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Network Coevolution and Democracy: A Spatial Econometric Approach

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Abstract

Regime transitions are contagious according to the diffusion-of-democracy literature: a country's regime is affected by others' through various predefined networks (e.g. geographical proximity), as well as by the country's own political, economic and social attributes (e.g. GDP levels). My account departs from the existing diffusion theory by allowing for countries' self-selection into peer regime networks based on their democracy levels in the past. For example, a country can form stronger dependency ties with countries that demonstrated similar democracy levels in the past (homophily). In the longitudinal setting, the traditional diffusion mechanism with the presence of self-selection generates the "co-evolutionary dynamic" between country networks and democracy levels. With this recursive feedback process between tie formation and democracy levels, it becomes extremely difficult to evaluate empirically how each country's level of democracy is determined, because we need to distinguish the following three processes statistically. First, country-specific attributes determine the level of democracy as in the earliest democratization studies. Second, other states' democracy levels also predict a country's regime as demonstrated in the conventional diffusion studies. Finally with my theory of endogenous network formation, the seeming diffusion effect is partially a consequence of their self-selection into peer networks. A newer spatial econometric model, an "M-STAR + Co-Evolution" model, is one of the first that allows us to test for all of these three dynamics behind democratization. In my first-cut analysis, I find that all three processes indeed exist.

According to recent developments in the diffusion-of-democracy literature, regime transitions are contagious. Empirical studies of diffusion show that democracy spreads through various channels that determine the strength of interdependence among countries. These channels of interdependence include, for example, geographical contiguity and trade volumes. This implies that a country's political regime is affected more by its neighbors and significant economic partners than by distant countries and those with which it has little economic contact. It also implies that as countries develop closer economic ties over time, their regime dynamics will become more tightly interconnected.

The ultimate question that I want to answer is; how is a country's democracy level determined? The theories presented in this paper are built on the existing studies that have attempted to answer this long-standing question in political science. As in the earlier democratization theories, I think that country-specific internal and external attributes (the GDP level, GDP growth, the war/peace status surrounding the country etc.) are important predictors of their democracy levels. However, the literature has also demonstrated that we could not predict a country's regime development without taking into account the contagion effects of others' political regimes. The main question that this paper posits is about this diffusion mechanism: what are the effects of others' democracy levels through exogenous "spatial" connectivities?[1] In this paper, I re-examine the meaning of diffusion dynamics and consider the possibility that countries select into peer networks that strengthen their regime interdependence over time. By allowing for the endogenous selection of contagion paths, my diffusion model can show how a country's regime evolution could be path dependent, influenced strongly by the surrounding conditions at a certain time-period in the past, while traditional spatial models implicitly assume the irrelevance of the initial worldwide regime distribution in predicting the regime evolution.

I will later introduce a new spatial econometric model, which has been developed in Hays, Kachi and Franzese (2010), to estimate (1) the effects of each country's socio-economic attributes and international environments, (2) the strength of the diffusion effects through various channels, and (3) to demonstrate the path-dependency in predicting political regimes in the counterfactual analysis. I show that there is, in fact, a statistically significant effect of endogenous interdependence on democratic development and therefore the over-time development of political regimes around the world is path dependent.

1 Studies on the Diffusion of Democracy

Many believe in the intrinsic and non-instrumental value of more democratic regimes as opposed to autocracies. The belief has been reinforced as we observed positive outcomes associated with democratization, such as higher economic development level, lower levels of violence and culture that values education, human rights, free media and so on. These elements have been considered as both potential causes and consequences of democratization. Naturally academics have attempted to disentangle the causality among these social and

[1] "Space" here is not necessarily geographical space.

political elements, and practitioners have been eager to find out whether these suspected causes of democracy have any significant effects.

Most of the earlier democratization studies focus on estimating the effects of domestic socio-economic factors on democracy and one of the most suspected links is the one between economic development and democracy. This empirical question of whether economic development induces democratic transitions arises partly from the theory of modernization that Lipset (1959) posited half a century ago. Many scholars supported this idea of socio-economic development as a prerequisite of democratization. The seminal work by Huntington (1991) uses modernization theory to explain the emergence of the "third wave" of democracies that started as late as the mid 1970's. Przeworski and Limongi (1997) and Przeworski et al. (2000) challenges this view, by empirically demonstrating that democratization occurs at random, but a democracy will sustain more likely with higher GDP levels once democratization occurs. Later some other scholars challenge Przeworski and Limongi (1997) and Przeworski et al. (2000)'s finding by providing the opposite result (Boix, 2003; Boix and Stokes, 2003; Epstein et al., 2006). Other country-specific attributes that have been considered and are considered in this paper are the colonial history, economic growth, the proportion of country-specific assets and religions.

At the same time, for scholars of international relations and geography who study spatial patterns of political phenomena, topics such as regime type and war became the two most popular areas to test their theories about diffusion mechanisms. The diffusion-of-democracy studies emerged from this group of scholars almost independently from the studies of domestic causes mentioned above. The common premise lying under this type of studies is that political-regime type cannot be accurately predicted if we only look at a single country or if we treat the levels of democracy across countries as independent outcomes. Earlier works in "diffusion" focus on geographical clustering of regimes. Their careful tabulation, mapping and graphing of geographically subsetted data demonstrate clustering of different regime types in a given year (O'Loughlin et al., 1998; Starr, 1991; O'Loughlin, Staeheli and Greenberg, 2004). These earlier spatial studies of democracy defined "space" narrowly as geographical space. The connectivities among states through economic interdependence or similar colonial history, for example, were not considered as spaces around which political regimes might cluster. Also with their approaches, it is not possible to distinguish different sources of spatial clustering–common exposure, exogenous diffusion or endogenous diffusion, even though the studies were framed as "diffusion" studies of democracy. The spatial association of political regimes that they demonstrated could be the consequence of diffusion as they implied, but it could also have been due to the fact that some countries are exposed to common conditions that happened to be spatially clustered, such as GDP per capita, economic inequality, the average education level and the war-peace condition that is surrounding the country. In this sense, the earlier geo-political studies of democracies were not precisely about testing for the diffusion mechanisms.

In the past few years, as scholars have become increasingly aware of the importance of both the common-condition-based and diffusion-based spatial correlations of political regimes, and as they have developed more flexible estimation methods, more unified models of democrati-

zation have started to emerge (Beck, Gleditsch and Beardsley, 2006; Brinks and Coppedge, 2006; Gleditsch and Ward, 2006). Gleditsch and Ward (2006) provide a model of regime transition –both transition to democracy and reversion to autocracy– including domestic and international country-specific attributes (logged GDP per capita, logged energy consumption, civil war, peace/war status) and the factors that somewhat captures the influence of other countries' regimes (global and local proportions of neighboring democracies). This approach still assumes the exogeneity of other states' regimes and the way others' regimes enter the model is not any different from that of country-specific attributes. Beck, Gleditsch and Beardsley (2006) overcome this issue by applying their spatial econometric model to a cross-sectional analysis of democracy. Their model explicitly explains a state's democracy level by other states' levels, weighting the strength of others' influences by exogenously given connectivities among the countries. There are two "spatial" connectivities introduced in their model: one is trade volumes and the other is geographical proximity. The main contribution is that, by introducing the connectivity weights among countries, they explicitly modeled contagion of political regimes and distinguished the contagion effect from the effects of other country-specific covariates that could also induce spatial clustering in political regimes. Another contribution of their approach to the literature is to demonstrate that "space is more than geography" by introducing the idea of weighting the effect of others' regimes by how economically (trade volumes) and geographically (distance) close the countries are.

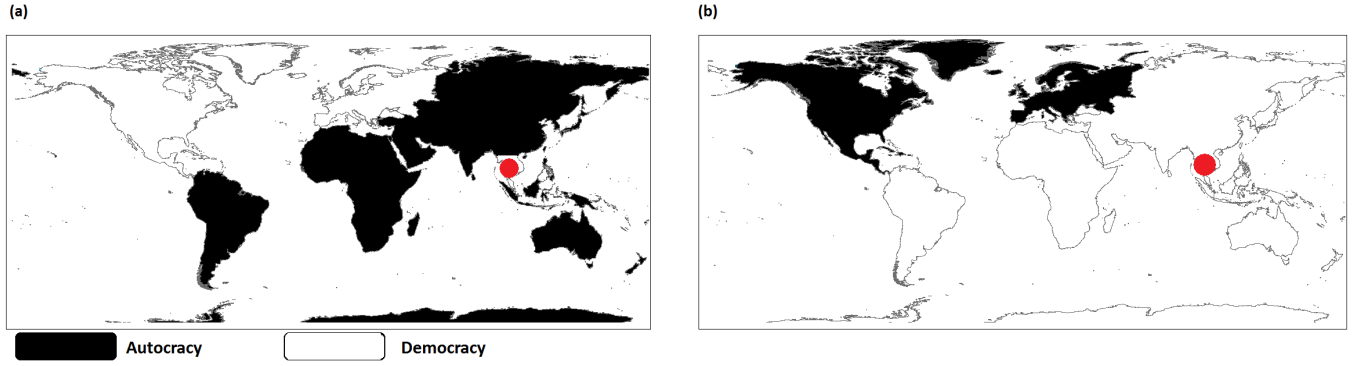
2 The Initial Conditions Puzzle

Even though each of the above-mentioned and many related studies has its own strengths and limitations– both conceptually and methodologically– it is evident that the questions that motivate these studies are more or less equivalent to what I asked at the beginning: (1) what are the effects of countries' socio-economic attributes and environments on their democracy levels, and (2) what are the effects of others' democracy levels through "spatial" connectivities?

All of the existing empirical analyses to my knowledge (whether mentioned above or not), however, implicitly assume that the worldwide distribution of political regime at one time-period does not affect a country's future regime development. As shocking as it is, this is true even to the fairly recent diffusion studies that utilize spatial econometric models. Imagine two counterfactual worlds with very different regime distributions as depicted in Figure 1. The white part indicates democracy and black indicates autocracy in these counterfactual dichotomous worlds. If a country indicated with a dot is born in the two different worlds, or if there is an exogenous democratic/autocratic shock to this country in these different environments, would we except that the country will experience the same regime development in the long run? I find this assumption problematic.

There can be a number of different ways that a country's democracy level depends on the past distribution of regimes around the world. The key factor that generates the path-dependent

Figure 1: Two Maps Representing Different Distributions of Political Regimes



regime evolution is the constantly-changing *relationships* between two countries' democracy levels, for every pair of the countries. Note that it is not merely the proportion of democracies in the world that we think affects countries' regime trajectory: both maps in Figure 1 have more or less 50-50 proportion of the two regime types but we expect different long-term consequences. In this study, I develop a theory that countries' democracy levels reinforce each other positively or negatively over time and emphasize this self-selection (into or out of the regime networks) as a source of path-dependence. This is equivalent to asking *all else equal, are political regimes more influenced by those that are currently similar or dissimilar?* Or *will countries look to others with different regimes to find institutional innovations?* The existing works on policy-learning suggest that learning more likely occurs among units that are similar, but works on coercion-based policy-diffusion suggests otherwise. Despite the fact that the differences in the two logics have significant implications for what democratization scholars and the promoters of democratization would predict, the effects of other states' regimes that travel through regime similarity/difference have never been a central focus of the diffusion literature. I call this type of diffusion "*endogenous diffusion*" and define it as the process in which the structure of the connectivities among actors are endogenously determined by the behavioral choices of the actors in the previous time period, generating a "*co-evolving*" dynamic between the connectivities and the outcomes. We could call the traditional contagion process "*exogenous diffusion*". This is diffusion that occurs through exogenously-determined channels, such as trade flows and geographical proximity, where we do not need to observe each country's democracy level (value of the dependent variable) of the past time-period to construct the connectivity among them in the following time-period.

To understand how the *endogenous diffusion* process is distinct from the traditional (*exogenous*) diffusion process, two aspects are worth noting. First, this particular type of diffusion has a distinct characteristic where the strength of ties among countries is now determined by the similarities in their regime scores, and at the same time the regime scores themselves are the outcome quantities to be explained in the diffusion models. Some network-analysis scholars call this phenomenon "homophily"– love of the same. More generally this can be thought of as a "selection" mechanism. Regardless of how it is called, one of the most important aspects of this co-evolution/homophily/selection mechanism is its implication for the magnitude of diffusion channeled by exogenous connectivities such as trade volumes and bor-

ders. Ignoring the diffusion mechanism driven by co-evolution likely inflates the estimated exogenous-diffusion effect given counterfactual shocks to covariates.

Secondarily, and more importantly, the qualitative difference in the long-run implications of the *exogenous* and *endogenous* diffusion dynamics is not trivial. The predicted long-run-equilibrium regimes for the system that only contains the *exogenous diffusion*, as in the existing diffusion literature, is *path-independent*, while that of *endogenous diffusion* is *path-dependent*. Simply put, regardless of the initial values, a country's long-run equilibrium regime deterministically reaches a certain level, given a set of parameter estimates. Suppose there were two worlds with very different distributions of political regimes; for example, democracies dominate in one world but autocracies dominate in the other world. If we derive the long-run democracy levels of a certain country in these completely different counterfactual worlds using the existing diffusion (spatial) models, the level of the country's democracy will eventually reach exactly the same levels in these two worlds. Which countries in the world have more democratic regimes in a certain year and how a country was connected to others in that particular time period do not matter to the country's long-run democracy level in this framework. Hence the path of the long-run political development is deterministic, solely depending on the initial conditions. However, it should be intuitive for any social scientist that two worlds with different distributions of regimes have very different implications for the political development of a country.

My empirical analysis of the diffusion of democracy attempts to distinguish the *exogenous diffusion* from the *endogenous diffusion*. Mechanically, the two diffusion processes–*exogenous* and *endogenous*– look extremely similar on the surface, in that I model the *endogenous* contagion as an influence of other countries' regimes that are weighted by the distance of their pair-wise political regimes of each pair of countries. The pair-wise distance of regimes is just like the weights that contain pair-wise trade volumes and border-sharing in the *exogenous diffusion*. However, in addition to the substantive importance of the similarity effects, the statistically-significant effect of the *exogenous diffusion* implies that we would likely overestimate the confidence of counterfactual regime predictions if we do not allow for the endogenous process. This is due to the path-dependent (non-linear) nature of the regime-development dynamic that is caused by co-evolution. Not surprisingly, the estimation method for testing the *endogenous* contagion adds significant complication to the existing spatial-econometric approach that Beck, Gleditsch and Beardsley (2006) utilized.

This is not to say that the notion of *endogenous diffusion* has been completely ignored in the current literature. Brinks and Coppedge (2006) attempt to answer the following question: among all the neighboring countries, would it be a similar or different regimes that a country mimics in terms of the level of democracy? This question has two main components: one is its implicit assumption that countries give influence on each other's regime through their regime similarity or dissimilarity only if they are geographically close. This is why the authors look only at the effect of regime distance among countries that are geographically close. The second important component is that among neighboring countries, the authors attempt to assess the effects of others' regimes through being similar/dissimilar to the others. The mechanism that Brinks and Coppedge (2006) attempt to analyze is somewhat similar

to what I call the co-evolutionary or endogenous diffusion process, in which the outcome measure itself defines the connectivities of the outcomes. The difference between Brinks and Coppedge (2006) and my views is that they limit the possibility of the path-dependent diffusion to the countries in arbitrarily-defined neighborhoods of a certain size. Also the estimation methodology that they use cannot estimate the true contagion effect–the effects of the regime proximity enters their empirical model just as country-specific *common conditions* and it assumes that the regime similarity is exogenous. As a consequence of the empirical strategy, the interesting path-dependent nature of the regime-development dynamic is never an issue of debate in their analysis.

The empirical analyses in this paper introduce a new spatial-econometric model developed in Hays, Kachi and Franzese (2010). It allows us to test for a unified model of democracy levels, by distinguishing the effects of country-specific attributes (*common-exposure*), others' democracy levels that travel through the exogenously-given ties (*exogenous-diffusion*) as in the existing diffusion studies, and through the ties that are endogenously defined by the past democracy levels (*endogenous-diffusion*).

3 The Empirical Strategy

The empirical analysis is to assess how states' democracy levels influence those of other states' after controlling for the effects of country-specific common conditions. Furthermore the model needs to be able to capture the two kinds of diffusion effects. To answer these questions, I estimate a multiparametric spatio-temporal autoregressive (M-STAR) model with co-evolutionary dynamics. This is an extension of existing M-STAR models, which contain multiple spatial lags but not the term that captures the co-evolutionary dynamic. Hays, Kachi and Franzese (2010) provides technical descriptions of the empirical model in detail.

The key properties of the M-STAR-plus-co-evolution model are the following. First, the model in matrix notation is

$$\mathbf{y} = \Big[\sum_{r=1}^{R} \rho_r \mathbf{W}_r\Big]\mathbf{y} + \phi\mathbf{M}\mathbf{y} + \gamma\mathbf{L}\mathbf{y} + \mathbf{X}\boldsymbol{\beta} + \varepsilon, \tag{1}$$

where $\mathbf{y}$, continuous democracy scores, is an $NT \times 1$ column vector of cross sections stacked by periods. Throughout the paper, $i = \{1, \cdots, N\}$ denote countries and $t = \{1, \cdots, T\}$ denote time periods included in the data. Note that the dataset does not have to have the balanced-panel structure; i.e., the number of countries included in a given time period, N_t, could vary over time due to data availability and deaths and births of countries. In total, $\sum_t N_t$ observational units are included in the entire dataset. For simplicity (in terms of writing), however, I will describe the model as if the dataset had a balanced-panel structure, denoting the total number of observations by NT. This does not change the properties of this estimator.

The notation $\boldsymbol{\beta}$ on the right-hand side captures the effects of various country-specific covariates included in $\mathbf{X}$. If there are K covariates in total, then β is a $K \times 1$ column vector and $\mathbf{X}$ is an $NT \times K$ matrix. In my specification, $\mathbf{X}$ contains *logged GDP per capita* and the *constant* term. If any of these explanatory variables happen to be spatially clustered, then the term $\mathbf{X}\boldsymbol{\beta}$ controls for the seeming spatial correlations observed in the outcomes variable, $\mathbf{y}$.

Similarly, ϕ represents the effect of *one-year lag of a country's own democracy score*. Since this first-order temporal lag is a country-specific exogenous (pre-determined) variable, it can also be treated as one of the $\mathbf{X}$ variable and can be included in the $\mathbf{X}\boldsymbol{\beta}$ term. The time-lag matrix $\mathbf{M}$ is an $NT \times NT$ matrix that conveniently maps y_{it} onto i's own past value $y_{i,t-1}$. This notation allows us to use the vector $\mathbf{y}$ instead of $\mathbf{y}_{t-1}$ and this will provide us with a more intuitive expression of the reduced form equation later.

The first term on the right-hand side, $\Big[\sum_{r=1}^{R} \rho_r \mathbf{W}_r\Big]\mathbf{y}$ captures the exogenous diffusion. The indicator $r = \{1, \cdots, R\}$ denotes different kinds of connectivity through which a country's regime influence others'. Suppose we have a theory that the economic interdependence measured by trade volumes partially determines to what extent a country is influenced by the others' political regimes. Each cell, w_{ij}, of the observable and exogenous weights matrix $\mathbf{W}_{trade}$ contains the pair-wise trade volume between country i and j. Since the trade volume is defined as the sum of import and export, the $\mathbf{W}_{trade}$ matrix is symmetric. For example, suppose there are only three countries, A, B, and C, and the trade volumes among these countries are as in Table 1. Table 1 implies that the extent to which B and C's regimes influence A's regime is 3/10 and 7/10 respectively.

Table 1: Imaginary Trade Volumes among Countries A, B and C

Country	A	B	C	Row total
A	0	3	7	10
B	3	0	5	8
C	7	5	0	12

Then the weights matrix that corresponds with the chart in Table 1 is as in equation (2). Note that conventionally we row-standardize the values in weights matrices. As can be seen in equation (2), ρ_r is the estimated coefficient for the effects of others' regimes through this particular type of connectivity, r. In my specification, there are two kinds of exogenous-diffusion channels: one is trade volume and the other is border-sharing. In other words, in the model I estimate, $R = 2$. Note that, even though $\mathbf{W}$'s are exogenously given and the coefficient that we estimate is only the ρ, the overall effect of other countries' regimes

(through one kind of connectivity) should be thought as the product $\rho_r \mathbf{W}_r$.

$$\rho_{trade,t}\mathbf{W}_{trade,t}\begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{pmatrix} = \rho_{trade,t}\begin{pmatrix} 0 & 0.3 & 0.7 \\ 0.375 & 0 & 0.625 \\ 0.583 & 0.417 & 0 \end{pmatrix}\begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{pmatrix}. \tag{2}$$

The term $\gamma\mathbf{L}\mathbf{y}$ captures the effects of the endogenous diffusion. The matrix $\mathbf{L}$ is an $NT \times NT$ "regime-distance" matrix with $|y_{i,t-1} - y_{j,t-1}|$ in cells (it, jt). The $\mathbf{L}$ matrix plays the role of a weights matrix just as a $\mathbf{W}_r$ does in the exogenous-diffusion term. The difference is that each element of $\mathbf{L}$ is defined as a distance between the political regimes of each pair of countries. Adding this term, $\gamma\mathbf{L}\mathbf{y}$, therefore reflects a substantive proposition that countries with more dissimilar political regimes affect each other's political regimes more if $\gamma > 0$, and less if $\gamma < 0$.

The reduced form equation follows from equation (1);

$$\begin{aligned} \mathbf{y} &= \Big(\mathbf{I} - \sum_{r=1}^{R}\rho_r\mathbf{W}_r - \phi\mathbf{M} - \gamma\mathbf{L}\Big)^{-1}\Big(\mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}\Big) \\ &= \mathbf{A}^{-1}\Big(\mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}\Big), \end{aligned} \tag{3}$$

where the matrix $\mathbf{A}$ is defined by $\mathbf{A} = \Big(\mathbf{I} - \sum_{r=1}^{R}\rho_r\mathbf{W}_r - \phi\mathbf{M} - \gamma\mathbf{L}\Big)$.

Finally, the likelihood function is

$$L(\sigma, \boldsymbol{\rho}, \phi, \gamma, \boldsymbol{\beta}|\mathbf{X}, \mathbf{y}) = |\det\mathbf{A}|\Big(\frac{1}{\sigma^2 2\pi}\Big)^{\frac{NT}{2}}\exp\Big(-\frac{1}{2\sigma^2}(\mathbf{A}\mathbf{y} - \mathbf{X}\boldsymbol{\beta})'(\mathbf{A}\mathbf{y} - \mathbf{X}\boldsymbol{\beta})\Big), \tag{4}$$

assuming that $\boldsymbol{\varepsilon} \sim N(\mathbf{0}, \sigma^2\mathbf{I}_{NT}), i.i.d.$

3.1 The Long-Run Implications of the Co-Evolutionary Dynamic

The methodological complication and the interesting dynamic caused by the co-evolution between $\mathbf{y}$ and $\mathbf{L}$, which never existed in the traditional spatial models, becomes evident when we rewrite the model for a cross-section given a time-period t. First, the structural-form equation for a cross section can be written as;

$$\mathbf{y}_t = \sum_{r=1}^{R}\rho_r\mathbf{W}_{rt}\mathbf{y}_t + \phi\mathbf{y}_{t-1} + \gamma\Big[abs\Big(\boldsymbol{\Pi}(\mathbf{y}_{t-1}\otimes\mathbf{I}_{N_t})\Big)\Big]\mathbf{y}_t + \mathbf{X}_t\boldsymbol{\beta} + \boldsymbol{\varepsilon}_t, \tag{5}$$

and the reduced-form cross-sectional equation directly follows from (5);

$$\mathbf{y}_t = \Big(\mathbf{I}_{(N)} - \sum_{r=1}^{R}\rho_r\mathbf{W}_{r,t} - \gamma\Big[abs\Big\{\boldsymbol{\Pi}(\mathbf{y}_{t-1}\otimes\mathbf{I}_{(N)})\Big\}\Big]\Big)^{-1}\Big(\phi\mathbf{y}_{t-1}\mathbf{X}_t\boldsymbol{\beta} + \boldsymbol{\varepsilon}_t\Big), \tag{6}$$

where $\mathbf{y}_t$, $\mathbf{W}_{r,t}$ and $\mathbf{X}$ are $N \times 1$, $N \times N$ and $N \times K$ matrices. The matrix $\mathbf{\Pi}$ is $N \times N^2$ and it is produced by horizontally concatenating N separate $N \times N$ block matrices. The ith $N \times N$ matrix in $\mathbf{\Pi}$ has -1's on its diagonal and 1's for each element of the ith column except for the element (i, i), which is 0 as are all other unspecified elements in $\mathbf{\Pi}$. For example, if $N = 3$,

$$\mathbf{\Pi} = \left(\begin{array}{ccc|ccc|ccc} 0 & 0 & 0 & -1 & 1 & 0 & -1 & 0 & 1 \\ 1 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 1 \\ 1 & 0 & -1 & 0 & 1 & -1 & 0 & 0 & 0 \end{array}\right). \tag{7}$$

As can be seen in equation (6), the presence of the regime-distance connectivity, $\mathbf{L}$, renders the N-equation system nonlinear in the endogenous variable, $\mathbf{y}$. This significantly complicates calculations of the predicted effects. In fact, there is no analytical solution for the steady-state regime levels anymore, and the long-run responses (democracy levels) to changes in the covariates $\mathbf{X}$ must be calculated recursively. This is why the predicted long-run democracy levels are path dependent and the level(s) to which the system converges varies across different starting values of $\mathbf{y}$.

It is useful to compare this model with the one for a simple M-STAR model that does not contain the endogenous-diffusion term. The structural form of (a cross section of) the simple M-STAR can be written as follows. Note that there is no term that represents the endogenous diffusion.

$$\mathbf{y}_t = \sum_{r=1}^{R} \rho_r \mathbf{W}_{rt} \mathbf{y}_t + \phi \mathbf{y}_{t-1} + \mathbf{X}_t \boldsymbol{\beta} + \boldsymbol{\varepsilon}_t. \tag{8}$$

Unlike equation (5), one can analytically compute the steady-state (long-run) outcomes by equating $\mathbf{y}_{t-1}$ to $\mathbf{y}_t$ and fixing the exogenous right-hand-side variables to their counterfactual permanent post-shock levels;

$$\mathbf{y}_t = (\mathbf{I} - \rho \mathbf{W} - \phi \mathbf{I})^{-1} (\mathbf{X}_t \boldsymbol{\beta} + \varepsilon_t). \tag{9}$$

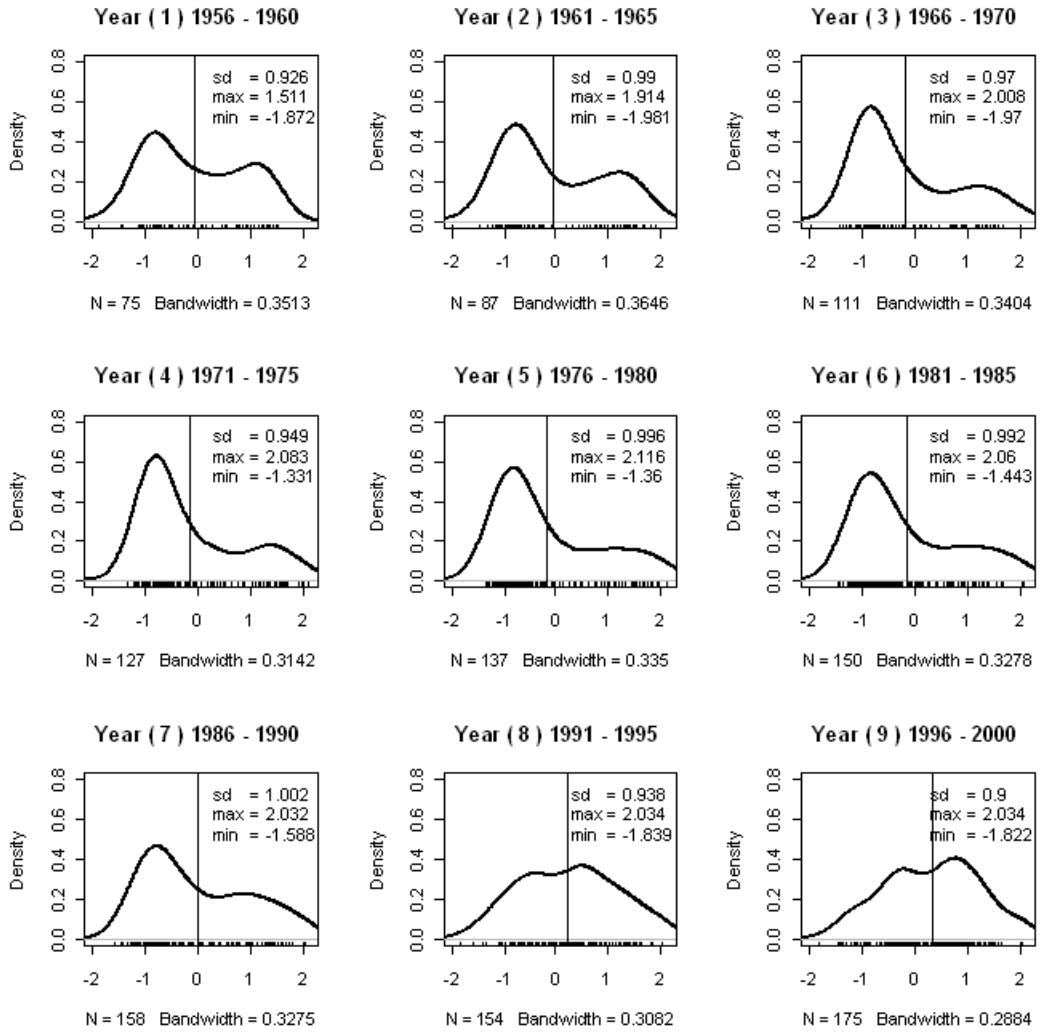
4 Variables and Data

The dependent variable is the level of democracy and the data are from the Unified Democracy Scores (UDS) constructed in Pemstein, Meserve and Melton (2010). A Bayesian latent variable approach, originally introduced in Treier and Jackman (2008), allows them to estimate the latent levels of democracy, integrating ten different existing democracy scores[2]. The UDS data provide a continuous measure of democracy levels in 67 to 191 countries, depending on years, from 1946 through 2000. For the empirical analyses here, I use UDS for the 1950-2000 time-period, and take the 5-year average to create a 10-time-block time-series-cross-sectional regime data. Taking the 5-year average has a couple of advantages. One is

[2]The ten measures are Arat (2003), Bowman, Lehoucq and Mahoney (2005), Bollen (2001), *Freedom in the World 2007* (2007), Hadenius (1992), Przeworski et al. (2000), Marshall and 2006 (N.d.), Coppedge and W.H. (1991), Gasiorowski (1996), Vanhanen (2003).

simply to reduce the dimension of the data set. With hundreds of observational units within each year, the matrix dimension, *(the number of observations across time and units)*×*(the number of observations across time and units)* can easily become very large.[3] More importantly, by taking the average, I could alleviate possibly erroneous fluctuations of democracy scores, which is a major concern often raised by the believers of dichotomous or trichotomous democracy scores as an argument against continuous scores. Figure 2 demonstrates

Figure 2: Summary of the Democracy Scores (Dependent Variable) by Time Period



Note: Data source: Pemstein, Meserve and Melton (2008)

summary statistics of the democracy score for each of the 9 time-periods.[4] The scores range

[3]For example, suppose the dataset includes 50 years and each year includes 100 countries. The dimension of weights matrices would become 5000-by-5000 and it incurs a substantial computational burden. It did not appear to me as a good strategy at this preliminary stage of the project to use such a large dataset.

[4]The ten time periods that I created by taking the five-year averages are; (0) 1951-1955, (1) 1956-1960, (2) 1961-1965, (3) 1966-1970, (4) 1971-1975, (5) 1976-1980, (6) 1981-1985, (7) 1986-1990, (8) 1991-1995, (9)

approximately from -2 to 2, and the means (indicated by vertical lines) are roughly around 0 in all time-periods.[5] To get a sense of how countries are ranked in a given year, I plotted the democracy score of each country for the last time period, 1996-2000 (or "year 9"), in Figure 3.

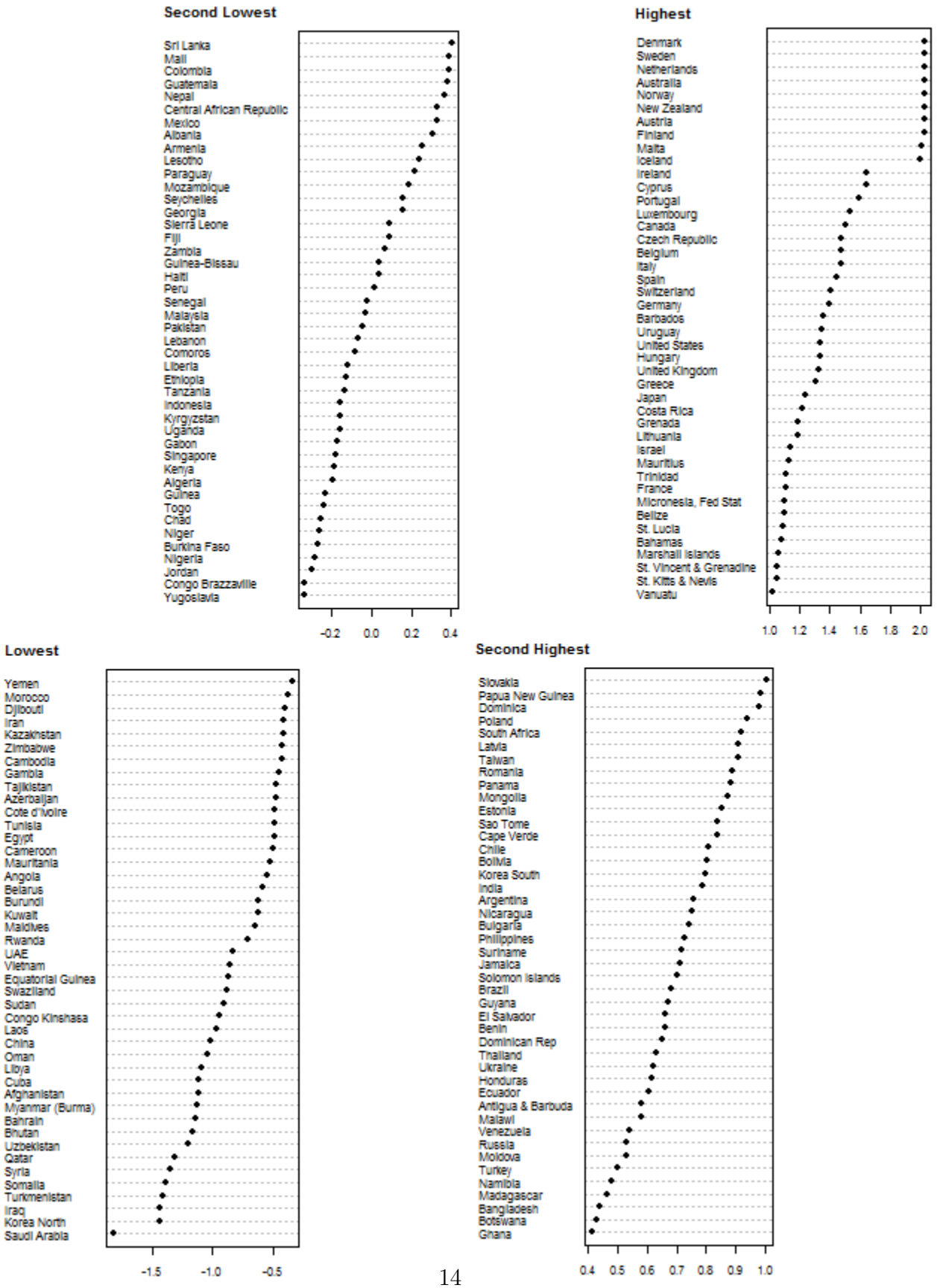
Each of the two main model specifications consists of three parts. First, following Lipset's social and economic requisites theory, the models contain country-specific social and economic attributes. A number of earlier democratization studies argue that the economic development level is positively associated with countries' democracy scores(Huntington, 1991; Boix, 2003; Boix and Stokes, 2003). To allow the possible curve-linear relationship between the economic development and the democracy levels, I include *real GDP per capita* and the squared term, *(real GDP per capita)*^{2}.[6] The data are taken from Gleditsch (2002) and it measures the real GDP per capita in thousands of constant U.S. dollars with the base year being 1996. Another economic variable is *growth rate*. Scholars have emphasized the importance of growth in explaining democratization and consolidation of democracies, but have found weak or no empirical evidence of economic growth. It might be due to multiple competing forces that growth can generate. As Boix (2003) theorizes, "[t]he possibility that low taxes may spur faster economic growth may entice the poor to commit to moderate levels of redistribution" and that "'should, in turn, reduce the wealthy's opposition to universal suffrage and hence facilitate the introduction of democracy." With this mechanism, economic growth should be positively correlated with the level of democracy. As the author points out, this mechanism works only when the country has some political institution that ensures that the poor abide by their commitment to maintain the taxes low once democratization occurs. However, another possibility is that growth might reduce the level of economic grievances among the repressed. With this mechanism, economic growth should reduce the force to mobilize population and should be negatively correlated with the occurrence of democratization. I should note that this demobilization force can be realized only in the authoritarian regimes that have some (imperfect) political institution that ensures redistribution not only among the elites but also among the poor as well. The variable, *growth rate*, is computed as the log difference of the real GDP levels. The last economic variable is *fuel export* that measures the percentage of a country's fuel export of all the merchandise exports. The data are taken from the World Development Indicator (the World Bank). When a country democratizes, it usually means that the government enfranchises the poor/repressed. This moves the median voter position from somewhere in the wealthy group to a point in the then repressed group, resulting in higher taxes for the rich than in the former authoritarian regime (Boix, 2003). While owners of relatively mobile business, such as manufacturers, could move their production sites outside the country if higher taxes are implemented, fuel (or natural

1996-2000. As I explain later, one of the explanatory variables is a one-time-period lag of the dependent variable. Consequently time-period (0) drops out of the dependent variable, leaving nine time periods, (1)-(9), in the final dataset.

[5]Unlike commonly-used democracy scores, such as Polity IV, the UDS are not restricted to a certain range. Each country's democracy score, estimated as its posterior mean, happens to have fallen between about -2 and 2.

[6]Later I tried estimating the models with the logged real GDP/capita variable instead of GDP/capita and (GDP/capita)^2. Qualitatively the results remained unchanged.

Figure 3: Democracy Scores of the 175 Countries included in the 1996-2000 Time Block



Note: Data source: Pemstein, Meserve and Melton (2008)

resources in general) is a highly location-specific asset and it would be difficult for the rich to "move" the production sites when the tax rates increase (Boix, 2003). Therefore in the fuel-rich countries, the rich have an incentive to block democratization movements and we should expect the negative effect of the *fuel export* rate on democracy scores.

The *commonwealth* variable is a dummy indicating the commonwealth membership. This variable is to capture the possible legacy of British colonization.[7] Due to the imposed British political institutions during the colonial era, these countries might have some political attributes in common with Britain that might lead to stable democratic regimes like the British one, regardless of their own political history before or after the colonization. Another socio-political variable is *urban population rate*. I expect that the urban population rate would be positively correlated with democracy for a couple of reasons. First, the urban population is more likely exposed to foreign culture, among which can be democratic countries. Second, higher degrees of urbanization imply higher population concentration. This could facilitate, in conjunction with the exposure to more democratic foreign culture, solving the collective actions that are oftentimes a key to overturn the dictatorial incumbents either by voting for the democratic opposition or revolting against the government. A concern might be that the urban population rate tends to increase as a country experiences economic development and it might be difficult to distinguish the effects of the urban population rate and other economic-status variables. Following Przeworski et al. (2000), three religion variables– *catholic*, *muslim* and *protestant*– are also included. Each measures the time-invariant percentage of the population that belongs to the religious group. The data are mainly from Przeworski et al. (2000) and for the countries that are not included in Przeworski et al. (2000), the current issue of the CIA World Factbook are used. As Przeworski et al. (2000) mention by citing Lipset (1959), Protestantism's emphasis on individualism and self-reliance is said to nurture democratic values while Catholicism "was antithetical to democracy in pre-World War II Europe and Latin America." Therefore we should expect to observe the positive association between *protestant* and democracy, but negative between *catholic* and democracy.

Lastly, the *temporal lag* variable is a one-year lag of a country's own democracy score. It controls for the history of the country's regime. If a country has a fairly democratic regime in one time period, then it is most likely that the democracy score of the country in the following time period is not too far away from the past score.[8]

It is important to control for these country-specific attributes not only because of each substantive rationale that I mentioned above. It is also because controlling for some of these socio-economic variables is essential to extract the "true diffusion" or "true" spatial-

[7] Later I should change this to a variable that indicates only former British colonies and not the commonwealth membership.

[8] Overall the set of these country-specific variables is very similar to the one Przeworski et al. (2000) have in one of their fuller models. The differences are that my specifications do not include variables that capture social fragmentation, such as ethnic and religious fragmentation, and also that I control for the effects of fuel export when they do not. Another important source of social divide that I do not have in my current specifications is income inequality, which is a key variable in Boix (2003). I plan to include these variable as soon as I collect them.

interdependence of the democracy level, which is the central theme of this project (Franzese and Hays, 2006, 2007, 2008). What does this mean? Supposed that we believe political regimes diffuse among countries through geographical connectivity; i.e., a country's democracy level is affected more by that of geographically closer others than that of distant others. At the same time, suppose it is the case that the similar levels of GDP/capita are geographically clustered. Finally suppose that we observe geographical clustering also in the dependent variable– the democracy score– as well. Now for the geographical clustering of democracy scores, two completely different explanations can co-exist. One is that political regimes spread among neighbors based on the geographical proximity of the countries. When there is an increase in the democracy score of a certain country, the democratic shock affects closer countries more than distant countries. This is one way we can observe geographical clustering in the regime score, and we consider this as a "true" diffusion or interdependent mechanism. However, the same clustering in the dependent variable can also be observed when each country's political regime responds similarly to a similar economic development level– one of the country-specific variables. In this mechanism, countries are responding to their own levels of the economic variable independently, and there is no diffusion of regime type. In this case, what we observe is, in fact, mere spatial clustering/association of the dependent variable, but it is not diffusion or interdependence. In the real world the two mechanisms can co-exist, and therefore it is important to include variables that capture both mechanisms in order to distinguish the two.

The second category of the explanatory variables is exogenous connectivity. As exogenous regime-diffusion channels, the model includes *trade volume* and *border*. Each of these weights matrices is multiplied by the outcome variable, democracy score. The overall product of the weights and the outcome variable represents other countries' democracy levels weighted by the strength of ties between each pair of countries. What is estimated in the regression models is the coefficient parameter attached to the whole product. This parameter captures how much the particular kind of connectivity matters in the context of democracy diffusion. In other words, for a certain pair of countries A and B, even if B's democracy score is very high and the tie between A and B is very strong, we should conclude that the diffusion through this particular connectivity does not exist, if the coefficient parameter attached to this term is estimated to be statistically not significant. The connectivity matrix *trade volume* is a proxy for the economic interdependence among the countries. The rationale to include the trade weights is that countries' political conditions tend to become more similar when they are economically interdependent. Each entry of the trade weights measures the sum of the import and the export (in millions of current-year U.S. dollars) for each pair of two countries and the data are taken from Gleditsch (2002). In some existing studies, trade volumes are divided by the effect-receiving countries' total GDP levels. The logic behind this practice is that the influence through trade volumes depends on how significant the volume is compared to the overall economic size of the effect-receiving country. A disadvantage of this practice is that it becomes unclear as to exactly which affects the outcome quantity, an increase/decrease in trade volumes or a decrease/increase in GDP. For this reason, the trade measure in my empirical analyses is a simple sum of import and export. The other connectivity matrix *border* is different from the trade matrix in that all the entries of the matrix are binary, 0 or 1. In this preliminary empirical study, the geographical contiguity is

defined strictly as countries that share inland borders. The data are taken from the "Direct Contiguity Data, 1816-2006 (Version 3.1. Online: `http://correlatesofwar.org`)" in the Correlates of War Project (Stinnett et al., 2002). The most strict definition of contiguity ("type 1" in the COW dataset) is used.[9] Both *trade volume* and *border* matrices are row-standardized.

The third and the most important category of the explanatory variables is the influence of others' regimes through the endogenous tie strength. The connectivity matrix for the *endogenous diffusion* consists of the distances of pair-wise regimes. Each cell (it, jt) contains the value $|y_{i,t-1} - y_{j,t-1}|$, where $y_{i,t-1}$ are taken from the UDS. The endogenous connectivity matrix is also row-standardized.

All of the regression models include time and region dummies. The nine time dumies are for the periods of (1) 1956-1960, (2) 1961-1965, (3) 1966-1970, (4) 1971-1975, (5) 1976-1980, (6) 1981-1985, (7) 1986-1990, (8) 1991-1995, (9) 1996-2000, and the dummy variable for the last time period, (9), s dropped from the regression equations. The eight region dummies are for (1) Africa, (2) North America, (3) Central and South America, (4) Asia, (5) Middle East, (6) Western Europe, (7) Eastern and Central Europe and (8) Oceania. The eighth regional dummy for Oceania is dropped from the regression equation.

5 Empirical Results and Discussions

What country-specific political and economic conditions lead to more democratic regimes? Are there diffusion effects in political regimes? Are countries' political regimes more likely affected by countries with already similar regimes, or dissimilar regimes? Table 2 reports the results of the maximum likelihood (ML) estimation of M-STAR models with the co-evolutionary dynamic.

Recall the regression equation;

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \phi\mathbf{M}\mathbf{y} + \Big[\sum_{r=1}^{R} \rho_r \mathbf{W}_r\Big]\mathbf{y} + \gamma\mathbf{L}\mathbf{y} + \boldsymbol{\varepsilon}. \tag{10}$$

With the actual variables and the connectivity matrices that are included in the model, the following model is fitted.

$$\begin{aligned}\mathbf{y} =& \Big\{\beta_{cons}\mathbf{1}_{cons} + \mathbf{x}_{c.specific}\boldsymbol{\beta}_{c.specific} + \phi\mathbf{x}_{lagged\ y} + \mathbf{X}_{time\ dumms}\boldsymbol{\beta}_{time\ dumms} + \mathbf{X}_{region\ dumms}\boldsymbol{\beta}_{region\ dumms}\Big\} \\ &+ \Big\{\Big[\rho_{border}\mathbf{W}_{border} + \rho_{trade}\mathbf{W}_{trade}\Big]\mathbf{y}\Big\} + \Big\{\gamma\mathbf{L}_{dissimilar}\mathbf{y}\Big\} + \boldsymbol{\varepsilon},\end{aligned} \tag{11}$$

[9] By this definition, for example, Korea and Japan, which are separated by the sea are not "neighbors". This definition seems too strict for the purpose of this study. In the next iteration, I am going to use a different contiguity definition, or the distance between countries as Beck, Gleditsch and Beardsley (2006) do.

where $\mathbf{y}$ is the continuous democracy scores from the UDS. The terms in the first curly brackets are for the country-specific variables, including time and region dummies. The matrix $\mathbf{X}_{c.specific}$ contains all the non-diffusion determinants of democracy, such as *real GDP/capita*, *(real GDP/capita)*^{2}, *growth rate*, *commonwealth*, *urban pop rate*, *fuel export*, *catholic*, *muslim*, *protestant*. These are the domestic or international determinants to which countries's democracy scores independently respond and have nothing to do with the diffusion mechanism. The second and the third curly brackets contain the possible diffusion processes. The second part is for diffusion through exogenously-shaped connectivities, *border* and *trade volume*. The third part is for the diffusion through endogenously-shaped ties, and this term generates the co-evolutionary dynamic between the outcome variable and the connectivity $\mathbf{L}$, which consists of the pairwise difference of the regie score ($\mathbf{y}$) from the previous time period.

Model (1) is a non-spatial specification and Model (2) is a traditional multiple-spatial-lag model without the co-evolution term. The likelihood-ration (LR) tests find that the difference between Model (1) and (2), and Model (2) and (3) are statistically significant (with the LRs being 21.64 and 8.9 respectively, and the chi-square critical values being 13.82 and 6.63 respectively at the significance level of 1%). It is likely that the non-spatial model (1) suffers from omitted variable bias and it shows up in the overestimated degree of temporal persistency.

My discussion will, therefore, focus on the spatial models (2), (3) and (4). Both Model (3) and (4) utilize the new spatial econometric technique to evaluate the diffusion of democracy allowing for the co-evolutionary dynamic. The only difference between (3) and (4) is that Model (4) contains all the country-specific explanatory variables that I considered for this study, based on substantive theories and following the conventions in the traditional democratization literature. However, the LR test suggests that Model (3) is the preferred specification. Even after adding six more explanatory variables, the LR test cannot reject the null hypothesis that the added parameters in Model (4) are jointly zero. (LR= 8.34, the chi-square critical value with the degrees of freedom 6= 10.65 at the significance level of 10%.) I left Model (4) in the results table to demonstrate the entire list of variables that I consider, but I will use Model (3) to conduct additional analyses in the later sections.

In interpreting the magnitude of the coefficient estimates, it is important to note that, for most time-periods, the democracy scores of the 75 to 175 countries lie in the range approximately between -2 and 2. For example, in the 1991-1995 time-block ("year 8"), the data include 154 countries. This implies that only about a 0.026-unit increase in the democracy score is necessary, on average, for a country to catch up with the next higher-ranked democracy.

The *real GDP/capita* variables are both highly statistically significant and the signs indicate that there is a curve-linear relationship between the real GDP per capita level and the democracy score where the level of democracy goes up as the income level increases with a diminishing curvature. The result suggests that, for a middle income country, the democracy score could increase by as much as 0.13, as real GDP/capita increases by one unit, or

Table 2: Estimation Results: Regressions of the Unified Democracy Scores on the Country-Attribute Variables and Other States' Democracy Scores

		Beck et al.	OLS	M-STAR	M-STAR + Co-Evolution	
		(Cross-sec.)	(1)	(2)	**(3)**	(4)
Common exposure	**Constant**	-13.24***	0.150**	0.099	**0.099**	0.078
		-3.11	(0.063)	(0.067)	(0.069)	(0.080)
$(\boldsymbol{\beta}, \phi)$	**Temporal lag**		0.862***	0.826***	**0.826*****	0.820***
			(0.015)	(0.016)	(0.016)	(0.016)
	Real GDP/cap		0.016***	0.016***	**0.016*****	0.012**
			(0.005)	(0.005)	(0.005)	(0.006)
	(Real GDP/cap)^2		-0.0005***	-0.0005***	**-0.0005*****	-0.0004**
			(0.0002)	(0.0002)	(0.0002)	(0.0002)
	Growth rate					-0.004
						(0.003)
	Commonwealth					0.033
						(0.025)
	Urban pop rate					0.001
						(0.0006)
	Fuel export rate		-0.0008***	-0.001***	**-0.0009*****	-0.001***
			(0.0003)	(0.0003)	(0.0003)	(0.0003)
	Catholic					-0.0001
						(0.0005)
	Muslim					-0.001*
						(0.0004)
	Protestant					-0.0001
						(0.001)
	log(GDP/cap)	1.53***				
		(0.37)				
Exogenous connectivity	Geog Distance	0.89***				
		(0.19)				
$(\boldsymbol{\rho})$	**Borders**			0.053***	**0.052*****	0.054***
				(0.019)	(0.019)	(0.019)
	Trade	0.59		0.105***	**0.105*****	0.1090***
		(0.43)		(0.027)	(0.027)	(0.028)
Endogenous connectivity	**Regime distance**				**-0.104***	-0.098*
(γ)					(0.055)	(0.055)
Other parameters	$\boldsymbol{\sigma}$		0.307***	0.303***	**0.303*****	0.302***
			(0.006)	(0.006)	(0.006)	(0.006)
	Time dummies?	NA	Yes	Yes	**Yes**	Yes
	Region dummies?	No	Yes	Yes	**Yes**	Yes
	Log-likelihood		-279.039	-268.219	**-263.769**	-259.601

Standard errors are in parentheses. Significance levels : * : 10% ** : 5% *** : 1%. Note that Beck, Gleditsch and Beardsley (2006)'s results are based on a cross-sectional specification with the 1998 data. Their dependent variable is from the Polity IV data. The dependent variable of Model (1)-(4) is the Unified Democracy Scores derived in Pemstein, Meserve and Melton (2008). Model (1) is an assumed-independence model, where spatial interdependence is assumed to be zero. Model (2) is a simple M-STAR model with no co-evolutionary dynamic; i.e., all the spatial lags are pre-determined. Model (3) and (4) are M-STAR models with the co-evolutionary dynamic; i.e., these models also include the regime-distance "spatial" lag that is endogenous over time. All the models are estimated with eight temporal dummies and seven regional dummies. The seven regions are Africa, North America, Central and South America, Asia, Middle East, Western Europe and Eastern Europe. The eighth regional dummy for Oceania is dropped from the regression equation.

$1000. This is equivalent to say, on average, a middle income country could improve its democracy ranking by 5, all else equal. However, the *growth rate*, as the log-difference of the real GDP/capita levels, turns out not statistically significant. This result confirms the basic findings both in Przeworski et al. (2000) and Boix (2003). Przeworski et al. (2000) points to the asymmetry of the effect of growth in democracies and autocracies. They find that democracies are more sensitive to economic crises (or sudden negative growths) than autocracies. Another possibility, as I mentioned in the previous section, is the existence of multiple competing forces that growth can generate. In countries where the poor can make a credible commitment to maintain moderate tax rates in the potential future democracy, growth could increase the the propensity of democratic transitions, because the poor take the growing economy as an opportunity to receive more redistribution even at an unfair redistributive rate (the rate is low but the pie itself is growing fast enough to make the benefit sufficient) and the elite/rich are convinced that, even after the democratization, the tax they will incur is sufficiently small. At the same time, in autocracies where there is a modest redistributive system, the level of economic grievances could be too low for the repressed to stand against the authoritarian incumbent when the economy grows fast. Without controlling for such institutional differences across countries, it is impossible to entangle the complex effects of growth.

Another country-specific variable that consistently turns out significant is *fuel export rate* . Even though the magnitude is very low, a percent increase in fuel export (out of all the merchandise exports) seems to decrease the democracy score by 0.0009 all else equal. It should be noted that Model (3) also includes a dummy for the Middle East region, which is a typical oil-rich region, and both the region dummy and the fuel export rate are statistically significant, at the 5% and the 1% significance levels respectively. This is strong evidence of the fuel effect or the country-specific-asset effect on democracy, confirming one of Boix (2003)'s main claims.

All the other country-specific variables turn out to be statistically insignificant. The results are very robust in that regardless of the combination of these common-exposure variables, only the coefficients of *temporal lag*, *real GDP/capita*, *(real GDP/capita)*^{2} and *fuel export rate* are statistically significant most of the time and not others. These results are not necessarily surprising. Przeworski et al. (2000) also find weak or no results of the religion dummies. In my Model (4), the *muslim* variable has a modestly significant and negative effect on democracy, but the Middle East region dummy in this specification becomes not significant while it is almost always significant in other specifications. From this, there is no way to tell empirically whether it is something about the Middle East region in general that prevents democratization, or whether there is something particular about their culture related to the religion. Also the high correlation between urbanization and economic development might be the reason why the coefficient for *urban population rate* is not statistically different from zero.

Finally, all the specifications find strong significant and positive effects of the temporal lag, confirming that history of each country's regime matters and the magnitude is large.

Now let us look at the estimated coefficients related to the diffusion and self-selection. The estimates for the exogenous-diffusion terms (ρ's), in all three spatial models, uncover positive interdependence of political regimes through the geographical and economic ties. Note the the strength of the effects of other countries' democracy scores through a particular connectivity can be computed as $\hat{\rho}_r \mathbf{W}_r$; i.e., the information we can obtain from the coefficient ρ's themselves is merely to what extent the connectivity of units matters overall, and it is not the magnitude of "influence" that other countries' regimes have. I will later compute the overall strength of other's influence in the next section. What we can learn from the significant estimates of *border* and *trade* is that to whom others and to what extent a country is connected matter in predicting a country's democracy level.

Finally the main contribution of this paper, the influence of other regimes through regime distance, is uncovered by the estimate of γ. The coefficients are negative and statistically significant. Note that the connectivity matrix $\mathbf{L}$ carries the information about the "magnitude" of the pairwise regime dissimilarity; i.e., all the entries are absolute values of the distance between political regimes of any given two countries. Since all the entries of $\mathbf{L}$ are greater than or equal to 0, the negative estimate of γ combined with the positive estimate for ρ_r's implies that a country's political regime influences those of countries with more similar regimes than dissimilar regimes: homophily in other words. This could imply that countries with similar democracy levels become more similar over time as if they were reinforcing each other's regime type, possibly generating several regime "blocs" in the long run. It should be noted that these regime blocs/clubs are not necessarily clustered geographically, if the effect of regime-similarity-based contagion is substantial compared to the effect of geography-based contagion, for example. I will discuss the long-term distribution of political regimes around the world in the later section on counterfactual simulations.

I have developed this somewhat unified model of the diffusion of democracy, building on the accumulated knowledge about the determinants of democratization in the existing studies. From the coefficient estimates of the most preferred specification, (3), we can conclude that countries' regime scores are highly correlated with some country-specific factors, such as their economic status and the asset specificity. After controlling for the effects of such variables, I find empirical evidence that there is true interdependence in countries' democracy levels and that geographical contiguity and trade volumes are at least partially defining the strength of this interdependence. Moreover, as I suspected, the democracy scores achieved by these countries in a certain time period partially determine the degrees of regime influence among them in the next time period. Even though it is difficult to see the magnitude of the selection bias in the coefficient estimates, it is suggestive that what we thought before was the diffusion of regimes occurring through exogenous ties is in fact partly due to the fact that countries with similar regime scores are more likely to have strong ties precisely because of their similarity in regimes scores. In other words, countries are selecting themselves into regime networks that in turn shape their next-stage democracy levels. Before the M-STAR model with co-evolutionary dynamics, we could not test for the possibility of this selection.

6 Estimated Latent Regime Interdependence and Counterfactual Analyses

There are a number of different ways to use the information obtained from the estimation in the previous section. The usefulness of different effect calculations and counterfactual analyses depend on what researchers would like to know. In this section, I will first introduce a way to interpret the estimated democracy interdependence (i.e., the estimated contagion paths of political regimes) using the network-analysis approach. Next I will conduct a counterfactual analysis for regime-change trajectories after a substantial democratic shock to a country, starting from the fitted democracy levels using the last time period (1996-2000).

6.1 Estimated Latent Interdependence for Political Regimes

With spatial econometric models, it is usually difficult to grasp the true meaning of effects simply by looking at the estimated coefficients reported in Table 2. For example, as mentioned in preceding sections, the regime interdependence can only be captured by a product of the estimated coefficient and the given spatial weights, $\hat{\rho}_r \mathbf{W}_r$ or $\hat{\gamma}\mathbf{L}$, but not simply by the coefficients $\hat{\rho}_r$ and $\hat{\gamma}_r$. A weights matrix $\mathbf{W}_r$ indicates how strongly a pair of countries is interconnected and the coefficient $\hat{\rho}_r$ tells us how much this particular connectivity matters in explaining countries' democracy scores. It is sometimes useful to compute the overall interdependence of countries by $\sum_{r=1}^{R} \hat{\rho}_r \mathbf{W}_r + \hat{\gamma}\mathbf{L}$. This quantity is the estimated latent structure of interdependence that explains and is partially explained by the level of democracy of the included countries.

Existing works in spatial studies had conventionally reported the $\sum_{r=1}^{R} \hat{\rho}_r \mathbf{W}_r$ matrix to demonstrate the estimated interdependence, but had never studied the characteristics of the information contained in the connectivity matrix until (Hays, Kachi and Franzese, 2010). This is somewhat ironic given that spatial studies are motivated by the very notion that there are a number of political outcomes and behavior that cannot be explained only by the actors' attributes; the strength of ties among actors is also an important determinant of such phenomena. The following graphs exemplify some of the patterns of the implicit network interdependence in democracy scores that were revealed by the estimation.

Most countries have at least weak connections with some countries, which makes the network graphs tend to look very busy. Figure 4 demonstrates only the ties with high magnitude (the 95th-percentile) among all the statistically significant ties at the 99% confidence level. Figure 4-(a) (the top panel) shows such ties in the time period of 1971-1975 and (b) (the bottom panel) is for the 1996-2000 time period. The size of edges indicates the strength of the estimated ties. Since the estimated coefficient of the similarity matrix $\mathbf{L}$ is a negative

value (-0.104), some cells of the overall interdependence $\sum_{r=1}^{R} \hat{\rho}_r \mathbf{W}_r + \hat{\gamma}\mathbf{L}$ have negative values; however it turns out that all the negative dependencies are statistically not significant, leaving in only the positive interdependence in the plots. The node size represents the democracy level (larger nodes for higher democracy scores), and the node color indicates geographical region.[10] For example, an arrow from Japan to the Philippines indicates the influence of Japan on the Philippines, or the Philippines "learning from Japan's regime experience".

As an example of over-time network change, Figure 5 shows the ego network of Thailand for each of the nine time periods. The ego network is defined as a network that consists of a focal actor ("ego" and in this case it's Thailand) and the actors to which ego is directly connected, as well as the ties among these "alters". A big (red) circle in each plot indicates the location of Thailand. There are various ways to analyze these plots. One might be interested in the change in network density over time. Since the number of countries to which Thailand is connected generally increases over time, the plots become "messier"; however, we never know if the density of networks is going up or down over time until we compute it for each year. Network density is commonly measured by the number of ties divided by the number of possible pairs–in other words it is a measure of the proportion of ties formed out of all the possible combinations in a given network. For the case of Thailand, the density has been almost constantly dropping since the 70's (see Table 3), even though the graphs might look increasingly busy over time.

Table 3: Density of Thailand's Ego Networks

	'56-60	'61-65	'66-70	'71-75	'76-80	'81-85	'86-90	'91-95	'96-00
Density	50.00	41.07	49.17	41.34	28.92	30.65	22.68	20.61	15.58

Note: Densities are computed using UCINET ver.6.

6.2 Preliminary Counterfactual Analyses

For each set of observed or counterfactual data, there is a set of steady-state (or long-run) levels of democracy to which countries eventually reach assuming that the observed or counterfactual values for each variable won't change over time. Clearly, time-invariance of the variables is not a realistic assumption, but it is still useful to conduct some counterfactual analyses. For example, it is difficult for us to foresee how a democratic change in one country spreads across the world through the estimated interdependence until we simulate such changes. Or a promoter of democracy might want to know how an improvement in the

[10] Black: Western Europe. Blue: Central and South America. Green: Middle East. Light blue: Oceania. Light green: Asia. Gray: Eastern and Central Europe. Red: North America. Pink: Africa.

Figure 4: Estimated Latent Regime Dependencies: High-Magnitude (95 Percentile) Cases for the 1971-1975 and the 1996-2000 Time Periods

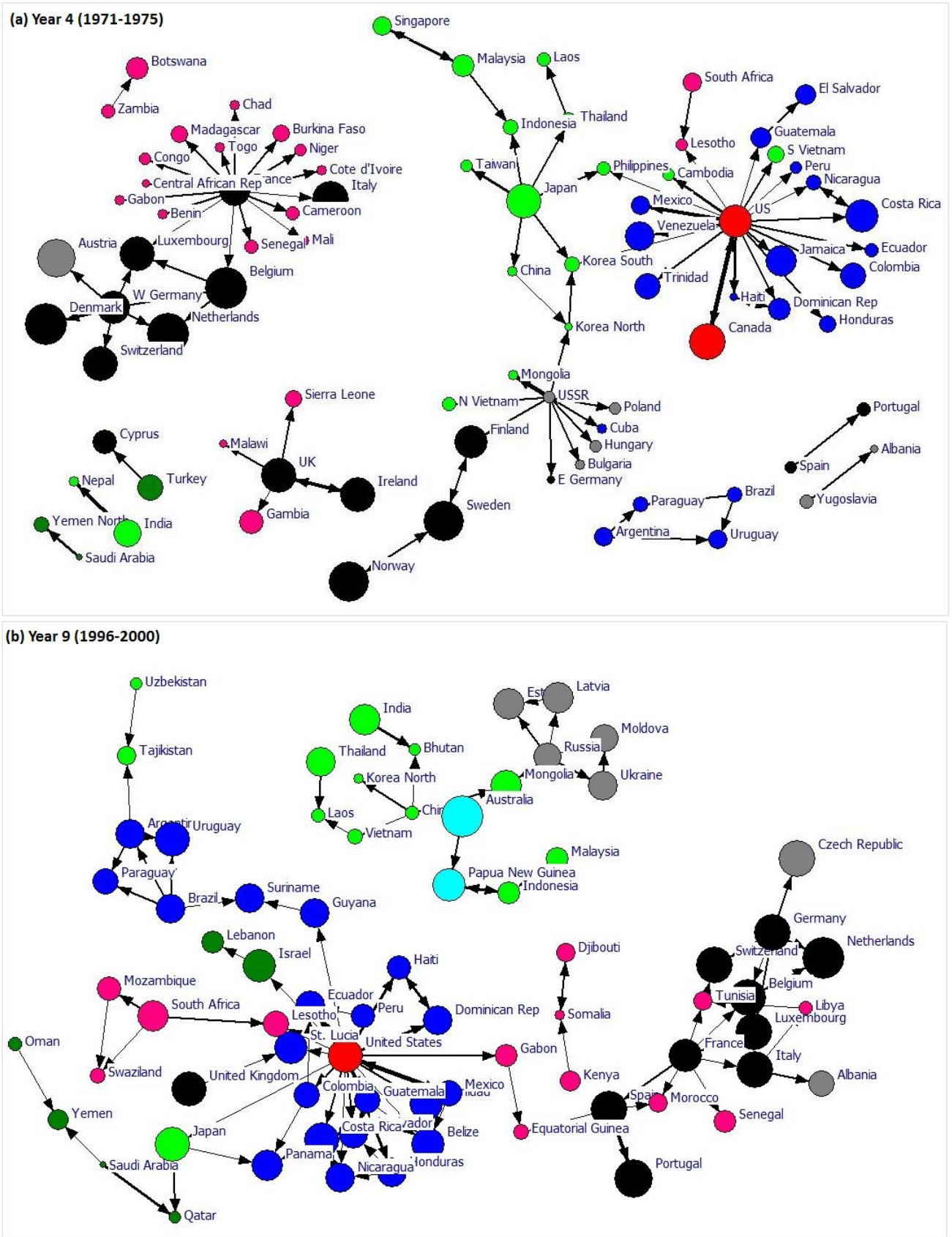
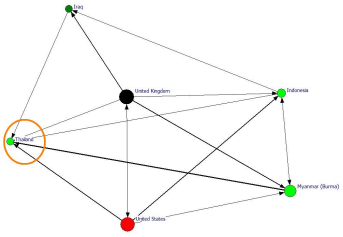
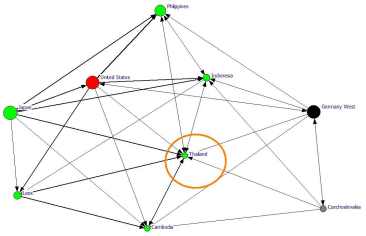


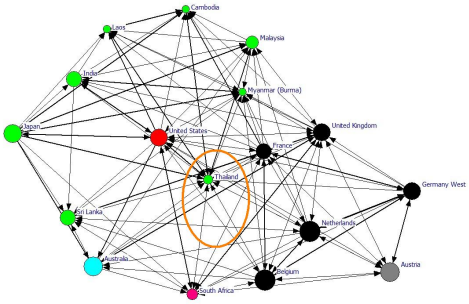
Figure 5: Thailand's Ego Networks (Distance = 1)



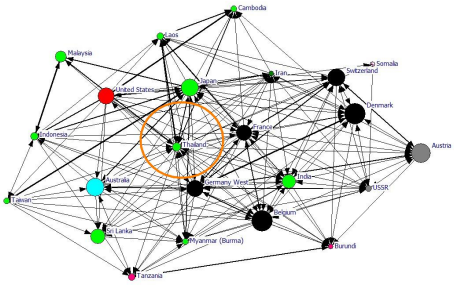
'56-'60



'61-'65



'96-'70



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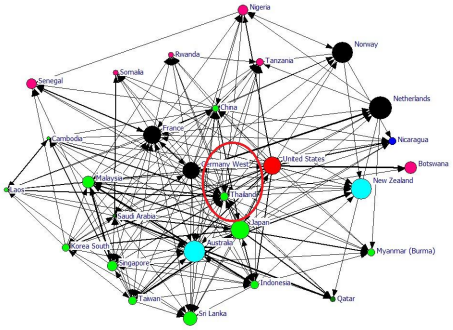
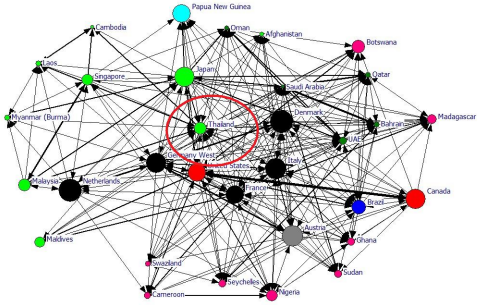
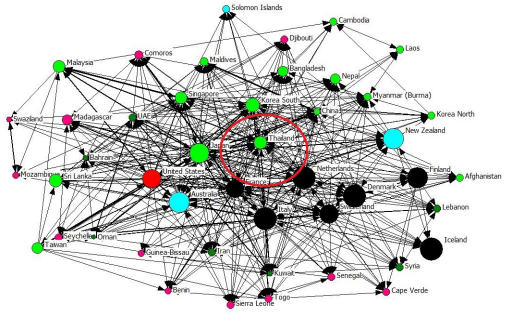


'76-'80

'81-

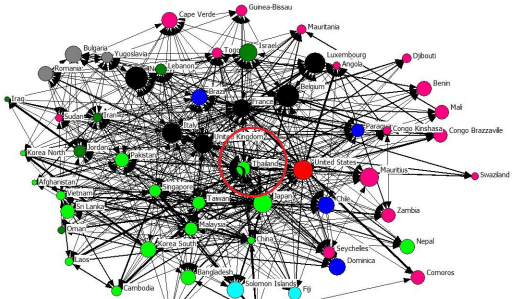


'85



'86-'90

'91-



average income level in one country affects the country's own *and* other countries' democracy levels in the following years. Obviously this is where theories about diffusion matter.

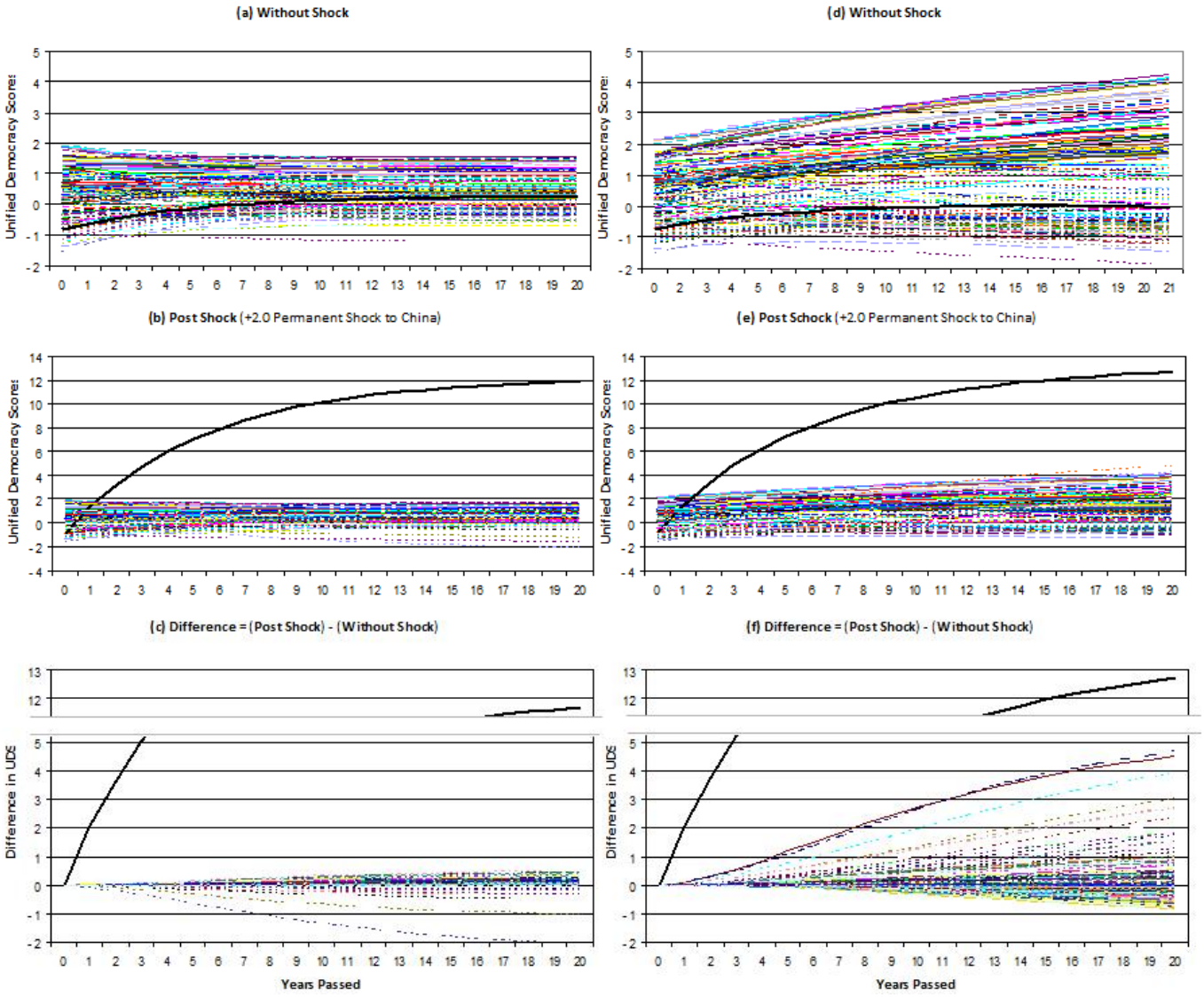
As an example, I gave a substantial democratic shock to China (+2.0 in the UDS unit) and observed how it changed the trajectories of all the countries' democracy levels over the following 20 years. For the spatial weights and the other variables, I used the values from the last time period (1996-2000), except the dependent variable which was computed using all the other variables and the estimated coefficients (i.e., the starting levels of the democracy scores are the fitted values). If the system maintain those variables' values in the following years, the countries' democracy scores follow the trajectories plotted in Figure 6-(d) (the top-right panel of Figure 6). Eventually all the countries would reach their own steady-state levels after many iterations, but I limited the length of simulation to 20 years (20 iterations), because an extreme extrapolation would not be a good empirical practice and the values for the explanatory variables fixed at the 1996-2000 level would become less and less realistic as time passes.

With a +2.0 shock to China's democracy level, the trajectories look like the ones in panel (e). The curves for China are highlighted in black and bold in all the graphs. The difference between the with- and without-shock curves can be seen more clearly in the last panel, (f). Graph (f) plots the difference of the with- and without-shock regime trajectory: as can be seen in the graph, the difference in the democracy score keeps going increasing for some countries, but decreasing or remains the same for others. If the difference increases over time, that means that the positive shock to China gave a positive influence to the country's democracy score and the (positive) gap between the original (no-shock) change in its regime score keeps widening over time. China, obviously, as well as Maldives and North Korea follow this pattern to a great extent.

The growing gap between the original trajectory and the trajectory after a shock mainly stems from the effect of co-evolution. When the shock occurs, a country's democracy level jumps up or down depending on its country-specific characteristics and through the estimated interdependence paths. Now with the new level of democracy in these countries, the new connectivity is defined both by the similarity in the new regime scores and the exogenous connectivities (i.e., trade and border). The new network now determines the level of these countries' democracy scores in the next iteration together with their country-specific variables. The co-evolutionary dynamic generated by the evolving similarity connectivity reinforces the direction of the regime change for most of the countries, whether upward or downward. This is mainly why we observe amplified effects of a shock over time. This is one type of history dependence, which is generated by the selection mechanism: the initial condition and the initial direction of change set a path (weakly or strictly) for an actor regarding its future behavior.

The effect of co-evolutionary dynamic becomes much more obvious when we compare panel (f) with panel (c), which is the same difference but generated from a specification that does not have the similarity (endogenous) connectivity. I used Model (2) to conduct the simulations for panel (a), (b) and (c). Comparing (c) and (f), it is clear that we could underestimate

Figure 6: Trajectories of Democracy Scores with and without a Counterfactual Shock in China



the effect of shocks if the actual process in democracies is closer to the specification with co-evolution but we estimate the effect using the traditional spatial models, which only contain exogenous connectivities.

7 Conclusion

This study revisited the meaning of diffusion in regime transitions and proposed a type of diffusion path that has been overlooked in existing studies. I posit a theory that a country form stronger dependency ties with countries that demonstrated similar democracy levels in the past (homophily). Incorporating such country networks that are shaped endogenously (to their past regime types) generates a co-evolutionary dynamic between the dependent variable and part of the connectivity among countries. I introduced a new spatial estimator, "MSTAR + Co-evolution" model, in order to distinguish three processes that can determine a country's democracy level. The first type of process is where country-specific attributes determine the level of democracy as typically suggested in the earliest democratization studies. The second process is the traditional diffusion mechanism in which other states' democracy levels predict a country's regime. Finally the third type of process is my theory of endogenous network formation. This third process important to consider because the seeming diffusion effect (the second mechanism) can be partially a mere consequence of countries' self-selection into peer networks, potentially inflating the estimated effect of diffusion in the existing empirical studies. The empirical analyses find that other states' democracy levels affect a country "positively" through the endogenous (or the regime-similarity) connectivity.

The first implication of this finding is that a selection mechanism (homophily) exists in political regimes transitions. Part of the estimated influence of others' regimes that travels through the exogenous paths (trade and border) in existing studies could be overestimated due to the fact that countries self-select themselves into regime networks.

Another implication of the co-evolutionary dynamic becomes evident in the counterfactual analyses. Since homophily (or selection) in democracy scores reinforces the current direction of change in the the democracy score of each country, it generates a path-dependent dynamic over time. The initial conditions influence the path that a country's democracy score follows later. Since this dynamic was not a part of traditional models, we were not able to test for path dependency before. In fact, by using the tradition models for diffusion, one would be implicitly assuming that regardless of the initial conditions (or a set of conditions surrounding country A at one time period), country A would always reach its own steady-state level, x, if the system runs for a long time. For example, which countries in the world have more democratic regimes in a certain year does not matter to one's long-run democracy level in this framework. However, it should be intuitive for any social scientist that two worlds with different distributions of regimes have very different implications for the political development of a country. Introducing the co-evolutionary dynamic enables us to address this issue.

Lastly another implication that has not been discussed in this paper throughly (yet) is the

exact working of path-dependence. As I mentioned earlier, the path-dependence generated by the homophilic network-formation over time reinforces the current direction of changes in the democracy scores. If this is the case, then there should be a border line/lines above which countries head toward more democratic regimes and below which countries head to more autocratic regimes. Eventually there should be several "convergence clubs". Under what conditions should we expect to observe a world with a complete convergence, dichotomous regime clubs, trichotomous clubs, and so on? And why do we see a two-regime world currently? To answer these questions, I will need to further explore the workings of the co-evolutionary dynamic both methodologically and substantively. (Part of the attempt to study analytically the working of path dependency that emerges from contagion and network selection has been published in Franzese, Hays and Kachi (2012)).

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