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ABSTRACT

In this paper, we study the extent to which social connections influence the legislative effectiveness of members of the U.S. Congress. We propose a new model of legislative effectiveness that formalizes the role of social connections and generates simple testable predictions. The model predicts that a legislator's equilibrium effectiveness is proportional to a specific weighted Katz-Bonacich centrality in the network of social connections, where the weights depend on the legislators' characteristics. We then propose a new empirical strategy to test the theoretical predictions using the network of cosponsorship links in the 109th-113th Congresses. The strategy addresses network endogeneity by implementing a two-step Heckman correction based on an original instrument: the legislators' alumni connections. We find that, in the absence of a correction, all measures of centrality in the cosponsorship network are significant. When we control for network endogeneity, however, only the measure suggested by the model remains significant, and the fit of the estimation is improved. We also study the influence of legislators' characteristics on the size of network effects. In doing so, we provide new insights into how social connectedness interacts with factors such as seniority, partisanship and legislative leadership in determining legislators' effectiveness.

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1 Introduction

Understanding what makes legislators effective, both in absolute and relative terms, is clearly a question of practical and theoretical importance. From a normative perspective, understanding effectiveness may help governments design more efficient political institutions. From a positive perspective, it may help explain the determinants of politicians' success and therefore their career paths. It is therefore not surprising that there is a large literature devoted to measuring and explaining legislative success (see, among others, Volden and Wiseman [2014]). This literature has investigated the extent to which idiosyncratic talent, skill sets, seniority, demographics (sex and race, in particular), institutional and party positions play a role in the process of passing legislation both at the state and federal level.

While most of this literature has focused solely on legislators' individual characteristics, journalistic accounts and political commentators have traditionally privileged the importance of social connections, portraying successful politicians as masterful "networkers." As a result, recent work in economics and political science has aimed to link social connectedness to legislative effectiveness. In a seminal contribution, Fowler [2006a] has shown that measures of legislative success correlate positively with politicians' connectedness in the network of cosponsorships. In Fowler's definition, politicians' connectedness depends on the number of cosponsorships their bills receive and a measure of the bills' quality. This line of research has been continued by Cho and Fowler [2009] and Kirkland [2011], who both use cosponsorships as their source of information on network connections. Craig [2015], in contrast, has constructed network connections using cosigners of congressional "Dear Colleague" letters, and has shown that "team players" are better at gathering support in the form of cosponsorships, but they do not have greater success in advancing their legislative agendas.

A key issue with the current literature on social connectedness and legislative effectiveness is that it relies on measurements of social connection that are naturally endogenous. Legislators are certainly strategic in choosing with whom to cosponsor and with whom to partner in sending "Dear colleague" letters. This strategic self-selection may make it difficult to interpret the correlation between legislative effectiveness and social connectedness, since omitted variables (such as social skills) may drive both social connections and legislative success. A positive correlation between centrality and effectiveness found while ignoring these issues may be spurious; similarly, the lack of a correlation may not rule out a causal relationship.

In this paper, we build on this early literature suggesting a role of social connections in determining legislative effectiveness, but we explicitly deal with the problem of the endogeneity of social networks and study the causal connections between them and legislative effectiveness. Specifically, we make two contributions. First we propose a simple model of legislative effectiveness in Congress that formalizes the role of social connections and generates simple testable predictions. Second, we propose a new empirical strategy to test these predictions. The strategy to deal with network endogeneity consists of implementing a Heckman correction based on an original instrument: the legislators' alumni connections. The advantange in using this technique is that it allows to control for the presence of individual-level unobserved factors. A politician's ability is a prominent example. More able politicians who are more effective may be more likely to attract cosponsors, and also may have attended the more prestigious schools.

In the model that we propose, legislative effectiveness depends on three factors: the legislator's characteristics, the effort directly exerted by the legislator, and the legislative effectiveness of all the legislators with whom the legislator has social connections. This last factor reflects the idea that if legislator i has cultivated a social relationship with j (for example, by contributing to the reelection campaign of legislator j through his own PAC or by playing golf with him/her), then i may conscript j to his own cause. Therefore, existing social connections make i more productive. Once equilibrium effort levels are taken into account, we show that our model has a unique Nash equilibrium in which the legislators' effectiveness levels are uniquely defined and are proportional to a standard measure of centrality developed in the sociological literature: the weighted Katz-Bonacich centrality (see for example, Bonacich [1987] and Zenou [2015]). More importantly, the model's equilibrium conditions can be expressed in the form of a simple spatial autoregressive system of equations that allows us to structurally estimate the model.

We then test the model predictions using data from five recent election cycles: the 109th Congress (election cycle 2004) to the 113th Congress (election cycle 2012). We measure each congressman's legislative performance using the Legislative Effectiveness Scores (LESs) for members of the U.S. House of Representatives, developed by Volden and Wiseman [2014]. This is a general metric of individual legislative effectiveness in the U.S. Congress, which identifies differences across legislators in formulating meaningful bills and moving them through the legislative process from introduction to the ultimate signing into law. As mentioned above, we deal with the endogeneity of available measures of social connections in Congress by implementing a two-step procedure. In the first step, alumni connections and other relevant legislators' characteristics (gender, party, seniority, etc.) are used to explain the map of cosponsorship linkages. In the second step, the residuals of the first stage (that incorporates unobservable variables explaining the existence of legislative networks in Congress), are included in the regression used to estimate our model. In our alumni network, two congressmen are connected if they graduated from the same institution within a given time window. The idea behind our approach is that shared educational experiences have long-lasting effects on the propensity for socialization later in life (see Cohen et al. [2008], Fracassi and Tate [2012], Cohen and Malloy [2014], Do et al. [2016], Battaglini and Patacchini [2017] among others).

Three main results emerge from our analysis. First, we find that, consistent with the theory, congressmen's Bonacich centralities have highly significant effects on their Legislative Effectiveness Scores. This result is robust to many natural controls suggested by the existing literature, including seniority, measures of relative institutional power inside the House, electoral success, and political ideology. Our estimate generalizes and, indeed, includes as a nested case, previous empirical models that ignore social connections: it therefore allows us to formally show social connections significantly improve the models' fit. In their survey of the literature on legislative effectiveness, Volden and Wiseman [2009] list nine factors that have been identified as predictors of legislators' legislative effectiveness: seniority, previous legislative experience, party influence, legislative leadership, committee influence, ideology, race, gender and ethnicity considerations, natural coalition partners and electoral connections. Our work provides a microfoundation and evidence for a tenth factor: social connections.

Second, we show that ignoring network endogeneity is problematic. We show that without the Heckman correction, traditional measures of centrality are apparently significant: betweenness, closeness and eigenvector. Once we control for omitted variables with our Heckman correction, however, none of these measures of centrality remains significant. The measure of centrality suggested by our model, on the contrary, remains significant when we correct for the Heckman correction. It also remains significant when we run a "horse race" in which all measures of centrality are included, suggesting that our theoretically founded measure of social connectedness is a robust predictor of effectiveness.

Third, our analysis provides insight into the mechanisms through which variables previously identified as important affect legislative effectiveness. We find that ethnic minorities appear to benefit more than the average congressmen from social interactions, whereas congressmen with higher seniority and committee chairs receive less benefits form interacting with others than other members of the Congress.

Our work is related to two strands of literature. First, there is the traditional literature on legislative effectiveness that focuses on the questions of how to measure effectiveness, its determinants and its effects. This literature has highlighted factors such as seniority and leadership position in Congress and the parties as unambiguous drivers of effectiveness (see for example Frantzich [1979], Anderson et al. [2003], Padro i Miguel and Snyder [2006], Cox and Terry [2008], Volden and Wiseman [2009]). Other factors have been highlighted but proven more controversial, such as electoral safety, ethnicity and gender (see for ex., Jeydel and Taylor [2003], Bratton [2005], Bratton and Haynie [1999]). A variety of measures of legislative success have been adopted, ranging from "batting averages" (i.e. the share of sponsored bills that are passed), to entrepreneurial measures (i.e. the number of sponsored and cosponsored bills), to productivity measures that count how a legislators help a bill move through stages in Congress, to direct surveys (for state congresses). As mentioned, for our work we have chosen a measure proposed by Volden and Wiseman [2009] that tracks the different forms of success and weights success by the importance of the bill.[1]

Second, our work contributes to the literature on social networks in Congress. As said, a number of works have investigated the correlation of legislative success and measures of social centrality using data from cosponsorships (Fowler [2006], Tam Cho and Fowler [2009] and Kirkland [2011]) and "dear colleague" letters (Craig [2015]). This pioneering literature first highlighted the importance of social links to legislative success, but has not investigated the problem arising with the endogeneity of social networks and therefore has not studied the causal link between observed measures of social connectedness and legislative success.

A recent literature has employed a variety of strategies to control for the endogeneity of social networks in Congress and other legislative assemblies. Masket [2008] and Harmon et al. [2017] use seat assignments to study voting behavior in the California state assembly and the E.U, Parliament, respectively. Cohen and Malloy [2014] and Battaglini and Patacchini (2017) use the alumni networks to study voting behavior in the U.S. Senate and PAC electoral contributions in

[1] The index tracks the number of sponsored bills (entrepreneurship), and sponsored bills that complete all subsequent steps in the legislative process (so productivity and "batting averages").

the U.S. Congress, respectively.

The remainder of this paper is organized as follows. Section 2 presents our model of legislative behavior, the equilibrium predictions and the estimation strategy. In Section 3, we describe the data. In Section 4, we discuss the empirical results and a number of robustness checks. Section 5 concludes.

2 Theory and empirical strategy

2.1 Setup

Consider a congress comprised of n legislators, where $\mathcal{N} = \{1, ..., n\}$ is the set of legislators. Each legislator has a pet legislative project that he cares to implement. The goal of each legislator is to maximize his legislative effectiveness, measured by the probability of implementing the project. We assume that legislator i's legislative effectiveness E_i is a function of legislator i's characteristics, his effort and the legislative effectiveness of all the legislators that i has befriended. For example, legislator i may have spent time playing golf with j, or (perhaps more substantively) contributed to the reelection campaign of legislator j through his own PAC. This may allow i to conscript j to his own cause.

Specifically, we assume:

$$E_i = A_i + \varphi\sqrt{\textstyle\sum_j g_{i,j}E_j} \cdot l_i \tag{1}$$

Equation (1) represents the "production function" for legislative effectiveness. The first term, A_i, is a fixed effect idiosyncratic to i. This term may include a variety of characteristics that have been highlighted in the existing literature as important for effectiveness: the legislator's seniority (Volden and Wiseman [2009], Padro i Miquel and Snyder (2006), for example), sex and race (potentially in the presence of discrimination) and the legislator's position in the committee system and party hierarchy (Anderson et al. [2003], Cox and Terry [2008], for example). The second term, which is new in our model, captures the importance of social connections. As in Ballester, Calvo-Armengol and Zenou [2006], the social network is described by a $n \times n$ matrix G with the generic element $g_{i,j}$ that measures the strength of the social influence of legislator j on legislator i. In (1), we assume that there is a complementarity between i's effort l_i and the effectiveness of the legislators in i's social circle, as measured by the weighted average of the effectiveness of the legislators with whom i has a social link. We normalize the social weights so that $g_{i,j} \in [0,1]$ for any i,j and $\sum_i g_{i,j} = 1$ for any i. This normalization simply means that legislator j has a total budget of resources to "help" connected colleagues: it is presumable that a legislator with many connections will have less time per connection. Assuming that effectiveness takes a value in $\left[0,\bar{l}\right]$ for some $\bar{l} > 0$, it is easy to see that a sufficient condition for $E_i \in (0,1)$ is that $\overline{A} + \varphi\bar{l} < 1$, an assumption that we will maintain throughout the analysis, where $\overline{A}$ is the upper bound on A_i.

A strategy for a legislator is described by a function $l_i : \mathcal{T} \to [0,1]$, mapping i's type A_i to an effort level. When the floor opens for business, each legislator i chooses his own level of effort l_i simultaneously, taking as given the social network and his own expectations of the other legislators' effectiveness. Given this, the levels of effectiveness are endogenously determined by (1).

In the following pages, we consider very complex networks with hundreds of nodes. It is therefore useful to define a simple statistic that describes the position of an agent in the network (which will prove important to interpret the theoretical predictions): the Bonacich Centrality (Bonacich [1987], Ballester, Calvo-Armengol and Zenou [2006], Zenou [2015]). For a given network matrix $\widehat{G}$, the vector of Bonacich centralities, if it exists, is defined as:

$$\mathbf{b}\left(\delta,\widehat{G}\right) = \left(I - \delta\widehat{G}\right)^{-1} \cdot \mathbf{1}, \tag{2}$$

where $\delta < 1$ is a positive parameter, I is the identity matrix and $\mathbf{1}$ is a column vector of ones. The Bonacich centrality of legislator i with respect to $\widehat{G}$ and δ is the ith entry of $\mathbf{b}\left(\delta,\widehat{G}\right)$. Bonacich centralities may not exist because the matrix $I - \delta\widehat{G}$ may fail to be invertible. Invertibility is guaranteed for any $\widehat{G}$ if δ is sufficiently small. For the reminder of the paper, a condition that guarantees that the relevant Bonacich centralities exist in our environment is the following:

Assumption 1. *The matrix $I - \frac{\varphi^2}{2}G$ is invertible and positive.*

It can be shown that Assumption 1 is not satisfied only if social spillovers measured by φ are very large (so as to induce reinforcement effects that lead to unbounded levels of effectiveness).[2] This is implausible and indeed it is not true in our empirical analysis. It is therefore very natural to assume that social spillovers, though significant, are sufficiently small to allow for Assumption 1.

[2] See, for example, Theorem 1 in Ballester, Calvo-Armengol and Zenou [2006].

2.2 Equilibrium predictions

The optimal level of effort l^i by a type $i = 1, ..., n$ solves the problem:

$$\max_{l_i} \left\{ A_i + \varphi \left(\sqrt{\sum_{j=1}^{n} g_{i,j} E_j} \right) \cdot l_i - (l_i)^2 / 2 \right\}, \tag{3}$$

Substituting the solution to this maximization in (1), we obtain that the equilibrium levels of legislative efficiency for a type $i = 1, ..., T$ are given by:

$$E_i = A_i + \frac{\varphi^2}{2} \sum_{j=1}^{n} g_{i,j} E_j. \tag{4}$$

These equations can be expressed in matrix form as:

$$\left[I - \frac{\varphi^2}{2} G \right] \cdot \mathbf{E} = \mathbf{A} \tag{5}$$

where $\mathbf{E} = (E^1(G, \mathbf{A}), ..., E^T(G, \mathbf{A}))'$ is the vector of legislative effectiveness $E^i(G, \mathbf{A})$ solving (5), and $\mathbf{A} = (A^1, ..., A^T)'$ is the vector of types' characteristics.[3] It is easy to show that given Assumption 1, E_i are uniquely defined with**:**

$$(E^1(G, \mathbf{A}), ..., E^T(G, \mathbf{A}))' = \left[I - \left(\varphi^2/2 \right) \cdot G \right]^{-1} \mathbf{A};$$

The vector $[I - \frac{\varphi^2}{2} \cdot G]^{-1} \mathbf{A}$ coincides with the vector of weighted Bonacich centralities $\mathbf{b}(\varphi^2/2, G, \mathbf{A}) = (b_1(\varphi^2/2, G, \mathbf{A}), ..., b_n(\varphi^2/2, G, \mathbf{A}))$ with weights $\mathbf{A} = (A^1, ..., A^T)'$, a well know concept in sociology and economics (see Ballester et al. [2006] for instance). We therefore have:

Proposition 1. *There is a unique equilibrium in which legislator i's legislative effectiveness* is *equal to* $b_i(\varphi^2/2, G, \mathbf{A})$.

From a theoretical point of view, a key novelty in the analysis presented above is the fact that legislators choose the optimal legislative effort l_i taking as given their rational expectations of the other legislators' levels of effectiveness. This approach is similar to the approach in general equilibrium theory in economics where consumers choose their optimal consumption taking prices as given. As in general equilibrium theory, where prices are endogenous since they need to clear markets, here the levels of effectiveness are endogenous since they must satisfy the externality equation (1) given the optimal effort levels.

[3] Note that if the matrix $\left[I - \varphi^2 \kappa \cdot G \right]$ is invertible, then the equilibrium legislative effectiveness levels at $t = 2$ are uniquely defined and equal to the Bonancich centralities $b(G, \varphi^2 \kappa) = \left[I - \varphi^2 \kappa \cdot G \right]^{-1} A$ of G with discount factor $\varphi^2 \kappa$**.** However, we should note that here G is endogenous, so to determine the invertibility of $\left[I - \varphi^2 \kappa \cdot G \right]$ and E we should first solve for G in the first stage of the game.

When there are no social spillovers (i.e., $\varphi = 0$), Proposition 1 tells us that legislative effectiveness is determined exclusively by the individual characteristics of legislators:

$$(E^1(G, \mathbf{A}), ..., E^T(G, \mathbf{A}))' = \mathbf{A}.$$

In the presence of social spillovers among connected legislators (i.e. $\varphi > 0$), however, the effectiveness of any legislator depends on the characteristics of all other legislators, with each legislator weighted using their distance in the network (the weights given by the rows of $\left[I - \left(\varphi^2/2\right) \cdot G\right]^{-1}$). Since the standard model is nested as a special case of the more general model (with $\varphi = 0$), we will be able to test if social connections improve the fit of our estimates of $\mathbf{E}$.

2.3 Empirical Model

Assume that we observe data from $\bar{r}$ congresses $r = \{1, ..., \overline{r}\}$, each comprised of n congressmen and characterized by a network $G_r = \{g_{i,j,r}\}$. Moreover, assume the vector of characteristics of legislators in congress r, $\mathbf{A}_r = (A_{1,r}, ..., A_{n,r})'$, is a linear function of a vector of congressman i's characteristics in congress r:

$$\mathbf{A}_r = \alpha + X_r \boldsymbol{\beta} + \boldsymbol{\varepsilon}_r, \tag{6}$$

where $\boldsymbol{\varepsilon}_r = (\varepsilon_{1,r}, ..., \varepsilon_{n,r})'$ is a vector of i.i.d. shocks, $\boldsymbol{\beta} = (\beta_1, ..., \beta_k)'$ is a vector of coefficients and α is a constant term. Given (6), our prediction (5) for congress r can be represented as:

$$\mathbf{E}_r = \alpha + \phi^* \cdot G_r \mathbf{E}_r + X_r \boldsymbol{\beta} + \boldsymbol{\varepsilon}_r. \tag{7}$$

where, for simplicity we denote $\phi^* = \varphi^2/2$. System (7) is a spatial autoregressive system that can be easily estimated given G_r and $\mathbf{X}_r$. When bringing this model to the data, however, we face a key challenge: the social network G_r is likely endogenous and determined by variables that also affect $\mathbf{E}_r$. If these characteristics are omitted in X_r or are unobservable, then we have a biased estimation.

To address this concern, we implement a Heckman correction of (7) with a two stage estimation. The idea is to estimate an extended version of our model in which we explicitly account for a possible correlation between unobserved factors driving network formation and outcomes.[4]

[4] Qu and Lee (2015) implement a similar control function approach for the estimation of a spatial autoregressive model with an endogenous spatial matrix in a geographic context. Their strategy is to model proximity between areas as a function of observed characteristics at a first stage and then add a function of the first stage residuals to the outcome equation.

Identification in Heckman selection models is notoriously difficult, especially in environments like ours in which networking in Congress is driven by the goals of the politicians. To address this problem, we rely on an original instrument: the network of the legislators' alumni connections. These connections offer an original instrument which rests on plausible assumptions: the network is exogenous to the political process, but still relevant even many years after the congressmen attend school (a fact that is well known in general and that we will documented for our specific case below).[5]

For the first step (i.e., the estimation of the network), we consider a standard dyadic model of link formation, used previously in the literature (see, e.g., Fafchamps and Gubert [2007)], Mayer and Puller [2008)], Lai and Reiter [2000], Apicella, Marlowe, Fowler and Christakis [2012] and Attanasio, et al. [2012]). When used in our context, the link $g_{i,j,r}$ between two congressmen i and j in congress r is explained by distance between i and j in terms of characteristics according to the model:

$$g_{i,j,r} = \delta_0 + \delta_1 w_{i,j,r} + \sum\nolimits_l \delta_{l+1} |x^l_{i,r} - x^l_{j,r}| + \eta_{i,j,r}, \tag{8}$$

where $x^l_{i,r}$ for $l = 1, ..., L$ are i's characteristics and $w_{i,j,r}$ denotes connections in the alumni network. The link $g_{i,j,r}$ is equal to the number of i's bills cosponsored by j over the total number of bills cosponsored by j; and the link $w_{i,j,r}$ between two congressmen i and j in congress r is equal to the number of educational institutions attended by both i and j whithin eight years from each other over the total number of institutions attended by j. For this definition, educational institutions include high schools and other higher institutions attended for both undergraduate and graduate degrees. We adopt an eight year time window to allow for post graduation interactions, since most university make signicant efforts to connect alumni graduating in nearby cohorts.[6]

As standard in the literature on dyadic link formation we assume:

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[5] Observe that the Heckman selection model would be identified even without exclusion restrictions. Identification, in this case, exploits non-linearities specific to the network structure of our model. The dyad-specific repressors used in the first stage (the network formation stage) are expressed in absolute values of differences: these differences in characteristics do not appear in the outcome equation.

[6] For example, graduates in the classes of 2008-2017 at Yale College are enlisted as members of BOLD ("Bulldogs of the Last Decade,"), a groups for which the university organizes special events (see http://boldalumni.yale.edu/). Similar organizations can be found, for example, at the Harvard Law School (see the GOLD association for "Graduate Of the Last Decade," http://hls.harvard.edu/dept/alumni/giving-to-hls/harvard-law-school-annual-fund/graduates-of-the-last-decade/) and Stanford where, for instance, the Stanford National Black Alumni Association organizes outreach events for young alumni (http://www.stanfordblackalumni.org/young-alumni-connectors/). At the Princeton reunions, graduation years are organized as satellites around the classes that celebrate major reunions (5th, 10th, 15th, etc. reunions). Cornell University has a "Second Decade Program" for graduates 10 to 20 years past graduation (https://alumni.cornell.edu/connect/young-alumni/second-decade/).

Assumption 2. *Assume that* $\varepsilon_r = (\varepsilon_{1,r}, ..., \varepsilon_{n,r})'$ *and* $\eta_r = (\eta_{i,1,r}, ..., \eta_{i,n,r})'$ *are jointly normal with* $E(\epsilon_{i,r}^2) = \sigma_\epsilon^2$, $E(\epsilon_{i,r}\eta_{i,j,r}) = \sigma_{\epsilon\eta}$ *for all* $i \neq j$, $E(\eta_{i,j,r}\eta_{ik,r}) = \sigma_\eta^2 \ \forall j = k$, *and* $E(\eta_{i,j,r}\eta_{i,k,r}) = 0 \ \forall j \neq k$.

Assumption 2 implies that the selection effect (i.e. the correlation between unobservable characteristics determining link formation and unobservable characteristics driving the outcome as measured by $\sigma_{\epsilon,\eta}$) is the same for all politicians. Under Assumption 2, it can be shown that expected value of the error term conditional on the link formation is $E(\epsilon_{i,r}|\eta_{i,1,r}, \ldots, \eta_{i,n-1,r}) = \psi \cdot \sum_{j\neq i} \eta_{i,j,r}$, where $\psi = \sigma_{\epsilon\eta}/\sigma_\eta^2$. It follows that our model can be written as:

$$\mathbf{E}_r = [I - \phi^* G_r]^{-1} \cdot [\alpha \cdot \mathbf{1} + X_r \boldsymbol{\beta} + \psi \boldsymbol{\xi}_\mathbf{r} + \boldsymbol{\varepsilon}_r] \tag{9}$$

where $\xi_{i,r} = \sum_{j\neq i} \eta_{i,j,r}$ with $\boldsymbol{\xi}_\mathbf{r} = (\xi_{i,r}, ...\xi_{n,r})'$. The term $\psi\boldsymbol{\xi}_\mathbf{r}$ now captures the selection bias.

An advantage of model (10) is that it allows to control for the presence of *individual-level unobserved factors*. As said in the introduction, a politician's intrinsic ability is a prominent example. More able politicians who are more effective may be more likely to attract cosponsors and may also have attended a more prestigious school. Another example may be unobserved features of the educational institutions attended by i. The term $\xi_{i,r}$ includes *all unobserved characteristics* of legislator i that contribute explaining his connections in (8).

For a sample of n agents at each congress r, stack up the data by defining $E = (E_1', \cdots, E_{\bar{r}}')'$, $\epsilon = (\epsilon_1', \cdots, \epsilon_{\bar{r}}')'$, and $\alpha = (\alpha_n', \cdots, \alpha_n')'$ as a $n\bar{r}$-dimensional vectors, $X = (X_1', \cdots, X_{\bar{r}}')'$ as a $n\bar{r} \times k$ matrix, and $G = \text{diag}\{G_r\}_{r=1}^{\bar{r}}$ as a $n\bar{r} \times n\bar{r}$ matrix. For the entire sample, the model is:

$$\mathbf{E} = [I - \phi^* G]^{-1} \cdot [\alpha \cdot \mathbf{1} + X\boldsymbol{\beta} + \psi\boldsymbol{\xi} + \boldsymbol{\varepsilon}] \tag{10}$$

Given the social network G, the covariates $\mathbf{X}$ and the correction $\boldsymbol{\xi}$, we can estimate the parameters of interest φ, α, $\boldsymbol{\beta}$, and ψ by Nonlinear Least squares (NLLS) using (10).[7]

Inference is complicated because the selectivity term $\boldsymbol{\xi}$ is a generated regressor from a previous estimation and no closed form solution is available for the NLLS standard errors estimates in a network context. We use bootstrapped standard errors with 500 replications. Because of the inherent structural dependency of network data, the design of the resampling scheme needs special consideration. The residuals in the vector $u = \left[I - \widehat{\phi}^* G\right]^{-1} \boldsymbol{\varepsilon}$ in (10) are not i.i.d., and thus one

[7] An OLS estimation of this system would not be consistent because of the simultaneity which is endemic in spatial autoregressive models (see, e.g., Anselin [1988]).

cannot sample with replacement from this vector. We thus use the residual bootstrap procedure in spatial econometrics (e.g., Anselin, 1990) where resampling is performed on the structural errors $\boldsymbol{\varepsilon}$, since they are assumed to be i.i.d. (see model (7)).[8]

3 Data

We measure each congressman's legislative performance using the Legislative Effectiveness Scores (LESs) for members of the U.S. House of Representatives, developed by Volden and Wiseman [2009]. Each member of Congress's score is based on how many bills each legislator introduces, as well as how many of those bills receive action in committee, pass out of committee and receive action of the floor of the House, pass the House, and ultimately become law. Data are available online by the Legislative Effectiveness Project (http://www.thelawmakers.org). Volden et al. [2013] have used it to explore the legislative effectiveness of women for the 93th - 110th Congresses. A similar index, Health ILESs, was proposed by Volden and Wiseman [2011] to examine which House members has been most successful to advance health care bills for the 93th to 110th Congresses. We use information from five recent election cycles: the 109th Congress (election cycle 2004) to the 113th Congress (election cycle 2012).

Consistent with existing theories of congressional politics, Volden and Wiseman [2009] argue that legislative effectiveness is a function of innate abilities, a cultivated set of skills, and institutional positions. The Legislative Effectiveness Project thus provides data on the observed legislators' characteristics that are theoretically important for lawmaking effectiveness. Nine factors are identified. The first one is the number of years served as a member of the Congress (*seniority*). As legislators spend more time in Congress, they are expected to become better, and more effective, at lawmaking. In our data, freshmen members of Congress have an average LES of 0.73 while it is 83% higher (1.33) for members in their fifth term. This pattern captures the idea that congressmen cultivate the set of skills needed to achieve effectiveness during their time in the Congress. The open question, however, is which skills they develop and in which ways. Our paper contributes to this debate by indicating that learning mechanisms are an important part of the story.

Consistent with the acquisition of skills over time, the second factor is previous *legislative*

[8] In practice, having in hand the residual vector u, the vector of structural errors are derived from $\boldsymbol{\varepsilon} = \left[I - \widehat{\phi}^{*} G\right] u$. They are thus resampled congress by congress.

experience. Legislators who have previously served in the state legislatures may be more effective than legislators without similar experiences.

The subsequent three factors (*party influence*, *committee influence*, and *legislative leadership*) capture the effect of institutional positions on the legislative process. The bills that they endorse are thus more likely to receive attention by their own (and other) parties and committees. By the same reasoning, committee chairs and members of the most powerful committees (Appropriation, Budget, Rules and Ways and Means) could also have greater legislative effectiveness. Volden and Wiseman [2009] find that the high level of effort required by the members of these committees, however, results in a number of endorsed bills which is lower that the average House member, thus making the relationship with their LES scores negative. Party leadership is also an important variable, with opposite effects for leaders of the majority or minority party. Majority party leaders are more likely to receive attention and have their bills pass the House. Minority Party leaders, in contrast, find it more difficult relative to other members of their party. Being Speaker of House may also result in less effectiveness, given then the LES score is based on how far legislators' bills advance in the legislative process and the Speaker of the House traditionally introduces few, if any, bills.[9]

The sixth factor captures ideological considerations. The Legislative Effectiveness Project data is merged with the http://voteview.com project data. It provides data on legislators' preferences for extreme or moderate policies. These preferences are captured by the absolute value of the first dimension of the *dw-nominate score* created by McCarty et al. [1997], which measures a legislator's distance to the center in terms of ideology. A number of legislative politics studies suggest a negative correlation between this variable and legislative success, reflecting idea that moderate policies obtain a larger consensus among the members of the House (see, e.g. Krehbiel [1992], Wiseman and Wright [2008]).

The seventh factor captures the *demographic characteristics* of under-represented members in Congress. The experiences of female and ethnic minority legislators in terms of effective lawmaking are different from the average congressmen, though the existing literature has not reached a consensus about the sign and the sources of these differences (Jeydel and Taylor [2003]; Volden and Wiseman [2009]; Volden et al. [2013]).

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[9] See Volden and Wiseman [2009] for further discussion about why Speakers of the House may be different from other legislators in terms of LES score.

The eighth factor is the *size of the congressional delegation*, which counts the number of districts in the state congressional delegation (and thus the number of congressmen in the House from the same state). Legislators coming from larger congressional delegations may be more effective since they can find coalition partners among the members of their delegations. In contrast, the presence of more legislators interested in the same issues (the interests of the state) may result in a lower number of bills advanced in the legislative process for each legislator. The last factor is built on the electoral competition. It is the margin of victory (i.e. the percentage of total votes that separated the congressman from the second-place finisher in the previous election). If voters value politicians' legislative effectiveness, then one would expect a positive relationship between legislators' levels of effectiveness and their margins of victory. The existence and sign of this relationship, however, is still a matter of debate. In fact, it is plausible to expect a negative correlation if electorally vulnerable legislators expend more energy to foster their agenda and increase support among voters. Alternatively, one may think that vulnerable legislators spend their energy on campaigning, while legislators in safe districts commit more time to the lawmaking process (see, e.g. Pedro I Miquel et al. [2006], Volden and Wiseman [2009]).

Our analysis considers all the legislator characteristics indicated in the Legislative Effectiveness Project. The control set X_r in model (10) includes the number of years spent in Congress, margin of victory, dw-ideology, the size of the state congressional delegation, party, chairmanship, majority and minority party leadership, whether the congressman is the Speaker of the House, gender and race. Because the information on previous legislative experience is missing for a large share of politicians, we add this control in a robustness check in Section 5.4 for the subsample of congressmen for whom the variable is available. The information on committee membership is also exploited in Section 5.4. While Volden and Wiseman (2009) use a dummy variable capturing membership in the most powerful committee, we include a full set of committee fixed effects as a robustness check. Members of the same committee who work on the same topic are likely to be connected in our network since they likely cosponsor the same bills and also likely to have similar LES scores. The committee fixed effects control for these common shocks.

We construct a legislative network using data on cosponsorship from the Library of Congress data information system, THOMAS (http://thomas.loc.gov). We use information on the 109th-113 Congresses. We collected all pieces of legislation proposed in these ten years and define two

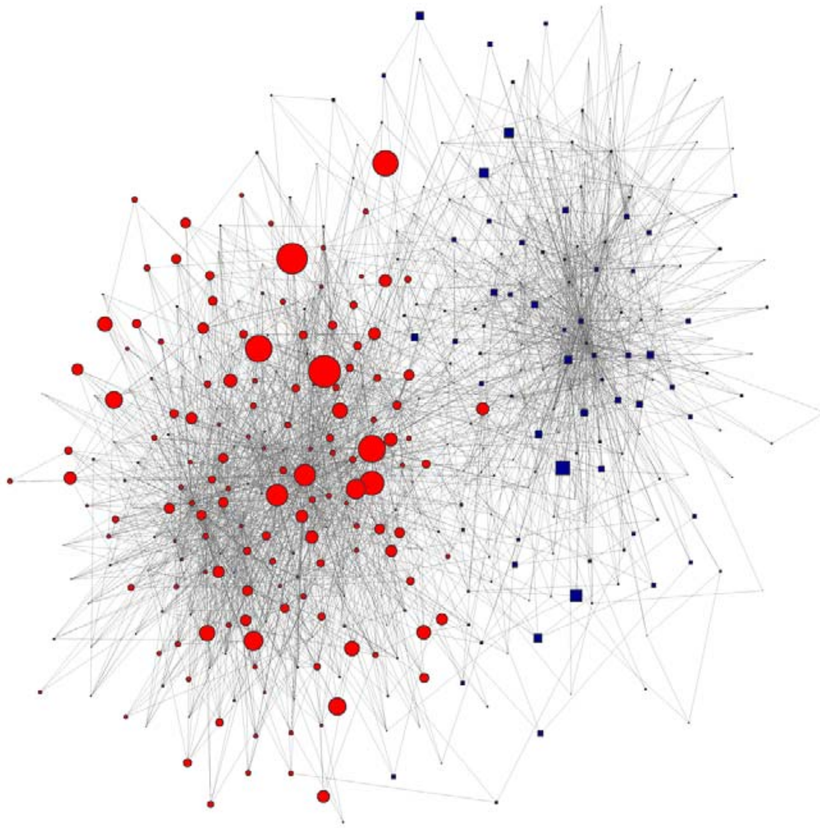

Figure 1: Legislative effectiveness and the cosponsorship network in the 113th Congress. Republicans are represented by circles, democrats by squares.

members of Congress as linked if they have cosponsored the same bill.[10] Each network includes roughly 433 Representatives (including midterm replacements). As a result, we obtain a sample of 2,176 connected congressmen. Figure 1 illustrates the cosponsorship network of the 113th U.S. Congress in a figure in which each node corresponds to a congressman and the size of the node is proportional to the LES of the associated congressman.[11]

[10] The same network definition has been used by Tam Cho and Fowler [2010] to investigate connections between topological characteristics of these Congressional networks and the production of important pieces of legislation. They use data for the 93th to the 108th Congresses. For the same Congresses, Fowler [2006a, 2006b] presents a more detailed description of each legislator's cosponsorship activities.

[11] The layout of the network was generated by the algorithm lgl (large graph layout) implemented in the R package "igraph" (see Csardi and Nepusz [2006]). To make the Figure clearer, we are plotting a link only for $g_{i,j}$ that are in the top 5% in terms of size. The two **a**gglomerations in Figure 1 correspond to *Democrats* and *Republicans*. Effectiveness levels are larger for Republicans because they constitute the majority in this congress.

To find a measure of social connections that is extraneous to the political process, we extract information on the universities attended by the congressmen using the Biographical Directory of the United States Congress (available online at http://bioguide.Congress.gov/biosearch/biosearch.asp) and construct a membership network based on educational experience.[12] Specifically, we match politicians to their colleges and universities. A tie between two congressmen exists if they graduated from the same institution within eight years of each other. By using alumni connections, we are able to link about forty percent of congressmen. Table A1 in the Appendix provides a detailed description of the variables used in this study, together with summary statistics for our sample.

4 Estimation Results

We begin our empirical analysis by showing that the alumni networks are still relevant even many years after the congressmen attended school. This exercise constitutes the first step of our analysis. Table 1 collects the OLS estimation results of model (8), with an incresing set of control variables. Table 1 shows that two politicians who attended the same educational institution are more likely to cosponsor the same piece of legislation than two politicians who attended different universities or the same university at different times, keeping constant similarities in terms of observed characteristics. We consider similarities in terms of seniority, vote share, party, ideology, chairmanship, party leadership, speaker, gender, race and Congress fixed effects.[13]

Table 2, Column (1) reports the OLS estimates of the traditional model in which campaign contributions are explained using only legislators' characteristics (ignoring the fact that congressmen are connected). This is the specification used by Volden and Wiseman [2009]. Although we use more recent data, most of the estimates remain in line with their findings. Table 2, Column (2) presents the NLLS estimates of our model (equation (7)). The estimates reveal a positive and statistically significant estimate of ϕ^*, which confirms the presence of externalities as predicted by our theory. We formally test whether the model fit improves with the addition of network effects

[12] We use academic institutions attended for both undergraduate and graduate degrees. In dealing with multiple campuses, we matched each satellite campus as a separate university (e.g., University of California at Los Angeles, San Diego, and Berkeley are treated as separate universities). We match specialized school to the university. We drop observations where a specialized school name could match multiple universities (e.g., School of Management).

[13] Our findings are in line with Cohen and Malloy's [2014] results showing that alumni networks help to explain voting patterns of Senators from the 101st to the 110th Congress.

(relative to the traditional linear regression in which $\phi^* = 0$) using a partial F-test.[14] The F-test rejects the hypothesis that the model with $\phi \neq 0$ does not provide a significantly better fit than the model with $\phi^* = 0$ ($p < 0.01$). In Column (3), we show the estimation results when controlling for network endogeneity (model (9)). It appears that the estimate of the selection correction term is statistically significant and negative. This is consistent with the presence of unobservable characteristics that are positively correlated with, say, legislator i's legislative effectiveness, but negatively with variables that affect other legislators' inclinations to cosponsor bills proposed by i (or viceversa). For example, i may have very specialized knowledge, so s/he sponsor only few bills, but very effectively. The partial F-test comparing the fit of the model without correction versus the fit of the model with correction shows that the fit of the model is further improved when adding the correction. The important result here is that the estimate of our target parameter ϕ maintains its statistical significance and positive sign.

The coefficients on most of the control variables are significant across models [Column (1)-Column (3)]. However, the interpretation and magnitude of these effects differs. Indeed, if $\phi^* > 0$ (in model (9)), then the marginal effect of the k-th covariate is not β_k, but $(I - \phi^* G)^{-1}(I\beta_k)$, which is an $n_r \times n_r$ matrix with its (i,j)-th element representing the effect of a change in x_{jk} on y_i. The important difference is that the marginal effects are heterogeneous across individuals, since they depend on the individual's position in the network. In Table 3, Panel (b) we show the magnitudes of the diagonal elements of this matrix [that is, the marginal effect of a change in x_{ik} for y_i, based on the estimates in Column (3) of Table 2]. We report the mean, standard deviation, minimum and maximum values. Panel (a) shows the OLS marginal effects, which can be compared to the mean values in Panel (b). In comparing the OLS estimates with the average effects of the model with network effects, we can see that the OLS estimates overestimate the effects of all of the legislators' characteristics. The OLS estimates are even higher than the maximum estimate from the model with network effects. For example, the OLS estimates suggest that being a committee chair is associated with an increase of 1.97 LES score points. This is higher than what is estimated in the network model with the strongest externalities (18% lower in magnitude). Thus this evidence suggests that the effects of the politicians' characteristics are capturing network

[14] Let RRS_1 define the residual sum of squares of the unrestricted model [Column (4)] and p_1 the number of parameters. Let RRS_2 the residual sum of squares of the restricted model [Column (5)], and p_2 the number of parameters. The partial F-test statistic $F = [(RRS_1 - RRS_2)/p_1 - p_2] / (RRS_1)/n - p_1$ will have an F distribution with $(p_1 - p_2, n - p_1)$ degree of freedom.

effects. Traditional estimates of the effects of these characteristics on legislative effectiveness which ignore those externalities risk overstating their importance by omitting a relevant variable, social connectedness.

Before turning to robustness checks and extensions, it is useful to compare the predictions of our model with the predictions we would have obtained if we attempted to establish the importance of network centrality using standard measures that are not backed by a theoretical analysis. There are two issues to discuss. The first is the effect of the traditional measures when endogeneity issues are taken into account. The second is how our analysis would change if we included these variables in our estimation.

Table 4 presents OLS estimates of the relationship between politicians' legislative effectiveness and Betweenness, Closeness and Eigenvalue centralities.[15] All control variables have the expected signs, consistent with Table 2, and it appears that a high connectedness score in the network of cosponsorship has a positive and significant impact in advancing agenda items [Columns (1), (3), and (5)]. This is consistent with Fowler [2006a], who studied the relation between centrality measures in the network of cosponsorship, and the number of amendments passed by each legislator in each Congress. However, when controlling for the unobserved factors related to agent's connectivity following our estimation strategy,[16] centrality measures are no longer significantly different from zero [Columns (2), (4) and (6)]. More importantly, when those centrality measures are included in a regression where network effects are modeled as predicted by the theory [Column (8)], they lose statistical significance: only the measure of network externality supported by Proposition 1, ϕ, seems to matter.

5 Discussions and extensions

In this section, we extend the basic model of Section 2 and the empirical analysis of Section 4 in many dimensions to investigate the determinants of legislative success and explore the robustness

[15] Degree centrality counts the total number of direct connections. Closeness centrality measures the length of the average shortest path passing between a node and each other node. Betweenness is equal to the number of shortest paths from all nodes to each other that passes through that node . Eigenvalue centrality of agent i is the ith component of the eigenvector associated to the highest eigenvalue of G. See Jackson [2008] for an introduction and detailed description of these measures.

[16] For each centrality measure, in the first step, a politician's centrality score in the cosponsorship network is explained as a function of individual characteristics and the centrality measure in the alumni network. The residuals of this regression are then used as a selection correction term in the second step regression when the LES score is explained by the centrality score (and controls).

of the results. In Section 5.1, we extend the model to allow for heterogeneous social spillovers that may depend on the legislators' characteristics. In Section 5.2, we explore the role of parties as a factor enhancing or inhibiting productive social connections. In Section 5.3, we investigate whether social connections matter more in early or late stages of the legislative process. In Section 5.4, we present a number of robustness checks of the baseline estimations.

5.1 Heterogeneity

In the previous analysis, we have assumed that the network externality is described by a single parameter, φ, that is the same for all agents. However, it is plausible to assume that network externalities are heterogeneous. For example, the degree to which an agent is "useful" to others may depend on whether or not the agent is a committee chair, has high seniority. The ability to "use" other legislators may also be heterogeneous. By extending the model to allow for these effects, we can study the determinants of these heterogeneous social externalities (which may be an important component of power in Congress).

To study this question let us generalize (1) to allow j's usefulness to depend on his characteristics:

$$E_i = A_i + \sqrt{\varphi_i \sum_j g_{i,j} \left(\eta_j \cdot E_j\right)} \cdot l_i \tag{11}$$

In (11) we allow for heterogeneity in social spillovers by splitting φ in $2n$ variables, $(\varphi_i)_{i=1}^n$ and $(\eta_j)_{j=1}^n$. The variable φ_i can be interpreted as measuring how legislator i's effectiveness is susceptible to the effectiveness of his socially connected peers: a legislator with a higher φ_i is able to better "use " all the other legislators whom he has befriended. The variable η_j, instead, describes how legislator j's effectiveness is useful to his socially connected peers: a legislator j with a higher η_j is more "useful" to all the legislators who have befriended him.

Following essentially the same steps as in Section 2.2, we can derive the analog of (4) for this more general model, obtaining:

$$E_i = A_i + \frac{1}{2}\varphi_i \sum_{j=1}^n g_{i,j} \cdot \eta_j E_j. \tag{12}$$

These equations can be expressed in matrix form as:

$$[I - \Phi \cdot G \cdot \Lambda] \cdot \mathbf{E} = \mathbf{A} \tag{13}$$

where Λ is a diagonal matrix with ith diagonal component equal to $\eta_i/\sqrt{2}$ and Φ is a diagonal matrix with ith diagonal element equal to $\varphi_i/\sqrt{2}$.

To bring (13) to the data, we assume:

$$\begin{aligned}\varphi_i &= \sqrt{2}(\theta_0 + Z_i'\boldsymbol{\theta}_1) \\ \eta_j &= \sqrt{2}(\gamma_0 + K_j'\boldsymbol{\gamma}_1)\end{aligned} \tag{14}$$

where $Z_i = (z_i^1, , ..., z_i^k)$ is a vector of characteristics of j, θ_0, $\boldsymbol{\theta}_1 = (\theta^1, , ..., \theta^k)$ and γ_0, $\boldsymbol{\gamma}_1 = (\gamma^1, , ..., \gamma^k)$ are coefficients. To interpret (14), imagine that the lth component of $\boldsymbol{\theta}_1$ and $\boldsymbol{\gamma}_1$ is seniority. Then $\theta^l > 0$ (respectively, $\theta^l < 0$) means that the seniority of a legislator increases (resp., reduces) the ability of the legislator "use " the effectiveness of his socially connected peers; $\gamma^l > 0$ (resp., $\gamma^l < 0$) means that seniority of a legislator increases (resp., reduces) the usefulness of the effectiveness a legislator to his socially connected peers.

Once we insert (14) in (13), the parameters of the model can be again jointly estimated using NLLS as in the estimation of (9).

The estimation of (13), in which we include the legislators' personal characteristics (the Z variables), are presented in Tables 5a and 5b. We find that ethnic minorities appear to benefit more than the average congressmen from social interactions, whereas congressmen with higher seniority and committee chairs receive less benefits form interacting with others than other members of the Congress.

5.2 The influence of parties

An important political factor which deserves special attention is the role of parties in fostering or hindering social connections among legislators. For example, is it more useful for a Republican to befriend a fellow Republican or to befriend a Democrat? A natural conjecture is that intraparty connections are more useful than interparty connections, especially in the polarized landscape that has developed in Congress since the 1970s. However, having some support from the other party may be essential to advance bills through the legislative process. Addressing this question is paramount for understanding the role of social connections in Congress.

To allow for party effects, let us reorder the legislators in congress r so that the first n_R are Republicans and the second $n_D = n - n_R$ are Democrats. The matrix G can now be divided into four submatrices. The top left $n_R \cdot n_R$ dimensional submatrix collects the interactions of Republicans with fellow Republicans; the bottom right $n_D \cdot n_D$ dimensional submatrix collects the interactions of Democrats with fellow Democrats; the top right $n_R \cdot n_D$ dimensional submatrix shows the influence of Democrats on Republicans (i.e. $g_{i,j,r}$ where j is Democrat and i Republican); and finally the bottom left $n_D \cdot n_R$ dimensional submatrix shows the influence of Republicans on Democrats (i.e. $g_{i,j,r}$ where j is Republican and i Democrat).

We can now decompose G_r in two $n \times n$ matrices G_r^* and G_r^{**} with $G_r = G_r^* + G_r^{**}$, where G_r^* is a matrix that has the same top left and bottom right components as G_r and it is zero otherwise and G_r^{**} is a matrix that has the same bottom left and top right components as G_r and it is zero otherwise. Given this, we can extend the basic model by assuming:

$$E_{i,r} = A_i + \sqrt{\varphi^* \sum_j g_{i,j,r}^* \cdot E_{j,r} + \varphi^{**} \sum_l g_{i,l,r}^{**} \cdot E_l} \cdot l_{i,r} \tag{15}$$

In (15) we are distinguishing between the effects of intraparty and interparty social connections, allowing them to be different: if the impact of i's effectiveness on a legislator of the same party is greater (resp. smaller) than that of a legislator of a different party, then we should see $\varphi^* > \varphi^{**}$ (resp., $\varphi^* < \varphi^{**}$). If we impose $\varphi^* = \varphi^{**}$, we are back at the baseline model (9).

Starting from (15), we can easily derive:

$$E_{i,r} = A_i + \frac{1}{2}\left[\varphi^* \sum_j g_{i,j,r}^* \cdot E_{j,r} + \varphi^{**} \sum_l g_{i,l,r}^{**} \cdot E_{l,r}\right]. \tag{16}$$

that in matrix form becomes:

$$\mathbf{E}_r = \left[I - \frac{1}{2}\left(\varphi^* G_r^* + \varphi^{**} G_r^{**}\right)\right]^{-1} \cdot \left[\alpha \cdot \mathbf{1} + X_r \boldsymbol{\beta} + \boldsymbol{\varepsilon}_r\right] \tag{17}$$

Given the social network G_r, from which we can easily construct G_r^* and G_r^{**}, and the covariates X_r, we can now estimate (17) as before by NLLS.

Table 6 shows the estimation results. The results appear to favor the hypothesis that being able to find support from outside one's own party is very useful, a result that appears in line with many informal accounts of how Congress works in practice.[17] It is interesting to note that the increasing polarization of politics in the U.S. Congress since the 1970s was paired by a drastic reduction in its aggregate productivity (see, for example, Mann and Orstein [2016] on this). The results of Table 6 may contribute to an understanding of why the increase in polarization has led to a reduction in aggregate productivity.

[17] Formal accounts on the importance of bridging gaps between parties include the biographies of notable legislators such as Speaker of the House Tip O'Neill (see O'Neil [1988] and Matthews [2013]), Senator Ted Kennedy (see Canellos [2009]), and Representative (and then Senator and President) Lyndon Johnson (see Caro [2003]).

5.3 Timing of interactions

In this section, we investigate whether network effects are more important in the early or late stages of the legislative process. We follow the classification presented by Volden and Wiseman [2009] who categorize bills as follows: bills proposed in the House of Representatives (BILL); bills that received any action in committee (AIC); and bills that received some action beyond the committee stage, distinguishing here between those that have passed (PASS) in the House, those that have not passed in the House (ABC), and those that have become law (LAW). The Legislative Effectiveness score (LES) that we used in the previous analysis is calculated by averaging the five indicators (BILL, AIC, ABC, PASS, LAW) and then normalizing so that the average LES takes a value of 1 in each congress. (The fraction of bills in each category is weighted by the category's importance.)[18] We now perform the same analysis considering each class separately.

Table 7 collects the NLLS estimations of (9) when the LES score is decomposed in order to isolate the congressmen's effectiveness at different stages of the legislative process. In Columns (1) and (2), the dependent variable measures the congressmen's effectiveness at the very early stages of the legislative, i.e. when effectiveness is calculated using only bills categorized as BILL. In Columns (3) and (4), the dependent variable is effectiveness computed using the bills in BILL and the bills deemed as AIC, thus capturing effectiveness at the next step in the legislative process. Finally, in Columns (5) and (6), the dependent variable is effectiveness of congressmen at the later stages of the legislative process. In this case the dependent variable is calculated including all bills that received any action beyond the committee stage on the floor of the House (ABC, PASS, LAW). The three dependent variables (BILL, BILL+AIC, ABC+PASS+LAW) are normalized so that their average take a value of 1 in each congress.

The results in Table 7 show that network effects are positive and significant for all stages of the legislative process. Interestingly, looking at the control variables one can see that the characteristics making legislators effective change along the stages of the legislative process. More senior congressman, committee chairs, and minority leaders acquire a sizable premium importance

[18] Volden and Wiseman [2009] categorize a bill's relevance in three groups: i) commemorative (C), ii) substantive and significant (SS), iii) substantive (S). A bill is deemed commemorative (C) when its subject is a provision for a renaming, a commemoration, the private relief of an individual, and the like. A bill is deemed substantive and significant (SS) if it had been the subject of an end-of-the-year write-up in the Congressional Quarterly Almanac. Finally, all other bills, and any "commemorative" bills that were also the subject of a CQ Almanac write-up are classified as substantive (S). Bills assigned to the substantive and significant category are counted 10 times more than those in the commemorative category, and twice as much as those in the substantive category.

at a later stage of the legislative process. Legislators with more extreme ideologies are more active in proposing bills, but their extremism does not help in advancing those bills through the legislative process. Finally, we observe that females are more penalized in the early stages.

5.4 Other robustness checks

To control for unobserved factors that may affect the parameter estimates in (9) and are not captured by our Heckman correction, in Columns (1) and (2) of Table 8 we include in our model (9) dummies for all the congressional committees (21 dummies). Committees are an important institutional feature of the legislative process and have been shown to be an important determinant of social connections (see, for example, Caldeira and Patterson [1987], Caldeira et al. [1993] and Arnold et al. [2000]).[19] As shown in the table, the estimates barely change, confirming the robustness of the results. Interestingly, the importance of unobserved factors remains statistically different from zero, signaling that unobserved factors that simultaneously affect politicians' legislative activity and patterns of cosponsorships are not the same for all members of a given committee.

We conclude this section by adding in the control set of the congressman's previous legislative experience. This is one of the nine factors indicated by Volden and Wiseman [2009] as drivers of legislative effectiveness. The Legislative Effectiveness Project dataset, however, does not report this information for about 20% of the politicians in our sample. Therefore we did not include it in our previous analysis to preserve the sample size. In Columns (3) and (4) of Table 8 we report the estimation results of model (9) when it is run on the subsample of congressmen for which this information is available. Previous legislative effectiveness is captured using a dummy taking value one whether a legislator has previously served in the state legislature (and 0 otherwise) and its interaction with the state's level of professionalism (see, e.g. Squire [1992]). Table 8 shows that our results hold true, and the point estimates are very close in magnitude to the ones in Table 2, Columns (2) and (3). Columns (5) and (6) of Table 8 show the results with committee dummies. Again, the estimates of the externality remain positive and statistically significant, indicating that

[19] Caldeira et al. [1993] find that representatives who share committee assignments are more likely to identify one another as a "friend" or "respected legislator," and that the probability of social bonds increases with the number of shared assignments. As noted by Caldeira et al. [1993], "the business of the legislature largely happens in its committees and subcommittees, where legislators become familiar with and take a measure of colleagues in a task-oriented environment. Legislators on the same committees or subcommittees share substantive interests and common workloads, so they have good reasons for establishing a relationship" (p. 12).

our evidence of network effects is not driven by common shocks at the level of the committee.

6 Conclusions

This paper presents a simple theory of legislative effectiveness in which a legislator's performance depends not only on his own characteristics and effort, but also on the legislative effectiveness of the legislators with whom he has social connections. Using data from five recent Congresses, we structurally estimate this model and test for the importance of social connections in determining legislative effectiveness.

Consistent with the theory, we find that congressmen's weighted Bonacich centralities have a significant effect on their levels of legislative effectiveness. Moreover, we find that controlling for the endogeneity of the network connections has important implications. If we ignore network endogeenity, then all measures of congressmen's network centralities are significant predictors of their levels of legislative effectiveness, leading to spurious correlations. Most measures of centrality, however, are not significant when we control for network endogeneity. The centrality measure suggested by our model remains significant not only when we control for endogeneity, but also when we include committee fixed effects and, importantly, when we include all other standard measures of centrality as controls in a "horse race."

With our framework, we can also study the sources of social influence by allowing for heterogeneous network effects. We find that ethnic minorities appear to benefit more than the average congressmen from social interactions, whereas congressmen with higher seniority and committee chairs receive less benefits form interacting with others than other members of the Congress. When we focus on the role of parties, we find that connections with those outside one's own party are more important than connections within one's own party, supporting the hypothesis that more effective legislators are those able to find support from outside their own party. Finally, we find that network effects are significant in all stages of the legislative process, but they appear to become more important in the later stages.

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TABLE 1. NETWORK FORMATION

	Dep. Var.: Link in Co-sponsorship network		
	(1)	**(2)**	**(3)**
Link in Alumni network	4.4519*** (0.2021)	3.8658*** (0.1941)	3.8561*** (0.194)0
Gender (1=Female)		-0.1128*** (0.0103)	-0.1048*** (0.0103)
No White (1=Yes)		0.3834*** (0.011)	0.3894*** (0.0111)
Party (1 = Democrat)		2.165*** (0.0098)	2.1663*** (0.0099)
Seniority		-0.0309*** (0.0011)	-0.0303*** (0.0011)
Vote Share		-0.4682*** (0.0209)	-0.496*** (0.0209)
Distance to the Median		-1.5762*** (0.0264)	-1.5496*** (0.0264)
Size of Congr. Deleg.		-0.0175*** (0.0003)	-0.0174*** (0.0003)
Committee Chair (1 = Yes)		-0.6119*** (0.0165)	-0.6226*** (0.0165)
Majority Leader (1 = Yes)			-0.5416*** (0.0213)
Minority Leader (1 = Yes)			-0.1818*** (0.0216)
Speaker (1 = Yes)			0.5620*** (0.0757)
Congress fixed effects	Yes	Yes	Yes
R2	0.0007	0.0791	0.0799
N. obs.	945,382	945,382	945,382

Notes. OLS estimated coefficients (multiplied by hundreds) are reported. An intercept is included. Standard errors (in parentheses) are clustered by dyad. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level.

TABLE 2. MAIN ESTIMATES

	Dep. Var.: Legislative Effectiveness Score (LES)		
	(1)	**(2)**	**(3)**
Φ		0.4448*** (0.0233)	0.8324*** (0.0516)
Gender (1=Female)	0.0128 (0.0493)	-0.0257 (0.045)	-0.0310 (0.0830)
No White (1=Yes)	-0.1643** (0.0577)	-0.1588** (0.0511)	-0.1088 (0.0929)
Party (1 = Democrat)	-0.2762*** (0.0605)	-0.179*** (0.0497)	-0.1166 (0.105)
Seniority	0.0251*** (0.0052)	0.0177*** (0.0047)	0.0229** (0.0102)
Vote Share	0.2193** (0.0877)	0.0781 (0.0806)	-0.0018 (0.1095)
Distance to the Median	-0.4084** (0.1276)	-0.4228*** (0.1132)	-0.3204* (0.1903)
Size of Congr. Deleg.	-0.0048*** (0.0011)	-0.0048*** (0.001)	-0.0034* (0.0020)
Committee Chair (1 = Yes)	1.9669*** (0.1147)	1.8693*** (0.105)	1.6107*** (0.1545)
Majority Leader (1 = Yes)	0.4083** (0.125)	0.182 (0.1167)	-0.0494 (0.1566)
Minority Leader (1 = Yes)	-0.3910*** (0.1143)	-0.3972*** (0.105)	-0.2944 (0.1799)
Speaker (1 = Yes)	-0.3563 (0.8745)	-0.8245 (0.7732)	-1.2605 (0.9538)
Unobservables (ξ)			-0.4133*** (0.0741)
Intercept	0.9976*** (0.0938)	0.6930*** (0.0786)	0.2531* (0.149)
Congress fixed effects	Yes	Yes	Yes
Partial F test (ϕ=0) *p-value*		350.81*** [2.2e-16]	59.51*** [1.8e-14]
N. Obs	2,176	2,176	2,176

Notes. NLLS estimated coefficients are reported in columns (2)-(3). OLS estimated coefficients are reported in column (1). Robust standard errors (in parentheses) are reported in columns (1) and (2). Standard errors in column (3) are bootstrapped with 500 replications. A precise definition of control variables can be found in Table A.1. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level.

TABLE 3. EFFECTS OF EXOGENOUS VARIABLES

	No Network Effects Panel (a)	*With Network Effects* Panel (b)					
		Direct Effects			Indirect Effects		
		mean	*max*	*min*	*mean*	*max*	*min*
Gender (1=Female)	0.0128	-0.0314	-0.0310	-0.0335	-0.0004	0.0000	-0.0117
No White (1=Yes)	-0.1643	-0.1100	-0.1088	-0.1176	-0.0012	0.0000	-0.0409
Party (1 = Democrat)	-0.2762	-0.1179	-0.1166	-0.1260	-0.0013	0.0000	-0.0439
Seniority	0.0251	0.0231	0.0247	0.0229	0.0003	0.0086	0.0000
Vote Share	0.2193	-0.0019	-0.0018	-0.0020	0.0000	0.0000	-0.0007
Distance to the Median	-0.4084	-0.3241	-0.3204	-0.3464	-0.0037	0.0000	-0.1205
Size of Congr. Deleg.	-0.0048	-0.0034	-0.0034	-0.0037	0.0000	0.0000	-0.0013
Committee Chair (1 = Yes)	1.9669	1.6292	1.7412	1.6107	0.0185	0.6060	0.0000
Majority Leader (1 = Yes)	0.4083	-0.0499	-0.0494	-0.0534	-0.0006	0.0000	-0.0186
Minority Leader (1 = Yes)	-0.39100	-0.2978	-0.2944	-0.3183	-0.0034	0.0000	-0.1108
Speaker (1 = Yes)	-0.3563	-1.2750	-1.2605	-1.3627	-0.0145	0.0000	-0.4743

Notes. Panel (a) reports the OLS estimates in Table 2, column (1). Panel (b) reports NLLS estimates in Table 2, column (3).

TABLE 4. HORSE RACE

	Dep. Var.: Legislative Effectiveness Score (LES)						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Centrality Measure:							
Betweenness	0.0079*** (0.0007)	-0.2599 (0.1662)					-0.0395 (0.1917)
Closeness			0.0011*** (0.0001)	0.0085 (0.0086)			0.0041 (0.017)
Eigenvector					0.1203*** (0.0073)	-0.4122 (0.2500)	-0.4813 (0.3908)
Φ							0.7095*** (0.0817)
Gender (1=Female)	0.0197 (0.0481)	0.7488 (0.491)	0.0087 (0.0472)	-0.1919 (0.2315)	-0.0131 (0.0465)	0.2023* (0.1101)	-0.0607 (1.1479)
No White (1=Yes)	-0.1491** (0.0563)	-1.0094* (0.5806)	-0.152** (0.0553)	0.4184 (0.6835)	-0.1345** (0.0544)	-0.5547** (0.2032)	-0.0634 (2.0651)
Party (1 = Democrat)	-0.2342*** (0.0591)	-0.6011** (0.2532)	-0.2407*** (0.058)	-0.26*** (0.0521)	-0.2218*** (0.0571)	-0.1815*** (0.0525)	-0.0385 (0.434)
Seniority	0.0227*** (0.0051)	0.1232* (0.0683)	0.0212*** (0.005)	-0.0029 (0.029)	0.0208*** (0.0049)	0.0373*** (0.0096)	0.0076 (0.1516)
Vote Share	0.1759** (0.0856)	1.6545* (1.0001)	0.1395* (0.0842)	-0.3838 (0.6263)	0.0726 (0.0832)	0.6508** (0.2825)	0.0153 (2.5583)
Distance to the Median	-0.349** (0.1246)	-0.8424** (0.3548)	-0.3752** (0.1223)	-0.5176** (0.1935)	-0.3327** (0.1204)	-0.2431** (0.1088)	-0.2426 (0.6088)
Size of Congr. Deleg.	-0.0051*** (0.0011)	0.0257 (0.0209)	-0.0054*** (0.0011)	-0.0152 (0.0116)	-0.0054*** (0.0011)	0.0018 (0.0036)	-0.0075 (0.0507)
Committee Chair (1 = Yes)	1.9779*** (0.1118)	2.3234*** (0.2753)	1.9119*** (0.1099)	1.2324 (0.8192)	1.8769*** (0.1082)	2.4862*** (0.3251)	1.8036 (1.9863)
Majority Leader (1 = Yes)	0.3565** (0.1219)	0.0258 (0.2493)	0.2373** (0.1204)	-0.7899 (1.2353)	0.1712 (0.1187)	1.1042** (0.4593)	0.3422 (2.5992)
Minority Leader (1 = Yes)	-0.4046*** (0.1114)	-0.8726** (0.3223)	-0.4022*** (0.1095)	-0.3849*** (0.1096)	-0.3385** (0.1078)	-0.6183*** (0.177)	-0.4875 (0.6070)
Speaker (1 = Yes)	-0.1024 (0.8528)	-8.1598 (5.5727)	-0.1973 (0.8377)	0.963 (1.5138)	-0.1043 (0.8243)	-1.1973 (0.7647)	-0.2851 (10.8160)
Unobservables (ξ)							
Between		0.0027 (0.0018)					-0.0440 (0.1916)
Closeness				-0.0074 (0.0086)			-0.0042 (0.017)
Eigenvector						0.5323** (0.25)	0.5152 (0.3856)
Φ							-0.2891*** (0.0858)
Intercept							-4.4950 (26.7543)
Congress fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. Obs.	2,176	2,176	2,176	2,176	2,176	2,176	2,176

Notes. OLS estimated coefficients and standard errors (in parentheses) are reported in columns (1)-(6). NLLS estimated coefficients are reported in column (7). In columns (2), (4), (6), and (7) standard errors are bootstrapped with 500 replications. Estimates for betweeness, closeness and eigenvector centralities are multiplied respectively by 100, 10,000 and 10,000. A precise definition of control variables can be found in Table A.1. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level.

TABLE 5a. HETEROGENEOS EFFECTS

	Dep. Var.: Legislative Effectiveness Score (LES)							
	Gender (1 = Female)		No White (1=Yes)		Party (1=Democrat)		Seniority	
	φ	η	φ	η	φ	η	φ	η
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
θ_0	0.8413*** (0.0572)		0.8535*** (0.0599)		0.8322*** (0.071)		0.6172*** (0.1004)	
θ_1	0.0345 (0.1014)		0.1584* (0.0955)		-0.0003 (0.0896)		-0.0339** (0.0123)	
γ_0		0.8409*** (0.1011)		0.8432*** (0.094)		0.8121*** (0.0937)		0.7191** (0.2944)
γ_1		0.0523 (0.4724)		0.0735 (0.3823)		-0.0458 (0.1198)		-0.0159 (0.0365)
Gender (1=Female)	-0.0006 (0.0929)	-0.0289 (0.0808)	-0.0423 (0.0792)	-0.0310 (0.0825)	-0.0310 (0.0776)	-0.0328 (0.0885)	-0.0352 (0.0821)	-0.0326 (0.0887)
No White (1=Yes)	-0.1101 (0.0931)	-0.1096 (0.0925)	0.0302 (0.0994)	-0.1031 (0.0877)	-0.1088 (0.1034)	-0.1064 (0.0918)	-0.1063 (0.0991)	-0.1062 (0.0999)
Party (1 = Democrat)	-0.1138 (0.1046)	-0.111 (0.1058)	-0.1169 (0.0975)	-0.1071 (0.1096)	-0.1169 (0.1076)	-0.1447 (0.1004)	-0.141 (0.1131)	-0.1386 (0.1025)
Seniority	0.0230** (0.0101)	0.0230** (0.0093)	0.0226** (0.0094)	0.0230** (0.0101)	0.0229** (0.0094)	0.0225** (0.0094)	-0.0023 (0.0108)	0.0216** (0.0098)
Vote Share	-0.0032 (0.1101)	-3e-04 (0.1204)	-0.0095 (0.1051)	0.0018 (0.1198)	-0.0019 (0.1122)	-0.0055 (0.1051)	0.0148 (0.124)	-0.0033 (0.1201)
Distance to the Median	-0.3163* (0.1901)	-0.3175 (0.2041)	-0.3292* (0.1908)	-0.3147 (0.2061)	-0.3205* (0.1942)	-0.3267* (0.1907)	-0.3231 (0.2087)	-0.327* (0.1864)
Size of Congr. Deleg.	-0.0034* (0.002)	-0.0034* (0.002)	-0.0034* (0.002)	-0.0034 (0.0021)	-0.0034* (0.002)	-0.0034 (0.0022)	-0.0035* (0.0019)	-0.0036* (0.0021)
Committee Chair (1 = Yes)	1.6084*** (0.1547)	1.6104*** (0.1569)	1.6225*** (0.1443)	1.61*** (0.1517)	1.6106*** (0.1472)	1.6102*** (0.1512)	1.5222*** (0.1662)	1.6105*** (0.153)
Majority Leader (1 = Yes)	-0.0435 (0.1569)	-0.0493 (0.1769)	-0.0608 (0.1794)	-0.0516 (0.1758)	-0.0494 (0.1742)	-0.0517 (0.1746)	-0.0525 (0.1706)	-0.049 (0.1802)
Minority Leader (1 = Yes)	-0.2896 (0.1820)	-0.2942 (0.1891)	-0.3176 (0.199)	-0.2953 (0.1895)	-0.2944 (0.1941)	-0.2907* (0.1763)	-0.2766 (0.1855)	-0.2951 (0.185)
Speaker (1 = Yes)	-1.2844 (0.959)	-1.2558 (1.0026)	-1.0359 (0.9756)	-1.2589 (1.0046)	-1.2608 (1.0214)	-1.264 (0.9428)	-1.2837 (1.0739)	-1.3571 (0.9692)
Unobservables (ξ)	-0.4121*** (0.0731)	-0.4134*** (0.0759)	-0.3895*** (0.0754)	-0.4146*** (0.0915)	-0.4133*** (0.0783)	-0.4148*** (0.082)	-0.4252*** (0.0796)	-0.411*** (0.0854)
Intercept	0.2426* (0.147)	0.2454* (0.1424)	0.2362 (0.1469)	0.2379 (0.1688)	0.2533 (0.1565)	0.2795* (0.1484)	0.4118** (0.166)	0.2832* (0.1583)
Congress fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. Obs	2,176	2,176	2,176	2,176	2,176	2,176	2,176	2,176

Notes. NLLS estimated coefficients and bootstrapped standard errors with 500 replications (in parentheses) are reported. A precise definition of control variables can be found in Table A.1. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level. According to the theoretical equation (15), θ_0 and θ_1 indicate how susceptible legislator i's effectiveness is, while γ_0 and γ_1 indicate the influence of legislator i on other legislators' effectiveness.

TABLE 5b. HETEROGENEOUS EFFECTS

	Dep. Var.: Legislative Effectiveness Score (LES)							
	Vote Share		**Distance to the Median**		**Size of Congr. Deleg.**		**Committee chair**	
	φ	η	φ	η	φ	η	φ	η
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
θ_0	0.8672*** (0.0920)		0.8672*** (0.0920)		0.9017*** (0.0824)		0.7865*** (0.0532)	
θ_1	0.0777 (0.1315)		0.0777 (0.1315)		0.0031 (0.0021)		-0.5981*** (0.1588)	
γ_0		0.8509*** (0.2475)		0.8509*** (0.2475)		0.7237** (0.2519)		0.6740*** (0.1806)
γ_1		0.0393 (0.4525)		0.0393 (0.4525)		-0.0052 (0.0107)		-0.4420 (0.4617)
Gender (1=Female)	-0.0320 (0.0773)	-0.0309 (0.0855)	-0.0320 (0.0773)	-0.0309 (0.0855)	-0.0398 (0.0756)	-0.0336 (0.0845)	-0.0285 (0.0873)	-0.026 (0.0822)
No White (1=Yes)	-0.1109 (0.0984)	-0.1081 (0.0959)	-0.1109 (0.0984)	-0.1081 (0.0959)	-0.1009 (0.0889)	-0.1089 (0.0956)	-0.1069 (0.095)	-0.1225 (0.0952)
Party (1 = Democrat)	-0.1089 (0.0946)	-0.1127 (0.0944)	-0.1089 (0.0946)	-0.1127 (0.0944)	-0.1107 (0.1106)	-0.1283 (0.1096)	-0.1214 (0.0987)	-0.1147 (0.1065)
Seniority	0.0227** (0.0096)	0.0229** (0.0097)	0.0227** (0.0096)	0.0229** (0.0097)	0.0227** (0.0093)	0.0225** (0.0097)	0.0235** (0.0092)	0.0228** (0.0112)
Vote Share	0.0621 (0.1375)	0.0009 (0.1216)	0.0621 (0.1375)	0.0009 (0.1216)	-0.0018 (0.1178)	-0.0032 (0.1169)	0.0237 (0.1193)	0.003 (0.1224)
Distance to the Median	-0.3094* (0.1713)	-0.3171* (0.1895)	-0.3094* (0.1713)	-0.3171* (0.1895)	-0.3242 (0.2036)	-0.3304* (0.1976)	-0.3407* (0.1908)	-0.3291 (0.2098)
Size of Congr. Deleg.	-0.0034* (0.002)	-0.0034* (0.002)	-0.0034* (0.002)	-0.0034* (0.002)	-0.0009 (0.0022)	-0.0040* (0.0022)	-0.0039** (0.0019)	-0.004* (0.0021)
Committee Chair (1 = Yes)	1.6117*** (0.1587)	1.6099*** (0.1615)	1.6117*** (0.1587)	1.6099*** (0.1615)	1.6404*** (0.1548)	1.6113*** (0.1449)	0.8194*** (0.2361)	1.6078*** (0.159)
Majority Leader (1 = Yes)	-0.0471 (0.1738)	-0.0503 (0.1709)	-0.0471 (0.1738)	-0.0503 (0.1709)	-0.0545 (0.1796)	-0.0413 (0.1819)	-0.0372 (0.1612)	-0.0381 (0.1683)
Minority Leader (1 = Yes)	-0.3013 (0.1836)	-0.2953 (0.1835)	-0.3013 (0.1836)	-0.2953 (0.1835)	-0.3076* (0.186)	-0.2934 (0.1962)	-0.3057 (0.1918)	-0.2877 (0.1868)
Speaker (1 = Yes)	-1.2874 (1.0309)	-1.2560 (1.0101)	-1.2874 (1.0309)	-1.2560 (1.0101)	-1.0870 (0.9838)	-1.3166 (0.9493)	-1.3037 (0.9429)	-1.1575 (0.9107)
Unobservables (ξ)	-0.4163*** (0.0854)	-0.4165*** (0.105)	-0.4163*** (0.0854)	-0.4165*** (0.105)	-0.3954*** (0.0685)	-0.4049*** (0.0951)	-0.4200*** (0.0726)	-0.3341** (0.1201)
Intercept	0.2149* (0.1233)	0.2447 (0.1512)	0.2149* (0.1233)	0.2447 (0.1512)	0.1998 (0.1506)	0.2892 (0.1883)	0.2920** (0.1473)	0.3498* (0.1824)
Congress fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. Obs.	2,176	2,176	2,176	2,176	2,176	2,176	2,176	2,176

Notes. NLLS estimated coefficients and bootstrapped standard errors with 500 replications (in parentheses) are reported. A precise definition of control variables can be found in Table A.1. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level. According to the theoretical equation (14), θ_0 and θ_1 indicate how how susceptible legislator i's effectiveness is, while γ_0 and γ_1 indicate the influence of legislator i on other legislators' effectiveness.

TABLE 6. PARTY EFFECTS

	Dep. Var.: Legislative Effectiveness Score (LES)		
	(1)	**(2)**	**(3)**
*G***	1.5984*** (0.4742)	0.8583*** (0.2409)	0.8668*** (0.2136)
*G**	1.4208*** (0.1000)	0.8535*** (0.0605)	0.8346*** (0.0584)
Gender (1=Female)		-0.0335 (0.0802)	-0.0304 (0.0850)
Non White (1=Yes)		-0.1053 (0.0911)	-0.1071 (0.0919)
Party (1 = Democrat)		-0.1177 (0.1109)	-0.1145 (0.0972)
Seniority		0.0216 (0.0093)	0.0228 (0.0094)
Vote Share		-0.0010 (0.1166)	-0.0019 (0.1074)
Distance to the Median		-0.3192 (0.1975)	-0.3100 (0.1889)
Size of Congr. Deleg.		-0.0034* (0.0020)	-0.0034* (0.0019)
Committee Chair (1 = Yes)		1.6195*** (0.1509)	1.6097*** (0.1431)
Majority Leader (1 = Yes)			-0.0498 (0.1772)
Minority Leader (1 = Yes)			-0.2973 (0.2030)
Speaker (1 = Yes)			-1.2540 (0.9746)
Unobservables (ξ)	-0.8558*** (0.1432)	-0.4368*** (0.0954)	-0.4216*** (0.1000)
Intercept	-0.4075*** (0.1191)	0.2295 (0.1522)	0.2384 (0.1543)
Congress fixed effects	Yes	Yes	Yes
N. Obs.	2,176	2,176	2,176

Notes. NLLS estimated coefficients and bootstrapped standard errors with 500 replications (in parentheses) are reported. A precise definition of control variables can be found in Table A.1. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level. G^* and G^{**} are the within-party and between-party co-sponsorship networks in the theoretical equation (15).

TABLE 7 LEGISLATIVE EFFECTIVENESS AT DIFFERENT STAGES OF LEGISLATIVE PROCESS

	Dep. Var.: BILL		Dep. Var.: BILL + AIC		Dep. Var.: ABC + PASS + LAW	
	(1)	(2)	(3)	(4)	(5)	(6)
Φ	0.4093***	0.5634***	0.4283***	0.8387***	0.4765***	0.8643***
	(0.0161)	(0.0539)	(0.0177)	(0.0465)	(0.0312)	(0.0767)
Gender (1=Female)	-0.0973**	-0.1054*	-0.0722**	-0.0829	-0.0162	-0.0167
	(0.0332)	(0.0566)	(0.0358)	(0.0682)	(0.0587)	(0.1076)
No White (1=Yes)	-0.1687***	-0.1461**	-0.1376***	-0.0834	-0.1901**	-0.1401
	(0.0377)	(0.0713)	(0.0407)	(0.0756)	(0.0665)	(0.1274)
Party (1 = Democrat)	0.2556***	0.2468***	0.0225	0.0468	-0.1808**	-0.1094*
	(0.0367)	(0.0479)	(0.0395)	(0.0722)	(0.0643)	(0.1300)
Seniority	0.0053	0.0063	0.0066*	0.0115**	0.0255***	0.0315***
	(0.0034)	(0.0051)	(0.0037)	(0.0072)	(0.006)	(0.0140)
Vote Share	-0.0616	-0.0779	0.0434	-0.0365	0.0515	-0.0352
	(0.0592)	(0.0666)	(0.0641)	(0.0815)	(0.1051)	(0.1497)
Distance to the Median	0.2062**	0.2199**	-0.0758	-0.0091	-0.3259**	-0.2279
	(0.0835)	(0.0945)	(0.0902)	(0.1464)	(0.1472)	(0.2439)
Size of Congr. Deleg.	-0.0035***	-0.0030**	-0.0041***	-0.0025	-0.0049***	-0.0036
	(0.0007)	(0.0011)	(0.0008)	(0.0016)	(0.0013)	(0.0027)
Committee Chair (1 = Yes)	0.0614	-0.0152	1.0509***	0.8044***	2.4852***	2.1891***
	(0.0769)	(0.0649)	(0.0833)	(0.0958)	(0.1372)	(0.2213)
Majority Leader (1 = Yes)	-0.2449**	-0.3153***	0.0301	-0.1961	0.2825*	0.0272
	(0.0854)	(0.0787)	(0.0926)	(0.1243)	(0.1525)	(0.2125)
Minority Leader (1 = Yes)	-0.308***	-0.2905***	-0.3947***	-0.3044**	-0.4100**	-0.2807
	(0.0772)	(0.0758)	(0.0835)	(0.1435)	(0.137)	(0.2295)
Speaker (1 = Yes)	-0.6342	-0.7144	-0.9418	-1.2202**	-0.8171	-1.3827
	(0.5719)	(0.3065)	(0.6165)	(0.4673)	(1.0026)	(1.5450)
Unobservables (ξ)		-0.1601**		-0.4402***		-0.4284***
		(0.0687)		(0.0647)		(0.0903)
Intercept	0.4719***	0.3140**	0.5830***	0.1373	0.5459***	0.1135
	(0.0577)	(0.0969)	(0.0624)	(0.1154)	(0.1018)	(0.1785)
Congress fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N. Obs.	2,176	2,176	2,176	2,176	2,176	2,176

Notes. NLLS estimated coefficients and bootstrapped standard errors with 500 replications are reported. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level. In columns (1) and (2), the dependent variable measures congressmen effectiveness at the earlier stages of the legislative process as the fraction of bills that they have introduced in the House of Representatives (BILL). In columns (3) and (4), the dependent variable also considers the fraction of bills that received any action in committee (AIC). In columns (5) and (6), the dependent variable indicates the effectiveness of congressmen at the later stages of the legislative process. The variable includes the fraction of bills that received any action beyond committee on the floor of the House (ABC), that have passed the House (PASS), and became law (LAW). The three dependent variables (BILL, BILL+AIC, ABC+PASS+LAW) are normalized so that their average take a value of 1 in each Congress. The Legislative Effectiveness Score (LES) is a weighted average of the five indicators (BILL, AIC, ABC, PASS, LAW) which is in turn normalized so that the average LES takes a value of 1 in each Congress. The details of this method are in Volden C. and Wiseman A. E. (2014), Legislative Effectiveness in the United States Congress: The Lawmakers, Cambridge University Press.

TABLE 8. ROBUSTENESS CHEKS

	Dep. Var.: Legislative Effectiveness Score (LES)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Φ	0.4112*** (0.0254)	0.6919*** (0.0740)	0.4367*** (0.0233)	0.8150*** (0.0517)	0.4325*** (0.026)	0.7114*** (0.0664)
Gender (1=Female)	-0.0015 (0.0502)	-0.0115 (0.0967)	-0.0476 (0.0458)	-0.0527 (0.0771)	-0.0067 (0.0509)	-0.0163 (0.0959)
No White (1=Yes)	-0.1847*** (0.0559)	-0.1311 (0.0978)	-0.1698** (0.0518)	-0.1222 (0.0908)	-0.1986*** (0.0569)	-0.1474 (0.0963)
Party (1 = Democrat)	-0.0974* (0.0552)	-0.0662 (0.1260)	-0.1621** (0.0501)	-0.1041 (0.1031)	-0.1125** (0.0555)	-0.0811 (0.1188)
Seniority	0.0208*** (0.0052)	0.0222** (0.0113)	0.0168*** (0.0047)	0.0222** (0.0102)	0.0244*** (0.0054)	0.0260** (0.0121)
Vote Share	0.0758 (0.0878)	0.0317 (0.1268)	0.0887 (0.0814)	0.0119 (0.1017)	0.0598 (0.0895)	0.0163 (0.1215)
Distance to the Median	-0.3172** (0.1246)	-0.2121 (0.2256)	-0.3702** (0.1145)	-0.2697** (0.1828)	-0.3560** (0.127)	-0.2502** (0.2088)
Size of Congr. Deleg.	-0.0047*** (0.0012)	-0.0040* (0.0021)	-0.0044*** (0.0010)	-0.0032 (0.0019)	-0.0055*** (0.0013)	-0.0048** (0.0021)
Committee Chair (1 = Yes)	1.9359*** (0.1089)	1.7824*** (0.1494)	1.9226*** (0.1053)	1.6679*** (0.1542)	1.9097*** (0.109)	1.7559*** (0.1484)
Majority Leader (1 = Yes)	0.1963 (0.1242)	0.0562 (0.1798)	0.2181* (0.1188)	-0.0008 (0.1448)	0.1586 (0.1257)	0.0180 (0.1618)
Minority Leader (1 = Yes)	-0.3303** (0.1097)	-0.2716 (0.1943)	-0.4202*** (0.1066)	-0.3117* (0.1658)	-0.3379** (0.1110)	-0.2741 (0.1772)
Speaker (1 = Yes)	-0.8051 (0.8463)	-1.1174 (0.9493)	-0.8206 (0.772)	-1.2668* (0.9212)	-0.8841 (0.8415)	-1.1708 (0.9450)
State legislative experience	0.1214 (0.0772)	0.1189 (0.1164)			0.1102 (0.0776)	0.1109 (0.1370)
State legislative experience * State legislative professionalism	-0.018 (0.1819)	-0.0369 (0.2900)			0.0538 (0.1856)	0.0301 (0.3383)
Unobservables (ξ)		-0.2939** (0.0968)		-0.4034*** (0.0742)		-0.2961*** (0.0957)
Intercept	0.4918*** (0.0959)	0.2052 (0.1728)	0.7062*** (0.1085)	0.2806* (0.1515)	0.4362*** (0.1262)	0.1762 (0.1825)
Congress fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Committee fixed effects	No	No	Yes	Yes	Yes	Yes
N. Obs.	1,775	1,775	1,775	1,775	2,176	2,176

Notes. NLLS estimated coefficients and standard errors (in parentheses) are reported. In columns (2), (4) and (6) standard errors are bootstrapped with 500 replications. A precise definition of control variables can be found in Table A.1. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level.

Table A.1: SUMMARY STATISTICS

	Variable Definition	Mean	St. Dev
Legislative Effectiveness Score (LES)	Weighted average of the number of bills introduced, that received any action in committee and beyond committee, passed the House, and became law, sponsored by a congressman. It differentially weights commemorative, substantive and significant legislation. Created by Volden C. and Wiseman A. E. (2014).	1.0081	1.4700
Gender (1=Female)	Dummy variable taking value of one if the member of Congress is female.	0.1723	0.3778
No White (1=Yes)	Dummy variable taking value of one if the member of Congress is Afro-American or Latino, and zero otherwise.	0.1388	0.3458
Party (1 = Democrat)	Dummy variable taking value of one if the member of Congress is a Democrat.	0.5051	0.5001
Seniority	Number of consecutive years in the House of Representatives.	5.7877	4.4372
Vote Share	Election Margin of Victory of the member of Congress.	0.3526	0.2488
Distance to the Median	Distance to the center in terms of ideology measured using the absolute value of the first dimension of the dw-nominate score created by McCarty et al. (1997).	0.5004	0.2236
Size of Congr. Deleg.	Number of seats assigned to congressman's State of election.	19.0988	15.4628
Committee Chair (1 = Yes)	Dummy variable taking value of one if the member of Congress is a chair of at least one committee.	0.0455	0.2084
Majority Leader (1 = Yes)	Dummy variable taking value of one if the member of Congress is member of the majority party leadership, as reported by the Almanac of American Politics.	0.0253	0.1570
Minority Leader (1 = Yes)	Dummy variable taking value of one if the member of Congress is member of the minority party leadership, as reported by the Almanac of American Politics.	0.0244	0.1542
Speaker (1 = Yes)	Dummy variable taking value of one if the member of Congress is speaker of the House.	0.0018	0.0428
N. Obs.		2,176	2,176