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What Do Street Names Tell Us? The "City-text" as Socio-cultural Data

By *Daniel Oto-Peralías*

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Keywords: Street names, city-text, quantitative empirical analysis, culture, religiosity, local-level analysis.
JEL Classification: O18, R19, Z12, Z13.

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I. Introduction

This paper shows that street names are a very useful source of information for quantitative empirical analysis in social sciences. Street names reflect the commemorative decisions of each municipality over time, and as such can be understood as the city's manifesto about its social, cultural and political values. In accordance with this view, this article proposes the use of the "city-text" (i.e., city toponyms interpreted as a text) as a source of information to create socio-cultural indicators at the local level. Given the scarcity of data at the city level, street names broaden the possibilities of empirical analysis. For instance, they allow creating indicators of religiosity, national identity, or male predominance at the local level –to mention just a few examples–, which are generally unavailable from other sources such as surveys or censuses. The city-text as a data source for constructing indicators is particularly convenient given the current emphasis among empirical researchers on the causes and consequences of culture (e.g., Guiso *et al.*, 2006, Alesina and Giuliano, 2015), and the advantages of working with city-level data, which help mitigate endogeneity problems.

A well-established geographic literature maintains that "the names we choose symbolize a great deal about our culture and view of the world" (Cooper et al., 2011, p. 460). The system of place names (or toponyms) configures the cityscape as a "'text' through which the commemorative priorities of a people can be read." (Rose-Redwood *et al.*, 2010, p. 460). These priorities represent a set of cultural and social values, as well as a version of history and hegemonic narratives of former periods. In this sense, street names express something important for the community –such as a well-known person, event or abstraction– that deserves to be commemorated by an inscription in the cityscape (Augustins, 2004). The use of street names for commemorative purposes is a core feature of modern political culture, and they can be considered markers of political identity (Azaryahu, 1996). It has been argued that "street names socialize space and celebrate cultural identity [… and] are significant cultural indicators" (Ferguson, 1988, p. 386).

This article brings together quantitative empirical methods and insights from the city-text literature to make a twofold contribution. First, we propose the use of street names as a source of information to create indicators of the population's attitudes and values. The rationale for this is that commemorative decisions in the form of street names arguably reflect the social reality and idiosyncratic characteristics of the local community. Second, we empirically show that an indicator of religiosity created from street names is indeed highly

correlated with the underlying factor it is supposed to measure, thus filling a gap in the literature on systematic evidence in this regard.

We use the Spanish case as an example to illustrate how the city-text can be used to create socio-cultural indicators, allowing us to discuss theoretical issues and propose a methodology for the construction of street-name indicators. More specifically, we provide an application of this methodology by creating an indicator of religiosity at the municipal level using a dataset of more than 700,000 Spanish streets in 2001. Interestingly, there is a close relationship between this indicator and the population's current religious attitudes. The correlation between our indicator of religiosity and a survey-based indicator of church attendance is above 50% at the provincial level, and highly statistically significant. In addition, municipal-level regressions show that the street-name indicator of religiosity is significantly associated with a lower incidence of separation and divorce and fewer *de facto* couples, with this result being robust to control for provincial fixed effects and a set of relevant control variables. Thus, this paper's results indicate that street names reflect a society's ingrained cultural characteristics, some of which are deeply rooted in history.

The use of street names as a data source broadens the possibilities of empirical analysis at the local level. Economics and other social sciences have recently placed more emphasis on this finer level of analysis (see, e,g., Trounstine, 2009). From an empirical point of view, the sample size increases dramatically when using municipalities (as does statistical power), and more importantly, endogeneity issues are better addressed at this level, as it allows the exploitation of within-regional variation. The utility of the city-text as a data source is particularly relevant for cultural variables, given the scarcity of data in this regard and the increasing interest in the role played by cultural factors in the economy (Guiso et al., 2006; Scott, 2004).[1] Thus, researchers can use street names to create indicators capturing the specific cultural, social and political values of local communities. Moreover, to the extent that the city-text reflects the history of towns and cities, street names can also be used to analyze the legacy of historical factors and past events.

Finally, the analysis of the city-text is, of course, not only interesting from the point of view of its utility to create indicators; while not the focus of this article, the city-text is also relevant to social scientists from several additional perspectives. The process of street naming is important in itself, and may have consequences for the population. This has

[1] There are a growing number of empirical studies on the interaction between culture and economics. See, for instance, Duranton *et al.* (2009), Falck *et al.* (2012), Maseland (2013), Nathan and Lee (2013), Bauernschuster and Falck (2015), Tubadji and Nijkamp (2015), Spigel (2016), and Guiso *et al*. (2016).

precisely been the focus of the critical literature on street names. The link between toponyms and the exercise of power has been extensively studied, particularly how political authorities use the former to promote particular views of history and national identity (Rose-Redwood *et al.*, 2010). According to Azaryahu (1996), "the main merit of commemorative street names is that they introduce an authorized version of history into ordinary settings of everyday life" (p. 312). Street names thus contribute to the (re)production of this narrative, becoming powerful instruments for legitimizing the sociopolitical order. Consider, for example, gender inequality and the historical marginalization of women in the public sphere. The overrepresentation of male names in the city-text not only reflects a historical and cultural fact, but also contributes to its perpetuation by making the presence of male names more "natural" in daily life.[2] Therefore, street names can also be used to explore the impact this symbolic infrastructure has on social behavior.

The remainder of the paper is organized as follows. Section 2 provides a brief overview of the related literature. Section 3 discusses theoretical and methodological issues related to the use of street names to create socio-cultural indicators, while Section 4 illustrates the construction of an indicator of religiosity at the local level using Spanish street maps. Section 5 explores other potential applications of street-name indicators to relevant topics in social sciences. Finally, Section 5 puts forward some implications and concludes.

II. Background and related literature

The practice of commemorating national personalities and events in the cityscape is a modern phenomenon. Even though naming places after important figures has existed since Antiquity (e.g., Alexandria), its widespread use began towards the end of the eighteen century in France. Traditionally, street names were vernacular, with a clear orientation purpose, and were associated with the local topography or history. During the French Revolution, however, the practice of using street names for political purposes became increasingly common, and other European countries subsequently followed the French lead. This practice was later included in the agenda of nation-building programs during the nineteenth century (Azaryahu, 1996). Today, commemorative street names are a familiar reality in many countries throughout the world.

[2] As a reaction to this, there are social movements promoting a more egalitarian presence of women in toponyms. An example is the Italian project "Toponomastica femminile" (for more details, see www.toponomasticafemminile.com).

Street names are normal features of the cityscape, but they carry a deep symbolic meaning. The city-text is a repository of the commemorative decisions made by the local authorities with the power to name streets. It is the product of the prevalent and hegemonic values in a determined community at a given time. This rich information can be studied from two complementary perspectives: the analysis of *place names* and the analysis of *place naming* (Giraut and Houssay-Holzschuch, 2016). The former focuses on the name itself, studying its origin and meaning, while the latter is related to the political dimension of commemorating; that is, the power relationships associated with the process of choosing and using names for political purposes.

Place name studies have investigated a variety of topics, including the reconstruction of settlement and migration histories (Arnold, 1977; Arge *et al*., 2005; Qian *et al*., 2016), the identification of past land uses (Conedera *et al*., 2007; Calvo-Iglesias *et al*., 2012), and regional and ethnocultural identity (Cooper *et al*., 2011; Fuchs, 2015; Weaver and Holtkamp, 2016). The crucial premise is that toponyms reflect a certain truth about social reality and history, and can therefore be used as a source of information to study different aspects of local communities and their interaction with time and space. Thus, place names can "be read as part of the official memory of a city or a nation, acting as evidence of social norms and values at a given time." (Hintermann and Pichler, 2015, p. 291). Weaver and Holtkamp (2016) state that "[p]lace names, or *toponyms*, are therefore traces of "cultural life" that reflect the thought processes of peoples in space–time" (p. 208; see also Loy, 1989). Similarly, Fuchs (2015) argues the utility of toponyms to trace the geographic contour of socio-cultural features. More specifically, place names "provide historical and cultural information on settlement patterns and allow insights into the status, character, and mindset of settlers, eponyms (name givers), and local residents", which help understand the culture that originated the names (Fuchs, 2015, p. 330).

Within this branch of literature, the work most closely related to this article from a methodological point of view involves the identification of regional identity through traces such as town and business names (Ambinakudige, 2009; Cooper *et al*., 2011; Fuchs, 2015; Liesch *et al*., 2015; Weaver and Holtkamp, 2016). Typically, researchers create indicators of regional identity by detecting and counting how many towns or businesses within a certain geographic area contain a specific word that can be related to a certain ethnocultural trait. For instance, Fuchs (2015) studies Germanic toponyms in the American Midwest, and calculates the proportion of Germanic place names at the county level. Interestingly, he finds a highly statistically significant correlation between the proportion of place names and ancestry data. Weaver and Holtkamp (2016) use toponyms and business names to investigate

the cultural geography of the Appalachian region in the US. They find a highly significant relationship at the county subdivision level between Appalachian place names and business names.

Although our research and these works share the use of a statistical analysis of toponyms to identify cultural patterns, this paper differs from the previous ones in many respects. We mainly focus on street names (rather than on other toponyms, such as town names or business names), and our aim is not to study regional identity, but to propose a methodology to create socio-cultural indicators at the local level, and prove the validity of this approach by analyzing the correlation between street-name indicators and the factors they are supposed to measure.

Place names can also be considered from the perspective of the process of assigning names (i.e., *place naming*). While not the focus of this article, it is worth briefly introducing some work in this area, because there are potentially interesting applications to quantitative empirical analysis. The research question here involves the procedures and interests in the place-naming process (Giraut and Houssay-Holzschuch, 2016). Generally speaking, this literature focuses largely on street names rather than on other types of toponyms, and the central issue is the political dimension of the naming process. As stated by Rose-Redwood *et al*. (2010), "the naming process sheds light on power relations –how some social groups have the authority to name while others do not– and the selective way in which such relations reproduce the dominance of certain ideologies and identities over others" (p. 462).

This question has attracted considerable attention because street names are considered to have strong symbolic power. In the view of Azaryahu (1996), commemorative street names are a "powerful mechanism for the legitimation of the sociopolitical order" (p. 311), whereby the source of their power lies in their naturalization of an official version of history by incorporating it into the common space of daily life. Thus, "the spatial configuration of historical street names defines a particular 'city-text' that pertains to a particular historical narrative" (Azaryahu, 1996, p. 324). Although frequently taken for granted, street names exert power over the public space by projecting the hegemonic discourses that legitimize the existing socio-political order and political authority (Tucci *et al*., 2011; Drozdzewski, 2014). In this way, street names contribute to the "ongoing cultural production of a shared past" (Azaryahu, 1996, p. 312). This power of street naming systems is reflected in the frequent renaming of streets that accompanies major political change (see, e.g., González Faraco and Murphy, 1997; Azaryahu, 1997; Light, 2004; Palonen, 2008; Drozdzewski, 2014).

Finally, there is a manifestly historical dimension in the analysis of street names. The current city-text is the outcome of a cumulative inscription process over a long period of time, whereby street-name indicators also reflect features of this long-term process.[3] This historical dimension of the city-text is clearly manifested in the literature. In his analysis of Paris and Evora, Augustins (2004) observes that social groups are strongly attached to their place names, which makes them persistent. Thus, and particularly in old cities, street names tend to remain unchanged. Likewise, Azaryahu (1996, p. 326) states that "[u]nless renamings were undertaken, a city-text would conserve notions and attitudes that prevailed in the different stages of its emergence". Tucci *et al*. (2011) show, for the case of Milan, the coexistence of fragments from its long history inscribed into the city-text. Interestingly, Conedera *et al.* (2007) argue that many toponyms have very old origins (even pre-Roman in Europe's case), and can therefore be considered historical records reflecting cultural heritage in a broad sense.

III. Street names as a data source for socio-cultural indicators

3. 1. Theoretical considerations

This section discusses certain theoretical and methodological issues related to the creation of socio-cultural indicators from street names, and we begin by focusing on the assumptions involved. In a nutshell, the basic argument underscoring this paper is as follows: the current system of street names is the result of a long process of commemorative decisions, and so the city-text reflects the commemorative priorities of the local community (Rose-Redwood *et al*., 2010). As these priorities are arguably the expression of social and cultural values, street names can be used as meaningful socio-cultural indicators. More formally, the suitability of street names as socio-cultural data depends on whether the following assumptions are satisfied:

Assumption (1) Street names are the result of commemorative decisions made by those with the authority to name.

Assumption (2) Authorities' decisions reflect the commemorative priorities of the local community.

Assumption (3) Commemorative priorities reflect social and cultural values.

It is evident that these three assumptions cannot be taken for granted. To begin with, *Assumption (1)* contains the precondition that streets are labeled with words ("names").

[3] Street names –even in the case of new inscriptions– are also the result of historical processes of cultural creation.

However, this is not necessarily the case, as streets may follow an alphanumeric system, which is common in US cities. Once this precondition has been satisfied, street names must be the result of commemorative decisions. This is not always the case either. Street names can be vernacular, as they were until the Modern Age, and only convey an orientation purpose. Vernacular –or autochthonous– names are those bearing specific local references which only make sense for the local community (González Faraco and Murphy, 1997). Finally, the last part of *Assumption (1)* (i.e., "by those with the authority to name") can be considered tautological, and is therefore always met. Decisions are obviously made by those with the authority to do so. We include it to better link *Assumption (1)* to the next assumption.

Assumption (2) refers to how democratic and open the naming process is. The assumption is met to the extent that the decision-making process is democratic and decentralized at the local level. If the authority to name is a prerogative of the local council, and it has been democratically elected, one expects that commemorative decisions will ultimately reflect the priorities of the local community. Completely different is the case in which the right to name belongs to the central government or to a non-democratically elected local ruler, as street names will then reflect their own particular commemorative priorities.

Regarding *Assumption (3)*, it is generally accepted in the literature that toponyms reflect the local culture, and that they can be used to study it (e.g., Augustins, 2004; Conedera *et al*., 2007; Weaver and Holtkamp, 2016). For example, a Christian community with a strong religious sentiment arguably tends to name more places after Christ, saints, etc. Likewise, communities characterized by a strong attachment to the nation are more likely to commemorate national symbols and heroes.

Before using street names to construct socio-cultural indicators, it is important to examine whether the previous assumptions are met. *Assumption (1)* can be checked by using local institutional knowledge and by analyzing the nomenclature system used to name streets in a sample of municipalities within the area of study. Importantly, not all streets must meet this requisite. It suffices if a significant percentage of streets have commemorative names. With respect to the validation of *Assumption (2)*, it can be done by analyzing the formal process of street naming; that is, who has the prerogative (i.e., who the authority is) and how it is elected. Finally, *Assumption (3)* can be validated by comparing indicators created from street

names with other indicators capturing the underlying variable that the researcher seeks to measure.[4]

3. 2. Methodological considerations

Street-name indicators can be easily created through the following formula:

$$Ind_1 = \frac{S}{N} \qquad \textit{Formula (1)}$$

where *S* refers to a variable counting the number of streets whose names contain a particular *search text* or keyword from a list of specific words or expressions, and *N* is the total number of streets in a municipality. The list of words or expressions for calculating *S* must be related to the socio-cultural factor that we want to measure. When creating a list of words, it is important to avoid potential biases by using methods that are not influenced by researcher subjectivity. Since the number of streets containing a *search text* is directly proportional to how many streets there are in a city, it is crucial to normalize according to the total number of streets (*N*).[5]

A relevant methodological observation involves measurement errors. The main notion that this paper conveys is the use of street names to create indicators for quantitative analysis for a large cross-section of municipalities. This implies that the procedure for identifying and quantifying the *search text* should be as automatic as possible, so an individualized analysis of the streets for each city is unfeasible. Due to the virtually infinite number of possibilities in street names, it is impossible to take into account every potential name, and therefore measurement errors are always present. However, to the extent that these errors are not systematically related to a confounding factor, they will only produce a downward bias. The regression estimates when using street-name indicators can therefore be interpreted as a lower bound. Furthermore, these measurement errors imply that street-name indicators

[4] An analysis of the correlation between street-name indicators and the underlying socio-cultural factor helps validate *Assumptions (1)* to *(3)* simultaneously. The reason is that a strong relationship in this regard means that commemorative street names reflect the priorities of the local population, which –in turn– reflect their cultural values.

[5] In the literature that uses business names to study regional and ethnocultural identity, it is also common to standardize by the total number of cases. This is generally done by dividing the variable that counts the number of business names containing the *search word* (e.g., "Dixie" or "Appalachian") by the number of businesses containing the word "American", which is a proxy for the total number of businesses (Reed, 1976; and more recently, Ambinakudige, 2009; Cooper and Knotts, 2010; and Cooper *et al.*, 2011).

should be used preferably for comparative purposes across municipalities, but they are not as appropriate for making claims about absolute values for specific municipalities.[6]

IV. Street-name indicators: Measuring religiosity in Spanish Municipalities

4. 1. Data preparation and preliminary text analysis

This section illustrates the creation of socio-cultural indicators from street names for the case of Spain, and analyzes their validity. Spain is a good case study because its streets largely satisfy the first two assumptions in the previous section. Commemorative streets are very common in Spain, and it is the local council's prerogative to name streets, with these councils being democratically elected since 1979. Consequently, municipalities have had enough time to change their street names whenever necessary to adapt them to the social and cultural values of the current population.

Regarding data on street names, we use the *2001 Electoral Census Street Map* provided by the Spanish Statistics Office (INE, 2016a). This dataset contains a list of Spanish streets in July 2001, indicating their name, type (avenue, street, square, etc.), and municipal code. There are a total of 730,082 streets in the dataset. Before using it to construct indicators, the data need to be prepared and refined: i) repeated street names in the same municipality are removed, which reduces the number of streets to 701,429; ii) the text is converted to lowercase, and accents are removed to streamline the text search process; iii) a blank space is added at the beginning and end of each street name, which reduces potential confusions when identifying words;[7] and iv) 83 streets with missing data are removed, whereby the total number of streets in the sample is 701,346.

Figure 1 takes a first look at the data through a word cloud representing the most frequent words that appear in our dataset of Spanish street names.[8] It clearly reflects the importance of religion, as the most frequent word is by far "san" (i.e., "saint"). The second one (i.e., "cortijo") can be considered vernacular because it refers to a type of farm that is widespread in Southern Spain. The third one is again a religious word, while the fourth refers to a male

[6] Measurement errors have more severe consequences for small municipalities than for large ones. The denominator –*N*– in *Formula (1)* is smaller, and so a variation in *S* due to an error will produce a larger variation in the indicator than for large municipalities.

[7] To illustrate this point, consider that we are interested in counting the number of streets containing the forename "Juan" (i.e., John in English) and suppose there is a street containing the name "Juana" (i.e., feminine of Juan). If we simply search for "Juan", we count the street name "Juana" as having the search text. By contrast, if –as explained above– we add a blank space both to the street name and to the search text, now " Juan " is not contained in " Juana ".

[8] Articles and other very frequently used words (i.e., prepositions) are excluded.

forename. Simply reading the first few lines of the word cloud suffices to create a picture of some of the main characteristics of Spanish street names: predominant commemorative purposes, the importance of religion, and the higher proportion of male names over female names. It is useful to repeat this visual analysis for each one of the Spanish regions in order to obtain a more accurate picture of regional differences and common features.

[Insert Figure 1 about here]

The next step is to conduct a preliminary text analysis of the list of street names. It is important for several reasons: i) to discover the most frequent types of names in the geographic area of study, ii) to create lists of words capturing the socio-cultural dimensions we want to measure, while avoiding researcher bias, and iii) to check whether street names are used for commemorative purposes, and therefore whether *Assumption (1)* above is met.

We conduct the preliminary text analysis as follows. First, we extract the 200 most frequent words appearing in the street names in each one of Spain's seventeen self-governing regions –Autonomous Communities–, provided that the frequency of a word is above 10. By doing so for each region separately we ensure that we collect information for all of them, which is particularly important given the fact that some regions have vernacular languages. We compile the whole list of words and remove any repetitions, rendering a total of 1,188 words. Second, we check both the meaning of each word and the function it generally performs in street names in order to classify the words into categories, such as "religious", "surname", "male forename", "female forename", "illustrious people", etc. Accordingly, a word categorized –for example– as "religious" allows us to identify whether a street has a religious name. Third, we distinguish between categories associated with commemorative street names and those associated with vernacular street names. Finally, we count how many streets contain each word, which allows us to estimate the relative importance of each category.

Table 1 shows the results from this analysis. Panel A presents the list of categories associated with commemorative street names. There are 53 words with religious meaning (out of 1,188 words analyzed), and 65,625 streets that contain any one of these religious words (columns 1 and 2). There are 155 words corresponding to surnames, and 46,297 streets containing any one of these surnames; etc. It is important to note that the total values reported at the bottom of Panels A and B do not correspond to the sum of values in columns (2), (3) and (4). This is because the same street name may contain –for example– both a religious word and a male forename (e.g., "San Juan"), so it is counted separately in each individual category, but when adding up all the categories the street is counted only once.

For this reason, the sum of the number of streets reported for each category in column 2 is larger than the total.[9]

[*Insert Table 1 about here*]

Regarding the relative importance of each category, religiosity is a highly significant cultural factor, accounting for around 30% of the total number of commemorative streets and 16% of the total number of streets (Panels A and B). It is also interesting to look at male and female names. The ratio of male to female forenames is as high as 6.2 (i.e., 91,809/14,733). However, this does not accurately capture the overrepresentation of men in street names. When we consider that the words included in categories such as "professions" and "illustrious people" –among others– almost always refer to male individuals, the male/female ratio increases to 7.6. Yet this ratio is higher (9.3) when we exclude streets related to religious figures, since their proportion is higher among streets with female names.

It is also important to note that according to this preliminary analysis the number of commemorative streets is larger than the number of vernacular streets. This indicates that commemorative streets are a widespread phenomenon in Spain, and consequently *Assumption (1)* above holds. Finally, at the bottom of Table 1 it is reported that 408,585 streets contain any one of the 1,135 words classified as commemorative or vernacular. This indicates that by analyzing the 200 most frequent words in the street names of each region we have been able to account for almost 60% of all Spanish streets (i.e., 408,585/701,346), which means that the preliminary text analysis conducted is effective in capturing the characteristics of the Spanish city-text, and can therefore be used as a guide for the construction of socio-cultural indicators.

4. 2. A street-name indicator of religiosity

Religious attitudes are a key cultural factor that has attracted considerable interest from social scientists since Weber's seminal work on the cultural origins of Capitalism (Weber, 1976 [1904-1905]; see e.g., Guiso *et al.*, 2003; Barro and McCleary, 2003; Becker and Woessmann, 2009; Cantoni, 2015). However, indicators measuring religiosity are generally not available at the city level, particularly for a large sample of municipalities. In what

[9] Words are classified into categories according to their meaning and, importantly, according to the primary function they actually perform in street names. We have therefore revised the list of street names containing each word to check whether the classification is valid. When a word is impossible to classify because –for instance– 50% of the times it works as vernacular and the other 50% as commemorative, we include it in *Panel C* ("non-classified"), which also contains conjunctions and single letters.

follows we use street names to construct an indicator of religious attitudes at the local level that can be used as a proxy for this cultural factor.

Cities and towns differ in the prominence they give to religion in the cityscape. If we assume that municipalities with a higher percentage of streets named after religious figures (or associated with religious events or symbols) give more importance to religion than municipalities with a lower percentage, then street names can be used to create an indicator of religiosity. The indicator is defined as follows:

$$Relig = \frac{R}{N} \times 100 \qquad \textit{Formula (2)}$$

where the numerator –*R*– captures the number of streets containing a word from a list of religious terms (e.g., "San" [Saint], "Virgen" [Virgin], etc.), while the denominator –*N*– refers to the total number of streets in each municipality. We take the list of religious words from Table 1 (i.e., 53 words) to avoid potential researcher bias, which could easily be introduced if we created a list of religious words that "we think" are most likely to be used in street names.[10] Naturally enough, this methodology produces measurement errors in the numerator of *Formula (2)*. It is virtually impossible to create a comprehensive list of all potential religious words that can be used in street names. However, to the extent that errors are not systematic, *Relig* is a valid indicator to compare this cultural factor across municipalities.

Bearing in mind the previous caveats, there are 65,625 religious streets. The proportion of religious streets is on average 11.77% across municipalities. Figure 2 shows the distribution of the variable along with the kernel density estimation. It is relatively close to a normal distribution, albeit skewed. To avoid an excessive influence of observations with very high values in religiosity, we exclude 53 observations with values higher than 50% in the municipality-level analysis conducted below. Figure 3 shows the geographic distribution of this indicator, with higher values of religiosity being found along Spain's northern meseta and on the western reaches of the Pyrenees.

[Insert Figures 2 and 3 about here]

Is the street-name indicator of religiosity really capturing the intensity of the population's religious sentiment? It is not easy to analyze the validity of this indicator –and consequently whether *Assumption (3)* above is met– due to a lack of data, particularly at the local level. One possibility is to aggregate street-name data at the provincial level in order to compare it

[10] This is because the resulting list would reflect words that are familiar to us, thereby creating a bias.

with a survey-based indicator of religiosity, which can be constructed at this level. This indicator measures the percentage of people attending religious services at least once a month (CIS, 2005). Figure 4 shows the provincial values of both indicators of religiosity for visually comparing whether high values in both indicators tend to overlap. In general, this appears to be the case, and indeed the correlation is strong ($\rho = 0.52$), and highly statistically significant (*p-value* < 0.000). This suggests that the street-name indicator accurately captures the population's religious attitudes. Table 2 reports further evidence on the strength of this relationship, which is robust to the inclusion of: i) GDP *per capita*, which may be a relevant confounding factor; ii) latitude, which controls for the North-South gradient in Spain; iii) the percentage of landless workers in 1797 as a proxy for historical inequality, which has been a very important factor in Spain's development (Oto-Peralías and Romero-Ávila, 2016); and iv) four dummy variables measuring whether the region has a second official language besides Spanish, which control for the cultural and linguistic particularities of these territories. Remarkably, the coefficient on the street-name indicator remains positive and highly statistically significant in all cases.

[Insert Figure 4 about here]

[Insert Table 2 about here]

It has been argued in previous sections that street names, as marks of cultural heritage, also capture the history of the population. Therefore, we would expect a positive association between religiosity in the past and the percentage of religious streets today. Following Oto-Peralías and Romero-Ávila (2016), we measure religiosity in the past as the percentage of population that was a member of the clergy (both secular and regular) at the end of the eighteenth century. Table 3 shows that this indicator of religiosity in the past is strongly and positively associated with our street-name indicator, both at bivariate level and when including control variables. All these results suggest that the street-name indicator actually captures the population's religious attitudes, and that in turn it is partially determined by a long historical process.

[Insert Table 3 about here]

Although the previous evidence seems convincing, it is still possible to argue that some unobservable province-level characteristics are driving the results. To address this concern, we test for the existence of a relationship between the street-name indicator and religious attitudes at the municipal level. This approach allows us to include province dummies to exclusively exploit within-province variation. However, a disadvantage here is the lack of specific indicators on religious attitudes, so it is necessary to use proxies. In this regard, the

ratio of separated and divorced people to married ones is a suitable proxy, as the doctrine of the Catholic Church (by far the predominant religion in Spain) is against separation and divorce (Lehrer, 2004).

Column 1 in Table 4 shows a highly significant and negative bivariate relationship between the previous ratio and the street-name indicator of religiosity.[11] Column 2 includes province fixed effects to control for all idiosyncratic province-level characteristics. The size of the coefficient decreases, but it remains highly statistically significant. Thus, within provinces, municipalities with a higher percentage of religious streets tend to have a lower incidence of separation and divorce. Columns 3 to 5 control for other relevant confounding variables, such as population, geographic factors, and demographic and socio-economic indicators. Notably, the coefficient remains negative, similar in size, and highly statistically significant. Column 6 restricts the sample to municipalities with more than 1,000 inhabitants. This is a way of mitigating the impact of measurement errors, as errors in identifying and quantifying religious streets have more severe consequences in small municipalities, where both the numerator and denominator in *Formula (2)* are smaller. It is reassuring that the effect of religiosity is now stronger, which is to be expected, as measurement errors generally create a bias toward zero. As a final check, we replicate the previous analysis using as dependent variable the percentage of *de facto* couples, which is also "anti-religious" behavior, as reflected by the expression "living in sin". The results are fully consistent with the previous ones.[12]

[Insert Table 4 about here]

In sum, this section has shown that a street-name indicator of religiosity can actually capture the underlying cultural variable it is supposed to measure. Thus, this econometric exercise provides support for *Assumptions (1)* to *(3)* for the case of Spanish street names, thereby indicating that the city-text is a valuable source of social and cultural data for municipalities. This broadens the possibilities of the quantitative empirical analysis of cultural factors at the local level. The evidence on the validity of the indicator also contributes to the extant literature on street names by empirically supporting the hypothesis that street names reflect the local culture.

[11] As indicated above, we exclude a few observations with values higher than 50% in the indicator of religiosity to avoid these outliers exerting an excessive influence on the coefficient.

[12] These additional results, along with the descriptive statistics and sources of all the variables used in the article, are presented in the Supporting Information.

V. Other potential applications: Some examples

This section briefly illustrates the versatility of street names to investigate other relevant topics that have attracted considerable interest from social scientists in recent years, including gender roles, national identity, and transitional justice.

5.1. Gender roles

Cultural values regarding gender roles constitute a central topic for social and economic development (e.g., Duflo 2012; World Bank, 2012). However, indicators measuring this factor are generally unavailable at the city level, particularly for a large sample of municipalities. Street names allow the construction of indicators of male predominance that can be used as a proxy for attitudes about the role of women in society. An indicator of male predominance can be defined as the percentage of streets with male names over the total number of streets with male and female names. An important issue here is to collect a list of male and female names. We use the 1,000 most common forenames in both genders in Spain (INE, 2016b), and then complement the list with the names collected in Table 1.[13] Figure 5 shows the geographic distribution of the indicator's values. At the national level, the percentage of streets named after men over the total named after men and women is 83.1%. If streets named after religious figures are removed, the percentage increases to 86.8%, which is a value close to that found in other studies that focus on specific cities[14]. Notable differences are observed in the figure both across provinces and within provinces, which suggests that an analysis at the local level could be fruitful to know more about the effect gender role attitudes have on socio-economic outcomes.

[Insert Figure 5 about here]

5.2. National identity

Political identity and, more particularly, national identity are key political phenomena. National identity is one of the main factors of personal attachments (Rodrik, 2013), and can foster civic involvement (Huddy and Khatib, 2007). Local communities commemorate symbols, dates, and events related to the nation they are part of in order to proclaim and emphasize their sense of belonging and identity. Therefore, street names can be used to study the intensity of national political identity. To illustrate this, we construct a street-name

[13] See the Supporting Information for details about the construction of this indicator and the others used in this section.

[14] For example, the percentage of streets commemorating a woman in Vienna is about 10% of all streets commemorating a person (see Hintermann and Pichler, 2015, and references therein).

indicator measuring the intensity of Spanish identity at the municipal level by calculating the percentage of streets that contain words related to "Spanishness". Figure 6 shows the geographic distribution of values. According to this indicator, municipalities in southern Spain tend to show a stronger Spanish identity, as does the region of Aragon (specifically the province of Zaragoza) in the north. By focusing on the local level, the study of the causes and consequences of national identity could help to provide new insights and evidence.

[Insert Figure 6 about here]

5.3. Memory, transitional justice, and law enforcement

An important topic in the literature on street names has been the use that political regimes make of the public space to commemorate their martyrs, heroes, and glorious events in order to promote particular notions of national identity and history (Rose-Redwood *et al*., 2010). In this regard, the study of historical memory and attitudes toward transitional justice is an interesting application of street-name indicators. Concerning the Spanish case, in 2001 there were more than 2,000 streets commemorating figures or events related to Franco's dictatorship, and more than 1,000 municipalities had at least one such street. Figure 7 shows the geographical distribution of values of the percentage of Francoist streets.

The presence of Francoist symbols raises the question of why so many municipalities still retain them in the twenty-first century. In other words, what factors explain the lack of support for simple measures of transitional justice such as the removal of Francoist symbols from the streets?[15] In addition, it would be interesting to study the impact of Spain's *2007 Law of Historical Memory*, according to which government entities must remove Francoist symbols from the public space. As there are still today at least 1,237 streets with Francoist names,[16] one can investigate the factors affecting the enforcement of this law, which is a relevant question for scholars interested in law enforcement in general.

[Insert Figure 7 about here]

VI. Conclusions

The wealth of information contained in street names has largely been ignored by quantitative empirical research. Street names are the result of historical processes, and reflect

[15] See Aguilar *et al.* (2011) for a survey-based study of the determinants of attitudes toward transitional justice at the national level in Spain.

[16] This figure corresponds to the *January 2016 Electoral Census Street Map* (INE, 2016a), and has been calculated using the same list of words as for 2001. These 1,237 Francoist streets are distributed across 688 municipalities. See more details in the Supporting Information.

the population's commemorative priorities (Rose-Redwood *et al*., 2010). They can be interpreted as a text from which we can read their social and cultural values. According to this view, this paper proposes the use of the city-text as a data source for constructing socio-cultural indicators for quantitative empirical analysis in social sciences. Given the scarcity of data at the city level, street names broaden the possibilities of empirical analysis. This is particularly convenient given the current emphasis on the causes and consequences of culture, and the advantages of working with city-level data.

After discussing theoretical and methodological issues, we apply this paper's premise to the construction of an indicator of religiosity. Empirical evidence at the provincial and municipal level shows that our street-name indicator can capture the population's religious attitudes. This suggests that street names actually reflect the local community's social and cultural values. We further illustrate the versatility of street-name indicators in a variety of relevant topics, such as gender roles, national identity, and transitional justice.

The use of street names as a data source to create cultural indicators at the local level opens many possibilities for empirical analysis, including the study of the potential consequences on individuals' behavior. However, researchers should be careful when doing so. It is important to familiarize oneself with the main features of street names in the area of study, to check whether the assumptions discussed above are likely to be met, and to be aware of the implications of measurement errors. This article is a first approximation to this issue, and more work is needed to refine the theory and methodology behind the use of street names in quantitative empirical analysis.

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Table 1. Preliminary text analysis of Spanish street names

	Number of words	Number of streets containing words included in each category	Percentage of streets	
			over the respective panel	over the total
	(1)	(2)	(3)	(4)
Panel A: Commemorative words				
Categories:				
Religious	53	65,625	29.5%	16.1%
Surname	155	46,297	20.8%	11.3%
Male forename	115	91,809	41.3%	22.5%
Female forename	22	14,733	6.6%	3.6%
Illustrious people	71	20,424	9.2%	5.0%
Professions	16	14,588	6.6%	3.6%
Crown and aristocracy	11	8,281	3.7%	2.0%
Regions and countries	85	25,025	11.3%	6.1%
Other commemorative	24	11,282	5.1%	2.8%
Total	**552**	**222,124**	**100.0%**	**54.4%**
Panel B: Vernacular words				
Categories:				
Urban geography	158	62,245	33.4%	15.2%
Rural geography	139	67,599	36.3%	16.5%
Geography (generic)	114	10,766	5.8%	2.6%
Nature	41	18,551	9.9%	4.5%
Other vernacular	131	48,557	26.0%	11.9%
Total	**583**	**186,461**	**100.0%**	**45.6%**
Total commemorative and vernacular	**1,135**	**408,585**		**100.0%**
Panel C: Nonclassified	**53**	**8,289**		

Notes: This analysis is conducted using the 200 most frequent words in the street names of each Autonomous Community, provided that the frequency of a word is at least 10. Totals in columns (2), (3) and (4) do not correspond to the sum of values corresponding to all categories. This is because the same street name can contain words from several categories, so it is counted separately in each row, but when adding up all categories the street is counted only once. When the same street name contains both a commemorative and a vernacular word, it is considered that the commemorative character prevails and, consequently, the street is considered commemorative. The category "geography" refers to broad geographic features that are not specifically related to the urban or rural world. Panel C contains polysemic words, conjunctions, prepositions, and single letters.

Table 2. Street-name indicator of religiosity: Assessing validity at the province level (I)

Dependent variable is Percentage of people attending the Church every month

	(1)	(2)	(3)	(4)	(5)	(6)
Street-name indicator of religiosity	2.124***	2.186***	2.007***	2.103***	2.253***	1.856***
	(0.545)	(0.553)	(0.534)	(0.521)	(0.614)	(0.588)
GDP pc 2001		-0.5				-0.301
		(0.374)				(0.476)
Latitude			0.551			0.064
			(0.341)			(0.426)
Historical inequality				-0.137***		-0.185*
				(0.049)		(0.1)
Catalan					-8.986*	-7.075
					(5.025)	(6.279)
Valencian					-10.67***	-11.363***
					(3.35)	(3.236)
Basque					-0.51	-6.67
					(2.742)	(4.714)
Galician					4.987	-4.02
					(4.303)	(5.596)
R-squared	0.27	0.30	0.30	0.34	0.40	0.46
Observations	50	50	50	50	50	50

Notes: Variables descriptions are provided in Table A1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** denote significance at the 10, 5 and 1 % level, respectively.

Table 3. Street-name indicator of religiosity: Assessing validity at the province level (II)

Dependent variable is Street-name indicator of religiosity

	(1)	(2)	(3)	(4)	(5)	(6)
Religiosity in the 18th century	2.802***	2.784***	2.74***	3.238***	2.162**	1.947*
	(0.748)	(0.718)	(0.773)	(0.835)	(1.039)	(1.104)
GDP pc 2001		0.013				0.087
		(0.107)				(0.214)
Latitude			0.136			0.166
			(0.085)			(0.138)
Historical inequality				-0.026		-0.033
				(0.016)		(0.035)
Catalan					-1.717**	-2.404
					(0.753)	(1.748)
Valencian					1.208	0.689
					(1.322)	(1.298)
Basque					-2.168*	-4.609**
					(1.179)	(1.806)
Galician					-2.283**	-4.01**
					(1.021)	(1.979)
R-squared	0.21	0.21	0.23	0.24	0.32	0.46
Observations	50	50	50	50	50	50

Notes: Variables descriptions are provided in Table A1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** denote significance at the 10, 5 and 1 % level, respectively.

Table 4. Street-name indicator of religiosity: Assessing validity at the municipality level

Dependent variable is Ratio separated and divorced to married people

	(1)	(2)	(3)	(4)	(5)	(6)
Street-name indicator of religiosity	-0.0465***	-0.0187***	-0.0178***	-0.0174***	-0.0145***	-0.0379***
	(0.01)	(0.006)	(0.005)	(0.005)	(0.005)	(0.008)
Population in 2001			0.0146***	0.014***	0.0112***	0.0082***
			(0.002)	(0.002)	(0.002)	(0.002)
Population in 2001 squared			-0.000005***	-0.000005***	-0.000004***	-0.000003***
			(0.000)	(0.000)	(0.000)	(0.000)
Altitude				-0.0005*	-0.0003	-0.0012***
				(0.000)	(0.000)	(0.000)
Quadratic polynomial in latitude and longitude				[0.0250]	[0.2612]	[0.5983]
Average age					-0.0208	-0.0213
					(0.013)	(0.026)
Education					2.2357***	6.0709***
					(0.556)	(1.004)
Average socioeconomic condition					2.6311***	0.6271
					(0.514)	(0.848)
Province fixed-effects		Yes	Yes	Yes	Yes	Yes
R-squared	0.02	0.32	0.33	0.33	0.36	0.65
Observations	8,023	8,023	8,023	8,023	8,023	3,128

Notes: Variables descriptions are provided in Table A1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors clustered at the province level are in parentheses. The p-values of the joint significance test for the quadratic polynomial in latitude and longitude are in brackets. *, ** and *** denote significance at the 10, 5 and 1 % level, respectively.

Figure 1. Word cloud of the most frequent words in Spanish street names

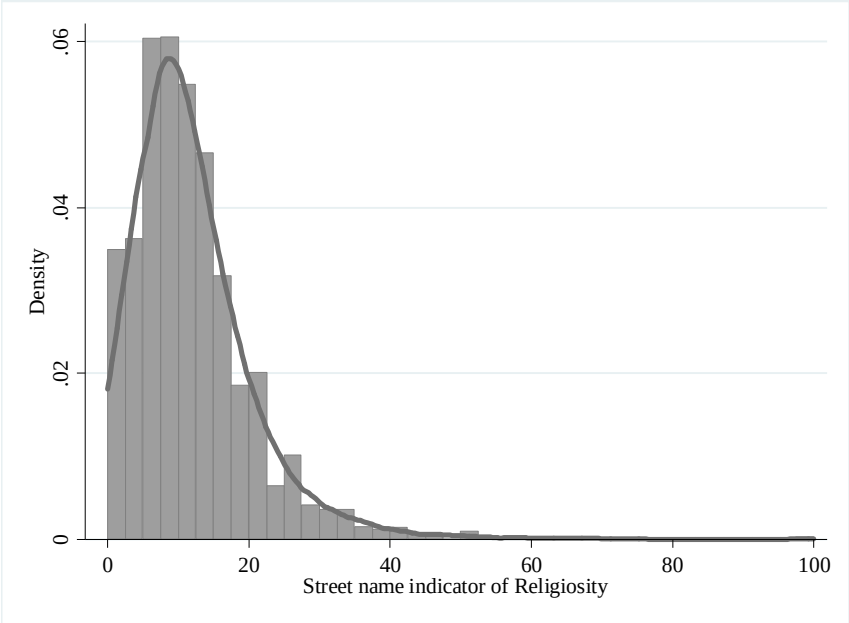


Figure 2. Distribution of the street-name indicator of religiosity

Note: Epanechnikov kernel function used; bandwidth equal to 2.5.

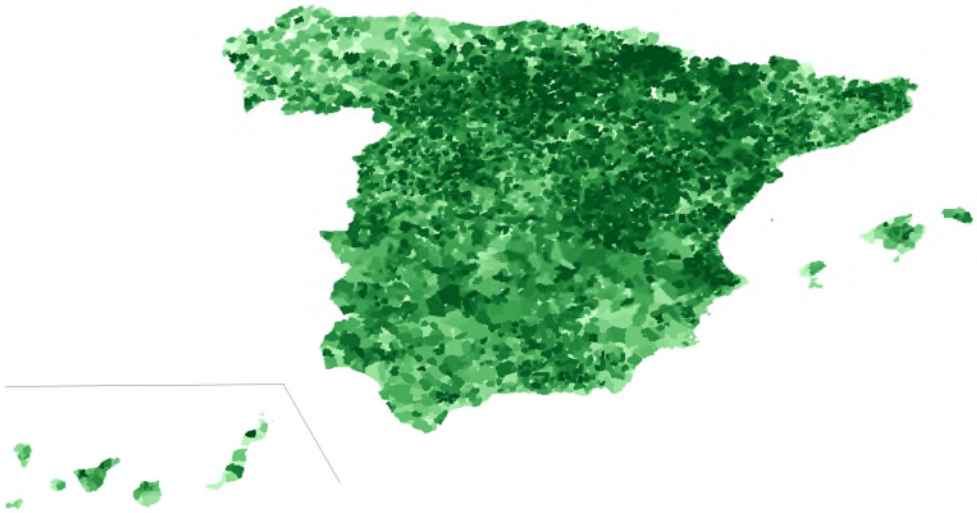
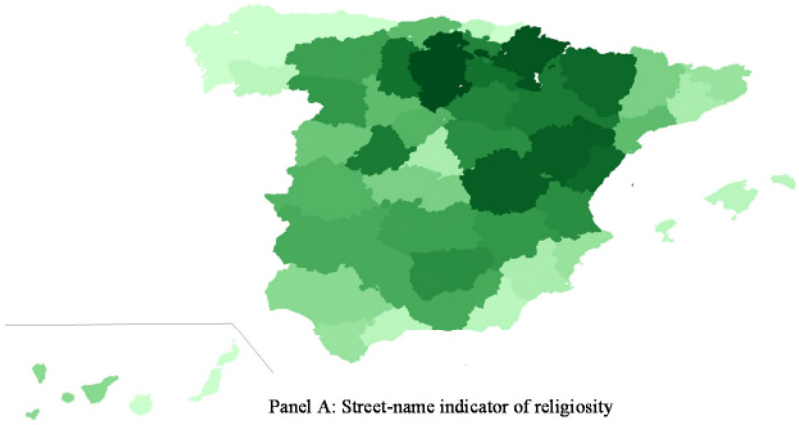
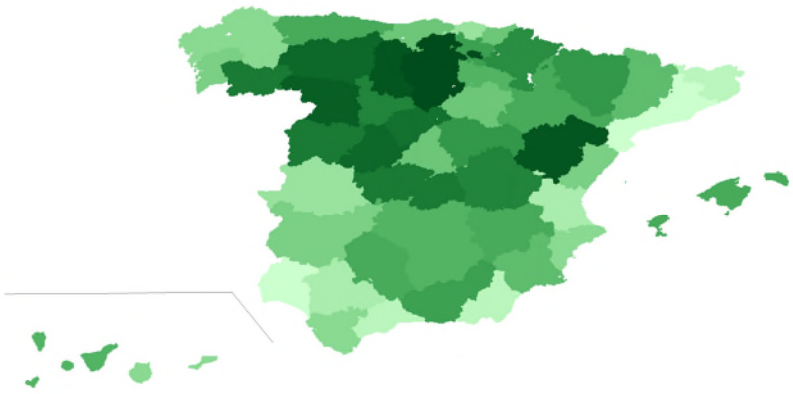


Figure 3. Geographic distribution of the street-name indicator of religiosity

Notes: A darker color indicates more religiosity. Municipalities in white have missing values.



Panel A: Street-name indicator of religiosity



Panel B: Survey-based indicator of religiosity

Figure 4. Street-name indicator of religiosity vs. survey-based indicator of religiosity

Notes: A darker color indicates more religiosity.

Figure 5. Examples of other applications (I): Male predominance

Notes: A darker color indicates a higher value. Municipalities with missing data are in white.

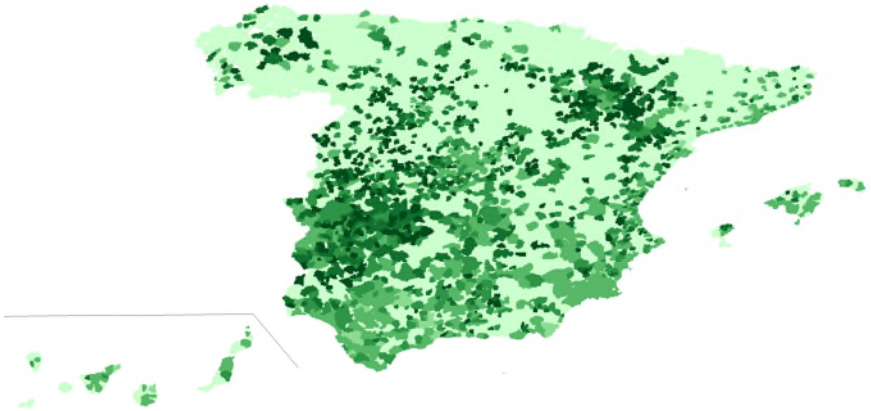


Figure 6. Examples of other applications (II): Spanish identity

Notes: A darker color indicates a higher value.

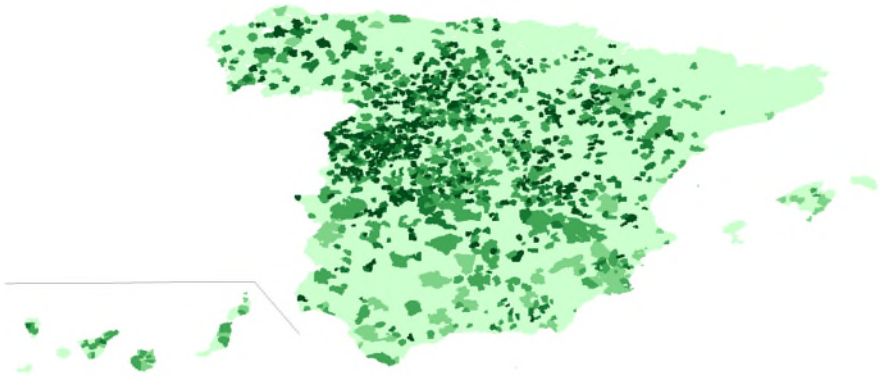


Figure 7. Examples of other applications (III): Francoist streets

Notes: A darker color indicates a higher value.

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16-007 **Ivan Lim, Jens Hagendorff and Seth Armitage:** Regulatory Connections and Public Subsidies: Evidence from the Banking Industry.

16-006 **Linh H. Nguyen and John O.S. Wilson:** How Does Bank Lending React to a Catastrophic Weather Event? Evidence from the Indian Ocean Tsunami.