

**The Introduction Chapter of the Thesis;**

**“Diffusion, Co-Evolution and Strategic Interdependence in Comparative and International Politics: New Spatial Econometric and Event History Approaches”**

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Let's face it, the universe is messy. It is nonlinear, turbulent, and dynamic. It spends its time in transient behavior on its way to somewhere else, not in mathematically neat equilibria. It self-organizes and evolves. It creates diversity and uniformity. That's what makes the world interesting, that's what makes it beautiful, and that's what makes it work.

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*Thinking in Systems*  
Donella H. Meadows

## 1 Interdependence in Regime Transitions

What determines countries' democracy or autocracy levels? For a long time, comparative scholars have attempted to build empirical models that explain political regime changes. In the literature, scholars have conceptualized and operationalized regime transitions in a number of different ways. Some studies focus on explaining the level of democracy (e.g. measured by the Freedom House and Polity IV democracy scores) given a country and a year. In these studies, each country-year observation is the unit of analysis. Another group of democratization studies explain the timing and occurrence of democratization, or the timing and occurrence of democratic breakdown. These studies operationalize the idea of timing and occurrence in two different ways. The most conventional approach is to explain the latent probability of a country's regime change from one type to another, given a country and a year (e.g., Przeworski et al. 2000). A newer approach is to model directly the spell of time till a transition occurs, either to or from democracy (e.g., Alemán and Yang 2011; Svoblik 2008).<sup>1</sup> In these duration analyses, the timing of *democratization* is measured as a spell of time between the emergence of autocracy and the transition, or between the independence of a country and transition. Likewise the timing of the breakdown of democracies is measured as a spell of time between the emergence and collapse of a democracy.

In this thesis, I highlight the inadequacy of existing empirical studies, by revisiting and restructuring three important theoretical arguments ignored in existing research. In a nutshell, the common problem lying beneath these empirical approaches is the assumption of *independent observational units*, when the units are highly interdependent in reality. First, I point out that the emergence and breakdown of democracies are interdependent, while existing studies look at each event in isolation. The second type of interdependence is the contagion of political regimes across countries. Diffusion studies exist, but most of their empirical approaches reduce the inter-state relational information down to country-specific attributes. The resulting empirical models can only test, at best, whether the average surrounding democratic/autocratic environment affects a country's democracy level. These models cannot test whether there exist *influence* dynamics among countries and how strong these influences are between each given pair of countries. Finally, I develop a theory of the regime-support dependency. I argue that countries are not necessarily "open to change" their regimes as the conventional diffusion concept assumes. They can also attempt to maintain their current democracy/autocracy levels, for better or for worse. In this case, countries seek peers that have currently similar regimes and form political/diplomatic ties with them. Through this regime-support and regime-approval network, countries can influence each other in a way that they reinforce their regimes over time. Once the regime-support dependency is defined, the influence mechanism across country is similar to the conventional diffusion theory in a cross-section. However, I need to separate the two—the conventional contagion and regime-reinforcement mechanisms—because the long-run dynamics generated by them are

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<sup>1</sup>I should note that Svoblik (2008) mainly contributes to distinguish empirically a subtle difference between cases where countries do not seem to democratize further because they are already consolidated democracies, and cases that are still at risk of reverting to authoritarian regimes. Hence the concept behind the dependent variable is not simply about "democratizing or not". However, this still represents a study of democratization, broadly defined, that operationalizes transitions as spells of time from one state to another, or equivalently, failure rates of democracies.

very different. This is due to the fact that regime-support networks are defined by similarity in the very outcome that the model tries to explain; i.e., political regimes.

Each of these three sources of interdependence creates its own methodological problems for empirical analysts, but there is a common mathematical characteristic lying underneath all the methodological problems; which is the notion of *feedback loops* in systems theory. At the abstract level, feedback loops are the main reasons why one needs more complex tools to make statistical inferences with the presence of interdependence among units. In the following, I elaborate on the (i) theoretical source of interdependence and (ii) the type of feedback loop generated by the theory, for each of the three types of interdependence in democratization. At the end, I lay out the plan of the thesis, focusing on what methodological solutions I suggest to each problem.

## 1.1 Interdependence (1): The Emergence and Breakdown of Democracies

Theoretical works on democratization suggest causal connections between the emergence and breakdown of democracies. Conventional empirical studies explain *either* the timing of transitions to democracy *or* the survival of existing democracies in isolation. However, there are a number of untested theoretical works that suggest (i) the speed of democratic transition depends on how likely the future democracy can be compromised (e.g. by a coup by the former authoritarian elite), and (ii) the timing of breakdown of democracy might depend on how and how quickly the democratic transition occurred.

For example, actor-oriented theories (namely game theoretic models) of democratization (e.g., Acemoglu and Robinson 2006) claim that, in deciding whether to democratize or not, authoritarian leaders might be aware that, later, staging a coup to reverse the newly-established democracy is possible. This anticipation by the elite about the survival of the potential democracy affects their decisions on when to democratize the country. If they expect that it would be costless to reverse the democracy by a coup, the elite might not negotiate hard with the democratic opposition, making the transition process quicker. On the contrary, if they expect that the democracy lasts longer once it emerges, then they might negotiate harder with the opposition, prolonging the transition duration as a consequence. Østerud (2011) also provides a theoretical argument about the elite's anticipation, based on cases of post-communist regimes in east and central Europe. He claims that authoritarian leaders are more willing to negotiate with the democratic opposition, when "they conceive this as a lesser or less risk evil"; in other words, authoritarian leaders are more willing to negotiate with the democratic opposition, when they sense that they might be able to retain some political power and influence after the transition. A specific example would be "the potential cost of coup" that the elite could stage to regain political power. This strategic thinking by the authoritarian elites can induce a positive causal effect from the expected duration (durability) of a future democracy to the length of the current dictatorship. The longer (expected) survival "causes" a prolonged dictatorship period.

It is not only the elite that is concerned about the future regime outcome. The democratic opposition can also form anticipation about the success and effectiveness of its anti-government movements. For example, citizens living in dictatorship attempt to gauge how likely a collective action against the authoritarian government would succeed. They might simply sense the odds of success, or they might learn from an experience of neighboring countries (Weyland 2009). The movements can also occur within the government. The opposition force within the government might gauge how much of political power (relative to the authoritarian incumbent) they possess to push for a new democratic constitution. For example, Seely (2005), comparing Benin's successful case and Togo's unsuccessful case of democratization, argues that the pro-democracy group's (including both governmental and civic actors) relative political power facilitated Benin's democratization. However, in my view, it is also important to note that the democratic opposition does not usually confront against the incumbent authoritarian regime, just because they know they have greater political power relative to the incumbent, because if the liberalization movement or negotiation does not lead to a lasting democracy in the future, they would most likely be punished by the continuing authoritarian government. This is a vital component of the classical collective action dilemma with the presence of severe punishment. The same applies to the theory of economic crises and democratization. Gisselquist (2008), for instance, partially attributes Benin's successful liberalization to the increasing pro-democracy movements in the late 1980's. She argues that those movements and the National Conference

that eventually led to a new democratic constitution were triggered by economic crises. To me this is only half convincing. It is because, again, the opposition would not participate in costly collective actions unless they anticipate a higher probability of success in the future. In fact, Nigeria in the late 1980's was also a dictatorship that was experiencing a major recession, but liberalization in Nigeria did not occur for another decade. In each of these cases, unobservable strategic calculations and assessment by the opposition involved their expectation about how likely their costly political actions would lead to the emergence and ideally the stability of a democracy.

Take another case in the Eastern and Central European countries in the late 80's and early 90's. After five years of Mikhail Gorbachev's leadership in the Soviet Union, the direct rule of the Soviet communist party came to an end and the effect of Soviet power started to decline even in other east European countries. With the stagnating economy and the weakened political authority of the centralized communist regimes, the liberalization demand from these societies heightened. There were increasing number of major and minor uprisings by the opposition. Lewis (2000) points out that gain in the political power by the liberalization forces was the key in the course of this change in the political atmosphere. He claims that the relaxation of dictatorship and repressive practices after Stalin's death in 1953 was not enough of liberalization of the regime, but it was "sufficient to permit freer communication and a degree of contact with the west that only made awareness of relative failure of the communist system that much sharper." This awareness of the economic and institutional failure of the communist regime in general invigorated the opposition force toward the end of the 80's. We, researchers, cannot observe exactly what triggers the opposition's "awareness" for the promising political atmosphere, but the key political dynamic one should note is that, to some extent, the opposition can sense the expected effectiveness of their movements and the potential emergence of a democracy in the future, and it affects the actual occurrence of revolutionary uprisings, shortening the duration of the dictatorial regime. To summarize the essence of these cases in Africa and Europe, the longer (expected) survival of democracies can "cause" a shorter dictatorship period through heightened political activities by the democratic opposition. Note that the causal direction is the same as the first case, but the effect is opposite.

Finally, there is also a dynamic that manifests the opposite direction of causal relationships. Gradualism advocates claim that quick transitions to democracies can lead to unstable (unconsolidated) democracies if transitions occur under premature socio-economic conditions. Mansfield and Snyder (2007, 1995, 2005), for example, argue that introducing multiparty elections under authoritarian regimes would more likely lead states to civil wars rather than stable democracies, due to the premature institutional foundations. This claim suggests a causal effect *from* the timing of the emergence of democratic institutions *to* the timing of their breakdown.

Almond and Verba (1965), Putnam (2002) and Moore (1966) imply a similar causal relationship between the emergence and breakdown of democracy, but their arguments emphasize the positive effects of gradual democratization on the stability of future democracies. Moore (1966) argues that incremental inclusion of different classes in politics, accompanied by the economic development and the development of liberal socio-political culture led Britain to a long-lasting democracy. Almond and Verba (1965) and Putnam (2002) argue, from more behavioral perspectives, that a gradual transition to democracy is favorable for the later stability because it cultivates the civic cultures that potentially prepare the citizens to value democracy.

Once we incorporate the theories of two-way causal relationships between the emergence and collapse of democracies, the "independent-unit" assumption made in traditional empirical analyses becomes questionable. Methodologically, what challenges the independent-unit assumption is a feedback loop—a flow of causal influences that go back and forth among the multiple events. A feedback loop is formed when a change in an outcome influences the outcomes of other units/events, which in turn comes back to affect the outcome that experienced the original shock. Suppose that the duration of democratic transition becomes shorter in a certain country than what it would have been. (Think of this as an external democratic shock, for the purpose of a thought experiment.) This is a change in an outcome event, the emergence of democracy. This change—a shortened democratization duration—might be associated with premature socio-economic conditions, leading the newly established democracy to an unstable regime in the future. This generates a flow of causal effects from the timing of democratization to the prospect of consolidation (i.e. the timing of the breakdown). The other causal relationship emerges in the elite's strategic thinking at the beginning of the

democratization process. As Acemoglu and Robinson (2006) suggest, an authoritarian elite could form an anticipation about the durability of future democracies, or similarly the cost of staging a coup in the future to reverse the democracy. Elites' anticipations about the survival of future democracies affect their decisions on when to democratize the country. If they expect that it would be costless to reverse the democracy by a coup, the elite might not negotiate hard with the democratic opposition, making the transition process quicker. On the contrary, if they expect that the democracy lasts longer, then they might negotiate harder with the opposition, prolonging the transition duration as a consequence. This strategic thinking by elites generates a causal effect from the survival to the emergence of democracies. As such, the two durations of our interest influence each other recursively, generating feedback loops.

If we suspect the two-way causal relationships exist, we should not model the timing of democratization or the odds of democratic consolidation by focusing only on one of the two phenomena, because it would not take into account the feedback loops that feed into the two political outcomes recursively.

## 1.2 Interdependence (2): The Contagion of Democracies

Another important source of interdependence in democratization is the regime influence across countries. Since geopolitical studies led by O'Loughlin et al. (1998) provided the evidence for geographical clusterings in countries' democracy/autocracy levels, scholars have attempted to model, theoretically and empirically, what might cause the seeming clusterings of regimes. This is where the theory of diffusion emerged. They theorized that a country's democracy level can influence others', just as a flu and habits travel across individuals who are connected. If citizens in these countries learn about the odds of successful revolution against the authoritarian government by observing the masses' behavior of other countries, revolutions might "spread" around the world, possibly turning such uprisings into transitions to democracies. Studies show that citizens do learn rationally from successful revolutionary movements in other nations (e.g., Weyland 2009). First, scholars suspected geographical proximity as a main pathway that "connects" countries. (e.g., Gleditsch and Ward 2006): countries that are geographically closer affect (or learn about) each other more than those farther away. Later, Beck, Gleditsch and Beardsley (2006) pointed out that "space is more than geography", suggesting a possible effect of implicit economic ties among countries as pathways of democratic diffusion. Goodliffe and Hawkins (2011) took a step further and considered three non-geographical dependency networks (trade, alliance, and international organization (IO) partners) through which democracy and autocracy might spread across countries.

Various other empirical studies of diffusion have been developed since then, but the important theoretical theme that commonly lies beneath all these theories is the idea that models that explain each country's democracy/autocracy level by its own domestic characteristics is not a sufficient representation of democratization. In other words, the independent-unit assumption is violated. Again, methodologically speaking, the violation of the independent-unit assumption stems from feedback loops of democracy levels generated by the diffusion flow.

To see how a shock given to the outcome of a certain observational unit comes back to its own outcome again, imagine the following flow of regime influence. Suppose country A's democracy level ("outcome") rises after a successful wave of social movements. By observing the successful riots in country A, democratization movements in country B become more organized and effective, leading to an increase in country B's democracy level (the outcome of another observational unit). The flow of diffusion does not have to stop at this point. Democratization in country A can further progress after their citizens' observing country B's success. Alternatively, if the democratization movement in country B fails due to lack of their prerequisite political-economic conditions, for example, then this might now slows down movements in country A. In either case, the original change in the democracy level in A has come back to A's own political outcome, after influencing the outcome of another observational unit. This is a feedback loop.

When we believe that these influence loops occur all simultaneously, we cannot predict a country's level of democracy only by its own political economic attributes for a single unit, because it would not take into account the feedback that involve other countries' democracy levels. This simultaneity occurs more often than one might imagine. Since typical data in comparative and international politics are aggregated at

the annual level, these dependencies can easily occur “simultaneously” within a single time point of the given data; i.e., it does not have to be literally “instantaneous”. In fact, it is known that when researchers overlook the spatial dependence (when it actually exists in data), the estimated effects of country-specific determinants of democracy levels will be biased in favor of the strength of the country-specific covariates (Franzese and Hays 2007); i.e., the effects will be *overestimated*.

### 1.3 Interdependence (3): Self-Selection and Regime Reinforcement

conventional diffusion studies summarized above offer insightful theories about the democratic (or authoritarian) diffusion; and yet, in my view, even their definitions of space is limited.

The third source of interdependence that I introduce is regime reinforcement across countries and over time. Part of this mechanism is similar to that of diffusion, but the reinforcement theory adds the inter-temporal connection to the conventional concept of contagion, which occurs across counties.

As the traditional diffusion studies theorize, I also recognize that countries affect each other’s regimes such that they change their institutions toward the direction of others’ regimes. However, I theorize that, at the same time, countries also attempt to maintain actively their current regime types. I introduce the idea of the regime-support or regime-approval dependency among countries; i.e., states *select* themselves into a dependency network, where the connections are defined by countries’ regime similarity. Country networks of support and approval is difficult to observe, but, for example, Brinks and Coppedge (2006) argue that political leaders use their neighbors’ regimes as “good or bad examples” in favor of their own regimes. Neumayer (2008) shows countries tend to form stronger diplomacy ties when their political ideologies are more similar. For instance, in December 2011, the Brazilian Embassy in Chile disclosed telegrams sent to the Chilean governments during the Pinochet regime (Pedigo 2011). They revealed that the Brazilian military dictator Emílio Médici granted a fifty million US dollar worth of economic aid to the newly-emerged Pinochet government. The telegrams also reveal that, at one point, the Pinochet government explicitly asked the Médici government for its political support in front of the international community. These examples suggest that countries form diplomatic support/approval networks precisely when they have more similar—than dissimilar—regimes, selecting themselves into a regime-support network. Hence the strength of ties (or “edges”, in the SNA language) of such regime-support networks should be defined by the degree of similarity in their democracy levels from the previous time period.

The regime influence through the support network generates even more complex feedback loops than the conventional diffusion dynamic. This is due to the fact that regime-similarity networks emerge from *homophily*; i.e., the dependency ties, which provide the platform of diffusion, are defined by the very outcome—democracy levels—of the model. Homophily is a phenomenon in which individual units form connections with similar others. McPherson, Smith-Lovin and Cook (2001) extensively review studies that demonstrate homophilic tie formation among individuals, which include situations where one becomes friends with others due to their similar behavioral habits (e.g., smoking, preferring to work in a certain industry etc.). The formation of regime-reinforcement network is a homophilic dynamic in which states form dependency ties with others when their regimes are similar.<sup>2</sup>

With the presence of regime-support networks, the emerging feedback loops is more complex than what we saw for simple diffusion. We can trace the feedback loops as follows. First, countries with more similar regimes form stronger dependency ties of political (diplomatic) and economic support. Second, through this dependency network, the contagion of regimes occurs. In this case, however, contagion or influence implies confirmation of each others’ regimes, rather than a change from the current regimes. With these updated democracy levels, an updated support network emerges and another wave of the reinforcing influence occurs in the next time period. In the long run, as the consequence of self-selection (into support networks)

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<sup>2</sup>Networks defined by geographical proximity, on the contrary, are completely fixed regardless of countries’ preferences. Likewise, economic networks are defined by numerous factors that are outside state similarity in any aspects; for example, obviously trade networks depend largely on the necessity for certain goods and services, geographical distance, and historical incidents that facilitate interstate transactions such as colonialism. None of these are purely correlated with the similarity in countries’ political, economic and social aspects.

and diffusion (through such networks), countries' political regimes can be reinforced. In this thesis, I refer to this dynamic as *network-behavior coevolution*: the latent connectivity across countries ("network") and their democracy level ("state behavior") co-evolve over time. With my theory of regime reinforcement, feedback loops emerge not only across countries in each time period, but those contagion dynamics are tied intertemporally as well. With the presence of both the conventional contagious dynamic and the possibility of reinforcement over time, it should be obvious that a model that explains the level of democracy only for each country-year is not a preferable representation of what we think is democratization.

## 1.4 New Statistical Tools: "Substantive" Approaches to Account for Interdependence

The methodological innovation of this thesis is to provide two sets of new statistical tools that account for the three sources of interdependence in democratization. Essay 1 investigates the dependence between the transition and survival of democracies with a new multivariate duration model. Essay 2 extends the multivariate duration model such that it properly accounts for democracy spells whose end-points are not observed within the data time-frame (*right-censoring*). Essay 3 introduces a new spatial econometric model that not only evaluates the contagion of regimes across countries, but also self-selection and reinforcement of regimes over time.

This is not to claim that there has never been an empirical strategy for inter-event, spatial or spatio-temporal dependencies in data. On the contrary, I share the concern with them that researchers should always address such dependencies when they can. However, much of existing work treats the dependence as a statistical "nuisance" rather than a part of political stories to be explained. For example, Boehmke (2006) models the dependence in the timing of Congresspersons' issue position taking, using a seemingly unrelated (duration) regression (SUR) model. The author substantively theorizes that strategic behavior by Congresspersons induces the interdependence among their position-announcement timings. However, with the SUR model, one can test for the *existence* of the dependence at best, and fails to test for the *structure* of the dependence informed by the theory. Qualitatively, this is equivalent to "controlling for" dependencies statistically, but not interpreting the dependencies substantively.

A similar argument applies to various error correction methods widely used in applied political-science research. These include the feasible generalized least squares (FGLS) estimator by Parks (1967), and the robust panel-corrected standard errors (PCSE's) estimators provided by Beck and Katz (1995) in order to account for temporal and spatial dependence in panel and time-series cross-sectional (TSCS) data. Since Beck and Katz (1995), the vast majority of applied empirical studies with panel and TSCS data have reported the robust PCSE's. Similarly, Beck, Katz and Tucker (1998) suggest splined time in logistic regressions to account for time dependency in binary data.

A common problem with the above approaches is that since researchers treat the dependency as a "nuisance," and are so focused on "correcting for" or "controlling for" the dependence in data, they tend to ignore it when it comes to interpreting the regression results as if the dependence did not exist (Franzese and Hays 2007; Carter and Signorino 2010). Similarly, Beck and Katz (1996) also address this problem and suggest that researchers model temporal dynamics by time-lagged dependent variables instead of by the error structure. They maintain "[t]he lagged dependent variable approach makes it easier for researchers to examine dynamics and allows for natural generalizations in a manner that the serially correlated errors approach does not."

In this thesis, I subscribe a different approach—a "substantive" approach—to account for interdependence. I maintain theoretically-informed structures of dependence in all of my empirical models. For example, in Essay 1, I develop a simultaneous equations model for duration variables, such that parameters associated with durations on the right-hand side of equations evaluate the degree to which durations influence each other. This modeling approach allows me to assess and interpret the relative importance of the duration dependence, *as well as* the effects of other structural determinants of each duration—transition and survival. Similarly in Essay 3, I *model* both the contagion and reinforcement dynamics as informed by substantive theories. This allows me to assess and interpret the relative strength of the dependencies *as well as* the effects of other structural determinants of democracy levels.

In addition, in terms of the inferential accuracy, the presence of system dynamics give rise to the following problems when we employ traditional single-equation approaches as in existing empirical studies. When there is dependency among observational units (e.g. the interdependence between the emergence and breakdown of democracies, or contagion and reinforcement of political regimes across states and over time), the estimated effects of the country-specific variables from traditional regression approaches would give us misleading results. The estimates would suffer from omitted variable biases if the dependency is completely ignored, and they suffer from simultaneity biases if we naively use the occurrence of one event as one of the predictors of the other, in a single-equation framework. For example, if a spatial dependence exists in data but is omitted from the model, it is known that the effects of other structural (or domestic, country-specific) variables will be *overestimated*. In other words the empirical finding will be biased toward finding stronger effects of structural determinants (Franzese and Hays 2007).

In this thesis, I present a solution by developing two kinds of systems of equations models (SEQ). The two models respectively accommodate the particular data structures that the three aforementioned sources of interdependence manifest in the studies of democratization. More specifically, first, I develop a multivariate event history (duration) model to test for the existence and the strength of the dependency between the emergence and breakdown of democracies. Next, I develop a new spatial econometric model to test for the existence of the conventional contagion processes and the reinforcement dynamic in democratization. The ability to distinguish statistically the conventional contagion dynamic and the selection/reinforcement dynamic is one of the major contributions of this new spatial model.

## 1.5 Plan

**Essay 1 “Interdependent Duration Models in Political Science: An Application to the Democratic Transition and Survival in Africa”** introduces the multivariate duration model that I developed in Hays and Kachi (2011). I apply the method to the study of democratic transitions and consolidation. More broadly, the multivariate duration model is useful when the timing of multiple political events or a single political event occurring to multiple units is interdependent across events or units. Specifically, in my application, the particular events of interest are the emergence and collapse of democracies. In a way consistent with earlier democratization studies (e.g., Przeworski et al. 2000), I recognize that each of these events is explained by the event- and unit-specific attributes, such as economic and political-institutional variables for each event and country-year. However, as explained earlier, a game-theoretic literature of democratization (e.g., Acemoglu and Robinson 2006) implies a causal relationship from the (potential, anticipated) survival of democracies to the timing of democratization. At the same time, scholars who advocate the importance of gradual transitions to democracy emphasize the negative effect of democratic transitions under premature socio-economic conditions on the stability of future democracies. They imply a possible causal effect from the timing of democratization to the survival of democracies. The potential two-way causality implied by these theoretical works is the reason why we need to utilize a systems-of-equations approach, instead of a single-equation approach (for each observation unit).

Since the dependent variables of interest are about timing (duration, or the rate of failure of a type of regime), this leads me to develop a multivariate duration model, in which one can estimate the effects of country-specific variables on the duration dependent variables, by, at the same time, statistically testing for the presence and evaluating the strength of the across-duration dependency.

**Essay 2 “Right-Censoring in Interdependent Duration Models with the Systems of Duration Equation Modeling (SDEQ) Approach”** extends the interdependent duration model developed in Essay 1 to account for *right-censoring*. To clarify the terminology, we say that the observation is censored when an observation’s full survival history is not observed, due to, for example, the time frame of the data collection. For example, if one is interested in the survival of democracies, the continuing democracies at the end of the data-collection date are right-censored (e.g., Alemán and Yang 2011; Svobik 2008). If we look at the duration of cabinet survival, there are two sources of right-censoring: first, cabinets that are still surviving at the end of the collected data are right-censored observations, and second, cabinets that lasted until the end of the constitutional inter-election period (CIEP) and “had to end” are also right-censored, because they could have lasted longer but we do not have complete information about their survival durations due to the



imposed cut-off (e.g., Laver and Shepsle 1996; Lupia and Strøm 1995; Warwick and Easton 1992; Alt and King 1994; Diermeier and Stevenson 1999). Generally, the existence of right-censored observations can be, in fact, one of the reasons to use the duration approach, because a modification in likelihood functions in duration models can account for censoring (Box-Steffensmeier and Jones 2004).

The idea of this treatment for right-censored observations is fairly simple to conceptualize and implement in single-duration models and interdependent duration models that are based on copulas. It is, on the contrary, not mathematically straightforward to account for right-censoring in the SDEQ approach. However, remember that the SDEQ approach has an advantage of modeling interdependence in a substantively meaningful way, compared to the copula approach. Therefore in this paper, I make a first attempt to develop a relatively simple way to evaluate an interdependent-duration likelihood function with a treatment that can account for right-censoring. Given the ubiquity of duration interdependence (see Essay 1) and right-censored observations in political science (Box-Steffensmeier and Jones 2004), the likelihood I derive here should be broadly applicable.

Just like in Essay 1, the key mathematical strategy to write the likelihood function for right-censored observations turns out to be the change of variables theorem, this time, however, on multivariate integrals. In short, the multivariate integrals (over the number of dimensions equivalent to the number of duration processes in the model) are the sources of difficulty in writing this likelihood function.

It is broadly believed that one cannot eliminate the integrals analytically, and hence estimation needs to be done by simulations. This belief seems to stem from the fact that the likelihoods for multivariate or spatial-lag probit models, for example, contain multiple integrals and they indeed require simulation approaches to estimate (e.g., Hays 2009). However, this is only due to the fact that the probit likelihood function contains normal cumulative distribution functions (CDF). Normal CDF contains an error function (“*erf*”), which in turn contains an integral, regardless of the dimensionality. If the error terms of the structural form have “simpler” distribution than normal, then it is possible to eliminate multiple integrals in the likelihood using the error i.i.d. assumption and the change of variables theorem.

[Edit later] I will also note the applicability and generalizability of this mathematical transformation to derive analytically the likelihood function for multivariate logit and spatial-lag logit models. It is also useful to develop an interdependent “duration” model, where some of the dependent variables are durations but others are binary; for example, one might want to address the dependency between the introduction of multiparty elections (by dictators or democratic leaders) and the survival of such democratic institutions. Since binary outcomes are common in political science, these estimators would be extremely useful for applied researchers.

**Essay 3 “A Spatial Econometric Approach to Coevolution: The Diffusion and Reinforcement of Political Regimes”** introduces a new spatial estimator, an MSTAR+C model, developed in Hays, Kachi and Franzese (2010) and applies it to the study of the diffusion and reinforcement of democracies. This model deals with the type of interdependence that arises when units are connected through various kinds of networks, and political behavior of these units are contagious through the networks. For example, if citizens in these countries learn about the odds of successful revolution/riots against the authoritarian government by observing similar incidences in other countries, revolution can spread. Moreover, it is likely that countries that are more strongly dependent influence each other’s politics more significantly than countries that are less dependent on each other, as Tobler’s Law summarizes very succinctly: “everything is related to everything else, but near things are more related than distant things.” Note that the distance here does not have to be geographical. Countries that are geographically far away from each other could have stronger economic ties (and therefore stronger political influences). The notion of explicit interdependence is the key of diffusion studies. The first merit of taking a spatial econometric approach is that we do not lose such “relational” dynamics specified in the theoretical model, unlike most statistical approaches in existing studies of “diffusion”.

Furthermore, my account departs from the existing concept of diffusion by allowing for the possibility that countries form implicit regime-support ties, reinforcing each others’ current regime types (selection). In this mechanism, countries’ regimes affect with whom they interact in the future. Such influence that occurs on the self-selective network generates a particular dynamic over time. In this essay, I refer to it as the *network-behavior coevolution*. The networks (of similar regimes) and countries’ behavior (their regime choice)

recursively feed in each other and evolve together over time. This becomes the source of regime reinforcement and potentially the source of the democracy and autocracy clusters in the world. The second, and the most important contribution of the present spatial model is the ability to distinguish this reinforcement mechanism from the conventional (and simpler) contagion mechanism, and estimate the strength of each.

## References

- Acemoglu, Daron and James A. Robinson. 2006. *Economic Origins of Dictatorship and Democracy*. Cambridge University Press.
- Alemán, José. and David D. Yang. 2011. "A Duration Analysis of Democratic Transitions and Authoritarian Backslides." *Comparative Political Studies* 44(9):1123–1151.
- Almond, G.A. and S. Verba. 1965. *The civic culture*. Little, Brown.
- Alt, James E. and Gary King. 1994. "Transfers of Governmental Power: The Meaning of Time Dependence." *Comparative Political Studies* 27(2):190–210.
- Beck, Nathaniel and Johnathan N. Katz. 1995. "What to do (and not to do) with time-series cross-section data." *American Political Science Review* pp. 634–647.
- Beck, Nathaniel and Johnathan N. Katz. 1996. "Nuisance vs. substance: Specifying and estimating time-series-cross-section models." *Political analysis* 6(1):1–36.
- Beck, Nathaniel, Johnathan N. Katz and Richard Tucker. 1998. "Taking time seriously: Time-series-cross-section analysis with a binary dependent variable." *American Journal of Political Science* 42(4):1260–1288.
- Beck, Nathaniel, Kristian S. Gleditsch and Kyle Beardsley. 2006. "Space is more than geography: Using spatial econometrics in the study of political economy." *International Studies Quarterly* 50(1):27–44.
- Boehmke, Frederick J. 2006. "The Influence of Unobservable Factors on Position Timing and Content in the NAFTA Vote." *Political Analysis* 14(4):421–438.
- Box-Steffensmeier, Janet M. and Bradford S. Jones. 2004. *Event History Modeling: A Guide for Social Scientists*. Cambridge University Press.
- Brinks, D. and M. Coppedge. 2006. "Diffusion is no illusion: Neighbor emulation in the third wave of democracy." *Comparative Political Studies* 39(4):463.
- Carter, David B. and Curtis S. Signorino. 2010. "Back to the future: Modeling time dependence in binary data." *Political Analysis* 18(3):271–292.
- Diermeier, Daniel and Randy T. Stevenson. 1999. "Cabinet Survival and Competing Risks." *American Journal of Political Science* pp. 1051–1068.
- Franzese, Robert J. and Jude C. Hays. 2007. "Spatial econometric models of cross-sectional interdependence in political science panel and time-series-cross-section data." *Political Analysis* 15(2):140–64.
- Gisselquist, Rachel M. 2008. "Democratic Transition and Democratic Survival in Benin." *Democratization* 15:789–814.
- Gleditsch, K.S. and M.D. Ward. 2006. "Diffusion and the International Context of Democratization." *International Organization* 60(04):911–933.
- Goodliffe, Jay and Darren Hawkins. 2011. "Dependence Networks and the Diffusion of Domestic Political Institutions." *Working Paper*.

- Hays, J.C. 2009. Bucking the System: Using Simulation Methods to Estimate and Analyze Systems of Equations with Qualitative and Limited Dependent Variables. In *2nd Annual St. Louis Area Methods Meeting (SLAMM)*, Washington University in St. Louis ([https://netfiles.uiuc.edu/jchays/www/Hays\\_SLAMM09\\_Revised.pdf](https://netfiles.uiuc.edu/jchays/www/Hays_SLAMM09_Revised.pdf)).
- Hays, J.C. and A. Kachi. 2011. "Interdependent Duration Models in Political Science." *Working Paper*.
- Hays, Jude C., Aya Kachi and Robert J. Franzese. 2010. "A spatial model incorporating dynamic, endogenous network interdependence: a political science application." *Statistical Methodology* 7(3):406–428.
- Laver, Michael and Kenneth A. Shepsle. 1996. *Making and Breaking Governments: Cabinets and Legislatures in Parliamentary Democracies*. Cambridge University Press.
- Lewis, Paul G. 2000. *Political Parties in Post-Communist Eastern Europe*. Routledge.
- Lupia, Arthur and Kaare Strøm. 1995. "Coalition Termination and the Strategic Timing of Parliamentary Elections." *American Political Science Review* 89(3):648–665.
- Mansfield, E.D. and J. Snyder. 1995. "Democratization and the Danger of War." *International Security* 20(1):5–38.
- Mansfield, E.D. and J. Snyder. 2007. "The Sequencing "Fallacy"." *Journal of Democracy* 18(3):5.
- Mansfield, E.D. and J.L. Snyder. 2005. *Electing to Fight: Why Emerging Democracies Go to War*. The MIT Press.
- McPherson, Miller., Lynn. Smith-Lovin and James M. Cook. 2001. "Birds of a Feather: Homophily in Social Networks." 27:415–444.
- Moore, Barrington. 1966. *Social Origins of Dictatorship and Democracy: Lord and Peasant in the Making of the Modern World*. Beacon Press.
- Neumayer, Eric. 2008. "Distance, Power and Ideology: Diplomatic Representation in a World of Nation-States." *Area* 40(2):228–236.
- O'Loughlin, J., M.D. Ward, C.L. Lofdahl, J.S. Cohen, D.S. Brown, D. Reilly, K.S. Gleditsch and M. Shin. 1998. "The Diffusion of Democracy, 1946–1994." *Annals of the Association of American Geographers* 88(4):545–574.
- Østerud, Øyvind. 2011. *Regime Transition and Varieties of Post-Communism*. Berliner Wissenschafts-Verlag chapter 3.
- Parks, Richard W. 1967. "Efficient estimation of a system of regression equations when disturbances are both serially and contemporaneously correlated." *Journal of the American Statistical Association* pp. 500–509.
- Pedigo, David. 2011. "Embassy Cables Reveal Brazil Supported Chile's Pinochet Regime." <http://www.santiagotimes.cl/chile/human-rights-a-law/23076-embassy-cables-reveal-brazil-supported-chiles-pinochet-regime>.
- Przeworski, A., M.E. Alvarez, J.A. Cheibub and F. Limongi. 2000. *Democracy and development*. Cambridge Univ. Press.
- Putnam, R.D. 2002. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton University Press.
- Seely, Jennifer C. 2005. "The Legacies of Transition Governments: Post-Transition Dynamics in Benin and Togo." *Democratization* 12:357–377.
- Svolik, Milan. 2008. "Authoritarian Reversals and Democratic Consolidation." *American Political Science Review* 102(2):153–168.

- Warwick, Paul. and Stephen T. Easton. 1992. "The Cabinet Stability Controversy: New Perspectives on a Classic Problem." *American Journal of Political Science* 36(1):122–146.
- Weyland, Kurt. 2009. "The Diffusion of Revolution: '1848' in Europe and Latin America." *International Organization* 63:391–423.