The U.S. Government as an *Interagency Network*

by Ryan Whalen

This article weaves together two parallel threads. On the one hand, it seeks to answer substantive questions about the structure of the U.S. government (USG). On the other, it explores methodological issues relevant to interagency studies and interorganizational network analysis. The methodological portion of the article tackles a number of questions left unanswered by the growing field of interorganizational network studies. The growth of this field has been encouraged by the explosion of available digital data about how organizations relate to one another. Many of the studies using this data rely on abstract measurements and untested assumptions. In this article, I propose a move toward triangulation of organizational relation measurement and a multiplex approach to understanding interorganizational networks.

The substantive portion of this article takes on a topical and important series of questions: Are there theoretically meaningful "communities" of interagency relationships within the federal government? Is the government becoming more or less hierarchical? As technology and economic imperatives transform the way governments serve citizens and the way agencies and departments relate with one another, can we better understand intergovernmental structure?

Studying Structure

The practice of conceptualizing organizations as part of an interorganizational system and subsequently using relational information to map out their place within that system is at least fifty years old. Evan was an early advocate of interorganizational analysis.[1] His focus on management led him to see interorganizational analysis as a way to better understand individual organizations—the "focal" organization of study. In recent years, scholars have sought to understand not only the component parts of the organizational network, but also the system as a whole.

The explosion of available data, especially digital trace data, has made interorganizational

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network studies much easier than in years past. It seems wherever researchers look, they are apt to find data that can somehow be used to infer how one thing relates to another. In many cases, these data can be abstractly interpreted as a form of organizational relation. Scholars have used email logs, corporate ownership records, and hyperlinks as ways to abstractly measure relationships.[2]

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The convenience of digital trace network studies has been no small development for social science. Where previously scholars had to either exhaustively survey subjects about relations[3] or carefully pore over records and assemble relational data structures by hand, they can now computationally mine huge amounts of data and extract the measurements of their choice.[4]

Government Structure

The digital communications revolution that has brought so much change to the practice of interorganizational network studies has also brought sweeping practices to the way governments function and—according to some—to the way governments are and will be structured.

Traditional ways of trying to understand how governments are structured have focused on the legislation and rules that create and empower government bodies. These legal representations ignore many empirical relationships and focus almost solely on hierarchical structure. The lateral relational dimension excluded from legal representations of government is important, not only to better understand how the federal government is structured, but also to provide insight into changes in government organization and provide feedback when public administrators consider organizational reforms.

The past three decades have seen increasing discussion about the potential for substantial reforms of government organization. Many believe the digital communications revolution will bring widespread changes to government structure and argue that digital governance will lead to a more networked, less hierarchically-structured government. In his wider discussion of the emergence of a "networked society," Castells argues that "the rational bureaucratic model of the state of the industrial era is in complete contradiction to the demands of the network society"[5] Fountain also argues that "the nature and structure of the state is changing fundamentally as information and communication technologies are being absorbed into governments."[6]

The structural changes that may have accompanied "digital era governance"[7] are, as of yet, unclear. Without established metrics to measure something as abstract as "government structure," it is difficult to determine whether claims of the transformational power of digital communications are supported by reality.

Some argue that the prophesied transformations have not or should not take place. Kraemer and King quite strongly rebuke claims that adopting new information technology (IT) will lead to substantial changes in government structure stating that "IT is not a catalyst for administrative reform in government" and "[t]he benefits of IT use are largely focused on administrative efficiency, and not on reform of administrative organization, practices, or behavior.[8] Others take the middle ground as with Scholl, who suggests that—at least in the short term—adopting government

technology has led to a change in government mode rather than in government nature[9] and Cordella, who argues the bureaucratic structure serves an important function and should be largely preserved as governments adopt new technological developments.[10]

These competing claims about the nature of twenty-first century government structure have led to calls for a more thorough examination of how adopting technology may or may not lead to changes in government structure.[11] This ongoing, digital-era governance structure debate requires a degree of empirical reflection and leads to the following questions regarding the USG's structure and how that structure has changed:

- Is the U.S. government structured in a predominantly network or predominantly siloed fashion?
- Is government structure static or is it shifting toward an increasingly networked or increasingly siloed structure?

If we treat government agencies as nodes in a network, we can apply network metrics to better understand interagency structure and answer the above questions. Agencies are connected in many ways by sharing resources, working in similar domains, and providing services to the same constituents; however, there is no objective record of agency relations. We need to devise indirect measures of agency relationship to assemble an interagency network.

Hyperlinks have become a popular way to abstractly measure the relationship between organizations. They are attractive for a number of reasons. Most organizations have some sort of web presence, meaning there will be some way to measure their hyperlinking behavior. Crawling the web—while not as simple as it might seem at first glance—is becoming easier, as new tools are developed,[12] and unlike many traditional forms of data collection, it does not require the cooperation of the study population. This analysis of the USG capitalizes on these strengths and mapped hyperlinks within the .gov domain.

Using Yahoo's Site Explorer, a well-established method for link analysis studies,[13] allowed me to leverage a very large and detailed web graph, while avoiding many of the pitfalls of individually crawling the web space of interest. In order to limit results to federal sites, I used a semi-manual spidering technique. The 85 government institutions and agencies listed in the *US Government Manual's* organizational chart seeded the search. Following the first and subsequent waves, the results returned were parsed to identify all the new .gov sites encountered. I then manually coded each of these sites. Any site representing a federal agency, organization, or initiative was coded as federal. All others, including state and municipal websites, were coded as non-federal. The federal sites were then used to generate another wave of searches. These waves continued until no new federal websites were discovered, and the inlink data for each federal website had been determined.

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When considered in aggregate, hyperlinks "reflect deep social and cultural structures"[14] and can lay bare organizational relations that would not otherwise be evident. Unfortunately, they are not perfect, and when used to infer organizational structure, measurement difficulties and their high level of abstraction pose a number of problems for hyperlinks.

There is no definitive way to measure hyperlinks. If researchers use web crawlers to

collect their own data, those crawlers are subject to the limitations of their code and the time and computational resources available to crawl. The hyperlink graph is vast and dynamic, and any one crawl can only hope to provide a limited snapshot of a part of that graph. Perhaps more importantly, without interviewing web site creators, it is difficult to say with any amount of certainty and precision just what a hyperlink means.

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In an interorganizational analysis situation, hyperlinks are usually interpreted as measurements of institutional affinity. Those sites sharing more links are considered "closer" in the interorganizational network. But hyperlinks exist for many reasons, not all of which can translate to institutional affinity. In some instances, hyperlinks are used to reject the contents of another website, linking to contested materials. Other times, hyperlinks contribute to site functionality, as when a site links to Adobe's homepage to steer users towards their *Flash* or *PDF Reader* software. These are functional links that are probably not best interpreted as expressing any sort of institutional affinity.

For these reasons, studies using only hyperlink networks are somewhat problematic. Hyperlinks lack standardization,[15] are highly abstract,[16] and pose many data gathering challenges.[17] They are too abstract and too small a part of complex relationship networks to be considered in isolation. This leads naturally to an argument for multiplexity, which is why two other measures of government organizational structure are used in this analysis: metadata and lobbying disclosure relationships.

While hyperlinks allow for an abstract measure of institutional affinity, they do not contain any information about the activities of the institutions in question. This lack of context contributes to the abstractness that challenges many hyperlink-structure analyses. Researchers can mitigate this abstraction by complementing hyperlink analysis with datalink analysis.

As the semantic web grows in popularity, more and more data is available in a Resource Description Framework (RDF) format. This data can be mined and analyzed to generate data networks with links generated between organizations that publish similar types of data. In the government context, data.gov acts as a central repository for government supplied data and publishes a catalog of available RDF datasets. Using the keyword descriptions contained in this data.gov catalog, researchers can generate a semantic network, linking organizations that publish sets of data that contain the same keyword descriptors.[18]

The result is a network similar to that achieved by hyperlink mapping the .gov domain; however in this network, government entities that work on similar issues and, therefore, publish similar datasets are linked together with links weighted by the number of keywords shared.

The hyperlink and datalink networks both reflect internal perspectives on government structure. They each use artifacts generated by those within government (i.e., hyperlinks and datasets) to infer relationships between government entities. To complement these perspectives, this analysis also measures a third external perspective of intergovernmental relations and adds it to the multiplex network: lobbying relationships. Using Lobbying Disclosure Act (LDA) documents to build a co-mention network of government agencies creates a network of the U.S. government as it

is seen by lobbyists.

The LDA of 1995 requires that the federal government keep a record of registered lobbyists and their lobbying-related activities. These records include reports filed with the Clerk of the House and the Secretary of the Senate that detail which agencies were the target of lobbying activities.[19] The network generated by analyzing these reports provides another layer of relational data to add to the hyperlink and datalink networks. While the hyperlink network provides insight into how government agencies view their relations to one another, and the datalink network shows which agencies have similar areas of interest, the LDA data facilitates understanding how agencies are seen by outside actors.

This analysis uses a co-occurrence technique to construct the LDA network. Lobbying disclosure reports list the set of government entities lobbied by the reporting organization during the given period. It is assumed that those entities often listed together—and thus lobbied by the same organizations—are in some dimension more closely related than those who never appear on the same disclosure document. So, each time two agencies are mentioned together on the same lobbying disclosure document, they are attributed one link within the network. These links are aggregated across documents and a one-year reporting period.

Multiplexity

While one could analyze any one of the individual networks on its own, they each represent a unique dimension of interagency structure. If one's research interest is not precisely reflected by that particular dimension of structure (hyperlinks, data similarity, or co-lobbying), combining multiple types of relation into a multiplex network can help provide a more accurate reflection of agency proximity. The assumption here is that each measurement of interagency proximity carries with it its own biases and degree of measurement error. By combining multiple measures, one triangulates these biases and error to arrive at a closer approximation of the underlying structure.

Because of the different natures of the metrics, the networks described below show a good deal of variation in size and density. Table 1 describes the network by size and density.[20] The hyperlink network is clearly the largest, but this includes relatively obscure nodes that often do not refer to a particular government entity, like students.gov. The metadata network reflects government agencies that share a lot of data and are verbose in their descriptions of their shared data. The lobbying network has a bias for government agencies and entities that have the power to influence policy, especially policy that is of interest to those with the resources to engage in lobbying campaigns. Combining networks leaves us with a multiplex network that shows how 166 different government agencies and entities relate to one another.

The networks vary not only on their dimensions, but also in the details of which agencies and relationships are most prominent. Table 2 (pg. 74) shows the top nodes by degree and the strongest relationships between nodes for each of the three dimensions and the resulting multiplex network.

	Hyperlink	Metadata	Lobbying	Multiplex
Nodes	1002	132	189	166
Links	35,288	2556	6623	3306
Density	0.035	0.30	0.37	0.24

Table 1. Network by Size and Density

	WWW	Lobbying	Data.gov	Multiplex
Nodes by degree	• Library of Congress (LoC) • White House • Government Printing Office (GPO) • National Institutes of Health (NIH) • House of Representatives (HoR)	• HoR • Senate • White House • Department of Defense (DoD) • Environmental Protection Agency (EPA)	• EPA • Census Bureau • DoD • US Geological Survey (USGS) • Department of State	• EPA • HoR • White House • Senate • DoD
Edges by weight	• National Endowment for the Humanities (NEH)/LoC • DoD/Navy NIH/Health and Human Services (HHS) • GPO/LoC • White House/ US Department of Agriculture	• House/Senate • White House/ Senate • HoR/White House • DoD/HoR • DoD/Senate	• Census Bureau/EPA • EPA/USGS • Center for Disease Control/EPA • General Services Administration/EPA • Department of Energy/EPA	• House/Senate • NEH/LoC • DoD /Navy • Census Bureau/ EPA • NIH/HHS

Table 2. Nodes by Degree and Relationship

This final multiplex network is an agency proximity graph. Agencies that are closely related to one another in this network work in similar domains, whereas agencies that are not linked to one another and those removed from one another by one or more steps work in different government realms.

One strength of network analyses is the ability to apply meaningful clustering or community detection algorithms to the data and determine where particularly well-connected groups of nodes exist. Applying an unfolding algorithm to the weighted multiplex network decomposes the federal government into eight communities.[21] Table 3 describes seven of these communities—excluding a single one-node community—showing fairly clear separation of governance roles. Some of these communities have more clearly defined roles, such as the transportation group in which almost all nodes have some relevance to transportation and transportation infrastructure, while others are more mixed, such as regulation, management, and statistics that contains many of the agencies responsible for day-to-day governance and somewhat more focused regulatory agencies.

The modularity score for the multiplex network of 0.21.30 suggests that, while these communities do exist and nodes within them share more connections with one another than with nodes outside their communities, there is still a significant number of inter-community links. The clustering results help shed some light on the first question. Some agency communities, largely organized by government domain, are by no means exclusive, and there is a significant amount of cross-community linking. However, this community structure and the accompanying modularity score do not provide absolutely clear evidence of how integrated or hierarchical the government is.

	Size	Notable Agencies
Transportation	12	• FAA • NHTSA • NTSB
Health and Wellbeing	19	• FDA • NIH • HHS
Defense	5	• DOD • Navy • Defense Logistics Agency
Trade, Finance, and Legislature	64	• Farm Credit Administration • Export-Import Bank • Senate • House • Dept. of Treasury • DOT • Dept. of Commerce DHS
Communications	14	• Library of Congress • FCC • Nat'l Telecommunications and Information Administration • Copyright Office
Regulation, Management, and Statistics	43	• Dept. of Interior • GSA BLM • OSHA • EPA
Misc.	8	• Education • USDA • Office of Management and Budget

Table 3. Communities and their Nodes

Another way we can get some insight into the degree of hierarchy within the U.S. government network is by examining how entities at different levels link to one another. If there are a preponderance of links between executive level agencies and lower level or independent agencies, it suggests a hierarchically-structured network. On the other hand, if there are many links between nodes at the same hierarchical level it suggests a flatter more integrated structure.

This analysis utilizes a p*/exponential random graph model to determine whether lateral links are significantly more or less likely than what one would expect to see by chance. The exponential random graph model demonstrated that the network is somewhat sparse and has more highly centralized hubs than would be expected. The model also shows a negative coefficient for the nodematch parameter that suggests that links are more likely to form between agencies at different hierarchical levels than between agencies at the same level. That is to say, executive agencies are more likely to link to subordinate or independent agencies and vice versa. All else being equal, links between agencies at the same organizational level happen significantly less than would be expected. Finally, the positive budget coefficient shows that nodes with a greater absolute difference in budget are more likely to form links between one another than those with similarly-sized budgets.

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Combining the p*/ergm results with the cluster analysis suggests that the federal interagency network exhibits both silo-like clustering and hierarchical organization, leading to the conclusion that the federal government has yet to achieve a post-hierarchical networked structure. The clusters we observe do not correspond one-to-one with traditional government portfolios. Instead we see some areas that remain relatively distinct from the larger network, such as transportation and communications regulation, and some areas where the boundaries have blurred. These clustering behaviors suggest that some government domains do indeed show tendencies toward a more networked interagency structure, whereas others remain relatively siloed.

Answering the second question requires an analysis of longitudinal data. Unfortunately, we only have multiple measures for one dimension of relationship. The LDA data goes back to 1999, allowing us to measure the structure of at least this one dimension across time.

The degree distribution within a network can inform us as to how centralized the network is. A highly skewed distribution would suggest that a few agencies have the majority of the links and are thus highly central. On the other hand, a more even degree distribution suggests less centralization in the network. We can measure degree distribution skewness by plotting the degree probability distribution function p(k) and measuring the slope of a line fit through the p(k) plot. For instance, Figure 1 shows the lobbying network p(k) plot for 2010.

Figure 2 demonstrates that as the years go by, the slope of a line fit through the lobbying network p(k) plot quite steadily increases. This suggests that as the years go by, the degree distribution is becoming more and more skewed, which suggests that there are fewer agencies garnering a greater proportion of the links within the network.

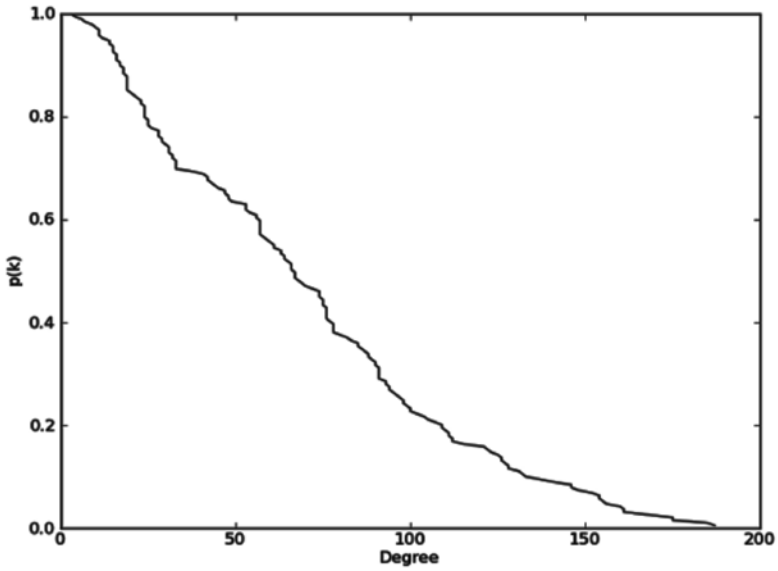

Figure 1. 2010 p(k) for the Lobbying Network

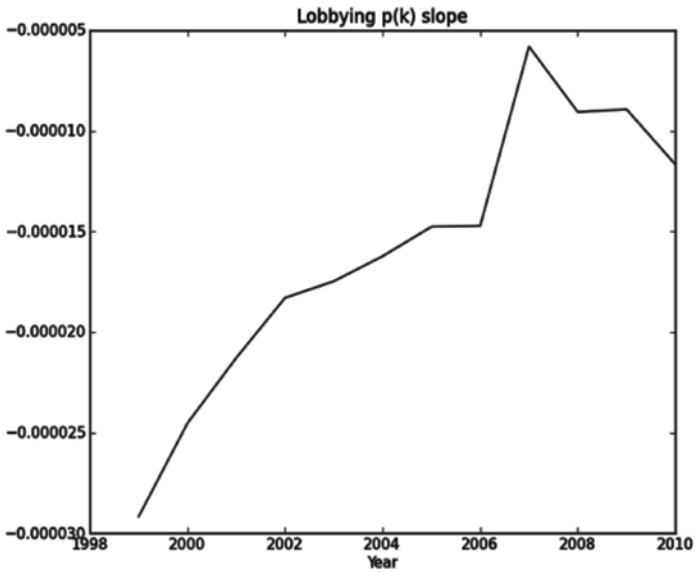

Figure 2. Lobbying p(k) Slope Over Time

While these results do not conclusively demonstrate that the interagency network is becoming more centralized, it does suggest—at least within the lobbying dimension—fewer agencies are attracting a greater proportion of the links. The tentative answer to the second question is that the government is becoming more hierarchically organized over time. If agency influence were becoming more dispersed—as some prognostications about the future of government would suggest—we would expect to see the exact opposite trend. If power were transferring from the center to the periphery, we would expect to see more agencies being lobbied together and thus a less skewed degree distribution. What we see instead is more concentration of lobbying efforts among a few central government entities.

Discussion

The multiple dimensions represented within this multiplex network lend more credence to the resulting analysis. By triangulating measurements, we come closer to understanding the reality of agency proximity. The results suggest that claims of a less hierarchical government in the twenty-first century are either wrong or premature. What we see instead is a structure that exhibits functional silos and a significantly high degree of hierarchy. While it is true that the year 2010 measurements that we rely on for the multiplex network may not show impending changes, the one dimension of time-series data we do have suggests that the interagency system is becoming more, rather than less, hierarchically structured.

...efforts like data.gov act as hubs connecting many agencies by publishing their datasets in a centralized repository.

While hierarchy remains in the observed interagency relations, there are still many connections between government entities at the same institutional level. The clusters of agencies suggest that there are some governance domains that remain relatively insulated from the more general interagency network, and some that tend to be more integrated. These domains tend to be more specialized, such as communications and transportation regulation, and specialized defense agencies tend to form their own clusters. On the other hand, many of the agencies that function in less-specialized domains cluster together in large groups.

The interagency network analyzed here uses agencies or other government entities as nodes. While this method shows a system that is both siloed and hierarchical, it does not include some interagency efforts that may suggest a move toward networked government. For instance, efforts like data.gov act as hubs connecting many agencies by publishing their datasets in a centralized repository. Indeed, by promoting data mash-ups, both by agencies and individuals, data.gov actively encourages cross-agency connections. Because they lack history and formal institutionalization compared to traditional government agencies and efforts, these interagency projects and projects undertaken by an individual agency that focus on amalgamating the work of diverse agencies are largely invisible to this analysis. It could be that changes in government structure will originate in these less formal, less institutionally-vested entities. Finding a way to map the structural traces of these activities and entities will be essential for future government structure research.

One of the biggest challenges to any study that attempts to measure interagency structure is the lack of an objective yardstick with which to assess accuracy. While measuring multiple dimensions helps allay some of the concerns about accuracy, without an objective comparison, it is impossible to say with certainty to what degree one's measurement reflects reality. The lack of an objective touchstone, a limitation implicit in many social scientific measures, is this study's chief limitation. That said, many of the constructs that social scientists are interested in cannot be objectively measured. Various indices and indicators are used to measure these constructs with the greatest reliability and validity possible. I believe that, in the realm of interorganizational analysis, a multiplex approach as used here is, all else being equal, inherently more reliable and more valid than any approach that only takes into account one dimension of relationship.

This study also struggled with was a lack of time-series measurements. The analysis relied on only one dimension—the lobbying

relationships—to draw conclusions about how government structure has changed over time. If more dimensions of time series data were available, it would make those conclusions that much more robust.

Conclusion

This multiplex analysis of the federal interagency network demonstrates how we can use digital trace data to measure multiple dimensions of interorganizational relationship and thereby more accurately reflect the reality of agency proximity. The resulting multiplex network shows a significantly high proportion of hierarchical relationships and fewer intra-level links than we would otherwise expect to see. In addition, we see many agencies clustered by domain with government entities engaged in activities such as communication regulation or transportation more likely to share links between one another than with others operating outside their domain.

While these results are not conclusive, they do suggest that those who claim that the organizational logic of twenty-first century communications technology will lead to a less hierarchical government structure may not be correct. Rather, the evidence suggests the existence of functional silos and a greater degree of hierarchical organization than we would expect to see by chance. ***IAJ***

NOTES

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