A DYNAMIC NETWORK STUDY ON HOW CONSOLIDATING STATE GOVERNANCE MODELS RELATES TO LEGISLATOR VOTING PATTERNS

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DISSERTATION ABSTRACT

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In 2011, Oregon was one of many states in the U.S. consolidating their education governance around an early learning, K-12, and postsecondary hub. This study uses legislator-voting data to investigate the relationship between this consolidated model and endogenous policy formulation processes. This study employs a separable temporal exponential random graph model (STERGM) to investigate how an education governance shift toward consolidated authority relates to bipartisan outcomes for education-related bills over time. Oregon legislator voting networks were analyzed for cohesion, centrality, and community detection measures, as well as by legislator attributes (e.g. gender, party, and title) to test the association they had on the likelihood of forming ties with other legislators. Finally, to study the relationship of bipartisanship with legislators' likelihood to vote commonly, I added the legislators' political party attributes within dyads to analyze the association that having *different* political parties had on legislators' common votes. The results highlight evidence of legislator networks that were very dense at each time point included in the study, with a high likelihood of forming ties. However, when Oregon shifted to centralized education governance model their legislator networks became more distributed and cohesive when compared to other years included in the longitudinal study. It is possible that such a shift prompted collaboration among

legislators resulting in mutuality that increased the likelihood for underrepresented groups of legislators (e.g. females and republicans) to vote commonly with their colleagues. Aligned with previous research, this study found that centralized governing bodies reinforced by political legislation provided collaborative initiatives for the legislative community. Attending to bipartisan voting patterns dynamically through a governance shift is a valuable investigation that will provide nuanced inferences about education governance and policymaking for states making similar consolidated governance shifts in the future.

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CHAPTER I

INTRODUCTION

Politicians and policymakers use education governance institutions like state boards, departments of education, and legislatures to influence education governance. State-level changes to education governance and policy result in shifting power and capital between the legislature, chief of education, and local administrators. Prior to 2011, Oregon's education governance departments were locally controlled and decentralized. For example, education policymakers representing different levels of power (e.g., the governor, superintendent of public instruction, and deputy superintendent) and different substantive areas (e.g., post-secondary, PK-12, and early learning governing bodies) across state departments were isolated by their organizational structure. After 2011, the Oregon Education Investment Board (OEIB) was introduced in order to restructure the state governance systems and create a centrally aligned vision and strategic plan. However, it remains unclear to what extent the OEIB was associated with achieving education goals set by the state legislature. The current study investigates how the OEIB and their related policy agenda changed Oregon's education policymakers' voting patterns, a proxy for education goals.

Prior to Senate Bill 909, which enacted the OEIB in 2011, the state superintendent of public instruction and the state board of education served as the two education policy advisors to Oregon's governor. Senate Bill 909 (2011) established that the governor now served as the state superintendent of public instruction whose role is to oversee the existing state department of education, as well as the newly created departments including (a) the Oregon Education Investment Board, (b) the Higher Education

Coordinating Commission, and the (c) Early Learning Division. With the enactment of the OEIB, the appointed Chief Education Officer became a new leading voice for the education policymaking community in Oregon. The Chief Education Officer and the OEIB were required to publish annual legislative reports to provide the legislative assembly direction and guidance. When the governor established the OEIB in Senate Bill 909, they were charged to "oversee a unified public education system that begins with early childhood services and continues throughout public education from kindergarten to post-secondary education" (Senate Bill 909, 2011, § 1). The bill required the OEIB to consist of the elected governor, twelve members appointed by the governor, an appointed member from each congressional district, and the Chief Education Officer. This shift centralized many disparate departments within the state department of education previously overseen by an appointed state superintendent of public instruction.

State education agencies function as education governance networks (e.g. the superintendent of public instruction, assistant superintendents, administrators, and analysts) whose roles are to build social, economic, and intellectual capital and improve effectiveness for policy setting and implementation. State legislators inform the political decision-making driven by the discourse of education policy advocates and public managers at state education agencies. The OEIB was intended to consolidate the distributed power from local policymakers toward a centralized education governance model in Oregon. The OEIB was charged with providing legislative proposals during each legislative session in order to centralize a policy agenda across the governance structure and inform the policy formulation process. The study presented here focused on the extent to which the OEIB shifted power among Oregon senators and representatives

by measuring longitudinal legislative support for enrolled bills using co-voting patterns among the legislative assembly as an indicator of the OEIB's association with policy formulation.

A Network Theory of Education Governance

The following literature review synthesizes two perspectives on organizations and individuals in the context of education governance. Brewer and Smith's (2008) three sequential frames of (a) what, (b) who, and (c) how are summarized in Table 1 and provide a basic format for understanding the mechanisms and functions of educational governance models. Network theory extends the traditional perspectives of governance in that it maps the organizations and individuals that constitute education governance structures. Network theory builds upon Brewer and Smith's (2008) governance dimensions by adding a dynamic layer about how the functions, institutions, and mechanisms in their sequential frames relate to one another within governance models. This systematic literature review included literature from the areas of education governance networks, legislation and social capital, and legislative voting. Brewer and Smith's (2008) framework with network theory uses three broad categories of education governance networks: (a) the functions and goals, (b) central agencies and key actors, and (c) mechanisms for policymaking as a framework to organize themes spanning these literatures.

Table 1

Brewer and Smith's (2008) Three Sequential Educational Governance Dimensions

1.	What	What are the goals of the system in terms of?
		(a) Structure and organization
		(b) Finance and business
		(c) Human resources/personnel
		(d) Educational programming
2.	Who	Who is best situated to carry out the tasks necessary to meet those goals?
		(a) Governor
		(b) Legislature
		(c) State board of education
		(d) State superintendent
		(e) State department of education
		(f) District superintendents
		(g) Regional education districts
		(h) Principals or teachers
3.	How	How should these actors best induce other to implement policy?
		(a) Mandates
		(b) Inducements
		(c) Capacity building
		(d) System changes

The *What*, *Who*, and *How*, of Education Governance and Policy Formation

Education governance reflects the interactions between school systems, politics, and the community (Brewer and Smith, 2008). Brewer and Smith (2008) use three dimensions that follow a sequential order for describing education governance structures at the state level. The first dimension represents the "what," or the *functions* required of the organization. The second dimension represents the "who," or the *actors*, *stakeholders*, and *institutions* needed to fulfill the functions. The third dimension represents the "how," or the *mechanisms* necessary to complete the functions of the organization. Generally, state education governance systems are complex and involve interrelated stakeholders

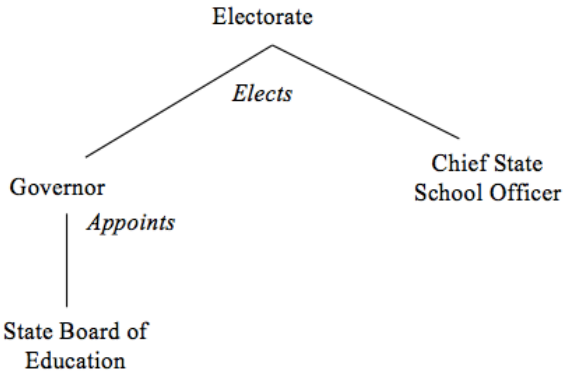
like regional centers, parents and guardians, and non-profit organizations, as well as the nuanced interactions of each group that influence the education system and quality of students' schooling (Manna and McGuinn, 2013).

In this study, Brewer and Smith's (2008) guiding questions frame the OEIB's potential association with the three dimensions of education governance. To extend on the what, who, and how dimensions (Brewer and Smith, 2008), I apply a network theory approach that operationalizes how actors form complex networks at both the legislative and organizational level and shape educational governance structures and policymaking. A theoretical understanding of networks advances Brewer and Smith's (2008) contribution and offers new ways of thinking about education governance structures change legislation outcomes across party lines.

State education governance in the United States. There is a myriad of formal education governance arrangements that affect how education policy is developed and implemented in the U.S. Among all 50 states, the degree to which state education governance systems are run by (a) local or state control, (b) participatory or restricted public input, and (c) distributed or consolidated authority determines their complex functions and how they inform education policymaking (Smith & Gasparian, 2017). *Local or state control* is determined by comparing the authority of the state education agency with that of the school districts over substantive decision-making areas, like curriculum adoption, teacher evaluation systems, and chronically underperforming schools (Zeehandler et al., 2015). The *degree of public participation and input* in education governance reflects whether voters and diverse stakeholders determine state leaders over existing authority (such as the governor or special interest groups). Whether

a state uses *distributed* or *consolidated* authority is determined by the presence of separate education boards, independent accountability offices, or the lack of a P-20 education system. This investigation will focus on how Oregon transitioned from a distributed to a consolidated state education governance system.

Oregon's authority structure has transformed from a distributed to consolidated governance model over the last decade. Prior to the enactment of the OEIB in 2011, the superintendent of public instruction and the state board of education were the leading advisors to the governor. On the left of Figure 1, the governor appointed the members of the state board of education and the chief state school officer (i.e. the superintendent of public instruction) was elected (Fulton, 2008). On the right of Figure 1, the Oregon Department of Education organization chart illustrates this hierarchical government model. The organization chart depicts how the superintendent of public instruction oversaw the state board and the deputy superintendent's offices, like school improvement, teaching and learning, and assessment prior to 2011. However, at this time the offices of early learning, higher education, and youth development services were isolated from the education governance.



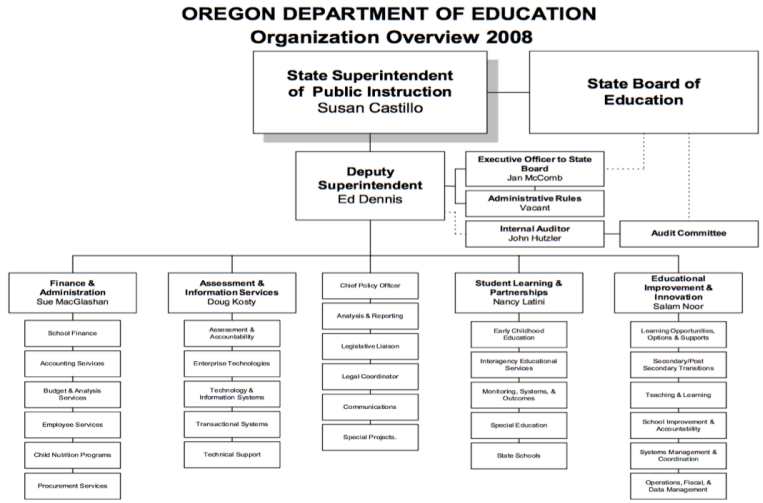


Figure 1. Illustrations of Oregon's education governance model prior to 2011 when the OEIB was enacted (left) and Oregon Department of Education's organizational chart (right).

A state governance intervention: The Oregon Education Investment Board.

According to the Education Commission of the States, there was a large movement among state education agencies to shift power over education policymaking to governors in 2011 (Zinth, 2011). Oregon uniquely implemented this shift by (a) enacting the Oregon Education Investment Board and (b) becoming the only state to put the governor at the helm of education governance as the chief state school officer or superintendent of public instruction (Zinth, 2011). Figure 2 illustrates how legislative changes during 2011 consolidated authority in Oregon's education governance model with the governor. Compared to the education governance system from 2008, depicted in Figure 1, Figure 2 displays how state offices moved from distributed and isolated positions within the governance model to a centralized structure overseen universally by the governor. I propose that this shift of authority functioned as a state education governance intervention. This shift changed Oregon's state education governance system in the following ways: (a) legislation deemed the governor the superintendent of public instruction, (b) the governor, not the public, appointed the state board education, a deputy superintendent of public instruction, and a chief education officer (who led the Oregon Education Investment Board), and (c) under Senate Bill 909 (2011) the governor now oversaw the newly enacted Oregon Education Investment Board, and (d) the early learning, higher education, and youth development offices were now housed within the Oregon Department of Education and overseen by the governor as well.

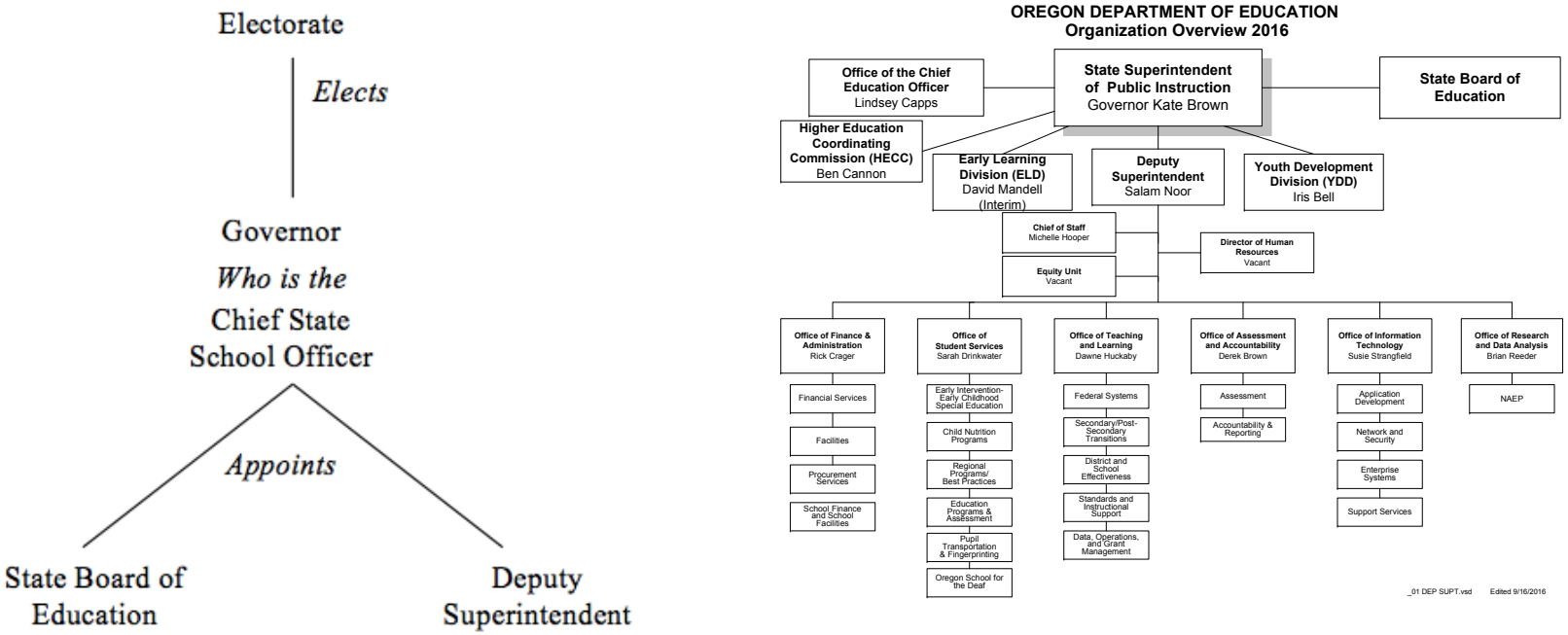


Figure 2. Illustrations of Oregon's education governance model after 2011 when the OEIB was enacted (left) and Oregon Department of Education's organizational chart (right).

With the enactment of the OEIB, the appointed Chief Education Officer became a new authority over education policymaking. In particular, the OEIB was charged with designing a cohesive public education system from early childhood into post-secondary education by developing and overseeing an early-learning council. To achieve this, the OEIB was also required to merge the state boards of education and higher education "by transferring the duties of those boards and the State Commission on Children and Families to the Oregon Education Investment Board," (Senate Bill 909, 2011, p. 4). Finally, the OIEB was to write a legislative report to the committee on education within the first six months on "proposed legislative measures" (Senate Bill 909, 2011, p. 4). Ultimately, Senate Bill 909 (2011) framed the OEIB's goals, scope, and work within the context of consolidating education governance authority in Oregon and informing legislative outcomes for the broad goal of a unified P-20 education system.

The Role of Social Networks in Education Governance

In the 21st century, education governance shifted from hierarchical bureaucracies toward public, private, and non-profit networks (Russell, Meredith, Childs, Stein, & Prine, 2015; Meier & O'Toole, 2006; Manna, 2012). Today, these public policy governance networks respond to complex social problems facing communities and crosscutting mandates (O'Toole & Meier, 1999). Recent educational governance network studies range from within-building analyses (Daly & Finnigan, 2011), to state-level policy implementation (Russell et al., 2015), to philanthropy driven reform (Au & Ferrare, 2014). These studies focus on policy *implementation* to illustrate the shift of education governance from a funder/auditor role toward a substantive decision-maker role (Mana, 2012). However, there remains a dearth of research on education governance

networks' ties to policy *formulation*, especially on the networked governance approaches (Au & Ferrare, 2014).

Political scientists are now using social networks to understand the capacity of stakeholders in the public policy sector (Rogowski, Sinclair, & Beck, 2012). Legislative scholars are employing networks to understand the dynamics of legislator influence on voting patterns (Alvarez & Sinclair, 2011; Rogowski et al., 2012). Yet, few legislative studies analyze how exogenous institutions relate to endogenous legislative processes (Alvarez & Sinclair, 2011). The current study investigates how an exogenous education policy intervention (i.e. the OEIB) related to bipartisan voting in the legislator network. To extend upon the existing education governance network research centering on policy *implementation*, this study intends to analyze state legislator networks for patterns of association on education-related bills at the policy *formulation* stage.

Policy formulation begins with a written legislative proposal, which, if supported, evolves into official legal language as a bill, then as a statute, and finally as an official policy (Fowler, 2013). The OEIB was charged with providing legislative proposals to the legislators during each session. While many legislative proposals derive from a single stakeholder group (e.g. chief executives, administrative agencies, or interest groups; Fowler, 2013), the OEIB provided their legislative proposals for the interests of a variety of stakeholders due to their organizational structure (e.g. governor, Chief Education Officer, and the board members). In some states, it is common for a coalition of actors to propose legislation, which ensures that the proposal enters the policymaking process with broad support (Fowler, 2013). In Oregon, the OEIB was designed so that the centralized

governance structure provided a policy formulation process that spanned stakeholder groups in this way.

The functions of education governance networks. The study of networks focuses on at least two layers of governance: (a) the individual level (i.e., human actors) or (b) the organizational level (i.e., an organization as a whole). This review of education governance networks literature delineated two goals for individual actors within networks: (a) *social cohesion* and (b) *social capital*. Data from the literature on education governance networks also revealed two goals for overall networks: (a) *network capacity* and (b) *network effectiveness.* These four characteristics identify the goals of public managers as individuals within an evolving education governance network by applying a unique dynamic layer of functions.

***Social cohesion*.** Social cohesion is a cornerstone of stability across social systems like economy, education, and governance. Within these areas of public policy, social cohesion can be conceived as the "*relational* togetherness of a group" or the "*sense* of togetherness that people express" (Moody & White, 2003, p.5). State education agencies play an essential role promoting social cohesion through ideation and social interactions (Woolman & Fleisch, 2008; Moody & White, 2003). State education agencies with a uniquely Democratic nature can become the cohesive group or central agency connecting constituents across external organizations. These collaborative governance networks offer incentives for cooperation, create forums for dialogue across multi-agency driven initiatives, and design and provide models for reflection and accountability. However, central agencies face pressure to adhere to traditional models of hierarchical government (Innes, Booher, & Di Vittorio, 2010; Klijn & Koppenjan, 2000).

Regardless of their theoretical role in creating social cohesion, state institutions' practical contribution may not always provide a useful scaffold. For many social service managers in our country, governing institutions remain an obstacle to collaborative practices (Innes et al., 2010). For example, the U.S. Constitution sought to maintain barriers to cohesion to protect minority rights from the power of momentary majorities by vetting popular preferences across representative institutions (McLendon & Eddings, 2002). For example, state legislatures introduced over 9,000 measures related to protecting immigrant rights between 2005 and 2012 and over 1,300 were enacted (Nienhusser, 2015). Yet, today educational progressives see current politics as misaligned with the broader social goal to benefit students' lifelong success. Educational progressives currently seek an instructional framework, like networked governance, that provides a lesser role for politicians, parochial neighborhood interests, and self-interested parents (Cibulka, 2001).

Researchers suggest that attaining systemic cohesion and goals requires districts and schools to practice shared sensemaking and transparent relationships around education reform (Daly & Finnigan, 2012). These inter-organizational relationships must overcome the negative effect of federal sanctions flooding state education agencies and trickling down to districts and schools. Specifically, an evidenced pattern of institutional change at the state, where actors from internal and external government agencies create new networks to deal with the complexities of education reform, can bridge interstitial spaces that lack the public's confidence and conflicting mandates (Innes et al., 2010). Daly and Finnigan (2012) explain that, in education, ties exist more often between like groups (e.g., intra school or intra central office) and less often across groups (e.g.,

between buildings and district offices), but when districts initiated a tie it was more likely reciprocated than when schools initiated a tie. Evidence suggests that patriarchal relationships between hierarchical layers discourage horizontal bonds between peers (Leonard et al., 2010). This model assumes that state education agencies can achieve the goals of social cohesion easier than districts or buildings.

Social capital. Actors within education governance networks build social capital, or their collective resources embedded within the network (Lin & Erickson, 2010). Russell et al. (2015) operationalize a state education agency's capital as their capacity using these resources to strategically enact policy. Democratic SEAs develop this capital through Fowler's (2013) Educational Policy Planning and Research Centers (EPPRCs), large state policy networks with cross-sector relationships. For example, Race to the Top plans emphasized collaborative work across a range of stakeholders, like universities, community partners, and public-sector industries (Russell et al., 2015). In these integrated networks social capital develops through informal social interactions, norm setting, trust building, and participation toward shared objectives (Forbes, 2006). Networked agencies working on education policy can stop cycles of negative social outcomes by developing social capital built from relevant and diverse discourse across heterogeneous individuals (Marshall, 2002).

Education policy networks achieve diverse networks through social inclusion using strategies acceptable across participants. Network norms and social connection reify their commitment to common efforts in spite of adversity (Marshall, 2002). Marshall (2002) found that across local, state, and federal policy levels teacher unions were a central agency that linked two levels of activists: (a) the locally driven activists

and (b) the macro policy actors. This social network developed capital and political pressure, driving the design of a gender equity policy (Marshall, 2002). In hierarchical networks across levels of actors, reciprocity, cooperation, and toleration are norms that ground relationships (Forbes, 2006).

Actors in a hierarchical network are embedded or nested in their social structure. Social embeddedness illustrates how dyadic relationships that extend beyond two actors' result in a sequence of changes, where behaviors or outcomes of an actor from the lower level will result in effects with actors at higher levels of an institutional hierarchy (Leonard et al., 2010). Leonard et al. (2010) describe how families, clans, castes, or religious communities are common social systems that represent social embeddedness. In these networks, actors embedded in lower levels of hierarchical relationships, like the poor, young, or old, usually benefit from providing services or loyalty to the more advantaged actors in the social network (Leonard et al., 2010). These vertical ties take the place of horizontal ties between actors within the same level and ensure lower level actors from potential social risk (Leonard et al., 2010).

Network Capacity. Network capacity refers to the aggregated social cohesion and capital across actors within a network. Russell et al. (2015) explain that capacity is determined by actors' structural placement within a network and their individual resources. Network capacity can be developed through mutual understanding and shared knowledge that informs policy-setting agendas at state education agencies (Innes et al., 2010). These are the cores of a cultural shift from an organization's discrete hierarchical governance model to a networked model built on social cohesion. Innes et al. (2010) describe an adapting metropolitan megaregion promoted by a planning institution of

advocates, technical experts, and skilled facilitators. Such a large networked governance shift occurred through institutional change from the inside out by creating new governance practices to deal with the complexity of the work (Innes et al., 2010). In effect, social cohesion is the outcome of mutual persuasion across social institutions (Knoke, 1990).

One critique of local and private education governance is its closed and narrow nature (Cibulka, 2001). Rooted in American culture, local and private networks in control of education inhibit their own performance by limiting the flow of novel information and restraining responsiveness (Cibulka, 2001; Daly & Finnigan, 2012). Cibulka (2001) explained that conflict across actors moving into local school politics is often "constrained by incentives for compromise and accommodation," (p. 6). Yet, social capital drives a networked governance model where (a) a small group of actors dominates the development of one particular policy arena, (b) policymaking includes bargaining and agreements, and (c) the networked arrangements overcome partisan politics (Berry & Berry, 1989).

Network effectiveness. Network effectiveness refers to the way that social networks implement the components of network capacity (e.g. social cohesion and capital) to benefit the population of interest. In education governance networks, sub-governments are useful for organizing social capital and implementing new practices that benefit public policy (Hannah, 1996). The views of bureaucrats who claim to speak for the public represent public policy reform, but institutional capacity at state and local leadership levels determines how education reform is implemented (Fowler, Heaney, Nickerson, Padgett, & Sinclair, 2011). The governmental systems in our nation are

designed to slow large shifts of power across government to protect public interest (Cibulka, 2001). Today, private organizations like think tanks, special interest groups, and non-profit agencies are diverse players in education policy who've developed a renewed interest in macropolitics in our society (Cibulka, 2001). However, since education governance is a local affair, public policy actors' behaviors and interests are predictable and often constrained by compromise with local leaders (Cibulka, 2001).

The interests and capacity of private sector partners drive public-private partnerships (Jones & Bird, 2000) and the extension of state government complicates their goals (Russell et al., 2015). When working with private sector partners, state education agencies require strategies to maintain their participation to achieve reform goals (Russell et al., 2012). For example, Russell et al. (2015) explain that for state-level Race to the Top networks state education agencies maintained mutual understanding by narrowing their focus toward the singular task of synthesizing knowledge-based resources. More systematic coherence across network efforts stems from mutual sensemaking about a specific topic of interest (Daly & Finnigan, 2012). The interactions of variables within governance networks and the causality of their non-linear functions are not well documented in the literature (O'Toole & Meier, 1999).

Traditionally, education governance relies on formal institutions and relationships among people across agencies to shape practice, policy, and innovation (Robertson & Dale, 2013). Daly and Finnigan (2012) explain that sanctions from higher levels of government affect professional collaboration negatively, but more laterally connected systems across institutions achieve organizational change and information sharing. Studies of patriarchal relationships in social settings find that patronage and hierarchy

discourage the relationships necessary to build networks between peers, and there is pressure to align with the traditional social exchange network to fortify social health in communities (Leonard et al., 2010). Collaborative networks overcome institutional hierarchies by developing capital across diverse participants, participant interaction, and mutual persuasion (Innes et al., 2010).

Central actors in education governance networks. O'Toole and Meier (1999) refer to the structure of hierarchies and networks as the "formal authority to compel" within a public agency (p. 508). Relationships across networks of public agencies are fluid in order to adapt to changing initiatives. The literature describes how legislative committees use (a) broad *macro-political arenas* central to education governance networks and (b) *public managers* informing the policy agenda. Differences in the distribution of authority are unique to the contexts within different education governance networks (Brewer & Smith, 2008). For education governance initiatives, networks' authority resides mostly with states to make policy-related decisions.

Macropolitical arenas. Complex education politics in America involves various sub-governments composed of public interest groups and a few macro-political actors (Cibulka, 2001). The macro-political actors influence issue-networks based on their interests and power (Hannah, 1996). In the past, education reform was driven by state-level actors like governors and legislators, but today education reform reflects a macropolitical discussion shaped by problem-solution discourse from education policy advocates (Cibulka, 2001). Specifically, an emergence in think tanks has strengthened the relevance of macropolitical concepts of educational policy for American society, local activists, and alternative actors of power (i.e. entrepreneurs and non-profit and private

organizations; Cibulka, 2001). For example, Au and Ferrare (2014), found that interrelated forms of sponsorship were powerful vehicles for passing charter school reform legislation in Washington. Unfortunately, this model of policymaking acts in the interest of a privileged few at the exclusion of interests affecting broader populations with less power (Hannah, 1996). In this case, horizontal ties are necessary to shift networks that are currently structured through strong vertical ties and do not represent the interests of the broader population (Hannah, 1996).

Sub-government models operationalize interest-based education policymaking and exclude public interests that do not align with the narrowly focused ends of exclusive populations (Cibulka, 2001). Current trends in educational progressivism deny the value and security of vertical ties because they view political actors, typically considered powerful at higher levels of institutional networks, so poorly (Cibulka, 2001). Cibulka (2001) explains that these progressive networks seek an institutional framework that departs from corrupt politicians and self-interested wealthy families. Progressive networks' horizontal ties aim to stabilize and reify their substantive stance through carefully selected vertical ties with actors like entrepreneurs, private organizations, and non-profit agencies that align with their norms and goals. This macropolitical network structure informs their ability to absorb information and build trust among a community (Daly & Finnigan, 2012).

Public managers. Education is a domain that is reserved implicitly to the states by the Tenth Amendment of the U.S. Constitution (Fowler, 2013). For many generations, states gave up their power to the local authorities and those authorities are very powerful when determining how factors in districts, schools, and classrooms operate. But, since the

1970s, states have been taking back their constitutional authority over education policy. Additionally, the federal mandates magnify the state role in educational policy (Manna, 2012). For this reason, state-level policy actors are more important than federal or local ones because states have returned as the major constitutional authority over public education since the 1970s (Fowler, 2013).

Media and political textbooks focus on policymaking at the federal level, so state level policy is often less understood and studied (Fowler, 2013). In order to move researcher's and policymaker's thinking forward beyond descriptive research of macro-level policy stages, I aimed to identify the power of public managers within an evolving state governance structure in the 21st century. According to Alvarez and Sinclair (2011), research on legislative behavior in the past has focused on internal "institutions," yet exogenous institutions that guide the legislative agenda and action are less rigorously investigated. The goal of this study is to leverage network theory to understand how nuanced interactions between bureaucracies, actors, and environmental factors might change legislative behavior.

The mechanisms of education governance networks. There is tension between the bureaucratic and networked institutions in the modern public sector. The literature describes how (a) *sociological characteristics*, (b) *power roles*, and (c) *stabilizing features* are mechanisms for change toward polycentric institutions that include many centers of decision making (Janssens & Ehren, 2016). In response to these changing factors, many resources and expenditures now fall between public and private sectors (Peters, 2010). Quasi-public organizations increased during the post-war era in most countries (Peters, 2010). O'Toole and Meier (1999) describe the increasing presence of

multi-organizational networks of agencies within the public administration field. They explain that networks provide stabilizing factors like prevention for social problems facing communities, crosscutting mandates, and public-private partnerships (O'Toole and Meier, 1999). Networked governance approaches work to stabilize social initiatives by providing institutional support for some sociological needs and destabilizing traditionally- based hierarchical structures that reify dominant power roles.

Sociological characteristics. Social networks lend themselves to analyses that identify how powerful groups of people are destabilized to empower disadvantaged groups. The social networks are designed to change social outcomes, which are driven by dominant discourses and non-dominant needs (Timm, 2014). In a qualitative study, Timm (2014) explored how Community Based Organizations, a central agency for school-community partnerships, liberated families in poverty by validating their non-dominant discourse through public speaking and formal partnerships. Yet, trends in communities are created by the dominant discourses that reify injustice and disadvantage (Timm, 2014). The bureaucratic Democracy creates obstacles to intuitive policy because public managers, not communities, are the beneficiaries of the policy yields (Jones & Bird, 2000).

Bureaucracy exists for tradition and stabilization, but recent education policy initiatives that span traditional institutions destabilize the bureaucracy. Chappelle (2006) suggests that the power and social class of those who dominate education policy discourse and the ideological state control of education policy are related. In education policy, those who define what education is and how it is implemented in a state rarely address the plurality of the context of children's experiences across the state (Chappelle,

2006). Recent South African legislation embedded school governing boards to strengthen political rights for local interests; instead, the boards' authority reproduced existing patterns of inequality (Woolman & Fleisch, 2008). Across sectors and agencies, policy-related decisions are made at varying scales without community collaboration for those affected and with no goal to achieve common agreements or social outcomes (Innes et al., 2010).

Social networks allow internal and external government actors to define new governance practices in response to emerging community needs (Innes et al., 2010). These connections potentially fill the interstitial spaces where government lacks formal authority or informal knowledge of contextual factors (Innes et al., 2010). Nienhusser (2015) describes how the policymaking environment, processes, and political forces shaped New York's policy-setting agenda for undocumented immigrants' postsecondary education. Policymaking efforts that affected undocumented immigrants in New York existed at federal, state, and local levels that worked in tandem, but did not operationalize a formal structure, agenda, or task list (Innes et al., 2010). Ultimately, social networks exist within governmental institutions by leading regional initiatives representing locally driven social initiatives.

Public interests are usually served through institutional efforts (e.g. the presidency, political party, or national government; Cibulka, 2001). National government efforts, like national surveys, often depict citizens apart from their social contexts as though they are a homogeneous group of unrelated people (Knoke, 1990). Progressive education movements argue that education policy today threatens the Democratic state because public interest groups control education policymaking without an understanding

of the embedded social outcomes (Cibulka, 2001). This belief illustrates how public education policy may need to be reconciled with public interest (Cibulka, 2001). These tensions between large and small political framings create a friction that disrupts powerful hierarchies.

Power. The power of state legislators is shaped by social characteristics of governance attributes, social, and intellectual capital (Renzulli & Roscigno, 2005). Politicians analyzing and designing policy must consider both the formulation and implementation phases across these levels and discrete turning points (Renzulli & Roscigno, 2005). For example, Nienhusser (2015) reported that an influential policymaker explained that bills were sometimes strategically introduced later in the legislative session when legislators were overwhelmed and unable to attend to the priorities of each bill. In this way, state legislatures fail to uphold the goals of the U.S. Constitution that aimed to destabilize destructive majorities, especially for the purpose of protecting minority rights (McLendon & Eddings, 2002). This gap within the governance structure makes way for one of two possible scenarios, (a) the introduction of a multi-sector network representing diverse facets of public interests or (b) increased power for actors and groups who have already defined the dominant discourse.

The intergovernmental system in the United States was designed to resist a rapid increase in power for any single group (Cibulka, 2001). In order to stall rather than facilitate power, government systems were created to stop majority groups. In reality, the tension between sub-groups in government reified the distribution of power through common discourse existing within bureaucracy (Cibulka, 2001; Timm, 2014). Today, education policy gains and uses social capital through sub-governmental networks

playing in the larger policy arena (Hannah, 1996). Legislators have the obligation to question the sub-governments' organizational goals, community support systems, and alignment of discourse with dominant or non-dominant populations (Timm, 2014). Although our forefathers attempted to align the national agenda with multifaceted public interest, the tension that they created, which was intended to protect minority rights, actually enforces the opposite (Cibulka, 2001).

Stabilizing features. The public policy literature agrees that structure, common agendas, and explicit tasks emerge from newly born processes set in motion by policy networks that span federal and state leaders (Innes et al., 2010). Specifically, self-governing practices and social Democracy principles stabilize networks aimed at destabilizing traditional hierarchical institutions (Woolman & Fleish, 2008). In the South African Schools Act, representative school governing bodies used social Democracy systems to stabilize political participation across language divides (Woolman & Fleish, 2008). In addition, the school governing bodies were reinforced by the macro-political legislation and filled the gap of government through collaborative regional initiatives (Innes et al., 2010; Woolman & Fleish, 2008). The literature agrees that common agreements that explicitly describe broad objectives and participation norms in networks achieve stabilizing outcomes for commonly ignored facets of public interest.

The Case of Oregon: A Movement towards Consolidated State Governance

The Education Commission of the States identifies four models of education governance in the U.S. based on how state boards of education are constituted and whether the chief state school officer is elected or appointed (Fulton, 2008). In 2011, the Education Commission of the States illustrated a shift in state education governance

structures aligning with "legislation or gubernatorial actions [that gave] … governors a greater role in education policymaking" (Zinth, 2011, p. 1). Eight states were reported to have proposed changes, like amending state board membership and duties and consolidating the governance or administration structures (Zinth, 2011). Among the eight, Oregon was included for (a) legislation that named the governor the superintendent of education and (b) "an executive order issued in February 2011 by Oregon Governor Kitzhaber [that] puts the governor at the helm of a group to develop consolidated finance mechanisms for all publicly funded education in the state" (Zinth, 2011, p. 2). Later that year, during the legislative session, the executive order would be formally voted into state law and the "groundbreaking budget and policy framework", the Oregon Education Investment Board, would be charged with (a) unifying a P-20 education system, (b) integrating early childhood and family services, and (c) consolidating state level responsibilities for public education (Zinth, 2011, p. 2).

Multistage intervention. This study treats the introduction of the OEIB in Oregon as a multistage "intervention" variable. The OEIB was charged with writing legislative proposals during each legislative session. The Oregon legislature meets for regular sessions in odd-numbered years, so this study uses voting data from Oregon legislators during the regular sessions in 2009, 2011, 2013, 2015, and 2017. Table 2 depicts a descriptive overview of the research design where data for 2009 serves as evidence of pre-intervention voting patterns, data for 2011 serve as an interruption when SB 909 was passed, and data for 2013, 2015, and 2017 represents the post-intervention voting patterns. Given the enactment of the OEIB in 2011, it is highly likely that any changes to voting patterns were delayed until 2013.

At each time point representing a regular legislative session, the intervention evolved by incorporating a new organization and charge with regard to the governance model of the OEIB. Table 2 illustrates the evolution of the intervention at each time point. This study includes one pre-intervention time point, the legislative session in 2009, to explore legislator network characteristics prior the enactment of the OEIB. The following time points under study are described in detail in the following sections.

Table 2

Descriptive Summary of OEIB as a Multistage Intervention

Phase	Core Features
Pre – OEIB (2009)	NA
Creation (2011)	Chief Education Officer Rudy Crew Created Oregon Education Investment Fund to, (a) oversee cradle to career initiative (40-40-20 vision) (b) recommend strategic investments (c) develop the Early Learning Council (d) develop Higher Education Coordinating Commission (e) create longitudinal student data system (f) provide legislation recommendations
Implementation (2013)	Nancy Golden, appointed Chief Education Officer Strategic investments disseminated Technical support for achievement compacts and networks Early Learning Council formed Higher Education Coordinating Commission formed Research department created for, (a) designing longitudinal student-database (b) studying legislative policy initiatives (c) technical support for strategic investments
Sun-setting	Lindsay Capps, appointed Chief Education Officer

(2015)	Organizational name changes to Chief Education Office Shifted focus on collaboration v. technical oversight Adopted a lens for equity and partnerships Oregon Education Investment Fund not in use
Rebranding (2017)	Colt Gill, Chief Innovation Officer appointed by governor New focus on community engagement qualitative analysis New charge to advise Educator Advancement Council Evolving business initiative for longitudinal student database

Creation (2011). Governor Kitzhaber established the Oregon Education Investment Board (OEIB) during the 2011 legislative session through Senate Bill 909. SB 909 required the board to consist of the governor and twelve members appointed by the governor. In addition, the governor appointed Chief Education Officer, Rudy Crew, who previously served as the chancellor of the New York City Board of Education. The OEIB was charged with (a) creating a cohesive public education system from early childhood into post-secondary education by developing and overseeing the Early Learning Council and Higher Education Coordinating Commission, (b) "recommending strategic investments in order to ensure that the public education budget is integrated and targeted to achieve the education outcomes established for the state," which would later be addressed in Senate Bill 253 (O.R.S. 909, 2011, p. 1), and (c) monitoring the effect of strategic investments and how they support the P-20 continuum by developing a longitudinal, statewide, student-based data system.

Underlying all of these initiatives were two core components. First, Senate Bill 253 established the high school and college completion goal: By 2025, 40% of young adults would have a Bachelor's degree or higher, 40% of young adults would have an

Associate's degree or higher, and 20% of young adults would have a high school diploma or equivalent (O.R.S. 253, 2011). Second, the Oregon Education Investment Fund was created within the State Treasury, separate from the General Fund of educational monies, for the purpose of funding, "duties of the board related to early childhood services and public education from kindergarten through post-secondary education." Ultimately, in 2011, the creation and ideation behind the development of the OEIB was to "oversee a unified public education system that begins with early childhood services and continues throughout public education from kindergarten to post-secondary education," (O.R.S. 909, 2011).

Implementation (2013). Between 2011 and 2013 Rudy Crew resigned and a local Oregon superintendent, Nancy Golden, was appointed to the role of Chief Education Officer. During this time, most of the initiatives for which the OEIB were charged were underway. Most notably, the strategic investments were disseminated across the state and technical support and research was resourced within the OEIB for this purpose. The Early Learning Council and the Higher Education Coordinating Commission were developed and taking on the 40-40-20 vision. Finally, the OEIB had developed relevant policy initiative reports for the state legislature during each legislative session. However, the challenge of creating the longitudinal, statewide, student-based data system provided one of the initial challenges for the public-private organization: designing structures and systems for cross-organizational partnerships for data sharing and collaboration.

Sunsetting (2015). In 2015 the OEIB was slated to meet their sunset. Many changes highlighted that year for the organization, some fundamental to their charge and others a part of their new structural shift into becoming the Chief Education Office as

enacted in SB 253. In 2015 Governor Kitzhaber resigned over personal accusations about his partner and soon after Nancy Golden resigned from Chief Education Officer. At that time, Lindsey Capps, who had been serving as Chief of Staff to Nancy Golden was named the Chief Education Officer and the governor's Education Policy Advisor. With the new legislation organized in SB 253, the OEIB underwent a name change to the Chief Education Office and although the Oregon Education Investment Fund was still intact under legislation, it was no longer in use for strategic investments. Fundamental to the work of the organization, the CEdO substantively shifted their focus from oversight to collaboration across state agencies, regional education districts, and educational networks. In addition, the CEdO adopted an equity lens that undergirded the nature of their partnerships, research, and initiatives.

Rebranding (2017). Since its creation, the purpose of the OEIB/ CEdO was unclear to the public. The OEIB fundamentally changed during each legislative session. In 2017, the governor appointed a Chief Innovation Officer, Colt Gill, formerly a superintendent in Oregon. The Chief Innovation Officer's work focused on implementing a statewide community engagement initiative and highlighting concerns from Oregon communities. Aligned with this approach to policy formulation, the CEdO continued using their equity frame to improve their partnerships and, in response to legislation, began advising the new Educator Advancement council. Also, under transition during 2017, the longitudinal, statewide, student-based data system evolved from a research-focused development to a business case for policy implementation. Along with these changes and the changes in staff and leadership at the OEIB/ CEdO the initiatives, practices, and future of the organization remain unclear to the public.

Social Network Analysis

With a focus on the structure of groups, communities, organizations, or systems, social network analysis (SNA) explores how interpersonal ties matter (e.g. whether they transmit information, behaviors, or capital). SNA provides a methodology for conceptualizing, analyzing, and interpreting these social networks (De Nooy, Mrvar, & Batageli, 2011). At its foundation, SNA is based on graph theory, where a graph is a set of vertices or nodes and lines or ties between pairs of vertices. A node is the smallest unit in a social network; it represents an actor. A tie between two vertices represents any social relation. Ties can be directed (e.g. nodes nominate or direct the relationship to another node) or undirected (e.g. nodes cooperate on a project or sit on the same board). With additional information about the nodes and ties (e.g. attributes), the graph becomes a network.

Network structure. Most broadly, networks are analyzed for their structural characteristics (see Appendix). For example, density refers to the total number of ties in a network expressed as a proportion to the total possible number of ties (de Nooy, Mrvar, & Batagelj, 2011). Since density is dependent on the size of the network it is not comparable across networks and average degree can also be used to determine the average number of ties adjacent with a node across all nodes in a network. Networks with lower density or cohesion result in heterogeneity of ideas that might lead to non-redundant ideas or innovation networks. On the other hand, groups with higher density or cohesion lead to stronger team viability (Wasserman & Faust, 1994). Analyses can also account for the weighted property of the ties between legislators by measuring node strength. The strength of a node represents the weight of their multiple ties with another

individual node. Finally, closeness centralization measured the global reachability for all nodes within a network. Conceptually, closeness centrality at the node level represents an individuals' independence in relation to the other nodes in a network. From a measurement perspective, closeness centralization for the global network indicates the variation in the closeness centrality of the vertices divided by the maximum variation in the closeness centrality scores possible in a network of the same size.

Cohesive subgroups. Building upon structural properties of networks and their embedded ties, dense groups of nodes that interact intensely or share attributes within a network are referred to as *cohesive subgroups* (de Nooy et al., 2011). Cohesive subgroups usually represent forms of social homogeneity and can be identified by analyzing network connectedness (i.e. the nature of paths between nodes as indirect or direct). An analysis of the structural cohesion of a whole network defines three classes of information about cohesive subgroups: (a) the collectivity of a whole group, (b) the positional properties of subgroups relative to other subgroups within a network, or (c) an individual's membership property (Moody & White, 2003). Modularity also provides information about cohesive subgroups by comparing the density of links within subgroups of nodes to links between subgroups. (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008). By determining the degree of connectivity within a subgroup one can better understand the extent to which a subgroup is robust to disruption and remains cohesive (Moody & White, 2003).

Homophily and heterophily. Another way to investigate the formation and function of networks is the study of homophily, or the social principle that "contact between similar people occurs at a higher rate than among dissimilar people,"

(McPherson, Smith-Lovin, & Cook, 2001, p. 416). Homophily implies that information or ideas shared within networks will usually be consolidated among people with similar characteristics (e.g. legislators from the same political party). A less commonly studied principle, heterophily, refers to social interactions or relationships between people with dissimilar characteristics. For example, considering that the OEIB intended to build social capital through common votes or ideas shared across party lines, the goal of the OEIB was to instill a pattern of heterophily among legislators. McPherson et al. (2001) explain that the social homogeneity within organizations is a homophilous baseline of the co-membership networks, in relation to this study this translates into the strong partisan voting patterns in the Oregon legislature. Given that the intention of the OEIB is to instill a common legislative agenda across all legislators, I predict that the implementation of the OEIB and consolidated education governance will increase heterophily or bipartisan voting.

Summary

Because there was a state shift toward governor-led and centralized state education governance models in 2011, attending to how legislators' party affiliation dynamically relates to their voting patterns during a governance shift is a valuable investigation that will develop a nuanced understanding of education governance and policymaking for states making similar shifts in the future. Previous research found that centralized governing bodies reinforced by political legislation provided collaborative initiatives for the community (Innes et al., 2010; Woolman & Fleish, 2008). In addition, the literature explains that central partnerships liberate participants to use non-dominant discourse within their formal partnerships through mutual understanding, shared

knowledge, and common agenda setting goals (Timm, 2014; Innes et al., 2010). Thus, it is hypothesized here that a centralized governance model will be associated with increased likelihood for legislators from different political parties to form new and maintain existing ties.

The Current Study

This study employed descriptive social network analysis measures and separable temporal exponential random graph modeling (STERGM) to investigate how an education governance model with consolidated authority over legislative proposals and policymaking relates to bipartisan outcomes for education related legislation in Oregon. Oregon legislator voting networks were analyzed descriptively using cohesion, centrality, and community detection measures. Then, legislator attributes were analyzed to determine how they related to the likelihood of common votes on education-related bills. First, legislators' attributes (e.g. gender, party, and title) were modeled to test the association they had on the likelihood of a common vote with legislative peers. To study bipartisanship, differential heterophily, I added the legislators' political party attributes within dyads to analyze the association that having *different* political parties had on legislators' common votes. This study treated the introduction of the OEIB in Oregon as a multicomponent "intervention" variable. Voting data were collected for all Oregon state senators and state representatives for 2009-2017.

The purpose of this study is to investigate the relationship between the move to consolidated education governance authority and legislator voting networks on education-related bills. Specifically, I address the following research questions:

1. To what extent is the Oregon legislator voting network cohesive, central, and grouped by communities at each time point?
2. To what extent do legislator attributes (e.g. gender, party, and title) change legislators' likelihood of voting commonly on education-related bills at each time point?

3. To what extent did legislators' differential party affiliation predict their likelihood to form ties from one legislative session to the next?

4. To what extent did legislators' differential party affiliation predict their likelihood to persist ties already formed from one legislative session to the next?

CHAPTER II

METHODS

Sample

All Oregon state representatives and senators serving between 2009 and 2017 were the participants in the current study. No eligibility or exclusion criteria were used to restrict legislator vote data in the sample. Thus, non-voters, legislators from and those serving any number of years during the studied period were included in the pooled sample within their appropriate cohort years. In Oregon, the number of representatives, 60, and senators, 30, remains roughly the same each year. A total of 159 unique legislators were included in the study across all five years of data collection. Of the 159 legislators, ten are represented twice in the dataset because they served as both a senator and a representative during the time period from 2009 to 2017. These legislators are represented twice based on the assumption that their voting patterns were dependent on the different contexts of the House and Senate.

Table 3 illustrates legislator demographic data, gender, and party affiliation by year and representation in House or Senate. Demographic makeup of legislators remained mostly constant across sessions included in the study from 2009 – 2017. The Democratic Party represented the majority of legislators included in the study each year. However, in 2011, Republican representatives in the house increased from 24 legislators to 30, eventually leveling back out in the following years included in the study. Representation from female senators decreased across legislative sessions from 2009 to 2017, while representation from female representatives in the house increased across the same time

period. Females represented between 26.67 and 36.67% of legislators in the House and 26.67 to 40% of the legislators in the Senate between 2009 and 2017, while males represented between 63.33 to 73.33% in the House and 60 to 70% in the Senate.

Table 3

Legislator Demographic Characteristic Counts (and Percentages) by Year and Governing Body

	2009		2011		2013		2015		2017	
	H	S	H	S	H	S	H	S	H	S
Gender										
M	44 (73.33)	18 (60.00)	42 (70.00)	21 (70.00)	40 (66.67)	22 (73.33)	39 (65.00)	22 (73.33)	38 (63.33)	22 (73.33)
F	16 (26.67)	12 (40.00)	18 (30.00)	9 (30.00)	20 (33.33)	8 (26.67)	21 (36.00)	8 (26.67)	22 (36.67)	8 (26.67)
Party										
R	24 (40.00)	12 (40.00)	30 (50.00)	14 (46.67)	26 (43.33)	14 (46.67)	25 (41.67)	12 (40.00)	25 (41.67)	13 (43.33)
D	36 (60.00)	18 (60.00)	30 (50.00)	16 (53.33)	34 (56.67)	16 (53.33)	35 (58.33)	18 (60.00)	35 (58.33)	17 (56.67)

Note. H = representatives of the House; S = senators of the Senate.

Measures

Data obtained from the Oregon Legislative State (OLS) Database across five successive regular legislative sessions between 2009 and 2017 were analyzed using social network analysis. The OLS database was queried for bills within the regular sessions of years 2009, 2011, 2013, 2015, and 2017 whose summaries included the term education ($N = 354$). Two classes of data were collected for all included bills: (a) legislators' individual votes on the included education bills or their reason for not responding and (b) legislators' covariate data (e.g. gender, party, and title).

Legislator votes. In this study, the legislator voting data are used to illustrate the changing shifts in variance among legislator voting patterns. Table 4 illustrates the two-stage process that I took to isolate this variance among legislator votes on education-related bills. First, I evaluated each bill in the pool sample to ensure that it directly referred to K-12, higher education, or education governance. In doing so, I removed 117 bills, leaving 237 bills in the Stage 1 sample. Second, I explored the distribution of the remaining 237 bills (see Table 5) to determine a cut-off point where the proportion of legislators voting yay on a bill increased substantially. I found that the legislative distributions were left-skewed, where most bills were at a higher percent of yay votes and the arithmetic mean was always less than the 50th percentile. I determined that the largest increase in percent agreement occurred between the minimum percent agreement and the first quartile. In order to remove the most homogeneity or agreement on passing bills, I chose to remove bills above the first quartile. In doing so I removed a total of 180 bills from the pooled sample, leaving 57 bills in Stage 2 and the final sample.

Table 4

Number of Bills Included in the Sample After Each Refinement Stage

Year	Pooled sample	Stage 1: Removed non-education related bills	Stage 2: Removed bills homogeneity above 25th percentile of percent yay votes
2009	42	18	6
2011	69	49	10
2013	86	63	15
2015	85	58	14
2017	72	49	12
Total	354	237	57

Note. Numbers represent bill sample remaining after evaluative criteria were applied.

Table 5

Distribution of Percent Yay Votes on Bills Included at Stage 1 of Refinement

	Min	Q1	Q2	Q3	Max	Average
2009	.52	.78	.88	.97	.98	.85
2011	.56	.84	.94	.98	1	.89
2013	.58	.81	.93	.97	1	.88
2015	.57	.86	.93	.98	1	.88
2017	.56	.87	.93	.98	.99	.91

Note. These data were used to determine the bills included in the final bill sample.

Table 6 provides summary bill and roll call data for the resulting sample of bills (N = 57). These data were organized in two-mode matrices for each year. In social network analysis, bipartite or two-mode networks consist of two different types of nodes,

such as people and organizations or legislators and bills. Breiger (1974) describes how two-mode networks can be projected onto a single mode algebraically to facilitate interpretation. Thus, similar to Alvarez and Sinclair (2011), I consider the roll call data for each legislative session as representing a matrix of agreement that can be used to describe social connections between legislators. The two-mode matrices were transformed into one-mode matrices, legislators by legislators, where relations represented the number of times legislators voted yes commonly on a bill included in the study. Legislator networks were analyzed at each time point, never pooled across time points, due to missing data in the pooled network (e.g. all votes and legislators from 2009 – 2017) when legislators were not present during a legislative session. This decision reduced biased estimates across the Exponential Random Graph Model (ERGM) and Separable Temporal Random Graph Model (STERGM) (Benton & You, 2017).

Table 6

Summary of Bill and Roll-Call Data by Legislative Session

Year	Total bills	Total votes	Total not present	Total aye	Total nay	% same legislator
2009	6	449	31 7%	310 69%	108 24%	NA
2011	10	900	20 2%	643 71%	237 26%	83%
2013	15	1,350	51 4%	933 69%	366 27%	79%
2015	14	1,170	42 4%	819 70%	309 26%	79%
2017	12	1,079	39 4%	829 77%	206 19%	80%

Note. % same legislator refers to the number of legislators serving in the indicated year who were also serving the previous year.

Covariate data. In addition to roll call data for each included bill, covariate data for legislators were also analyzed. Legislative gender, party, and title were compiled in separate vectors and included in the analyses for each legislative session as nodal attributes incorporated into network measures of cohesiveness, centrality, and community detection. The covariate variables were also included as dyadic attributes serving as predictors of tie formation likelihood among the annual network data.

Missing data. Each matrix was analyzed for missing data due either to (a) an absence from the session or (b) a legislator not serving during the session. Table 6 illustrates that between 2 and 7% of roll call data were missing due to legislators' absence

from the floor. Techniques for analyzing and accounting for missing data in dynamic network analyses are still under development; however, Leifeld, Cranmer, and Desmarais (2017) propose a two-step approach for handling non-response and incomplete data for longitudinal models including cross-sectional panel data. First, the missing data due to absence (n = 2-7%) were imputed with a modal value 0, as recommended by Leifeld, et al. (2017). Ingold and Leifeld (2016) explain that accounting for missing data this way is justifiable on the grounds that the voting data are undirected and do not misrepresent a potential directed tie (Ingold & Leifeld, 2016). Second, legislators with complete missing data in a session because they were not an acting legislator at that time point were removed from that year's model altogether (Leifeld, et al., 2017). Although the resulting five networks were not wholly identical because they did not have the exact same legislators, their one-mode matrices were symmetrical, represented by a 90 x 90 legislator matrix (Leifeld et al., 2017). Therefore, ERGM and STERGM estimations were still feasible given that row and column names representing nodes and their attributes are embedded accurately within the respective objects referenced in the formulas (Leifeld et al., 2017).

Data were prepared and analyzed for this dissertation using the statistical computing environment *R* (R Core Team, 2016). Data analysis and visualization were conducted with base R, as well as the *tidyverse* package (Hadley, 2017), the *igraph* package (Csardi & Nepusz, 2006) and the *statnet package* (Handcock, et al., 2016). Social network analysis was used to address all research questions. First, exploratory social network analysis was used to investigate the network structure (e.g. cohesion, subgroups, and centralization) for each year included in the study. Second, an exponential

random graph model (ERGM) was used to determine the association that legislator attributes had with the probability of legislators to form ties with one another for each time point relating to the evolution of the Oregon Education Investment Board. Third, an extension of the ERGM, the separable temporal exponential random graph model (STERGM), was used to analyze the bipartisan voting patterns occurring in relation to each time point over the evolution of the Oregon Education Investment Board. The ERGM used Markov chain Monte Carlo maximum likelihood estimation (MCMC-MLE) (Snijders, Pattison, Robins, & Handcock, 2006), while the STERGM used Conditional Maximum Likelihood Estimation (CMLE) (Krivitsky and Handcock, 2014). The Akaike information criterion (AIC) was used to determine model fit with the ERGM and STERGM analyses (Akaike, 1973).

Analyses

In social network analysis, the selection of network statistics used to analyze the network data should be informed by theory, just like a traditional regression model (Cranmer, 2011). In this study of the Oregon legislator voting network, I posit that the centralized governance model developed and evolving between 2009 and 2017 established cause for increased bipartisan voting on education-related bills. Hence, our analyses follow a model building process to investigate (a) the network structure for each year, (b) the association between legislator characteristics and tie formation, and (c) the likelihood that legislators maintained ties across each time point from 2009 to 2017. More importantly, the results must be interpreted in the context of multicomponent intervention described above in Table 2.

Three analytic phases were used to address the four research questions. The first phase addressed Research Question 1 with an exploratory social network analysis to determine the network structure of Oregon legislators each time point of interest (e.g. density, centrality, and cohesion). The second phase addressed Research Question 2 employing an exponential random graph model (ERGM) to estimate the likelihood that legislator characteristics associated with tie formation with other legislators. The third phase addressed Research Questions 3 and 4 employing a separable temporal exponential random graph model (STERGM) to estimate the likelihood that bipartisan voting patterns were constant across time points. Each analysis is described below.

Exploratory social network analysis. Social network analysis was used to analyze descriptively legislator voting patterns on education-related bills across years included in the study (2009, 2011, 2013, 2015, and 217). I assume that legislators' co-voting patterns represent a social relationship that implies a network exists based on their strategic interactions and similar or dissimilar ideas (Alaverz & Sinclair, 2011; Cherepnalkoski, Karpf, Mozetic, & Grcar, 2016). Voting data organized by bill and legislator were collected for each legislative session where voting possibility was yes (1) or no (0). The data were transformed into an implicit adjacency matrix, A, where the number of co-votes of legislators, α_{ij}, is the binary indicator that is 1 if the legislator i co-votes for a bill l that with legislator j, and 0 if not. Each term, α_{ij}, can be conceptualized as the representation of proximity between legislators i and j. With the term α_{ij} I calculated network-level characteristics, (a) cohesion, (b) centrality, and (c) communities.

This analysis visualized legislators within their one-mode, undirected, weighted networks tied by their common votes with their colleagues. The direct or distant ties

between legislators within this network affect the structure of their social position within the voting network (Granovetter, 1985). This study measured the whole network by its *density*, *average network degree, average network strength,* and *closeness centralization*. This study also measured *modularity*, a scale score from -1 to 1, at each time point representing the legislative networks.

The analyses also included *cohesive blocking* based on legislator characteristics (e.g., degree and connectedness) by employing an algorithm that iteratively removed nodes and bound nodes together (Mizruchi, 1990). This cohesive blocking procedure iteratively removed nodes until the resulting subgroup was not connected to any other group of legislators. As the weakly connected legislators were removed and strong subgroups remained, the analysis revealed the nested composition of cohesive subgroups (Moody & White, 2003). Each unique subgroup within a network shares a common connectivity value and belongs to a single class or subgroup (Moody & White, 2003).

Understanding main effects of legislator characteristics. In this study, an exponential random graph model (ERGM) was used to explore how legislator characteristics or nodal attributes related to tie formation between legislators. An ERGM estimates parameters for statistics by maximizing the probability of the observed network over randomly distributed networks with the same node sets that could have been observed (Cranmer, 2017). Using this probability model, endogenous variables related to network structure (dyad dependent) or exogenous variables related to node or tie attributes (dyad independent) are included to investigate their relationship to tie formation (Cherepnalkoski et al., 2016). The general ERGM probability specifications for a network are modeled by,

$$P(Y = y) = \frac{\exp(\theta' g(y))}{k(\theta)},$$

(1)

where *Y* is the random state of the network variable, y is the realization of the adjacency matrix underlying the network structure, g(y) represents the vector of various endogenous or exogenous model statistics for network y, θ represents the vector of coefficients for the chosen statistics, and $k(\theta)$ is a constant summing all possible permutations of the network constrained to be the same as network y to ensure proper probability distribution.

Based on these specifications, an ERGM simply computes the probability of the observed network over the potential networks observed, involving only minimal assumptions (Cranmer, 2017). The legislator voting network under study met the two assumptions required for accurately interpreting ERGM parameters, (a) there was an equal probability of observing any of the networks with the same values of the statistics included in the specified model (e.g. the model was completely and accurately specified), and (b) the observed network exhibited the average value of each statistic over the networks that could be observed (this is similar to the assumption of normality in regression models) (Cranmer, 2017). The ERGM in this study was estimated using MCMC-MLE, the most preferred method for estimating cross-sectional ERGMs (a single network at one-time point) (Snijders, Pattison, Robins, & Handcock, 2006). Through the model building process, the Akaike information criterion (AIC) was used to determine model fit to account for additional parameters (Akaike, 1973). Following accurate requirements for model specifications, the main effects ERGM model specification also included an edges term to account for general interdependence even though Research

Question 1 primarily focused on exogenous covariates of legislators (e.g. party, title, and gender) (Cranmer, 2017).

Following a model building process, the ERGM began with a simple random graph model, or null model, establishing a baseline for the edges term (e.g. the number of ties in the network). The null model is depicted by rearranging Equation 1 to provide the coefficients for calculating the probability of tie formation

$$logit\left(P\left(Y_{ij}=1\middle|\, Y_{ij}^{c}\right)\right)=ln\frac{P\left(Y_{ij}=1\middle|\, Y_{ij}^{c}\right)}{P\left(Y_{ij}=0\middle|\, Y_{ij}^{c}\right)}\theta'\delta(g(y_{ij})),$$

(2)

where $(g(y_{ij}))$represents the change statistic for the included parameter, here the edges term, and θ' represents the coefficient of the specified term. In network statistics, the change statistic represents the change in network statistics when an edge between nodes *i* and *j* is added (when Y_{ij} becomes 1, not 0). Using Equation 2, the coefficient and change statistics are transformed into probabilities using a logistic function

$$p=\frac{1}{1+\exp\left(-\theta\right)}.$$

(3)

After the null model was established, a dyadic independence model was used to answer Research Question 2. The dyadic independence model estimated the main effects of nodal attributes or relationship of nodal attributes with the likelihood of a tie being formed between two legislators. The dyadic independence model assumed that each dyad was independent of all other dyads in the model, so the likelihood of a link between legislator A and B are not related to a link between legislator B and C (Harris, 2014). The

dyadic independence model predicted the probability of a tie between network members of varying classifications within the vectors of nodal attributes (e.g. party, title, or gender). The *nodefactor* parameter was included in the ERGM specification to account for main effects of legislator party, title, and gender, where the reference groups were removed because these were categorical variables. The main effects coefficients were transformed into odds ratios and confidence intervals to further interpret their meaning.

Longitudinal analysis of heterophily. An extension of the ERGM family, STERGMS use two discrete time models to estimate parameters of tie (a) formation, and (b) persistence (Krivitsky & Handcock, 2014). The STERGM is appropriate when ties are states and hence their initiation and duration can be modeled (in this case the state is the legislative session and legislator votes). In this study, the changing relations between legislators based on their votes represent the dynamic data that were modeled to estimate the likelihood that ties were created and maintained from time t to time t+1, between legislative sessions from years 2009 – 2017.

What is separable in a STERGM is the assumption that tie formation and dissolution are distinct, therefore STERGMs really include two models, (a) one to predict which ties form by time t+1 (Equation 4), conditioned on their absence at t, (b) the other to predict which ties dissolve by time t+1, conditioned by their presence at t (Equation 5).

$$ln\frac{P\left(Y_{ij,t+1}=1\middle|\ Y_{ij}^{c},Y_{ij,t}=0\right)}{P\left(Y_{ij,t+1}=0\middle|\ Y_{ij}^{c},Y_{ij,t}=0\right)}=\theta^{+}\delta(g^{+}(y))_{ij},\tag{4}$$

$$ln\frac{P\left(Y_{ij,t+1}=1\middle|\ Y_{ij}^{c},Y_{ij,t}=1\right)}{P\left(Y_{ij,t+1}=0\middle|\ Y_{ij}^{c},Y_{ij,t}=1\right)}=\theta^{-}\delta(g^{-}(y))_{ij},\tag{5}$$

where the model is an extension of the ERGM model denoted in Equation 2. The extensions added to the models include, (a) a time index added to the tie values, (b) a conditional added (e.g. in the formation equation the expression is conditional on the tie not existing prior and in the dissolution equation it is conditional on the tie existing prior), (c) the coefficient and statistic vectors were redefined for formation (+) and dissolution (-), and (d) the dissolution model represents persistence rather than dissolution because the $P(Y_{ij,t+1} = 1)$ term is included in the numerator and the $P(Y_{ij,t+1} = 0)$ term is included in the denominator to parallel that of the formation model. These STERGM specifications had the advantage of offering clarity to the network processes for tie formation distinct from tie persistence or stability as it was portrayed in the observed legislator networks.

Following the recommendations of Schaefer and Marcum (in press), the theoretical treatment of tie formation and dissolution drove our modeling specifications. Similar to Mousavi's (2016) study of political networks, this study modeled bipartisan voting patterns, through tie formation and tie dissolution between times t to times t+1. That is, the STERGM explored how the evolution of the centralized governance model associated with bipartisan voting at each time interval. Specifically, our theory posits that tie formation and persistence for legislators from one legislative session to the next were two different dynamic processes based on the context of the governance model and that they must be accounted for in the STERGM (Schaefer & Marcum, in press). In addition, I assumed a foundational treatment of time in our model, departing from other dynamic network models, in that time was not modeled continuously, but was instead assumed to be conditionally independent from one interval to the next (Schaefer & Marcum, in

press). In contrast to the ERGM, the STERGM was estimated using Conditional Maximum Likelihood Estimation (CMLE) to model the transition between two networks from time t to time t+1 (Handcock, et al., 2016). Similar to the ERGM, the Akaike information criterion (AIC) was used to determine model fit (Akaike, 1973).

The baseline model contained two edge terms, one for tie formation and dissolution and one for heterophily or bipartisan voting. The formation and dissolution terms accounted for the likelihood of tie formation and dissolution endogenous to the network between observations. While the exogenous parameter, party, accounted for the bipartisan voting patterns between two legislators. Differential heterophily was modeled for the exogenous covariate using the *nodemix* term. To interpret the coefficients, the probability of the parameters was calculated using the change statistics.

CHAPTER III

Results

Results from the exponential random graph model (ERGM) and separable temporal exponential random graph model (STERGM) suggest that the data utilized in this study exhibited the average value of each statistic included in the models that could be observed, however they did not meet the assumption that the models were accurately specified (Cranmer, Leifeld, McClurg, & Rolfe, 2017). The ERGM and STERGM models were conditioned on the base parameter endogenous to the network, edges, or the likelihood of forming ties generally. This resulted in some very large confidence intervals in the ERGM and large standard errors in the STERGM. With the edges parameter included in the models to maintain unbiased estimates and the covariates of interest (e.g. gender, party, title, and bipartisanship), there was potential for multicollinearity that reduced the internal validity of the estimates. Therefore, the ERGM parameter estimates that were significant (i.e. the confidence intervals were above or below 1) are interpreted with caution because they may not be precise given their large confidence intervals. The STERGM parameter estimates that were estimated by the model (some were not estimated by the model due to multicollinearity) and significant all related to the endogenous network term, *edges*, and are reported with caution due to the overlapping relationship between the edges term and bipartisan ties.

Cohesive Legislator Networks

Table 7 provides summary statistics for the structural properties of (a) cohesion, (b) centrality, and (c) communities for each legislator voting network from 2009 to 2017. For each legislator network from 2009 to 2017, nearly all of the possible ties were

actualized, ranging from 97.25% to 99.95% complete. The highest density (i.e., 99.65%) occurred in 2011, the creation stage of the OEIB, and in 2013 (i.e., 99.95%), the implementation stage of the OEIB. On average, legislators' degree, or the number of other legislators for which they were connected, ranged from 86.25 to 88.96 out of 90 total legislators. Like network density, legislators' average degree also approached maximum values during 2011 (M = 88.69, SD=0.93) and 2013 (M=88.96, SD=0.26). Average legislator strength, or legislators' weighted ties, rose steadily from 2009 (M=259.42, SD=83.38) to 2017 (M=644.51, SD=202.99). Each network's closeness centralization, or the extent to which legislators were generally reachable or close with other legislators within the network, decreased from 2009 (0.0489) to 2011 (0.0069) and then again in 2013 (0.009).

Table 7

Descriptive Summary of Legislator Voting Networks

	2009		2011		2013		2015		2017	
	M	SD	M	SD	M	SD	M	SD	M	SD
Average degree	86.56	4.79	88.69	0.93	88.96	0.26	86.25	2.11	88.51	1.60
Average strength	259.42	83.38	460.53	112.48	632.18	238.64	620.91	259.32	644.51	202.99
Network density	0.9725		0.9965		0.9995		0.9914		0.9945	
Closeness Centralization	0.0498		0.0069		0.0009		0.0156		0.0105	

Table 8 provides the summary statistics of the cohesive subgroups included in legislator networks from 2009 to 2017. More cohesive subgroups were detected in 2009 (n = 6), prior to the creation of the OIEB, than any other year included in the study. The most cohesive subgroup of the six (i.e. the k-core) included 83 of the 90 legislators, all of who reached a degree of at least 79. The legislators' cohesive subgroups within the networks decreased in frequency but increased cohesiveness in 2011 (n = 2), with 86 of the 90 legislators in the network reaching at least 85 degrees, and in 2013 (n = 2), with 89 of the 90 legislators reaching at least 86 degrees. The cohesive subgroups increased in 2015 (n = 3), during the sun setting of the OEIB, and in 2017 (n = 4), during the rebranding of the OEIB. Following a complementary pattern, modularity, or the density of ties within versus outside of cohesive subgroups, increased from 2009 (0.03) to 2011 (0.04), holding constant during 2013, and then decreasing during 2015 (0.02) and 2017 (0.01).

The representation of legislator attributes within each k-core was fairly steady from 2009 to 2017 for gender and title (Female = 31.33–34.48%; Male = 65.52–68.67%; Senator = 31.40–34.88%; Representative = 65.12–68.60%). Democratic representation dropped nearly ten percentage points from 2009 (62.65%) to 2011 (53.48%), remained somewhat constant in 2013, and then increased again in 2015 (61.63%). Conversely, Republican representation increased from 2009 (37.35%) to 2011 (46.12%), remained constant in 2013, and decreased again in 2015 (38.37%).

Table 8

Descriptive Summary of Communities Within Legislator Voting Networks

	2009	2011	2013	2015	2017
Modularity	0.03	0.04	0.04	0.02	0.01
Cohesive blocks	6	2	2	3	4
Max degree/ n	79/83	85/86	88/89	81/86	85/87
Democrat	52	46	49	53	52
	62.65%	53.48%	55.05%	61.63%	59.77%
Republican	31	40	40	33	35
	37.35%	46.12%	44.94%	38.37%	40.23%
Female	26	27	28	28	30
	31.33%	31.40%	31.46%	32.56%	34.48%
Male	57	59	61	58	57
	68.67%	68.60%	68.54%	67.44%	65.52%
Senators	27	27	30	30	28
	32.53%	31.40%	33.71%	34.88%	32.19%
Representatives	56	59	59	56	59
	67.47%	68.60%	66.29%	65.12%	67.82%

Increasing Tie Likelihood

All findings reported about the relationship between legislator attributes (e.g. gender, party, and title) were conditioned on the base parameter, edges, or the likelihood of forming ties generally. In 2011, females were 3.8 times more likely than males to vote

commonly on education bills compared to their male colleagues, 95% CI [1.12, 12.86] (see Figure 3). Given the large range between the lower and upper bounds, this estimate is not precise. Compared to Democratic legislators, Republican legislators were 6.6 times less likely to vote commonly on education-related bills in 2009, 7.7 times less likely in 2015, and 8.3 times less likely in 2017, 95% CIs [0.11, 0.23], [0.06, 0.25], and [0.05, 0.29], respectively (see Figure 4). Most notably, these were narrow lower and upper bound estimates indicating precision. Regarding legislators' title, there were no significant findings (see Figure 5), and there was not enough variability to estimate an accurate parameter in 2013 because the network voting data were so dense.

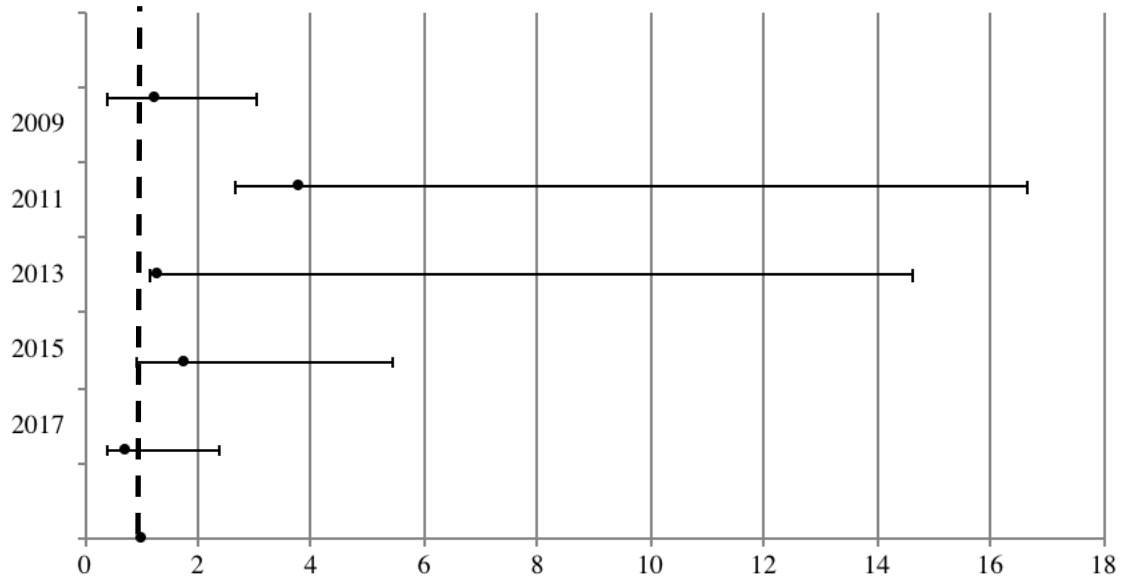


Figure 3. Female legislators' likelihood in odds ratios and 95% confidence intervals for voting commonly compared to males.

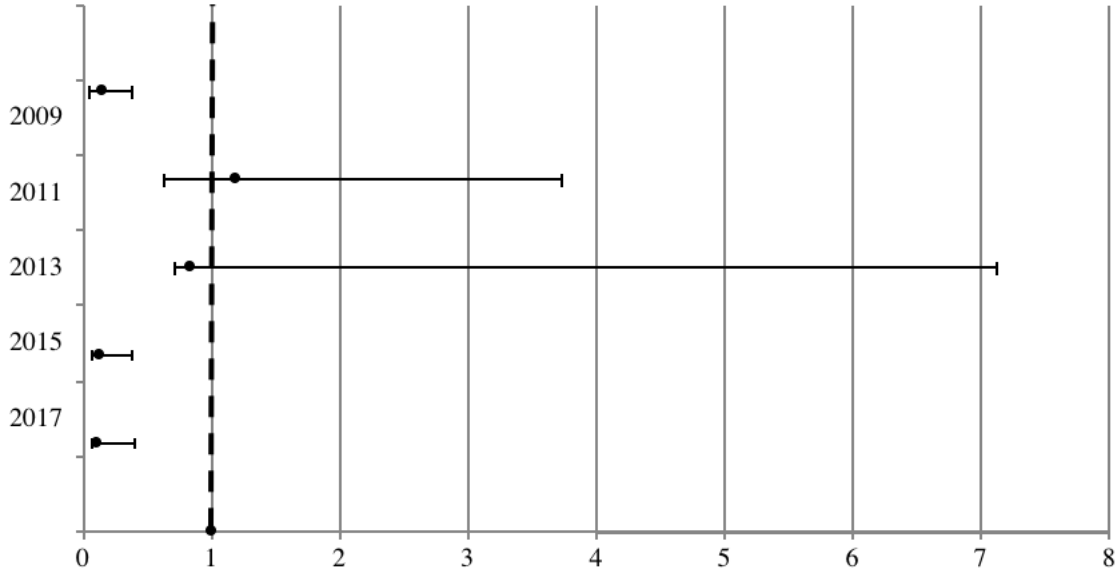


Figure 4. Republican legislators' likelihood in odds ratios and 95% confidence intervals for voting commonly compared to Democrats.

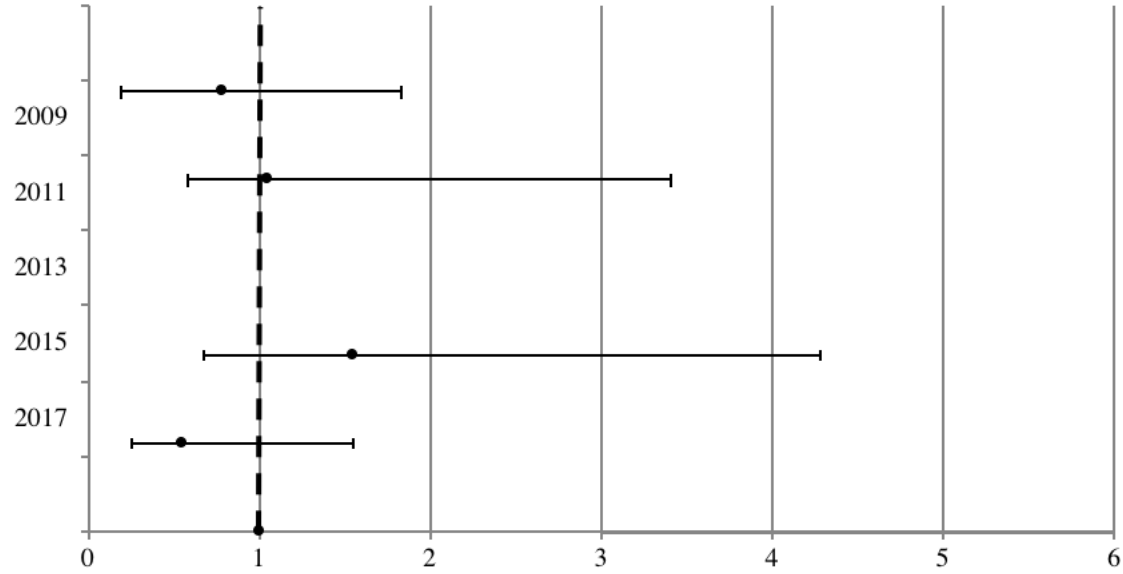


Figure 5. Senator legislators' likelihood in odds ratios and 95% confidence intervals for voting commonly compared to representatives.

Missing Parameter Estimates

Table 9 depicts each time interval included in the separable temporal exponential random graph model (STERGM). During each time interval, the parameters for tie formation were (a) non-significant or (b) not estimated. Due to the density of the networks, the parameters for the formation and persistence models of the 2011–2013 time-interval and the formation model of the 2013–2015 time-interval results in coefficients were not estimated, most likely because there was not sufficient variance. ERGM family models are known for their instability in some measurement cases, where even if specification of the model is intuitive and driven by theory, the models will not estimate parameters (Cranmer et al., 2017). This is especially true for cases where networks are very sparse or very dense, like in the case of the legislator networks under investigation in this study.

The only statistically significant findings resulting from the STERGM occurred within the persistence models for the endogenous variable: edges. In between 2009 and 2011, 2013 and 2015, and 2015 and 2017, legislators were 99% likely to make a tie with another legislator ($p < .001$). Although persistence estimates for bipartisanship are not significant in this model and interpreted with caution, it is notable that the predicted probability for legislators to maintain bipartisan ties between 2009 and 2011, which was during the creation of the OEIB, was 76%. This predicted likelihood is rather high compared to the likelihood for legislators to maintain bipartisan ties during the 2013 to 2015 (36%) and 2015 to 2017 (42%) time intervals.

Understanding the non-significant trends underlying the STERGM model provides some insight into the longitudinal portion of this study, especially when

triangulated with the findings from the purely descriptive analyses presented in Figures 6. Figure 6 illustrates that, during 2011 and 2013, when the OEIB was created and its components were implemented, the legislator networks became very dense and formed one cohesive community. In comparison, during the pre- and post-OEIB eras (e.g. 2009, 2015, & 2017), the legislator networks were slightly less dense, and some subgroups departed from the larger k-core to form their own central communities (see Figure 6). In addition, the weighted ties or strength of legislators' relationships with one another increased post-OEIB reaching their highest values during 2017. In other words, Figure 6 illustrates convergence across Democrat and Republican legislators in 2011 and 2013, whereas in 2009, 2015, and 2017 the networks appear to be somewhat more partisan.

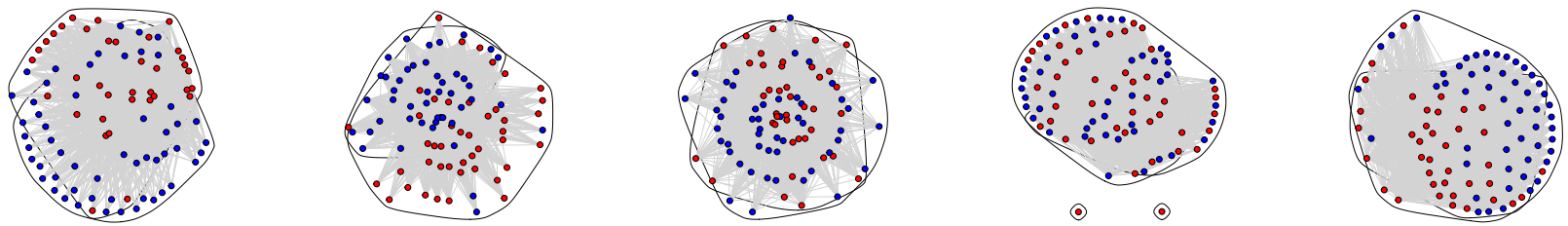
Table 9

Estimated Coefficients and Predicted Probabilities for STERGM Models

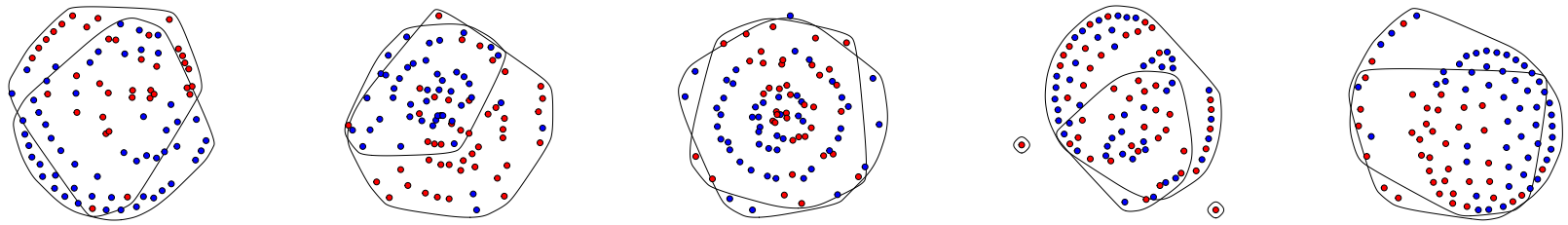
	2009-2011				2011-2013				2013-2015				2015-2017			
	Formation		Persistence		Formation		Persistence		Formation		Persistence		Formation		Persistence	
	β	P	β	P	β	P	β	P	β	P	β	P	β	P	β	P
Edges	21.9 (4256)	1.0	5.29* (0.32)	.99	NA	NA	NA	NA	0 (1.41)	0	5.11* (0.29)	.99	20.70 (4357)	1.0	5.41* (0.33)	.99
Node mix	-18.40 (4256)	0	1.1586 (0.66)	.76	NA	NA	NA	NA	NA	NA	-0.57 (0.36)	.36	-18.06 (4357)	0	-0.33 (0.44)	.42
AIC	13.55		169.90		NA		NA		6.73		383.9		11.35		265.5	

Note. Standard errors are reported in parenthesis and predicted probabilities are reported to the right of each coefficient. NA stands for not applicable and refers to models in which network density was collinear with predictor variables and parameters were not estimated.

* $p < 0.001$.



Pre-OEIB (2009) Creation (2011) Implementation (2013) Sunsetting (2015) Rebranding (2017)



Pre-OEIB (2009) Creation (2011) Implementation (2013) Sunsetting (2015) Rebranding (2017)

Figure 6. Annual legislator networks depicting party attributes and communities with and without ties represented.

CHAPTER IV

Discussion

In 2011, Oregon was one of many states consolidating much of their education governance authority around early learning, K-12, and postsecondary education into a single entity (Zinth, 2011). The primary purpose of this dissertation was to investigate the relationship between this consolidated model and endogenous policy formulation processes, like legislators' voting patterns. While education governance research usually investigates policy implementation, such as how districts redistribute resources, capacity-building models for personnel, or system-changing statutes (Fowler, 2013), this study sought to investigate how the OEIB changed legislators' association with policy formulation through legislative proposals. The longitudinal study documented the potential non-linear relationships internal to education governance networks, which have not been documented in the literature previously (O'Toole & Meier, 1999). Social network analyses were used to understand the extent to which (a) Oregon legislator networks were cohesive, central, and grouped by community, (b) legislator attributes (e.g. gender, party, and title) changed legislators' likelihood of voting commonly on education-related bills, and (c) there was a tendency for legislators to form and maintain bipartisan ties between time points.

Substantive Findings

The results highlight evidence of how this consolidated education governance shift in 2011 potentially changed legislative processes. When the OEIB was created and implemented, legislator networks became more cohesive (e.g. fewer subgroups) and distributed (e.g. fewer central legislators) when compared to other years included in the

longitudinal study. It is possible that the OEIB prompted collaboration among legislators resulting in mutuality that increased the likelihood for underrepresented groups of legislators (e.g. females and Republicans) to vote commonly with their colleagues. Ultimately, legislator networks were very dense with a high likelihood of forming ties generally during the creation and implementation years of the OEIB.

Legislator Networks' Distributed Properties

Communities and politicians have an equal role in education policymaking when education governance networks are applied instead of traditional bureaucracies (Cibulka, 2001). As an education governance network, the OEIB created a cohesive central agency that connected constituents through their board meetings, coalitions organized by initiatives, and direct relationship with the Oregon Department of Education. SB 909 (2011) aimed for social cohesion during the policy formulation stage by fostering mutuality across institutions (Knoke, 1990). For example, during the most intensive years of creation (2011) and implementation (2013), the legislator networks were more cohesive than the pre- and post-OEIB years (2009, 2015, & 2017). The frequency and strength of legislators' connections with their colleagues increased during the creation and implementation years of the OEIB. Therefore, when the OEIB was most active, co-voting was more common and relationships between legislators were stronger than during other years of the intervention.

Research posits that renewed interests from think tanks, special interest groups, and non-profits are overcoming governmental systems at the macro-political level that are designed to detour social shifts (Cibulka, 2001). The resulting policy formulation shift implies that the OEIB may have overcome existing governmental systems by proposing

legislation that highlighted legislators' interests and mediated relationships between political parties (Cibulka, 2011). The results from the current study indicate that legislator relationships were spread broadly across all legislators for each year included in the study; in other words, there were few subgroups. From 2009 to 2017, the most cohesive subgroup among the legislators included 83 to 89 of the 90 legislators and the fewest subgroups (n = 2) were found during the creation and implementation years of the OEIB. It is possible that the OEIB provided an opportunity for legislators to compromise broadly within a systematic structure across the stakeholders (Cibulka, 2001). Additionally, I found that legislators' relationships increased in strength during most time intervals included in the study. Consistent with existing research on governance networks, Oregon legislators may have engaged in increasing mutual sensemaking about the legislative proposals published by the OEIB and developed increasingly coherent relationships from 2009 to 2017 (Daly & Finnigan, 2012).

While bureaucratic policy formulation from higher levels of government have a negative effect on professional collaboration, more lateral systems across institutions achieve organizational change and information sharing (Daly & Finnigan, 2012). Consistent with this research, the current study found that legislator relationships were not central to a small group of legislators across each year included in the study, but during the creation and implementation years, the decentralized trend among legislator relationships was at its strongest. In other words, relationships among legislators and shared intellectual capital were shared across the network during the creation and implementation years more than any other years included in the study. The introduction of the OEIB may have prompted an already collaborative legislative body to become

even more collaborative across participants of different groups due to the shift from a bureaucratic policy formulation process to a networked approach (Innes et al., 2010).

Underrepresented Legislators' Changing Ties

State education governance actors have the most authority over education policymaking than local or federal actors (Fowler, 2013). In order to adapt to changing social interests, legislators' relationships across public policy areas would benefit from being fluid. In this Oregon case study, I aimed to understand how legislators' gender, party, and title affected the probability that they would co-vote with another legislator. The results indicate that females were significantly more likely to co-vote than males during the creation of the OEIB in 2011. In addition, Republicans were less likely to co-vote than Democrats during the pre- and post-OEIB eras (2009, 2015, & 2017), suggesting that for a brief period the OEIB may have helped the legislature overcome party lines. These findings provide information about how female and Republican legislators in Oregon may have informed the policy formulation stage more during the centralized governance model than they would under the traditional governance model.

More Research Needed to Understand the Bipartisan Voting Outcome

Education governance networks can potentially drive the discourse for social change, removing power from dominant voices (Timm, 2014). This implies that in a Democratic state like Oregon, a networked governance approach might result in increased bipartisan voting. Unfortunately, the limitations of the dataset and the homogeneity among votes within the education realm did not provide enough variance among votes. Apart from party, the findings indicate that legislators were 99% likely to maintain ties with all other legislators during the pre- and post-OEIB eras (i.e. 2009-

2011, 2013-2015, & 2015-2017). Due to this high rate of forming ties, there was generally not enough heterogeneity among the voting data to show evidence of increased bipartisan voting patterns. The same applies to the creation and implementation time interval from 2011-2013 when there was not enough variance for estimation. Although there were no conclusive estimates for parameters of bipartisanship, it is noteworthy that between the creation and implementation years the legislator networks were nearly complete. In this case, it seems that the governance practices established by the OEIB possibly catalyzed an internal change to the legislature, resulting in a nearly complete network during its implementation.

Limitations

The current study has several limitations. First, the internal properties of legislator voting data on education-related bills provided little variance for the inferential statistical models to estimate parameters. This study attempted to model legislator voting data in a unique way by predicting endogenous relationships with an exogenous variable. In contrast, prior studies relied on more concrete co-sponsorship or communication data representing exogenous variables (e.g. Alvarez & Sinclair, 2011; Mousavi, 2016; Fowler et al., 2011). The legislator voting networks were nearly complete, ranging from 97.25 – 99.95% of ties being actualized. While this extremely high density provided some insight into the structure of legislator voting networks, it also reveals that highly dense networks might be a characteristic of legislator voting networks on education-related bills, generally. The roll-call data from legislative sessions on education-related bills did not provide enough detailed information about legislators' ideas to fully explain the education governance shifts related to their vote ties. Future research will benefit from

expanding the content of bills included in a study of legislator voting data to incorporate multiple substantive areas.

Second, using an exponential random graph model (ERGM) limited the estimable parameters based on the modeling specifications required to maintain unbiased estimates. In Cranmer et al's. (2017) recent article there is a clear point that researchers must include at least one endogenous variable in an ERGM family model, or else the model becomes a logistic regression and estimates are inaccurate. For the very dense legislator networks under study, this resulted in the endogenous term edges, explaining all of the variance existing within the estimated networks. Therefore, the exogenous predictor of interest to this study, bipartisanship, was not significant and collinear with the edges term. In the end, what makes ERGM family model techniques so unique – their ability to model their own interdependence – becomes their most challenging feature. Future researchers interested in using legislator voting networks in the context of exogenous predictors will benefit from exploring how LAM or QAP provide more flexibility regarding model specifications and more intuitive estimates relating the theoretical hypotheses.

Third, the single-state case study design limits the generalizability of the findings. There is a trend growing across America for state education governance models to centralize their organizational structures. The current study was intentionally designed as a longitudinal study to understand the impact of the consolidated approach to structuring educational governance in one state over time. Therefore, the specific results cannot be applied broadly to other states functioning among a variety of other variables. However, the broader policy story told through the current longitudinal study provides information

for education policymakers about how a centralized approach to educational governance evolved in the Oregon policymaking context. In the future, researchers will benefit from applying a mixed-methods research design that triangulates more data sources (e.g. legislator interviews, transcripts from hearings, or media articles).

Finally, the existence of confounding variables may have mediated the relationship between legislator attributes and co-voting, as well as bipartisan voting. While the results indicate potential trends throughout Oregon legislator voting networks on education-related bills during 2011 and 2013 there were two notable factors that may have attributed to these shifts or lack of identifying further evidence, (a) the makeup of party affiliation across legislators and (b) the number of bills included in the final sample each year. These variables were included as part of the bill and legislator descriptive analyses but were not further explored as potential extraneous variables during the model building process. Since both the number of republican legislators and the number of bills included in each year of the study both varied along with the trends occurring in legislator networks they may be confounding variables.

In 2011 there was a substantial increase in the number of republicans in the Oregon house, by six legislators, and senate, by two legislators. In comparison to other years in the study, these increasing variables indicate that there may have been shifts occurring among Oregon politics and education bills generally that were not accounted for in this study. In addition, during that same year the network structure findings indicate that legislator networks were increasingly dense (i.e. more ties actualized), stronger (i.e. more weighted ties), cohesive (i.e. fewer subgroups), and distributed (i.e. fewer central legislators). The increase in republican representation in the Oregon legislature in 2011

may have been a catalyst for bipartisan voting in 2011, leading to increasingly dense, cohesive, and distributed networks. Since republican shifts were not included as an external variable and these trends align with the legislator voting networks it is likely that this is a confounding variable.

In addition, there were different numbers of bills included in both the pooled sample of bills, as well as the final sample of bills analyzed. In particular, there was an increase in the number of bills from 2009 to 2011, by 4, and again from 2011 to 2013, by five. The study results during those years also indicated that there was increasing degree, density, and little variance among data overall. It is possible that, since these changes in bill sample were not controlled and they align with the changing characteristic of the network structure, they were confounding variables. This is especially relevant since the increased number of bills may have increased the degree and density of the networks, as well as decreased the variance, resulting in the inestimable STERGM parameters. This confounding variable may have been controlled with further exploration of the nature of the increase in bills using a qualitative approach to study the bill topics during each year.

Implications

Despite the limitations presented, the current study implies that a governance network, like the OEIB, may relate to increased co-voting under a governor-led centralized model. In 2011, many states explored the role of governor-led education governance models (Zinth, 2011). States shifted their structures to pursue state goals that represented common social interests across stakeholders (Railey, 2017). For many states, this goal included a new approach to designing education systems and initiatives around birth-to-career education. However, with a consolidated model run by the governor, the

success of education policy formulation lies with the priorities of the governor's office (Railey, 2017). The current investigation showed evidence about how Oregon's SB 909 (2011) departed from this model by enacting the OEIB with the charge of engaging in problem-solution discourse about social issues arising from various stakeholders (Cibulka, 2001).

Today, seven years after the formation of the OEIB, states are pursuing new accountability models aligned with the Every Student Succeeds Act that incorporate more elaborate state goals (Railey, 2017). A recent report on education governance models published by the Education Commission of the States challenges states to determine the extent to which policymakers at the state and local levels hinder or reinforce student success and cohesive policy goals (Railey, 2017). Assuming that the current study results are true, states struggling to find coherence among their state goals will benefit from understanding that a networked approach to policy formulation, like the OEIB, might result in improved co-voting. In addition, this implies that a model like the OEIB might be applied to other sectors with similar partisan social interest like health, infrastructure, or the environment. Policy decisions must be intentional; whether centralized at the state level or distributed to districts, there is a balance between applying a fully centralized or decentralized model and setting coherent state goals that apply to embedded contexts like governance capacity and vision (Railey, 2017).

In February 2018, Ohio Republicans introduced HB 512 (2018), similar to Oregon's SB 909 (2011), which proposed to combine Ohio's PK-12 department of education with their higher education and workforce development agency into a single unit, the Department of Learning and Achievement (DLA). If enacted, very similar to the

OEIB, the DLA will be headed by a governor-appointed director and assistant director for higher education and workforce transformation (Napp, 2018). Most importantly, this legislation transfers authority from the State Board of Education, State Superintendent of Public Instruction, and Department of Education to the DLA. In addition, the Department of Higher Education and the Ohio Board of Regents, as well as the Chancellor of Higher Education roles will be abolished. Like the evolution of the legislative language in Oregon SB 909, current analyses of Ohio HB 512 explain that Republicans face challenges advancing this governance shift (Napp, 2018). For example, the state constitution provides there must be a State Board of Education and Superintendent of Public Instruction, so although under Ohio HB 512 these roles and institutions would remain, much of their power would be shifted to the DLA.

Ohio is attempting to incorporate a large coordination institution remarkably similar to the OEIB in order to make elusive state goals a reality (Railey, 2017). Ohio and other states considering legislation that aims for this consolidation would benefit from understanding exactly how this exogenous shift of power might result in endogenous legislative changes, as well. For example, the current study found that during the years where this model was implemented legislators' co-voting relationships were distributed broadly across all legislators. By creating common agreements that explicitly set simple and transparent education goals for the state and functional norms, the legislators might have achieved more coherence across common areas of public interest (Cibulka, 2001; Railey, 2017).

Future Research

Applying social network analysis to governance and legislative processes is an emerging field. Researchers are still investigating optimal design and methodological choices that produce the most valid parameters for social networks. The current study reinforced existing recommendations for research in (a) social network analysis and (b) governance and legislative research.

First, with regard to social network analyses, researchers interested in predicting variables exogenous to the networks would benefit from applying methods other than exponential random graph models like latent space models (LSM) and quadratic assignment procedures (QAP). These models allow researchers to test theoretical hypotheses about exogenous variables, where the structures of the dependencies endogenous to the network are not tested. Ultimately, which model is chosen depends on the theory and aims of the research, as well as the data properties (Cranmer et al., 2017).

Second, with regard to governance and legislative research, the current study findings provide insights about what analyses and topics should be investigated next. The current study focused on the what and who components of Brewer and Smith's (2008) education governance model by studying the governance model and legislator networks (e.g. goals & actors, respectively), but in order to fully understand the dynamic nature of the social network under study it is necessary to continue investigating the *how.* In other words, how did the policy formulation stage operationalize during the policy implementation stage and did the policies implemented achieve their desired ends? Such an investigation was not possible in the current study because data collection was retrospective, but efforts in Ohio and other states offer unique opportunities to add to our

knowledge by collecting data prospectively. A study of this kind would provide further explanation for states about how education governance models provide accountability for the full cycle of policymaking at the state level.

Third, future research may benefit from more robust research designs by applying mixed-methods approaches. Researchers applying social network analysis to governance and legislative networks can triangulate their findings by incorporating qualitative methods intentionally into the study design. For example, the current study could have benefited from a document analysis of the legislative hearings, popular press, or legislative analyses. In addition, interviews with legislators and members of the OEIB would provide valuable information about the potential relationships documented in the social network analysis.

In sum, the current study suggests opportunities to better understand education governance models and networked approaches to policy formulation. This study documents evidence of the potential for politicians and policymakers, who are part of the education governance institutions, to relate to education policy formulation. While previous education governance research has documented shifts in education governance at the policy implementation level (Daly & Finnigan, 2011; Russell et al., 2015), the current study sought to investigate how shifts in education governance relate to policy formulation endogenous to the state legislature. Further, research on networked approaches to policy formulation may benefit from mixed-methods analyses that include qualitative approaches (e.g. document analysis or interviews) to supplement any kind of network analysis. However, the results of the current study provide insights into the complex social interactions underlying education policy formulation, like legislative

processes, even when considering the highly homogenous context of education- related votes. This study may help states considering such a consolidated governance structure understand how to guide coherence across legislators toward improved co-voting and policy formulation.

APPENDIX

Social Network Analysis Glossary

Term	Technical Definition	Study-specific Definition
Arc	Directed tie between two nodes in a network where the nodes are related by choice or nomination	Line between two legislators that represents when their connection is explicitly stated (not studied in this investigation)
Closeness centralization	The number of nodes, other than the node of interest divided by the sum of all distances between the node and all others	Indicator of the extent to which there are central legislators within the network
Cohesion	More ties within a network or subgroup denoting relational togetherness	More connections between legislators within the network
Degree	Number of lines incident with a node	Number of bills co-voted on with other legislators
Density	The number of ties expressed as a proportion of the maximum possible number of ties	The proportion of actualized connections between legislators among a network out of the total possible connections
Edge	Tie between two nodes in a network that is undirected	Line between two legislators that represent when they vote the same on a bill and their connection is implied
Graph theory	Modeling pairwise connections between nodes	Analyses of actors and lines between pairs of actors
Node	Smallest unit in a network or graph (represents an actor or vertex)	A legislator
Social network analysis	Methodology for conceptualizing, analyzing, and interpreting social networks	Analyses that detect and interpret patterns of social ties
Strength	The sum of weighted ties for all nodes in a network	The sum of legislators' multiple ties with other legislators across the network

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