Research Note: Do Virtual Policy Networks Matter? Tracing Network Structure Online

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Introduction

Addressing the effects of the Internet on social, economic and political organization has become a common academic pursuit among social scientists. The "science" of networks and the scholarly popularity of network analysis have gained increasing relevance in the last decade as traditionally disparate academic disciplines have joined analytical forces to explain the complexity of social organization in the context of globalization, information technology, global civil society and the modernization of the policy process. The emergence of the Internet as a laboratory of human activity has provided analysts with a new set of empirical tools by which to test theoretical models of social and political behaviour with data extrapolated from the regularities of online organization and information exchange. This recent academic convergence around the new science of networks has produced an exciting body of evidence from which political science will surely profit. However, the discipline's ability to navigate the Internet and draw insight from the wealth of human information on the Web remains in the earliest stages of development. This research note takes tentative steps towards understanding Web-based politics and policy making through an examination of virtual policy networks (VPNs) in Canada.

The methodological approach used in the VPN discovery process is of particular interest to scholars studying policy communities. The method applies network analysis to large *n* data sets, generating precise results

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quickly and economically. The approach provides significant improvement in associational network tracing techniques (Laumann and Knoke, 1987) and is easily replicable. The methodology is called hyperlink network analysis and is used to study Web-based communication (Jackson, 1997; Rogers, 2002). Hyperlinks are the building blocks of the Web and provide "technological capacity that enables one specific Website (or Web page) to link with another" (Park, 2003: 49). The information garnered from hyperlink analysis is publicly accessible, increasingly international, and strongly imbued with latent human judgment.

This research note demonstrates how Web-based analysis allows researchers to understand the manner in which policy actors are using technologically mediated environments as new political and policy forums. It will be shown that virtual policy networks do exist and that these Web-based communities possess several key structural traits. Following this, I present the hypothesis that VPNs imitate the organization of their offline counterparts. This supposition is tested on four national VPNs, including Aboriginal policy, agriculture, banking, and women-centred policy. The selection of these particular policy domains was strategic and based upon existing political science policy research. The Aboriginal VPN represents a traditionally closed policy community with privileged access and controlled flows of information. Agriculture and banking typify sectors featuring dynamic information circulation and the penetration of international actors seeking entry to domestic decision-making processes. Finally, the women's-centred policy community was selected as representative of an open, discursive network with strong international connections and fluid flows of information.

A large body of evidence suggests social movements, policy discourse, engagement in civil society, political campaigning and information dissemination all occur in Internet-mediated environments (Becker and Wehner, 2001; Bimber and Davis, 2003; Blumler and Coleman, 2001; Jeffery and Mayman, 2001; Mansell and Steinmueller, 2000). That Web-based policy networks exist is significant, however. If these online networks are mimicking the characteristics of their respective offline policy communities, both political scientists and policy scholars are presented with a powerful new analytical tool to study online power differentials and political organization. The following section introduces the formal principles of the new science of networks and explains how these methods are applied to the study of Web-based policymaking and the national policy Web.

Identifying Structure through Web Cartography

In 1998 Duncan Watts and Steven Strogatz discovered that certain characteristics of real world networks could be encapsulated by a relatively

Abstract. The Internet, operating as a technologically embedded laboratory of human activity, provides social scientists with a new set of analytical tools by which to test and replicate models of social and political behaviour, with data extrapolated from the regularities of online activity, organization and information exchange. This research note demonstrates that virtual policy networks, arrangements of public interaction between mutually supporting actors that form around policy activities, exist on the Web. In addition, the note considers whether or not Canadian virtual policy networks are mimicking their respective national policy communities through the application of a methodological approach referred to as link structure analysis. Four sectorally based networks, including Aboriginal policy, agriculture, banking and women-centred policy, are analyzed to assess the extent of virtual policy networks' replication of real world policy dynamics.

Résumé. L'Internet, agissant comme laboratoire technologique de l'activité humaine, fournit aux chercheurs un nouvel ensemble d'outils analytiques par lesquels ils peuvent tester et recréer des modèles de comportements sociaux et politiques, à l'aide de données extrapolées à partir d'activités, d'organisations et d'échanges d'information en ligne. Cet essai montre qu'il existe sur Internet des réseaux virtuels d'action politique, à savoir des arrangements d'interaction publique entre différents acteurs sociaux se regroupant autour de certaines idées politiques. En outre, il essaie de déterminer si les réseaux virtuels canadiens imitent leurs communautés politiques nationales respectives, en utilisant une approche méthodologique désignée sous le nom d'analyse de la structure des liens. Quatre réseaux appartenant à des secteurs distincts, soit la politique autochtone, l'agriculture, les opérations bancaires et la condition féminine, sont analysés pour évaluer l'ampleur de la reproduction des dynamiques politiques et sociales du monde réel par les réseaux d'action politique virtuels.

straightforward mathematical formula. More specifically, Watts and Strogatz (1998) found that networks exhibit properties of both complex and random systems, and that using a graphic model that introduced randomness into order revealed specific rules concerning network configuration, allowing them to discern a "universal class of networks; that is, a family of networks that share certain aggregate properties regardless of many of their individual details" (Watts, 2004). Their discovery has become popularly known as the "small world phenomenon," and has been replicated in the network configuration of social organizations, cities, the Internet, the World Wide Web, cerebral neurons, patterns of wealth accumulation, communication networks, power lines, and a myriad of other entities that are predicated on the small world architecture (Buchanan, 2002; Johnson, 2001; Milo et al., 2002; Taylor, 2003).

This insight into complex networks has provided scientists with a set of global network properties that may be used to classify structure and understand how recurring patterns of organization condition network configurations. The pervasiveness of the small world phenomenon in dynamic social networks and human organization has the potential to trigger a paradigmatic shift in the social sciences. If, indeed, an empirically verified set of scientifically based rules is available to identify network structure, describe their evolution, and provide insight into the relational context among participants, then this discovery may be able to answer many of what were previously considered recalcitrant problems in the social sciences.

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The application of small world networks for understanding the structure of online communities is associated with the popular theory of "six degrees of separation," which measures the structural properties of the network through path lengths (the average separation between two vertices within the network). In the case of the Web, the degrees of separation, the average number of mouse clicks it takes to locate a specific document, is nineteen (Barabási, 2000). Considering the size of the Web, this nominal path length suggests that an underlying network is anything but random. The key attribute of random networks is that each node has an equal opportunity of connecting to another node, which produces a normal distribution curve that stops at the horizontal axis. In contrast, scale-free networks are characterized by a preponderance of scantily connected nodes and a restricted minority of highly connected nodes, which tend to grow throughout the life of the network (Watts, 2003). Preferential node attachment results in clustering and non-uniform, continual network growth, suggesting some nodes will possess a higher number of linkages within the network (Barabási and Albert, 1999).

Examples of scale-free networks abound in the social world, with distributions derived from the power law or *Pareto's law*. The power law differs from a normal distribution curve in that it does not have a peak at its mean value, nor does it have a rapid decay (Watts, 2003). One of the best-known examples of Pareto's law is associated with the distribution of wealth, where privileged nodes have a greater influence on the network. Just as privileged citizens have a greater influence in society, policy brokers have a greater influence on their domains, and social connectors have a greater influence on their circle of friends. The same holds true on the Web, with some pages possessing an anomalously large proportion of in-links. As Albert-László Barabási (2000) explains,

> [t]he architecture of the World Wide Web is dominated by a very few highly connected nodes, or hubs. These hubs, such as Yahoo! or Amazon.com, are extremely visible—everywhere you go, you see another link pointing to them. In the network behind the Web many unpopular or seldom noticed nodes with only a small number of links are held together by these few highly connected Websites.... Compared to these hubs the rest of the Web is invisible. For all practical purposes pages linked by only one or two other documents do not exist. It is impossible to find them. (58)

As individuals surf the Web for information, search engines direct online activities through an independent indexing of the Web's content, assuming greater authority or legitimacy of information by the quantity of users endorsing the source. This human annotation or shadow produces two types of Web pages, hubs and authorities, which are systematically organized into topical communities (Kleinberg, 1999).

Hubs and authorities are determined by the intrinsic social organization of the Web and are mutually reinforcing.

Consider the significance of a link $p \rightarrow q$: with such a link p suggests, or even recommends, that surfers visiting p follow that link and visit q. This may reflect the fact that pages p and q share a common topic of interest, and that the author of p thinks highly of q's content. Such a link, called an informative link, is p's way to confer authority on q. (Lempel and Moran, 2000)

Authorities are those pages that are topically organized, provide information and guide the user to alternative sources of related knowledge. Hubs are centralized nodes that direct users to various authorities embedded within that network. Each individual Web page in the network has the potential to receive inbound links and to publish outbound links, and thus each node is characterized by both a hub and authority weight. Authority weights are calculated by the summation of all inbound links ($a_p = \Sigma h_q$ q such that q $\rightarrow$ p), while hub weights are determined by summing all outbound hypertext links ($h_p = \Sigma a_q$ q such that p $\rightarrow$ q).

Using a Web-based algorithm that retrieves large quantities of data from the Internet, the topographical structures of the online communities are calculable through measures of link information. Manipulating link information allows the identification of various online communities and traces incoming and outgoing links to determine connectivity and identify network structure. Hypertext links, generated by human judgment, are the ties that bind the Web together, and when users add links to their homepages, they are revealing both an interest in a specific topic, as well as conferring trust in another related Web page. Extraction and identification of those links most relevant to the topical community provides identification of the key nodes (Kleinberg, 1999). Informative links are thus critical to network identification and are the foundations upon which the community or topical cluster is defined.

Despite the heterogeneity of pages, online hyperlinked collections are self-organizing systems that evolve naturally (Flake et al., 2002). Nodes tend to cluster around topical interests, with new members joining through preferential attachment to already well-connected pages. The absence of a central organizing body online allows Web communities to evolve collectively without a predetermined organizing principle, suggesting that the network is robust and resistant to erosion (Tu, 2000). Distilling virtual networks is thus achieved by identifying the relationships between highly connected nodes operating as information hubs that direct users to trusted online sources. The status of these nodes, and the density of the linkages among them, reveal the ideological, political and policy-orientated propensities of the community.

Tracing virtual networks from the Web is achieved through a methodology referred to as link-structure analysis, which applies various tech-

niques to study linkage patterns (Foot et al., 2003; Park, 2003; Park and Thelwall, 2003; Rogers, 2002). The largest hubs on the Web are search engines that use electronic spiders that crawl through the Web space, mapping the network through hyperlinked ties. Using a search engine, researchers may enter specific search criteria that, when processed through a search engine, will distill critical nodes (hubs and authorities) in the communities under investigation. Virtual networks are identified using an algorithm that maps the networks using a focused sub-graph of the Web (Rogers and Marres, 2000). The method was first developed as a search engine optimization procedure used to analyze the cartography of the social ties between Internet-mediated communities publicizing their affiliations, partnerships and belief systems in a hyperlinked environment. The architects who originally created this algorithm based their engine on hub and authority weight/rank measures by using the citations of the Web graph (Brin and Page, 1998). Following from Jackson (1997), this project combines the technologically embedded human annotation between Web sites and hyperlink text with traditional social network analysis.

The computational complexity of collecting and analyzing a large number of nodes is achieved through the use of a specific algorithm designed to crawl through the Web's link-structure extracting informative links that are recorded in a large database. The algorithm used for data capture in this project was designed to determine a ratio for each source point and provide a weighted ranking. The engine used in this project was the Issue Crawler, which is designed to map a Web space using seeded URLs. Developed by Richard Rogers and the govcom.org foundation in Amsterdam, the Issue Crawler generates raw data and provides network visualization (Rogers, 2002). The issue space in each network is defined broadly using Boolean criteria that identifies domain (in this case .ca) and names the policy field or sector. For this project, all initializing nodes were gathered from Google with various content filters applied, disallowing linkages from Amazon.com and eBay, for instance. To locate an online community, "seeds" or initializing nodes (URLs) are entered into the Issue Crawler, which then begins mapping the Web graph from the outgoing links of the seeds (Rogers and Marres, 2000; Rogers, 2002). Network membership is determined through co-link analysis, which only includes those nodes that are bidirectionally paired ($p \leftrightarrow q$) and that have received a minimum of two inbound links from a third node in the sample population. The engine crawls two layers of hyperlink text, beginning with the pages derived from the seeds and tracing two more levels thereafter.

After the parameters of the network are determined and unrelated links are discarded, a second iteration occurs mapping the link structure of the networks by measuring linkage occurrences. Using the Issue Crawler for data collection, the link structure of the four networks under

consideration (Aboriginal policy, agriculture, banking and women-centred policy) were located and mapped. Each of the four networks did constitute a VPN, as each was characterized by growth through preferential attachment and scale-free distribution.

Modeling Virtual Policy Networks

Knowing that VPNs exist allows for consideration of the extent to which these Web-based networks mimic their offline counterpart policy communities. Drawing insight from existing empirical studies and Canadian policy scholars, predictions concerning the structural configuration of these four networks are provided in this section. However, prior to hypothesizing structure, a conceptual model designed to empirically validate network configuration is necessary. The model must be dexterous enough to be applied in both real world and virtual settings.

One of the most recent studies of policy network configurations in Canada was undertaken by Howlett (2002), who sought to determine the empirical validity of network analysis. Howlett's evaluation of network structures was conducted through an in-depth study of longitudinal policy change in four sectors: banking, education, trade and transportation. This study produced evidence that network configurations provided reliable, predictive measures concerning the pace and type of policy change.

As Howlett's model is grounded in network theory, the application of this logic to virtual policy settings is reasonable. According to the model, the policy community is comprised of the set of all actors and institutions engaged in the policy process in any given domain. Howlett identifies two primary constellations of participants: a discourse community and an interest network. The first subset of participants he distinguishes is the discourse community, which is comprised of various actors associated through relationships premised on identifiable sectoral/topical affiliation. Alternatively, an interest network refers to actors engaged in information exchange relations, whereby participation is motivated through self-interest. Howlett's model (2002: 248–9) posits that an important aspect of the "cohesiveness" or "closedness" of policy subsystems, identified in earlier studies as a key dimension of subsystem structure related to policy change, is the nature of the relationship existing between the discourse community and the interest network. Subsystems which feature closely integrated communities and networks will be more cohesive, and better able to resist the entrance of new ideas and actors into policy processes than will those which feature sizable distances between the two subsets of actors.

Howlett recognizes four ideal-type networks, each characterized by the policy subsystem's permeability to new actors and ideas. Policy com-

munities with tightly fused membership will display strong cohesion and be insulated from outside influences. An open structure suggests a network configuration more exposed to external information circulation and the entrance of new policy actors, while closed subsystems are protected from exogenous influences and thus remain stable and insulated. Howlett also identifies resistant and contested networks, which are similarly identified by degrees of insulation and extent of symmetry between network and community (Table 1).

Howlett's model was substantiated with evidence from four subsectors (airline deregulation, continental free trade, funding for federal-provincial post-secondary education, and the deregulation of federal banking). Considerations of sub-system policy goals, instrumental types, and programme specifications were collected to observe the policy dynamics of each sector and to determine the insulation and symmetry of the core of each policy network. The hypotheses concerning VPN configuration are premised on Howlett's model and are expected to reveal a relationship between network hyperlink structure and internal network dynamics. To test this, the two independent variables (symmetry and isolation) will be measured separately and then combined to determine where each VPN is located in Howlett's model. Applying this framework to the four VPNs under consideration should determine whether Web-based networks have similar structural configurations of real world policy communities.

Applying Howlett's model to the Aboriginal VPN, it is hypothesized that this network will be characterized by a closed structural configuration with a closely controlled relationship between the federal government and First Nations. Jonathon Malloy's (2001) research suggests that this network should be characterized by contestable and competitive policy dynamics, as the bond between provincial institutions and Aboriginal populations is not as collaborative as that found between First Nations and Ottawa. However, at the national level, the constitutionally entrenched and fully institutionalized relationships with First Nations and the fed-

TABLE 1
Howlett's Operationalization of Policy Subsystem Configurations

		Network's degree of insulation from community	
		High	Low
Extent of symmetry	High	Closed	Resistant
	Low	Contested	Open

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eral government would be expected to produce a set of dominant actors with flows concentrated at the core (Abele and Prince, 2002). These state actors tend to have privileged status in decision-making outcomes, with First Nations and complex bureaucratic structures managing land claims, justice, and economic and social programme coordination.

The agriculture VPN is hypothesized to feature a structural configuration that would be classified as a resistant network. Although the offline agriculture policy community has traditionally been considered a closed policy community, this sector has been experiencing various exogenous shocks in the recent past as a result of environmental concerns (Montpetit, 2002), the policy overlap with the biotechnology sector (Montpetit and Garson, 2004), and increased media attention arising from such focusing events as the mad cow scare, avian flu fears and genetically modified seed. Furthermore, the VPN has significant connections to the American government and various international policy institutes, suggesting that the entrance of new international actors into the domestic agricultural policy community may be conditioning network behaviour (Coleman, 2003).

On the other hand, I predict that the banking VPN possesses a contested structural configuration. Research focused on this sector's real world policy activities suggests that the community will be influenced by high levels of internationalization and extensive interdependencies in the global policy domain (Coleman, 1996). The Canadian banking policy community has gone through various stages of adaptation in the last decade, including significant changes in the global financial structure (Coleman, 1996), new regulatory processes and service reforms, internal lobbies seeking mergers, and various attempts to expand eligibility criteria so that national banks may compete in the global market (Harris, 2004b). Challenges arising from the larger policy universe and interest articulations outside the core have not toppled policy monopolies but instead seem to have triggered venue shopping (Harris, 2004a). Drawing from real world analysis, it is hypothesized that the banking network will feature limited information flows beyond the interest network and higher levels of permeability.

Finally, I expected the women's-centred VPN to be very porous, open to flows of competing information and fluid membership. Feminist organizational efforts aimed at achieving greater inclusion in policy making and democratic activity may be partially responsible for the configuration of this community (Burt, 1999). There have also been several concerted efforts to increase women's online political mobilization using the Internet as a mechanism of empowerment (Davis, 1998; Harcourt, 2000). In the last decade, traditional state control over the Canadian women's policy community (Pal, 1993) has been dramatically restructured, partially through the loss of state funding and partially through the efforts

of feminist policy scholars, women's community activity, femocrats and critical policy analysts (Brodie, 1996; Burt, 1993, 1995, 1999; McLaren, 1998). Thus this VPN is hypothesized to be an open network with free flows of information.

Do Virtual Policy Networks Matter?

Howlett's model (2002) suggests that the organizational structures of real world policy communities will condition policy dynamics and propensity towards change. He identifies two primary variables: network symmetry and core insulation from exogenous forces. To determine the levels of symmetry and permeability of the four VPNs studied here, each network was tested for density and information flows. The policy universe of each VPN was comprised of the full set of nodes culled from the Web crawl. To test for symmetry, the top 20 percentile of pages were chosen to represent the core or interest network. The universe of VPN nodes was then subdivided into two sets that paralleled Howlett's discourse community and interest network typology. Next, the core or interest network's hub weights (outbound links) were calculated to determine the degree of insulation the interest network enjoys from the discourse community.

If the pages published in the discourse community are recognized, and linked to, the core, then the network is open. If the core is insulated from Web pages advocating alternative policy positions, then the network is closed. Determining structural configuration of VPNs is in the earliest stages of development, and as a result the cutoffs for determining symmetry and insulation presented in this research note are experimental, with 72.05 being the mean average of 40 VPNs' core hub weights previously tested by the author. Thus any VPN with a hub weight of less than 72 is considered less insulated or more open, while a network with a core hub weight of greater than 72 is considered more insulated and closed. The Aboriginal policy VPN represented a closed, symmetric network, as did banking. Alternatively, the women's and agriculture VPNs were less symmetric, with agriculture particularly revealing lower degrees of cohesion (Table 2).

The second key characteristic to be tested was permeability or resistance to new ideas and actors, which was accomplished by simply studying the density of information flows. As already discussed, VPNs will reference other sources of information and provide lists of advocacy partners, providing researchers with strong evidence of information coalitions. Following Howlett's findings, circulation of informational sources and ideas is variable across networks, and should be evident in the amount and concentration of information circulating in the online policy community. To test for this, only the hyperlinks connecting the core pages are

TABLE 2
Levels of Insulation

VPN	Policy universe	Interest network	Discourse community	Interest network hub weight	Insulation
Aboriginal	105	26	79	77.19	High
Agriculture	134	36	98	65	Low
Banking	81	23	58	73.14	High
Women	102	26	76	71.44	Low

considered in determining the information density among the interest network.

To measure information flow, the links hosted by the core are subtracted from the universe of network linkages and normalized into percentages. The higher the concentration of linkages in the interest network, the lower the flow of competing information, suggesting that the network's core belief system is well established and resistant to alternative policy views. Similarly, higher flows of information would indicate that a network is more porous, providing opportunities for alternative agendas or competing perspectives. A mean average of information flows was calculated again using data from 40 previously tested VPNs. Within the context of this sample, networks characterized by information flows of less than 65 percent are considered more nebulous and open to competing policy alternatives and ideas. Alternatively, networks with a core concentration of information flows greater than 65 percent are more prone to lower levels of symmetry, and more protected interest networks. Of the four cases, the Aboriginal and agriculture VPNs are characterized by controlled (lower) information flows, while women's policy and banking are distinguished by higher degrees of information flows (Table 3).

After measuring the two variables, degrees of insulation and extent of symmetry are combined so that each of the four networks may be located in Howlett's model (Table 4).

TABLE 3
Symmetry of Information Flow

	Information flow		% Info. flow in the core	
VPN	*Universe*	*Core*	*Core*	*Symmetry*
Aboriginal	10770	8848	82.15	High
Agriculture	21462	14901	69.43	High
Banking	3988	2828	62.3	Low
Women	3767	2230	59.2	Low

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TABLE 4
Virtual Policy Network Configurations

		Degree of insulation	
		High	Low
Symmetry (information flows)	High	Closed-Aboriginal	Resistant-agriculture
	Low	Contested-banking	Open-women

The structural configuration of the women's VPN features low levels of insulation and symmetry, and thus represents an open network, amenable to new actors and discursive online dialogue. The Aboriginal VPN is characterized by higher levels of symmetry and insulation, suggesting that it would be closed to new actors and ideas. The agriculture VPN reveals attributes of a resistant network in that it features lower degrees of insulation combined with higher flows of information concentrated at the core. Finally, banking was found to be a contested network with low symmetry and higher insulation.

Discussion

The four networks presented here, characterized according to symmetry and insulation, appear to be mimicking their real world counterparts. For instance, the Aboriginal VPN was the most highly insulated and symmetric of the four networks, and was classified as a closed policy network, confirming the original hypothesis. At the opposite end of the spectrum, the women's-centred VPN was far more porous, open to flows of competing information and fluid membership, behaving as expected. The banking VPN also appeared to be reflecting real world policy activities, as this network is the most global of the four, with extensive interdependencies in the international policy communities. Finally, the agriculture VPN, traditionally considered a closed community, appears to be under pressure.

Early indications thus suggest that further analysis of VPNs will provide significant insight into politics and policy, in both online and real world policy settings. The propensity for VPNs to mimic their real world counterparts is a product of Web-based information exchange, public statements concerning coalition partners, the organizational infrastructure of the Web, and the use of this technological channel in human communication patterns. As technological and social networks coalesce, social scientists are presented with new insights into the complexity of modern

politics and policy-making activities. Identifying and analyzing VPNs is an important step towards understanding the impact of new technologies on both the policy process and the Canadian political landscape.

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