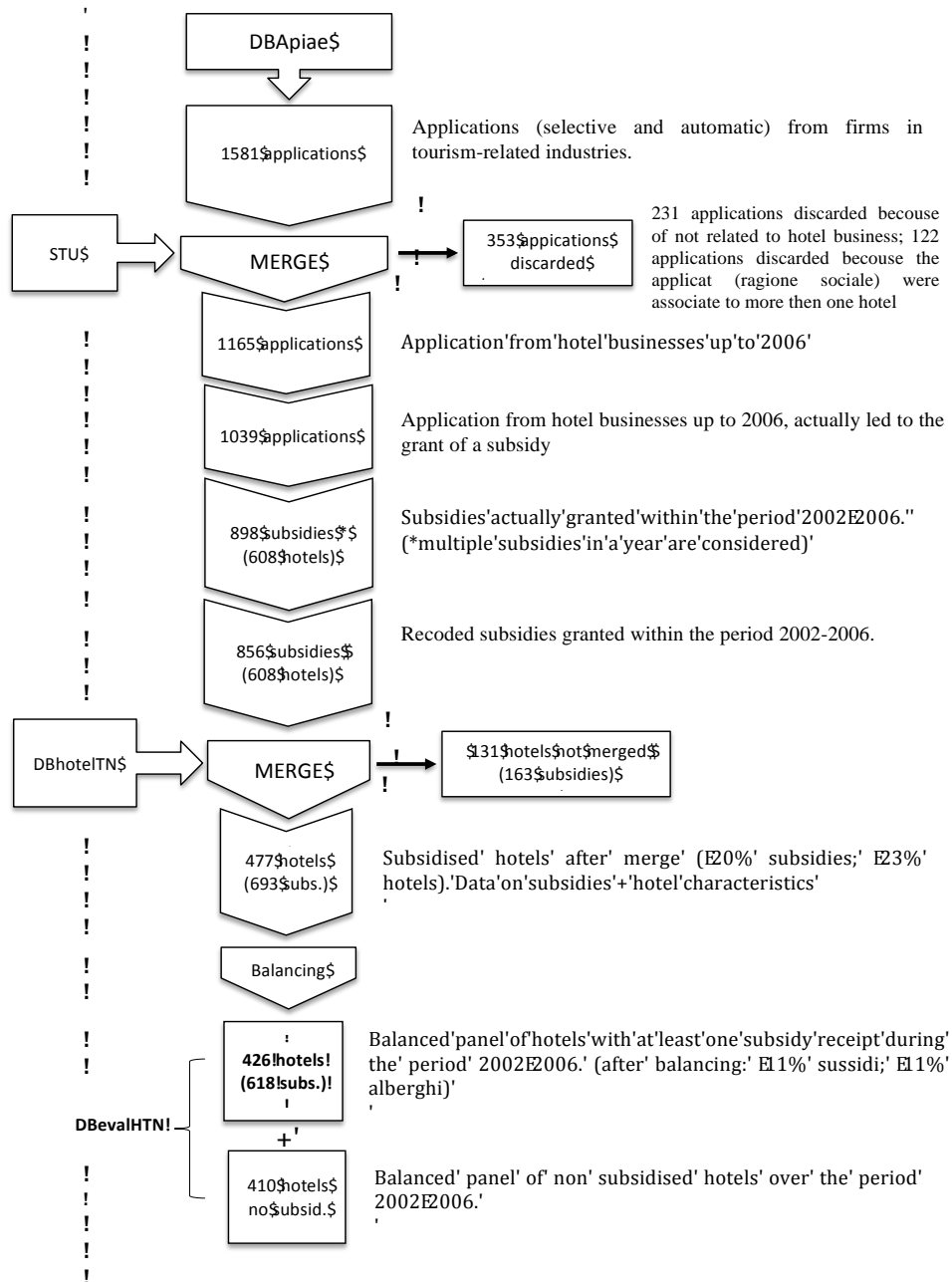
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Appendix

A: Database construction

Figure A.1. Construction of the final database (BDevalHTN)



The construction of the database unfolded in several steps (see also Figure 4.1):

1. We select all applications for subsidies submitted by firms in tourism-related industries in the Trentino province from 1999 to 2006. We identify 1518 applications.

- Data on these 1518 applications were merged with the hotels registered in the STU⁶. Records were merged with the tax code, and further checked against the name (the “ragione sociale”) and address of the hotel in question. This merging process allowed us to identify the applications related to a hotel business and made possible the subsequent merge with data contained in the DBhotelTN database. The merge was possible for 1165 applications (Table 4.1), while 353 applications were discarded⁷.

Table A.1. Selected applications: type of assessment procedure and final outcome

	granted	rejected	revoked	refused	other	n.a.	TOT
Automatic	745	75	13	0	2	13	848
	72%	95%	68%	0%	33%	93%	73%
	88%	9%	2%	0%	0%	2%	100%
Selective	294	4	6	8	4	1	317
	28%	5%	32%	100%	67%	7%	27%
	93%	1%	2%	3%	1%	0%	100%
TOT	1039	79	19	8	6	14	1165
	100%	100%	100%	100%	100%	100%	100%
	89%	7%	2%	1%	1%	1%	100%

- We focus only on applications which actually led to the grant of a subsidy: 1039 applications submitted by hotels up to the 2006.
- To evaluate the effect of a subsidy information before and after the treatment (the receipt of a subsidy) is needed. According to the LP6, investments linked to applications following the automatic procedure must be completed one year after the grant of the subsidy. Instead, investment associated with a selective procedure must be completed in the three years after the announcement of allowance of a grant. Unfortunately, our data did not contain exact information on the year of the beginning of the investment. Therefore, we made the following assumptions: for selective subsidies the year of subsidisation corresponds to the year in which the hotel receives a notification of allowance from the local government; for automatic subsidies the year of subsidisation is the one in which the application is filed. Following the above assignment rule, we identified 898 subsidies granted to hotel businesses in the period from 2002 to 2006 (see Table A.2).

⁶ The STU (Sistema Informativo del Turismo – Provincia autonoma di Trento) is the official register of hotel businesses in the Trentino Province managed by the Statistical Office of the local government. The register contains information for the entire population of hotel in the province.

⁷ Among the discarded applications, we identify some applications (122) where the applicant (ragione sociale) was associate to more then one hotel, making not possible the one-to-one matching. We identify 78 hotels potentially subsidised, which were escuded.

Table A.2. Number of grants directed to hotel businesses during the period 2002-2006.

Year	Number of subsidies	Hotel size			Average	Std. Dev.
		micro	small	other		
2002	332	269	63	0	42368.89	102576.3
2003	119	92	27	0	110181.6	228353.7
2004	137	102	35	0	109191.4	190736.2
2005	128	107	21	0	122794.5	211376.6
2006	182	136	44	1	218077.2	354520.1
Total	898	706	190	1	108698.6	228191.1

5. It can be the case that a hotel received more than one subsidy in a year. We consider a firm as treated if it received at least one subsidy in a given year. Accordingly, we recorded subsidies per year, ending up with 856 subsidisations (608 hotels) over the period 2002-2006.
6. After having identified the subsidised hotels, we merged the data with the DBhotelITN database. The merge (made on the STU internal code) was possible for 693 (about 80%) of subsidization events associated to 477 (78%) hotels. We selected only those hotels observed in each year within the period 2002-2006, hence a balanced panel structure (426 hotels; 618 subsidies). Although this choice can lead to the exclusion of some subsidised hotels, it allows to observe the temporal order of events and to control for time-invariant unobserved individual differences.

At the end of the whole process of merging and balancing, we obtained a balanced panel of 426 hotels that received at least one subsidy during the period 2002-2006. Table 4.3 shows the distribution of subsidies grants to hotels observed in the period for each tourist destination in the region. There is a discontinuity on the number of subsidy, especially after 2002, probably due to the fact that in 2001-2002 there was the first large wave of applications after the necessary period for the policy to become definitely operative.

Table A.3. Distribution of subsidies across touristic destination and year

TD	Tourism destination	2002	2003	2004	2005	2006	TOT.
1	Trento	9	3	1	2	6	21
2	Brenta-Paganella	16	13	14	7	12	62
3	Pinè-Cembra	6	0	3	0	4	13
4	Valle di Fiemme	16	6	6	7	8	43
5	Valle di Fassa	56	20	23	22	31	152
6	San Martino di Castrozza	11	5	4	5	9	34
7	Valsugana-Tesino	22	7	5	7	3	44
8	Folgaria	9	0	2	2	4	17
9	Rovereto	5	3	2	0	0	10
10	Garda	18	6	11	8	11	54
11	Comano-Brenta	6	2	1	5	2	16
12	Madonna di Campiglio	16	8	6	4	6	40
13	Valle di Sole	27	12	9	11	10	69
14	Valle di Non	5	1	5	5	1	17
o.d.	Places outside tourism destinations	10	4	5	4	3	26
TOT.		232	90	97	89	110	618

As final step, we add to the panel of subsidised hotels a panel of 410 hotels that did not received any subsidy (did not apply for subsidy) up to the 2006 contained in the DBhotelTN database. For all of these non-subsidised hotels we have the same type of information as for the subsidized ones. Therefore, we obtained a panel of 836 hotels (DBevalHTN database) for which we have data on the subsidisation status (subsidised vs non-subsidised), hotel characteristics, and outcomes of interest in each year within the period 2002-2006.

After the merging process we checked for possible selection due to the discarding of those hotels which lacked data for our evaluation purposes. We compared our sample with the whole population of hotel in terms of average size and spatial distribution. The data (see Appendix 4A) show that our final sample is representative of the hotel industry in the region.

B: Sample representativeness checks

After the merging and balancing process we checked for possible selection due to the discarding of those hotels which lacked data for our evaluation purposes. Table B.1 reports data on the variations of the spatial distribution of hotels in our final sample and for the population of hotels in the Trentino province. Data shows that the whole sample as well as the two subsamples of subsidised and non-subsidised hotels contained in the final database (DBevalHTN database) reproduce sufficiently well the spatial distribution observed in the population.

Table B.1. Distribution of hotels across destination (year, 2006)

TD	Population		DBevalHTN database										
	N. hotels	(1) ^a	Whole sample			Subsidised*				No-subsidised**			
N. hotels			(2) ^a	(1)-(2)	N. hotels	(3) ^a	(3)-(2)	(3)-(1)	N. hotels	(4) ^a	(4)-(2)	(4)-(1)	
1	49	3.06	16	1.91	1.15	11	2.58	-0.67	0.48	5	1.22	0.69	1.84
2	127	7.94	79	9.45	-1.51	40	9.39	0.06	-1.45	39	9.51	-0.06	-1.57
3	39	2.44	13	1.56	0.88	10	2.35	-0.79	0.09	3	0.73	0.82	1.71
4	103	6.44	54	6.46	-0.02	27	6.34	0.12	0.10	27	6.59	-0.13	-0.15
5	293	18.31	182	21.77	-3.46	102	23.94	-2.17	-5.63	80	19.51	2.26	-1.20
6	91	5.69	46	5.50	0.19	27	6.34	-0.84	-0.65	19	4.63	0.87	1.05
7	118	7.38	56	6.70	0.68	31	7.28	-0.58	0.10	25	6.10	0.60	1.28
8	80	5.00	44	5.26	-0.26	16	3.76	1.51	1.24	28	6.83	-1.57	-1.83
9	45	2.81	17	2.03	0.78	7	1.64	0.39	1.17	10	2.44	-0.41	0.37
10	156	9.75	83	9.93	-0.18	39	9.15	0.77	0.60	44	10.73	-0.80	-0.98
11	34	2.13	17	2.03	0.09	10	2.35	-0.31	-0.22	7	1.71	0.33	0.42
12	135	8.44	71	8.49	-0.06	29	6.81	1.69	1.63	42	10.24	-1.75	-1.81
13	145	9.06	81	9.69	-0.63	41	9.62	0.06	-0.56	40	9.76	-0.07	-0.69
14	77	4.81	30	3.59	1.22	14	3.29	0.30	1.53	16	3.90	-0.31	0.91
n.a.	108	6.75	47	5.62	1.13	22	5.16	0.46	1.59	25	6.10	-0.48	0.65
TOT	1600	100	836	100		426	100			410	100		

NOTE: *hotels that received at least one subsidy over the period 2002-2006; ** hotels that did not receive subsidies over the period 2002-2006; ^a values in percentage.

We further checked the representativeness of our sample by looking at the differences in the average size of the hotels included in the DBevalHTN database compared to the population. We measure firm size as number of rooms, an indicator widely used in the literature (Chung and Kalnins, 2001).

Table B.2 shows the number and average size of hotels for the population and for the sample and subsample (subsidised and non-subsidised) of interest, by tourism destination,. For the whole sample and each subsample, the last two columns show, respectively, the differences in the averages with respect to the population and the p-value associated with the t-statistic constructed to test the null hypothesis that the observed differences are not statistically significant. The results suggest that, with the exception of destination 9 (Rovereto area) the average size of hotels in the selected sample is not significantly different from those of the entire population. Table B.3 shows how the process of merging with the DBhotelTN did not changed the composition of the sample of subsidised hotels.

Table B.2. Comparison of size distribution of hotels in the DBevalHTN database with population (year 2006)

TD	Population		DBevalHTN database											
			Whole sample				Subsidised*				Not-subsidised**			
	N. hotels	Avg. rooms (1)	N. hotels	Avg. rooms (2)	Diff (2)-(1)	p-val	N. hotels	Avg. rooms (3)	Diff (3)-(1)	p-val	N. hotels	Avg. rooms (4)	Diff (4)-(1)	p-val
1	49	32.12	16	40.12	7.43	0.34	11	44.54	11.85	0.20	5	30.40	-2.29	0.85
2	127	29.48	79	32.69	3.21	0.18	40	35.82	6.34	0.05	39	29.49	0.01	0.99
3	39	20.77	13	25.23	4.46	0.21	10	25.10	4.33	0.25	3	25.67	4.88	0.49
4	103	27.48	54	29.75	2.27	0.41	27	34.11	6.62	0.07	27	25.41	-2.08	0.56
5	293	25.67	182	27.36	1.68	0.24	102	28.78	3.11	0.06	80	25.53	-0.13	0.95
6	91	21.11	46	29.24	3.13	0.31	27	32.22	6.11	0.11	19	25.00	-1.11	0.80
7	118	28.44	56	31.03	2.59	0.39	31	33.39	4.94	0.20	25	28.12	-0.32	0.94
8	80	24.76	44	26.34	1.58	0.61	16	27.37	2.61	0.56	28	25.75	0.98	0.78
9	45	22.47	17	33.23	10.76	0.02	7	36.28	13.81	0.04	10	31.10	8.63	0.12
10	156	29.85	83	34.08	4.23	0.20	39	35.69	5.83	0.17	44	32.66	2.81	0.51
11	34	27.73	17	26.70	-1.03	0.83	10	23.70	-4.03	0.51	7	31.00	3.26	0.64
12	135	23.99	71	28.29	4.30	0.10	29	32.17	8.17	0.03	42	25.62	1.62	0.60
13	145	34.64	81	32.13	-2.50	0.49	41	36.36	1.72	0.72	40	27.80	-6.84	0.17
14	77	23.28	30	26.63	3.35	0.29	14	25.71	2.42	0.56	16	27.43	4.15	0.31
o.d.	108	17.21	47	17.19	-0.02	0.98	22	18.81	1.60	0.47	25	15.76	-1.45	0.46

NOTE: *hotels that received at least one subsidy over the period 2002-2006 ; ** hotels that did not receive subsidies over the period 2002-2006

Table B.3. Impact of data merging and balancing on the distribution of observed subsidized hotels (year, 2006)

TD	Population		Subsidized hotels* Before merge with DBhotelTN				Subsidized hotels** After merge with DBhotelTN and balancing			
	N. hotels	Avg. rooms (1)	N. hotels	Avg. rooms (2)	Diff (2)-(1)	p-val	N.	Avg. rooms (3)	Diff (3)-(2)	p-val
1	49	32.12	15	41.67	-8.97	0.26	11	44.54	2.88	0.81
2	127	29.48	48	37.18	-7.71	0.01	40	35.82	-1.36	0.65
3	39	20.77	18	23.44	-2.67	0.38	10	25.10	1.65	0.62
4	103	27.48	36	32.94	-5.46	0.10	27	34.11	1.17	0.76
5	293	25.67	128	27.11	-1.44	0.35	102	28.78	1.67	0.29
6	91	21.11	35	31.68	-5.57	0.12	27	32.22	0.54	0.88
7	118	28.44	39	30.84	-2.40	0.49	31	33.39	2.54	0.60
8	80	24.76	18	26.72	-1.96	0.64	16	27.37	0.65	0.89
9	45	22.47	11	30.27	-7.81	0.16	7	36.28	6.01	0.53
10	156	29.85	55	35.47	-5.62	0.13	39	35.69	0.22	0.96
11	34	27.73	14	24.00	3.73	0.48	10	23.70	-0.30	0.96
12	135	23.99	41	31.41	-7.42	0.03	29	32.17	0.76	0.87
13	145	34.64	58	36.31	-1.67	0.70	41	36.36	0.05	0.99
14	77	23.28	22	22.50	0.78	0.82	14	25.71	3.21	0.47
o.d.	108	17.21	43	17.41	-0.21	0.90	22	18.81	1.40	0.55
TOT	1600		581				426			

NOTE: * start ups are not considered; ** subsidised hotels in the final database DBevalHTN