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Spatial contagion of civil liberty: some evidence from a spatial econometrics analysis*

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Abstract

This paper focuses on civil liberty, which is defined as the individual right to make decisions without interference within a given vital space. It studies the principal factors conditioning civil liberty, one of them being the spatial contagion among neighboring countries. To this purpose, we employ the Civil Liberty Gastil index from Freedom House in a spatial autoregressive (SAR) model estimated from a sample of 175 countries for the year 2010. The results provide good evidence for spatial contagion (spillover effects) of civil liberty across the world. Countries "catch" around 30% of the average changes in their neighbors' civil liberty levels. Additionally we have also identified religious culture and the Internet as other important variables explaining the differing levels of civil liberty among the world's countries.

Key words: Civil liberty, spatial contagion, Internet, religion, spatial econometrics.

JEL codes: C21, C31, D02, O43, P48

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Resumen

Contagio espacial de la libertad civil: algunas evidencias desde el análisis de la econometría espacial

El presente artículo trata sobre libertades civiles, entendidas como el derecho individual para tomar decisiones sin interferencias dentro de un espacio vital. En él se estudian los principales factores que condicionan las libertades civiles, entre ellos, el efecto de contagio espacial entre países vecinos. Con este propósito, utilizamos el índice de Libertades Civiles de Gastil, publicado en *Freedom House*, como variable a explicar en un modelo autorregresivo espacial (SAR) estimado para una muestra de 175 países en el año 2010. Los resultados proporcionan grandes evidencias de la existencia de autocorrelación espacial (o efectos de desbordamiento) de las libertades civiles en el mundo. Los países captan hasta un 30% de las variaciones medias experimentadas por sus vecinos en los niveles de libertades civiles. Hemos identificado también otras variables importantes, como la cultura religiosa y el uso de Internet, que explican las diferencias en términos de libertades civiles entre los países del mundo.

Palabras clave: Libertades civiles, contagio espacial, Internet, religión, econometría espacial.

Introduction

Similar to happiness or goodness, the concept of liberty has such a porous nature that we can find more than two hundred meanings of this protean word in the literature. These perspectives of liberty were formally framed by Isaiah Berlin (1958) who called them “positive liberty” and “negative liberty”. While the former guarantees the external actions of the individual (political rights or democracy), the latter designates a negative condition in which an individual is protected from tyranny and the arbitrary exercise of authority (civil liberty or civil rights). That is to say, civil liberty is understood as the individual right to make decisions within a given vital space without interference. It defines the limits between the state and the individual and, within those limits, guarantees the right for human beings not to have their freedom of action restrained.

Built on Berlin´s conceptual work, this paper focuses on civil liberty in order to explain its spatial contagion and the conditions for its existence. There are not many references in the literature using spatial econometrics to study the contagion of freedom. The principal authors are O´Loughlin *et al.* (1998) and Leeson and Dean (2009), who have investigated the spread of democracy among countries, Leeson *et al.* (2012) and Sobel and Leeson (2007), who have studied the spread of economic freedom, and Sobel *et al.* (2010) who have analyzed media freedom contagion. We differ from all this literature by focusing on the spread of civil liberty, which is not the same concept as democracy or any other type of freedom, such as economic or media freedom (Aixalá and Fabro, 2009). To our knowledge, there are no empirical studies of the spatial contagion of civil liberty.

Consequently, the aim of this paper is to study whether civil liberty is a contagious phenomenon across countries. We also estimate the spreading rate of civil liberty using spatial econometric models, which are specifically designed to measure spatial dependence. In other words, this paper explores if the level of civil liberty in neighboring countries explains the level of civil liberty in any country. Furthermore, this paper studies other factors conditioning civil liberty. To these purposes, we use the Civil Liberty Gastil index from Freedom House (2012) as the endogenous variable in a spatial autoregressive (SAR) model estimated with a sample of 175 world countries for the year 2010. We reach the conclusion that civil liberty does spread across geographical space. There is indeed a positive and significant 30% spreading rate of civil liberty across neighbouring countries, which is similar but a little higher than that obtained in related applications. In addition, our results show that religion and the Internet, as well as other explanatory control variables, are also statistically significant and may explain the level of civil liberty in any country.

This paper proceeds as follows. Section 1 analyzes the spatial contagion and other conditioning factors of civil liberty. Section 2 describes the data used. Section 3 explains and justifies the empirical model used. Section 4 shows the most relevant econometric results and, finally, it is concluded.

1. Territorial Contagion and other Determinants of Civil Liberty

1.1. Territorial contagion of civil liberty

Historically, civil liberty did not appear everywhere at the same time: from a focal point, there was a subsequent territorial "contagion". This focal point was basically France with the proclamation of civil rights in the late eighteenth century (Palmer, 1959 and Nair, 2011), though one century before, the Netherlands and England had already created and molded the rules leading to the full incorporation of the human being into society (North and Weingast, 1989; North, 1995). With hindsight, the lack of clear borders in Europe, as well as the existence of similar legal and cultural customs, facilitated the territorial spread of these new ideas, mainly by means of commerce and population migrations (Sobel and Leeson, 2007). From the European epicenter, civil liberty was progressively exported to the rest of the world.

Thus, the diffusion and contagion of any thought or event, and therefore civil liberty, will be imitated and reflected in neighboring territories through geographic channels (Sobel and Leeson, 2007, Leeson and Dean, 2009 and Leeson *et al.,* 2012). This concept of spatial contagion or "geographic spread" has been recently used in the literature as related with the democratic "domino effect" (Leeson and Dean, 2009), media freedom (Sobel *et al.,* 2010), social networks (Centola and Macy, 2007) and even with financial crisis (Dornbusch *et al.,* 2000 and World Bank, 2013), in which contagion has been defined as the "cross-country transmission of shocks or the general cross-country spillover effects". Following this latter definition, the term contagion will be used in this paper –with reference to civil liberty– as a synonym for cross-country (inter-country instead of intra-country) spillovers. Inter-nation more or less formal connections could be decisive for the contagion process of civil liberty to become definitely established in a territory, since interactions between countries clearly shape their social, economic and political agenda. Though there are diverse ways in which different countries are linked to one another, it is conceivable that any one of these links alone could serve as a long-run conduit for the forces of civil liberty, as demonstrated by O'Loughlin *et al.* (1998) and Rhue and Sundararajan (2014). Close physical proximity may indicate similar cultures and strong ties among nations. Countries with strong relationships and similar cultures are more susceptible to all kinds of pressures from each other.

For this reason, we expect a spatial contagion effect of civil liberty, in the sense that the level of civil liberty in any country depends on the levels of civil liberty in its neighboring countries.

1.2. Other conditioning factors of civil liberty

We find other two leading causes of variations in civil liberty worldwide: religious culture and urbanization (or what could be called “the city factor”). Additionally, we consider some other conditioning factors proposed in the literature such as education, government expenditure, ethnic diversity, etc.

First, according to cultural theories, religion is a significant variable in explaining the ethic of a society, as well as trust and other characteristics that could be important in explicating the quality of institutional development (Landes, 1998) or the quality of a government (La Porta *et al.,* 1999 and Haynes, 2013). In the literature on freedom, religious affiliation has been used as an important determinant of civil liberty and democracy (Lipset, 1994 and Boone, 1996). The classical sources of the main religions are based on the ethics of humanity and have provided high standards of human social conduct, social values and socio-political rights (Natharaj, 2011).

Nevertheless, not all religion-based cultures and their philosophies have fostered the development of civil liberty in their respective countries. Some authors like Huntington (1996), Barro (1999) or Gundlach and Paldam (2009) claim that various expressions of Christianity have a propensity to be supportive of civil liberty, while other religions do not. Conversely, Islam (particularly Arab) states remain authoritarian, since it offers not only a set of spiritual beliefs but also a set of rules by which to govern society, as well as incapacity to dissociate the religious from the political spheres (Wright, 1992). Society and state are merged and no legitimacy is provided for autonomous social institutions at the national level (Eisenstadt, 1968). In fact, Asian societies, in which Buddhism and Confucianism are the predominant philosophies, have strong traditions of order, centralized power and discipline, which may jeopardize civil liberties.

Second, the modern city constitutes another powerful force in the emergence of civil liberties in Europe since the Middle Ages (De Long and Shleifer, 1993). Human agglomerations are the natural location for new ideas to be propagated. Nevertheless, during the last two decades, the physical city has been deeply transformed by the new technologies. The smart city, digital city or e-city is now the new environment in which innovations, in general, and civil liberty in particular, develop and flow. In this new environment, the Internet has been the principal means of diffusion of ideas, opportunities, news, social processes, and so on, and this has taken place on a scale and at a speed never seen before (Aurigi, 2005 and Chokoshvili, 2011). The Internet has been defined as the new "digital public square", since lower communication costs enable it to supplement or substitute "built-space" public square gatherings, in which individuals fulfil their collective beliefs and opinions (Chwe, 2003 and Zhou *et al.,* 2011). That is to say, the "city factor" remains an essential vehicle for the initial transmission and subsequent institutionalization of new ideas and values, though it adapts to the changing conditions of human civilization.

Finally, there are other factors, which have been selected in the literature as explanatory of civil liberty. Income, population, education, urbanization rate, percentage of middle class (or Gini index), foreign direct investment, openness and government consumption are the most important economic explanatory variables in references such as Stouffer (1955), who analyses the elements which promote civil liberty using the results provided by a survey, and more recently Barro (1999), Curran and Wherry (2003) and Rhue and Sundararajan (2014).

Following all the referred literature, we have taken into account most of these variables in our model of civil liberty, in order to control for all of them.

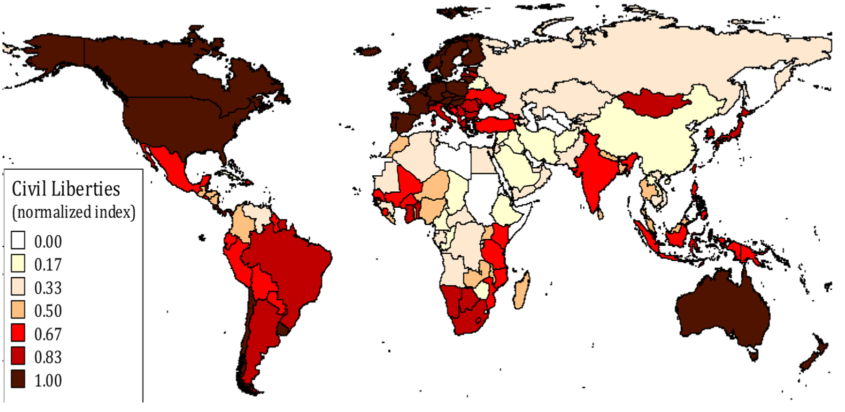
2. Data Description

To empirically study the spatial contagion of civil liberty (CL) and its other conditioning factors, we have chosen to work with the Civil Liberty Gastil index (Freedom House, 2012). Since this index ranges from 1 (most free) to 7 (least free), following Bollen (1990), we use a simple transformation to construct a normalized index, denoted ICL, ranging from 1, indicating the most civil freedom (Gastil's rank one), to 0, corresponding to the least civil liberties freedom (Gastil's rank seven):

$$ICL = \frac{(7 - CL)}{6} \tag{1}$$

When displayed on a map, ICL appears to be spatially clustered (Figure 1). In effect, the lowest values of the ICL score are observed mainly in Central Africa and most of the Asian countries. At the other end of the distribution, the countries with the highest values of ICL are located in the Western OECD countries, plus Chile and Uruguay.

Figure 1
FREEDOM HOUSE CIVIL LIBERTIES NORMALIZED INDEX (ICL) IN 2010



Source: Self elaboration.

This geographical concentration of similar values of ICL levels across the world's countries is a spatial effect called spatial autocorrelation, which can be defined as the coincidence of value similarity with locational similarity (Anselin, 2001). There is positive spatial autocorrelation when high or low values of a random variable tend to cluster in space and there is negative spatial autocorrelation when geographical areas tend to be surrounded by neighbors with very dissimilar values. The measurement of global spatial autocorrelation is based on Moran's I statistic, which is the most widely known measure of spatial clustering (Cliff and Ord, 1973 and 1981):

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(y_i - \bar{y}\right)\left(y_j - \bar{y}\right)}{\sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2} \qquad (2)$$

where y_i is –in this case– the civil liberty index (ICL) in country *i*, $\bar{y}$ is the average value of variable *y*, and w_{ij} is an element of a spatial weights matrix, W, such that each element (w_{ij}) is set equal to 1 if country j belongs to the set of country i's five nearest neighbors (country distance is computed from the centroid X and Y coordinates).[1] This specification is appropriate when two pairs of countries, which are significantly distant from each other, drive the minimum nearest neighbor distance (Fiji and New Zealand, at 1,859 miles). In such cases, the minimum distance will not be representative of the rest of the distribution and a k nearest neighbor weight matrix will assure the same number of neighbors for all the observations. Very similar results have been obtained with other specifications of the spatial weight matrix, though we will later demonstrate the superiority of this definition for country neighborhood over other specifications. For the computation of many spatial statistics, and particularly for the estimation of spatial regression models, the spatial weights matrix should be row-standardized to yield a meaningful interpretation of the results. Row standardization consists of dividing each element in a row by the corresponding row sum. Each element in the new matrix thus becomes: $w^{*}_{ij} = w_{ij} \big/ \sum_j w_{ij}$. Hence, the row-standardized version of a five-nearest neighbor matrix assigns a value of 0.2 to those countries which belong to the set of country i's five nearest neighbors.

The computation of Moran's I for CL distribution displays a high degree of spatial autocorrelation: the magnitude of Moran's I test is high (I=0.56822) and strongly significant at p=0.0010, which is well above its expected value under the null hypothesis of no spatial autocorrelation, E[I]= –0.006. Inference is based on the permutation approach (999 permutations), as shown in Anselin (1995). This result demonstrates that the distribution of freedom, measured as CL, across the world appears to be clustered in nature. That is, countries with very relatively high/low CL levels tend to be located in nearby countries with high/low CL levels more often than would be expected due to random chance. If this is the case, then each country should not be viewed as an independent observation and it could be concluded

[1] The spatial weight matrix is of dimension (n, n), for n the number of countries, and it specifies the connectivity structure within the observations in the sample. It has non-zero elements w_{ij} in each row i for those columns j that are neighbors of location j. The elements on the diagonal are equal to 0. When the spatial scale of the data analysis is global in nature as in this paper, the straight-line Euclidean distance is no longer an appropriate measure. Instead, distance between two points should be based on the concept of great circle distance or arc distance on a sphere.

that CL has a geographical contagion effect across countries in the world. This previous exploratory analysis constitutes initial empirical evidence in favor of our hypothesis.

In the next section, we specify and estimate an econometric model of the ICL endogenous variable, in which we consider –as explanatory variables– the conditioning factors already shown: spatial contagion, religion and the city, plus some other control variables (see in Table 1 a full description of the model variables).

Table 1

VARIABLE LIST SPECIFICATION

Variable	Description	Units	Source	Period
Endogenous variable:				
icl	Civil Liberties normalized indicator	0-1 index	Freedom House and self-elaboration	2010
Spatial neighbourhood variable:				
wicl	Civil Liberties (icl) spatial lag	0-1 index	Freedom House and self-elaboration	2010
Largest religion explanatory variables:				
jcrist: Jewish and Christian, *musl*: Muslim, *budd*: Buddhist, *hindu*: Hinduism.		0-1	ARDA (2011)	2008
City factor explanatory variables:				
urb	Population residing in urban areas	%	United Nations	2010
ldens	Population density	% (in logs)	World Development Indicators, GIS	2010
inter	Percentage of Internet users	%	International Telecommunication Union (2012)	2010
Control explanatory variables:				
a) Socioeconomic variables:				
lgh	GDP per capita, PPP (constant 2005)	Internat. $ (in logs)	World Development Indicators	2009
edu	Average total years of schooling	Years	Barro and Lee (2010)	2010
gini	Gini index		World Development Indicators	2010
gov	Government Consumption share of PPP converted GDPpc (constant 2005)	Internat. $	Penn World Tables*	2010
open	Openness (constant 2005)	%	Penn World Tables*	2010
Largest language: *arab*: Arabic, *chin*: Chinese, *engl*: English, *fren*: French, *port*: Portuguese, *span*: Spanish		0-1	ESRI cartographic database	2010

Table 1

VARIABLE LIST SPECIFICATION

Variable	Description	Units	Source	Period
Legal system origin: *leguk*: British, *legfr*: French, *leger*: German, *legsc*: Scandinavian, *legsov*: soviet		0-1	La Porta *et al.* (2008)	2008
b) Geographic variables:				
xcoo	Longitude (X-coordinate)	Degrees	GIS**	-
ycoo	Latitude (Y-coordinate)	Degrees	GIS**	-
landl	Landlocked country	0–1	GIS**	-
ecud	Distance to the Equator	Km	GIS**	-
distuk	Distance to the UK	Km	GIS**	-
distnd	Distance to the Netherlands	Km	GIS**	-
altit	Maximum elevation over the sea level	Meters	GIS**	-
area	Territorial extension	Mile Km^2	GIS**	-

*Heston *et al.* (2012). **Self elaboration with a Geographical Information System (GIS).

Spatial contagion is measured as the spatially lagged ICL variable (*wicl*). To measure religion we have considered the largest religion in each country from ARDA (2011). Three indicators have been used for the city factor: population residing in urban areas (*urb*), the natural logarithm of population density (*ldens*) and percentage of Internet users (*inter*). The first two variables are proxies for the physical city, while the last one is a proxy for the technological or digital city. Additionally, we consider a group of control variables, which, according to the previous empirical literature, have been shown to be linked with freedom. In a first group of socioeconomic variables, we include GDP per capita in natural logarithms (*lgh*), years of schooling (*edu*), the Gini index (*gini*), government consumption (*gov*), openness (*open*), commonest languages (*arab*, *chin*, *engl*, *fren*, *port*, *span*) and the origin of the legal system (*leguk*, *legfr*, *leger*, *legsc*, *legsov*), since different legal origins shape national institutions differently (La Porta *et al.,* 2008). In a second group of geographical indicators, we can include distances to given world enclaves, such as the Equator (*ecud*), the United Kingdom (*distuk*) and The Netherlands (*distkd*), the spatial Earth coordinates, latitude (*ycoo*) and longitude (*xcoo*), maximum country height above the sea level (*altit*), territorial extension (*area*) and landlocked countries (*landl*). The sample used in this paper is made up of 175 countries and most of the data refers to the year 2010.

3. Empirical Model

3.1. Baseline non-spatial model

Following the modeling strategies proposed by Anselin (1988) and Elhorst (2010), we first specify a basic non-spatial linear regression model, which is estimated by Ordinary Least Squares (OLS), in order to test whether a spatial model is more appropriate to describe the data. This basic model takes the following form:

$$icl_i = \beta_0 + \beta_1 R_i + \beta_2 U_i + \sum_{c=1}^{C} \varphi_c x_{ci} + \varepsilon_i \;\; ; \;\; \varepsilon_i \quad i.i.d.N\left(0, \sigma_\varepsilon^2\right) \tag{3}$$

where icl_i is the endogenous variable; R is religion, U is the city factor, X_{ci} are a group of c control variables, β, φ are parameters to be estimated, and ε_i is the error term, which is supposed to be independent and identically distributed (i.i.d.) following a normal distribution with zero mean, constant variance (σ_ε^2) and absence of spatial autocorrelation.

The estimation of this empirical model in expression (3) for the full set of 31 explanatory variables leads to a strong multicollinearity problem.[2] Because of this problem, we have opted to look for a more parsimonious and efficient model, in which fewer explanatory variables are statistically significant. In this model, CL (*icl*) is set as a function of religion, specifically the largest Muslim (*musl)* and Buddhist (*budd*) religions, the percentage of Internet users (*inter*) and the following group of control variables: Arabic (*arab*), Chinese (*chin*) and Portuguese (*portu*) commonest languages, British (*leguk*) and Soviet (*legsov*) legal systems and maximum altitude (*altit*).

[2] In fact, the multicollinearity conditional number test for this expanded model is 123.5, which is well above the acceptable limit of 30-40 (all computations are available from the authors upon request).

Table 2

Estimation results for the civil liberties (CL) model

	Model 0 (M_0) Basic	Model 1 (M_1) Spatial Durbin (direct effects)	Model 2 (M_2) Spatial lag direct effects)	Model 3 (M_3) Spatial error
Estimation methods:	OLS	ML	ML	ML
Constant	0.52984^{***}	0.31631^{***}	0.33733^{***}	0.52504^{***}
Spatially lagged variables:				
Wicl	-	0.39500^{***}	0.295^{98*}**	-
wε	-	-	-	0.47847^{***}
Religion variables:				
Musl	-0.19459^{***}	-0.14647^{***}	-0.13886^{***}	-0.15990^{***}
Budd	-0.18899^{***}	-0.22420^{***}	-0.1523^{8*}*	-0.19217^{***}
City variables:				
Inter	0.00604^{***}	0.00590^{***}	0.0050^{7**}*	0.00575^{***}
Control variables:				
Arab	-0.24745^{***}	-0.17725^{***}	-0.22127^{***}	-0.21095^{***}
Chin	-0.21983^{**}	-0.21675^{*}	-0.18929^{*}	-0.23018^{**}
Portu	0.11412^{*}	0.12468^{*}	0.16452^{**}	0.15577^{**}
Leguk	0.08619^{***}	0.07791^{**}	0.10186^{***}	0.07982^{**}
Legsov	-0.42453^{**}	-0.46561^{***}	-0.42222^{**}	-0.40921^{**}
Altimax	-0.00002^{**}	-0.00001^{*}	-0.00001^{*}	-0.00001^{*}
Spatially lagged independent variables (original estimators):				
W·musl	-	0.04057	-	-
W·budd	-	0.09009	-	-
W·inter	-	-0.00224^{*}	-	-
W·arab	-	-0.06290	-	-
W·chin	-	0.25885	-	-
W·portu	-	-0.27617	-	-
W·leguk	-	0.01521	-	-
W·legsov	-	-0.02452	-	-
W·altimax	-	0.00001	-	-
R^2	0.6619	-	-	-
Pseudo-R^2	-	-	0.6892	0.5524
Multicollinearity #:	6.1570	-	-	-
Jarque-Bera test:	5.7717^{*}	-	-	-
BP heteroskedast. test:	20.080^{**}	27.234^{*}	20.765	20.937^{**}
H_0: $\theta = 0$	-	10.587	-	-
Common factor LR test:	-	1.0651	-	-
LM test on spatial error/*lag*	-	0.1955	1.9605	*0.42047*

*** Significant at $p < 0.01$; ** significant at $p < 0.05$; * $p < 0.1$; OLS: Ordinary Least Squares; ML: Maximum Likelihood; *wε*: spatial autoregressive error term; R^2: determination coefficient; *Multicollinearity #:* Multicollinearity conditional number test; BP: Breusch-Pagan test; Rob. LM: Robust Lagrange Multiplier spatial autocorrelation tests for a five nearest-neighbors spatial weight matrix; *BP*: Breusch-Pagan test on homoskedasticity.

The results are presented in Table 2. All the coefficients are statistically significant at 5%, with the exception of the Portuguese as the commonest language (only significant at 10%). The determination coefficient R^2 in M_0=0.6619. There are no longer multicollinearity problems, since the multicollinearity conditional number is 6.1570. The Jarque-Bera non-normality statistic on the residuals takes on a non-significant value at 5% (Jarque-Bera M_0=5.7717), which is indicative of normality in the error terms. Finally, the Breusch-Pagan heteroskedasticity test is significant (BP M_0=20.080) rejecting the null hypothesis of homoscedasticity at 5%.

This first result confirms the important role played by religion and the "city factor" (represented by Internet users) as explanatory of CL across countries. In line with previous research (Barro, 1999 and Gundlach and Paldam, 2009), Islam is inversely correlated with CL. That is to say, it is more difficult for Islam countries to reach higher levels of civil liberties compared to countries with any other largest religion. CL also depends directly on the percentage of Internet users, as a new indicator for the contemporary digital city. Finally, all the control variables are also statistically significant.

The main limitation of this baseline model is the presence of spatial autocorrelation in the residuals, which could happen in two cases: when the dependent variable at each location is correlated with observations on the dependent variable at other locations and when the error term at each location is correlated with observations on the values for the error term at other locations. In the first case, the omission of spatial autocorrelation will lead to biased OLS estimators and the spatial lag model (SAR model) is the adequate specification since it absorbs the spatial autocorrelation in the error term. In the second case, the consequences of omitting a spatial contagion effect in the error term (ε), will lead to inefficient OLS estimators. In this case, the spatial error model (SEM) is the correct specification since it incorporates a spatial autoregressive process in the error term (Wε).

3.2. Specification strategy

The classical modeling strategy relies on the standard Lagrange Multiplier (LM) tests proposed by Anselin (1988), and their robust counterparts proposed by Anselin *et al.* (1996). These instruments allow not only acceptance or rejection of the null hypothesis (absence of spatial autocorrelation), but also discernment of the alternative basic spatial model (SAR *versus* SEM) if the null is rejected. Both the standard and robust types of LM-tests have two forms, the LM-lag and LM-error, which point to a SAR model or SEM, respectively, in case of refusing the null hypothesis. Particularly, if one of the LM test statistics rejects the null hypothesis and the other does not, the alternative spatial regression model matching the test that rejects the null must be estimated. Only when both tests reject the null hypothesis, must the robust forms of these tests be considered: the robust LM-lag test on spatial lag dependence and the robust LM-error test on spatial error dependence. Typically, only one of them will be significant but in the case that both are highly significant, the model with the largest value for this test will prevail.

The computation of these LM tests on spatial autocorrelation requires the previous selection of a spatial weights matrix. Since –as is very frequent in empirical applications– we do not have prior indications about the best specification for our model we have opted to investigate whether the results are robust to the specification of W, which is a common practice (Elhorst, 2010). In Table 3, we present the values of the standard LM tests and their robust counterparts for eight different distance-based specifications of the spatial weight matrix:

- Two inverse squared distance matrices such that each element, w_{ij}, is set equal to the inverse of the squared great circle distance between the centroids of countries *i* and *j*: one matrix for the full set of countries and the other matrix for a cut-off point of 1,859 miles (2,992 km), which is the minimum distance at which all the countries have at least one neighbor.
- A minimum distance (or distance band) matrix, which assigns the value 1 if two countries are at most 1,859 miles apart.
- Five *k* nearest neighbor matrices for sets of 2 to 6 countries, since 95% of the world's countries have 6 or less neighbors with a common border.
- A first-order contiguity spatial weight matrix, in which country neighborhood is defined as having a common geographic border. In our sample, this broadly used matrix is problematic because there are 34 unconnected countries with no neighbors (islands).[3] However,

[3] Unconnected spatial units (*i.e.*, spatial units for which the corresponding row in the W contiguity matrix consists of zeros only) are inappropriate for the computation of many spatial statis-

for comparison purposes since it has been applied in other similar analysis in the literature (e.g. Sobel and Leeson, 2007 or Lesson *et al.,* 2012), we have also employed this specification for a 141 country sample, from which the islands have been excluded.

In all the specifications of the spatial weight matrix, both standard LM tests reject the null hypothesis of absence of spatial autocorrelation in the error term. Hence, the basic OLS model must be rejected in favor of SAR or SEM models. Additionally in almost all the cases, we find that the robust LM test on spatial lag dependence is the most significant. This result demonstrates the superiority of the spatial lag model (SAR) over the spatial error model (SEM) as explanatory of CL across the world countries.

Table 3

Robust LM spatial autocorrelation tests for different weight matrices (Model 0)

	LM test on spatial lag	LM test on spatial error	Robust LM test on spatial lag	Robust LM test on spatial error
Inverse squared distance (1,859 mile radius)	16.4539***	11.4360***	5.51031***	0.49233
Inverse squared distance (full matrix)	14.9995***	8.7636***	6.35361**	0.11772
Minimum distance (1,859 mile radius)	15.8423***	6.6158**	9.31381***	0.08726
2-nearest neighbors	19.2698***	14.8368***	4.94983**	0.51674
3-nearest neighbors	17.3758***	11.8278***	5.96865**	0.42062
4-nearest neighbors	20.2448***	15.7097***	6.01553**	1.48042
5-nearest neighbors	19.7496***	19.4394***	3.89550**	3.58530**
6-nearest neighbors	22.2973***	25.1128***	4.32070**	7.13620***
Contiguity-common border (141 countries)	14.0888***	9.2835***	4.81511**	0.00990

*** Significant at $p < 0.01$; ** significant at $p < 0.05$; * $p < 0.1$

3.3. Alternative spatial dependence models

In accordance with Elhorst's modeling strategy, if the OLS model is rejected in favor of the SAR or SEM, then the spatial Durbin model (SDM) should be first estimated, since it constitutes a generalization

tics. They also alter the estimation of the spatial autoregressive parameter in spatial models, since the spatial lag values for these units are zero.

of both the SAR and SEM. The SDM contains –in the right hand side of the equation– a spatially lagged dependent variable (Wy) and the spatially lagged independent variables (WX). This expression includes the SAR, which is characterized by the incorporation –in the right hand side of the equation– of only the spatially lagged dependent variable (Wy). The SEM incorporates a spatial autoregressive process in the error term (Wε), which can be easily demonstrated as being equivalent to a restricted SDM, in which $\theta = -\rho \cdot \beta$, being ρ the autoregressive parameter corresponding to the Wy variable, and β and θ the parameter vectors of the X and WX variables, respectively.

Accordingly, we re-specify Model 0 as a SDM (Model 1) as follows:

$$icl_i = \rho Wicl_i + \beta_0 + \beta_1 R_i + \beta_2 U_i + \sum_{c=1}^{C} \varphi_c x_{ci} + \theta_1 WR_i + \theta_2 WU_i + \\ + \sum_{c=1}^{C} \theta_c W x_{ci} + \varepsilon_i \qquad (4)$$

where W is the spatial five nearest neighbours matrix, ρ is the spatial autoregressive coefficient, θ (just as φ and β) represents a $K\times 1$ vector of fixed but unknown parameters, while ε_i is the error term, which is assumed to be independent and identically distributed (i.i.d.) following a normal distribution with zero mean, constant variance (σ_ε^2) and absence of spatial autocorrelation. Therefore, CL is explained by three relevant elements: spatial endogenous and/or exogenous interaction-contagion effects, religion and the city. The presence of (Wicl) in the right-hand side of the equation is similar to the inclusion of endogenous variables in the regressor group in systems of simultaneous equations. For this reason, the OLS estimators of the SDM will be biased and inconsistent. Instead of OLS, estimation must be based either on instrumental variables (Generalized Method of Moments approach or Bayesian methods) or, if the error terms distributes normally as here, on an explicit maximization of the likelihood function.

The estimation of the SDM implies discerning the specification of the spatial weight matrix and whether the SDM could be simplified as a SAR model, as indicated by the robust LM tests. First, since a wrong choice of the spatial weight matrix could distort the coefficient estimates severely, it is necessary to make the right chose for this matrix, which has the role –in our paper– of capturing the spatial interaction structure underlying the cross-country contagion effects of the model variables. As far as we know, there is no underlying theory about the adequate specification of this structure. For this reason, we follow the increasingly common practice of using a weights matrix selection procedure that is based on a 'goodness-of-fit' criterion, as is the case of the log-likelihood (LIK) function value. This approach produces robust estimations when spatial autocorrelation is strong, as in our case (Stakhovych and Bijmolt, 2009).[4] Therefore, we estimate the SDM (Model 1) by Maximum Likelihood (ML) using the seven matrix specifications presented in Table 3 in order to select the spatial weight matrix exhibiting the highest LIK value, which is the five-nearest neighbor spatial weight matrix (Table 4). Accordingly, this matrix will be the selected one to estimate the spatially lagged variables in our model.

Second, since the SDM contains the SAR, it is necessary to discern about these two specifications. For this purpose, we use the likelihood ratio (LR) derived from the ML estimation, which allows us to test the hypothesis H_0: $\theta = 0$, which examines whether the spatially lagged independent variables are not jointly significant (i.e. the SDM can be simplified to the SAR model). This test follows a chi-squared distribution with as many degrees of freedom as regression coefficients in the basic model, excluding the constant term (i.e. nine degrees of freedom in our case). As shown in Table 4, neither of the specifications can reject the null, which is consistent with the non-significant coefficients of the spatially lagged independent variables in the SDM (Model 1 in Table 2). Then the SAR is the model that best describes the data, since the robust LM tests also coincide in pointing to the SAR, and there is no reason to reject the spatial lag model in favor of the spatial Durbin model. Similarly, in most of the specifications in Table 4, we cannot reject the hypothesis that the SDM can be simplified to the SEM, as demonstrated by the common factor hypothesis: H_0: $\theta = -\lambda \cdot \beta$ (Anselin, 1988).[5]

[4] LeSage and Pace (2009) provide another criterion for selecting spatial weight matrices and models, namely the Bayesian posterior model probability, which has the advantage of being suitable for not only nested but non-nested models to carry out these comparisons.

[5] The common factor hypothesis is the nonlinear constraint implied on the coefficients of the spatially lagged initial error term (ρ), the explanatory variables (β) and the spatially lagged explanatory variables (θ): $\theta = -\lambda \cdot \beta$. If this hypothesis holds, then the SDM will be reduced to a SEM, since it can also be expressed as: $y = \lambda \cdot Wy + X \cdot \beta - \lambda \cdot WX \cdot \beta + u$, for λ the spatial autoregressive coefficient of the initial error term (ε) and u a well-behaved error term. This test follows a chi-squared distribution with as many degrees of freedom as regression coefficients in the basic model, excluding the constant term.

Table 4

SPATIAL WEIGHTS MATRIX COMPARISON FOR THE SDM (MODEL 1)

	Log-likelihood function values	Likelihood Ratio (LR) test $H_0(\Theta= 0)$	Common Factor hypothesis $H_0(\Theta=-\lambda\cdot\beta)$
Inverse squared distance (1,859 mile radius)	68.766	10.926	13.467
Inverse squared distance (full matrix)	66.582	8.0124	11.762
Minimum distance (1,859 mile radius)	68.660	13.736	19.501**
2-nearest neighbors	70.096	10.089	12.281
3-nearest neighbors	68.192	14.065	6.1617
4-nearest neighbors	69.174	8.7658	1.8975
5-nearest neighbors	70.379	10.587	1.0651
6-nearest neighbors	69.655	8.1940	0.6629
Contiguity-common border (141 countries)	51.015	6.8904	11.687

*** Significant at p < 0.01; ** significant at p < 0.05; * p < 0.1

Therefore, our selected model is the following SAR model (Model 2):

$$icl_i = \rho Wicl_i + \beta_0 + \beta_1 R_i + \beta_2 U_i + \sum_{c=1}^{C} \varphi_c x_{ci} + \varepsilon_i \quad (5)$$

As shown in Table 2, the Breusch-Pagan heteroskedasticity test is no longer significant, which ensures efficiency in the results. Additionally, we compute the LM test for spatial error autocorrelation, which does not yield significant values. To check the robustness of our findings, we reran Model 2 (SAR) for the different specifications of the spatial weight matrix, as in Tables 3 and 4. Results are quite similar for the LM and Breusch-Pagan tests. The spatial autoregressive parameter ranges from 0.25 to 0.40 depending on the specification, though it keeps close to 0.30 in most cases. This result for the spatial contagion effect of CL is significantly higher than that obtained for other liberty measures in the literature, such as political and economic freedom, and freedom of the press. In these studies, the spatial autoregressive parameter ranges from 0.05 to 0.20, mainly because these models consider –as explanatory– the time lagged endogenous variable, which captures most of the variance of the dependent variable, including the spatial contagion effect.[6] Such models, mainly when the freedom variable is specified in levels (and not in growth rates), are possibly creating a downward bias in the spatial contagion effect which explains the differences found in our study.

Table 5

SPATIAL CONTAGION EFFECTS FOR THE SAR MODEL (MODEL 2)

	Spatial contagion: r parameter	LM test on spatial error	Breusch-Pagan test
Inverse squared distance (1,859 mile radius)	0.3097^{***}	0.2652	23.334
Inverse squared distance (full matrix)	0.3359^{***}	0.1993	22.716
Minimum distance (1,859 mile radius)	0.3970^{***}	0.2089	41.746^{***}
2-nearest neighbors	0.2525^{***}	0.0496	30.677^{**}
3-nearest neighbors	0.2712^{***}	0.0225	22.961
4-nearest neighbors	0.2858^{***}	0.8253	24.902
5-nearest neighbors	0.2960^{***}	1.9605	20.766
6-nearest neighbors	0.3219^{***}	3.2299^{*}	23.315
Contiguity-common border (141 countries)	0.2740^{***}	0.3344	18.650

*** Significant at $p < 0.01$; ** significant at $p < 0.05$; * $p < 0.1$

4. ECONOMETRIC RESULTS

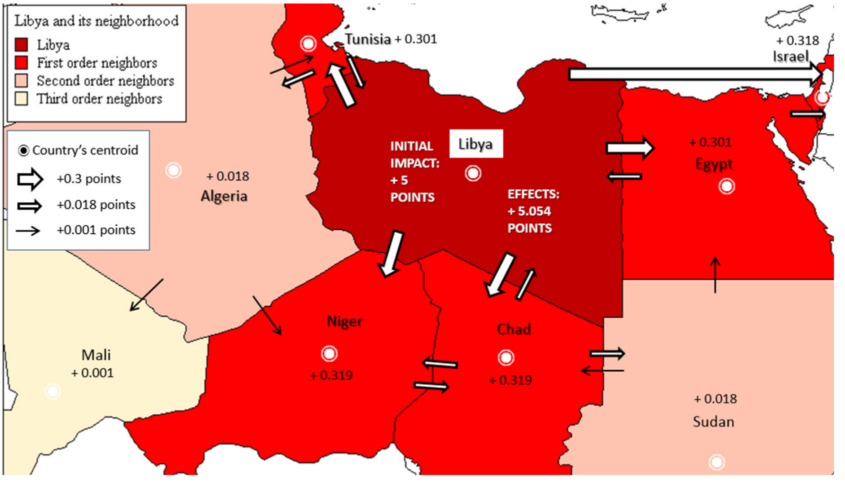
In Table 2, we present the results of the ML estimation of the SAR (Model 2), for the selected spatial weight matrix (five nearest neighbors). Since the interpretation of the coefficients of the independent variables in SAR is not straightforward, as they do not correspond to marginal effects (Dall'erba and Le Gallo, 2008; LeSage and Pace, 2009; Anselin and Rey, 2014), we report the direct effects, which are summary measures of the impact arising from changes in the i^{th} observation of each variable. In this model, CL is explained by the spatial spillover effect, religion, internet and other variables.

6 For political freedom, Leeson and Dean (2009) found a spatial spread rate between 10% and 17%, depending upon the model and specification used. For economic freedom, Sobel and Leeson (2007) quantified a spread rate of 20% and Leeson *et al.* (2012) concluded that both democracy and economic freedom spread at approximate the same modest rate of 15%. In a more recent work, Leeson *et al.* (2012) found that both political and economic freedom spread at approximately the same modest rate of 15%. Finally, Sobel *et al.* (2010) studied media freedom spatial contagion detecting a spatial spread rate of 20%.

First, our most relevant result is the clear and positive significance of the spatial contagion of CL across neighboring countries, shown by the spatial autoregressive parameter ($\hat{\rho}$ = 0.2960), the rate at which CL spreads. Therefore, we can conclude that countries "catch" approximately 30% of their civil liberties from neighboring countries. This result also means that if the average level of CL across country *i*´s neighbors increases by one unit in its CL Gastil index, country *i* would experience a 0.30 unit increase in its CL index.

Figure 2

Impact effects of Libya's neighborhood of an advance of CL in this country



Source: Self elaboration.

We can also simulate the effects of a significant change of an individual country's CL level on its neighboring area, as presented in Figure 2. If the CL level of a country (say Libya) improves by 5.00 units (reaching the second best score in the CL scale, at the same level as Israel or South Africa), it will produce an equal effect of 1.00 point on each of its five nearest neighbors (5.00 times 1/5). Hence given a spatial autoregressive coefficient estimate of 0.30, this would imply that Libya's new (better) level of CL would improve, for instance, Egypt's, by 0.30 units (1.00 times 0.30). Accordingly, this change in Libya's level of CL will also spread –in the same quantity– to not only Egypt but also the rest of its five nearest neighbors (Chad, Israel, Niger and Tunisia).[7] As it can be seen, an impact in only one country produces an effect that is shared by its neighbors. For this reason, even a large change in the CL level of Libya (5.00 points in a 1-7 scale) has only a limited impact on one of its neighbors. As demonstrated previously in a related study (Sobel and Leeson 2007), only when broad regional changes occur, such as the Arab Spring, can the impact be much more substantial.

Additionally, due to the global nature of spatial spillovers in SAR,[8] these changes in the set of Libya's first five nearest neighbors would again spread to their corresponding sets of five nearest neighbors, though with less intensity as they are farther apart from Libya, and so forth. Hence, this improvement 5 points in Libya's CL level will also upgrade each of its second order neighbors (for instance, Algeria) by 0.018 points ($0.30^2 \times 5.00/5^2$), each of its third order neighbors (for instance, Mali) on 0.001 points ($0.30^3 \times 5.00/5^3$), etc. Since the value of the spatial autoregressive parameter (ρ) is not very large, the influence of higher-order neighbors on the level of a country's CL declines abruptly to almost zero beyond the fourth order (0.0001).

Global spillovers also include feedback effects that arise because of impacts passing through neighboring countries (e.g., from Libya to Tunisia and from Tunisia to Algeria) and back to the unit that the change originated from (Libya and Tunisia, respectively). The loop occurs when one country is a neighbor to its neighbor (second order neighbor), which is not always the case in matrix specifications based on nearest neighbor criteria, since they are not symmetrical. For example, Libya and Israel: whereas Israel is one of Libya's five nearest neighbors (according to the great circle distance between their respective centroids), the former is not one of the latter's five nearest neighbors. Hence, impacts passing through neighboring regions can exert a feedback influence on this

[7] A country's nearest neighbor must not necessarily be the one with a common political border. For instance, Libya's geographical center is closer (in terms of a great circle distance) to Israel's than Sudan's center, although it does not border on Israel.

[8] Anselin (2003) and LeSage and Pace (2009) presented the expected value of vector y corresponding to the endogenous variable in a pure SAR model $y = \alpha.\iota_n + \rho Wy + \varepsilon$ (where ι_n is a constant term vector of ones and α its associated parameter), as follows: $E(y) = \alpha.\iota_n + \rho W \iota_n \alpha + \rho^2 W^2 \iota_n \alpha + \ldots$ Given that α is a scalar, $|\rho|<1$ and the elements of W, $w_{ij} \leq 1$, the data generating process assigns less influence to higher-order neighbors, with a geometric decay of influence as the order rises. Stronger spatial dependence reflected in larger values of ρ leads to a greater role for the higher order neighbors.

country itself. Figure 2 represents the spillover effect system created by a positive shock of 5 points in Libya's CL across its neighboring region. For instance, the total impact on Egypt (0.301) is larger than that estimated by the ρ parameter (0.3) once the feedback indirect effect from Sudan (0.001) is included, and the CL scores of all other countries in the area are affected as well. Algeria, a second-degree neighbor (a neighbor of a neighbor of Libya) experiences only a 0.018 increase in CL from the 5-unit increase in Libya. Therefore, the overall improvement in the CL index of the considered region rises to 0.739, though most of this is due to the 5-unit increase in Libya.

The other result worth noting is the statistical significance of the other two main independent variables: religion and the Internet. CL is negatively affected by the fact that Muslim or Buddhist religions are the largest in a country, and it increases with the percentage of Internet users. Additionally, the level of CL in the world's countries nowadays depends positively on the Portuguese commonest language and British legal system origin, whereas it is negatively affected by the Arabic and Chinese commonest languages and the Soviet legal system origin. In addition, we find strong evidence for the leading role played by the Internet as a prominent engine for the improvement of CL in any country, substituting other important classical conditionant of freedom such as economic growth, education level and urbanization.

The analysis of the impacts caused by these explanatory variables on CL is not straightforward. As demonstrated by LeSage and Pace (2009), the coefficients of the independent variables of models containing spatial lags of the explanatory or dependent variables (as SDM and SAR) cannot be interpreted as marginal effects. This is due to the nature of the matrix inverse which determines the expected value of the dependent variable. For instance in the SAR model:

$$\hat{y} = \left(I_N - \hat{\rho}W\right)^{-1} X\hat{\beta} \tag{4}$$

Therefore, the impact of a change in an explanatory variable (say, the percentage of Internet users) for a single country on the level of CL, will affect this country itself (a direct impact) and potentially affect all other countries indirectly (an indirect impact), also if two locations are unconnected according to the spatial weight matrix, since the $(I_N - \hat{\rho}W)^{-1}$ can be demonstrated to be equivalent to $I_N + \hat{\rho}W + \hat{\rho}^2W^2 + \hat{\rho}^3W^3 + ...$

Since the impacts of changes in an explanatory variable, on the endogenous variable, differ over all observations, Pace and LeSage (2006) suggest computing the average of the total effects and the average of the direct effects, deriving the indirect effects from the difference between them. Direct impacts are contained in the principal diagonal elements of the $n \times n$ elements of matrix $S_r(W)$, for r the number of explanatory variables, which is equal to $(I_N - \hat{\rho}W)^{-1}\hat{\beta}$ for the case of a SAR model. The off-diagonal elements of this matrix represent indirect impacts. The magnitude of this type of feedback will depend upon: (1) the position of the regions in space, (2) the degree of connectivity among regions which is governed by the weight matrix W in the model, (3) the parameter ρ measuring the strength of spatial dependence and (4) the parameter β.

These three impacts or effects are presented in Table 6 for all the explanatory variables of the SAR model, as well as the direct effect standardized coefficients. Though both direct and total effects are significant for all the variables, indirect effects are only clearly significant (at 5%) for Muslim religion, Internet users and British legal system. As pointed out by the standardized coefficients, the percentage of Internet connections is the most relevant explanatory variable, more than double that of Muslim and Buddhist religions. The positive estimate for the total impact of Internet (0.00711) means that a 50 percent increase in the Internet connections in a country would result in an approximately 0.4 percent increase in the level of CL in this country (0.00711×50). More than 2/3 of this total impact comes from the direct effect magnitude of 0.00507, and 1/3 from the indirect or spatial spillover impact based on its scalar impact estimate of 0.00203. For Muslim and Buddhist religions, the estimated total effects (-0.19372 and -0.21333) mean that the consequence for a country of adopting these religions as majoritarian is a decrease of 0.2 points in the CL scale, from which more than 2/3 correspond to a direct effect and the other 1/3 to the spatial spillover –indirect– impact.

Table 6

Direct, indirect and total effects for the SAR model (Model 2)

	Direct Effects	Indirect Effects	Total Effects	Standardized Direct Effects
Religion variables:				
Musl	-0.13886***	-0.05486***	-0.19372***	-0.2024
Budd	-0.15238**	-0.06095*	-0.21333**	-0.1171
City variables:				
Inter	0.00507***	0.00203***	0.00711***	0.4634
Control variables:				
Arab	-0.22127***	-0.08906*	-0.31033***	-0.2169
Chin	-0.18929*	-0.07609	-0.26539*	-0.0815
Portu	0.16452**	0.06829	0.23281**	0.1068
Leguk	0.10186***	0.04178***	0.14365***	0.1573
Legsov	-0.42222**	-0.17373*	-0.59595*	-0.1054
Altimax	-0.00001*	-0.00000	-0.00001*	-0.0672

*** Significant at $p < 0.01$; ** significant at $p < 0.05$; * $p < 0.1$.

Finally, the standardized coefficients for the direct impacts highlight the prominent role of Internet connections on CL, more than double that of Muslim and Buddhist religion variables.

Conclusions

This study has focused on exploring the principal factors conditioning CL in order to evaluate whether there is spatial contagion of civil liberties among neighboring countries. The empirical results show that the level of CL in any country is determined by both external and internal conditions. First, we have found strong evidence that CL spreads across countries. The results show the existence of external spillover effects in CL across the world's countries. CL does indeed spread through geography at a rate of 0.29. This means that countries "catch" about 30% of their average geographic neighbors´ levels in CL. The higher the level of CL in a country, the higher it is in its neighbors (and vice versa) due to a spatial contagion effect. It should be also said that the geographical spread of CL has a less impact on neighboring countries with interventions that target only one country compared to the substantial effect caused by widespread regional changes.

Secondly, among the internal conditions, the results confirm the prominent role played by "religious culture" in accounting for CL.

We have found that –compared to other societies– CL is less likely for countries with a Soviet legal system as well as predominance of Muslim and, Buddhist religions and Arabic and Chinese languages. Indeed, as pointed out by the literature, the implementation and diffusion of CL is much more challenging in these countries due to the tight relationship existing between religion and state, which provides no legitimacy for autonomous social institutions.

Additionally, we find strong evidence for the leading role played by the Internet as a prominent engine for the improvement of CL in any country; it doubles –in absolute values– the role played by Islam, Buddhism, and Arab countries. Defined as the new digital public square, it substitutes other classical conditionants of freedom such as economic growth, education level and urbanization. The Internet embodies the modern digital agora where people are informed, educated and connected. It is a new instrument, which empowers individuals and disempowers the state (Zakaria, 2011).

Therefore, we can confirm the initial hypothesis in favor of the existence of a spatial contagion effect in CL across countries; *i.e.* CL spreads like a social "virus", for which national frontiers are not a decisive obstacle. However, it must be said that, though the horizon of CL is expanding day by day, there are multiple elements threatening these achievements, as shown by the Freedom House survey. In fact, during 2010 there were 31 countries registering a decline in their level of CL and only 10 recording gains. The main channels through which CL is transmitted from one place to another are human flows, trade, formal and informal networks and organizations and, more recently, the Internet. For this reason, all these interactions between individuals and countries are of capital importance and should clearly shape the social, economic and political agendas of all countries.

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