

Social Network Analysis

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Final Report

**Collaboration and Influence: A Network Analysis of Legislative
Co-sponsorship in the Pakistani Parliament**

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1. Abstract

How does a highly polarized parliament manage to maintain legislative function? Moving beyond superficial voting records, this study employs Social Network Analysis to map the underlying architecture of legislative collaboration in the Pakistani Parliament, spanning the 14th, 15th, and 16th Assemblies (2013–2024). Analyzing a dataset of 398 legislators and 2,409 co-sponsorship ties, the network reveals a 'small-world' topology, with high local clustering (0.55) and short average path lengths. This structure indicates a system optimized for rapid internal communication but inherently segmented into tight, specialized cliques. We identify a clear structural division of labor: While legislators from PTI and MQM drive the bulk of legislative activity and volume, members of PML-N function as the indispensable 'brokers', providing essential cross-party bridges. Although collaboration remains overwhelmingly intra-party, about 61.2% of all ties, the overall cohesion of the entire network depends on this small, strategic group of cross-party connectors. These findings highlight a critical paradox: the legislative system is structurally efficient, yet very fragile. The potential absence or disengagement of just a few key brokers poses a systemic risk that could significantly fragment the lawmaking process. This research establishes an important quantitative framework for assessing how the interplay between high polarization and centralized brokerage fundamentally shapes parliamentary effectiveness in Pakistan.

2. Introduction

The main challenge for any democratic legislature is not just voting, but building consensus. Elected officials must work together to draft, debate, and pass laws. For a parliament to work truly well, cooperation needs to happen across party lines, not just within them. However, looking at voting records often fails to show true cooperation because these records usually reflect strict party orders rather than individual efforts to work together (Aleman et al, 2009).

A much better way to measure collaboration is "legislative co-sponsorship." This refers to multiple legislators voluntarily agreeing to support the same bill. By mapping these connections, we can see past political appearances and uncover the real structure of cooperation. This helps us identify which members are actually driving the agenda and, importantly, which individuals act as bridges between opposing political groups.

This approach is especially important for the Pakistani Parliament. It is a political environment often defined by deep polarization and rigid party divisions that can slow down the law-making process. These formal divisions might hide informal networks of cooperation that keep the system running. Without analyzing these networks, it is impossible to know if the parliament is a unified body or a group of isolated islands. It also leaves us unsure of who the key individuals are that keep the legislature productive during tense times.

This paper fills that gap by applying Social Network Analysis to the legislative co-sponsorship records of the Pakistani Parliament. The study covers the 14th, 15th, and 16th Assemblies from 2013 to 2024. By treating legislators as "nodes" and the bills they co-sponsored as the connections between them, we can visualize the exact shape of parliamentary cooperation. This allows us to look deeper than simple voting numbers to

understand structural factors, such as the assembly's efficiency and the difference between legislators who produce a high volume of bills and those who act as strategic connectors.

Specifically, this study is guided by the following core research questions:

- 1. Does the Pakistani Parliament exhibit a cohesive core-periphery structure, or is it fragmented into isolated party clusters?**
- 2. Who are the central actors in the legislative network, and does high legislative activity (volume of bills) correlate with high structural influence?**
- 3. How permeable are party lines, and which political parties or specific legislators act as the primary "bridges" for cross-party collaboration?**

3. Literature Review

Research on legislative networks confirms that co-sponsorship is a critical indicator of political cooperation (Fowler, 2006). It reveals the informal structures of lawmaking that exist underneath formal voting records. Our study builds on this foundation by combining established network theories with recent research on how cooperation survives during times of deep political division.

To identify influential actors, we rely on Fowler's (2006) groundbreaking work on the U.S. Congress. Fowler showed that "connectedness", how central a legislator is in the co-sponsorship network, predicts legislative success better than holding a formal leadership title. Cho and Fowler (2010) expanded on this by describing the "small-world" phenomenon in legislatures. This refers to a network structure where members are tightly clustered locally but connected by short paths globally. They argue this structure makes the assembly more efficient by allowing information to travel quickly. These studies set the standard for our **first research question**, allowing us to test if the Pakistani Parliament has this efficient "small-world" structure or if it has broken into inefficient, disconnected groups (measured by "modularity" as defined by Zhang et al., 2008).

A key debate in the research is how cooperation continues despite political hostility. In a study of twenty parliaments, Briatte (2016) found that party affiliation is the main driver of collaboration worldwide. However, recent studies challenge the idea that polarization destroys cross-party ties. Duxbury (2024) argues that high-level polarization actually increases the need for collaboration networks. He suggests a process of "risk mitigation," where lawmakers in divided environments rely heavily on trusted relationships and past cooperation to get things done. Similarly, Crewe and Taylor-Robinson (2025) found that even with extreme ideological divides in the Texas House of Representatives, practical cooperation survives through informal social habits and returning favors. These insights frame our **third research question**, suggesting that cross-party connections in Pakistan may not be accidental, but rather strategic moves to handle political instability.

Finally, the research highlights specific types of people who bridge these divides. Skigin (2019) emphasizes the importance of "weak ties", which are infrequent but strategic connections, as essential bridges in fragmented legislatures. Furthermore, Holman et al. (2021) identify personal identity as a key factor. They found that female legislators often form cross-party coalitions to overcome being sidelined by the institution. This offers a critical perspective for our **second research question**. Together, these works suggest that legislative influence is not just about how many bills one proposes, but about the strategic "broker" roles that connect different groups (Burt, 2004).

4. Data and Methodology

Data Collection and Preprocessing

The primary dataset for this study was acquired from Open Parliament Pakistan, a digital platform that maintains comprehensive records of legislative activities. We utilized a web scraping approach to extract structured data tables covering the 14th, 15th, and 16th National Assemblies, spanning the period from 2013 to 2024. The raw data included detailed logs of bills, co-sponsors, bill types (Government vs. Private), and committee assignments.

The scraped data provided legislators names with each bill along with all the rest of the information. To analyze the direct relationships between politicians, we transformed the data and projected it into a legislator-to-legislator network, instead of legislator-to-bill network. This step was essential because our goal was to measure peer-to-peer collaboration and influence, rather than just tracking which bills were popular. By simplifying the network so that two legislators are connected if they co-sponsored a bill together, we could apply social metrics, like centrality and community clustering, to see how information and influence flow directly between people.

To ensure analytical accuracy, the dataset underwent a cleaning process to standardize legislator names and resolve inconsistencies in party affiliations across different tenures. About 12 legislators, who remained in at least two of the assemblies, changed their parties. Their party difference was handled accordingly wherever relevant. We then structured the data into two distinct files, of nodes and edges, for network processing.

Network Construction

The legislative body was modeled as an **undirected, weighted social network** to facilitate this direct analysis of peer-to-peer legislative cooperation. This model is based on the idea that legislators collaborate through the mechanism of supporting bills. The network is **undirected** because co-sponsorship is inherently a reciprocal act of collaboration, meaning neither legislator's involvement is prioritized over the other's, and it is **weighted** by the frequency of co-sponsorship. A higher weight reflects a stronger working relationship established through multiple co-sponsored bills. This construction effectively projects the original data (Bills with legislators) into a unipartite (Legislator to Legislator) network. The final network consists of **398 nodes**, with each node representing a unique legislator, and **2,409 edges**, where an edge exists if two nodes co-sponsored at least one bill together.

5. Analysis and Results

Our investigation into the parliamentary networks of Pakistan reveals a system defined by a critical paradox. On the surface, the legislature appears robust and efficient, capable of moving information quickly across the floor. However, beneath this efficiency lies a structure of deep fragility. The parliament does not function as a single, unified body of lawmakers; Instead, it operates as a collection of tight-knit "tribes" held together not by broad cooperation, but by a very small, strategic group of gatekeepers.

By mapping the connections between 398 legislators and analyzing over 2,400 collaborative ties, we have moved beyond simple voting records to understand the "hidden architecture" of the 14th, 15th, and 16th Assemblies. The following analysis details our five primary findings, telling the story of how Pakistan's laws are actually made, who drives the volume, who controls the flow, and where the system is most at risk of breaking.

5.1 The "Small-World" Paradox — Efficient but Fractured

The most immediate finding from our network analysis is that the Pakistani Parliament exhibits a classic "Small-World" architecture. In network science, a "small world" is a specific type of environment where most people do not know each other, yet strangers can be linked by a very short chain of mutual acquaintances.

Our data confirms that the parliament fits this model perfectly, but with a twist that highlights Pakistan's unique political polarization.

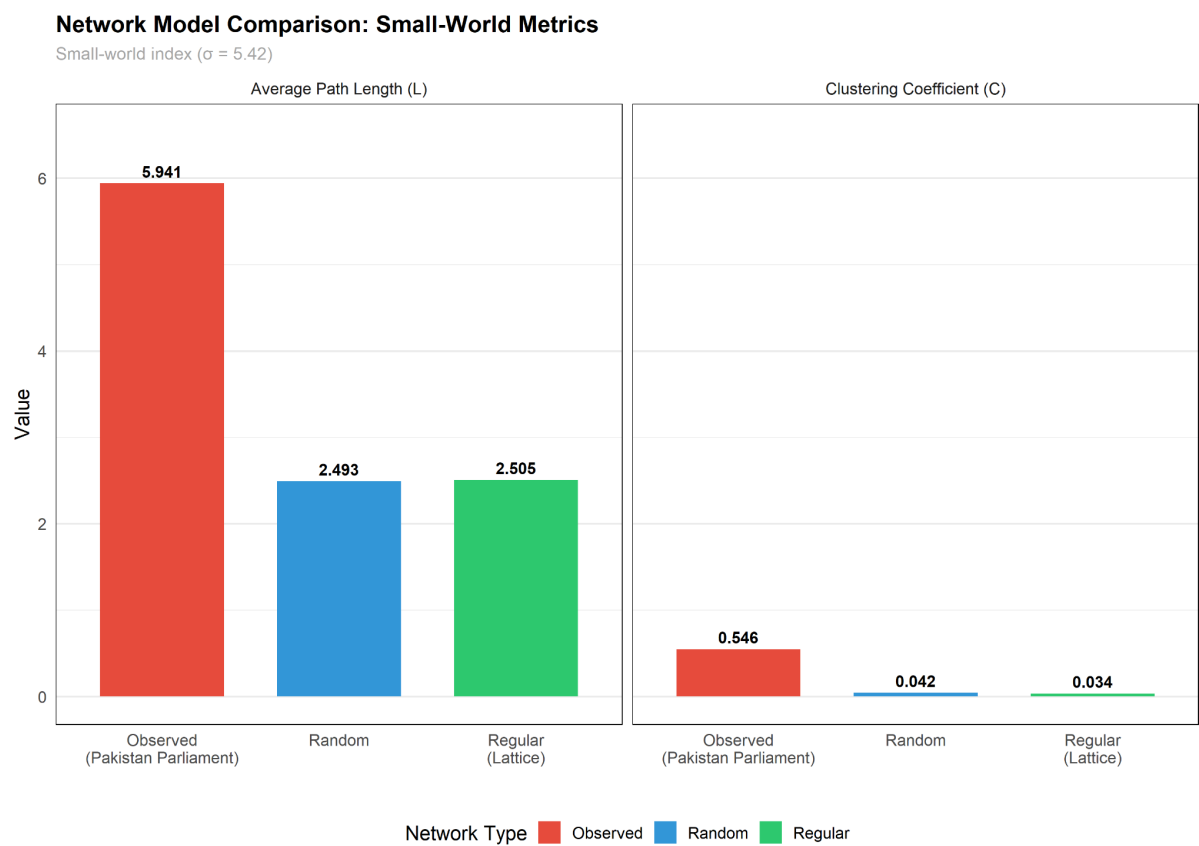


Figure 1: Small-World Properties of the Pakistani Parliamentary Coauthorship Network

First, the system is surprisingly efficient. We calculated the "Average Path Length", the number of steps it takes to get from one random legislator to another, and found it to be approximately **6 steps** (5.94). This is a remarkably low number for such a divided house. It implies that, theoretically, a legislative idea introduced by a backbencher in a minority party can reach the core leadership of the ruling party relatively quickly. The "distance" between opposing sides is not as vast as the political rhetoric suggests.

However, this efficiency is coupled with intense "cliquishness." We measured a very high **Clustering Coefficient of 0.55**. To put this in perspective, in a purely random network, this

number would be close to zero (0.04). A score of 0.55 tells us that if Legislator A works with Legislator B and Legislator C, it is extremely likely that B and C also work with each other. This creates a network composed of tight, self-reinforcing triangles, which can essentially be considered echo chambers in this context.

The Deviation from Theory

When we compared the Pakistani Parliament against theoretical mathematical models, the fragility of this system became clear. Note that we used the giant component for this comparison, which is the standard way of comparing different models.

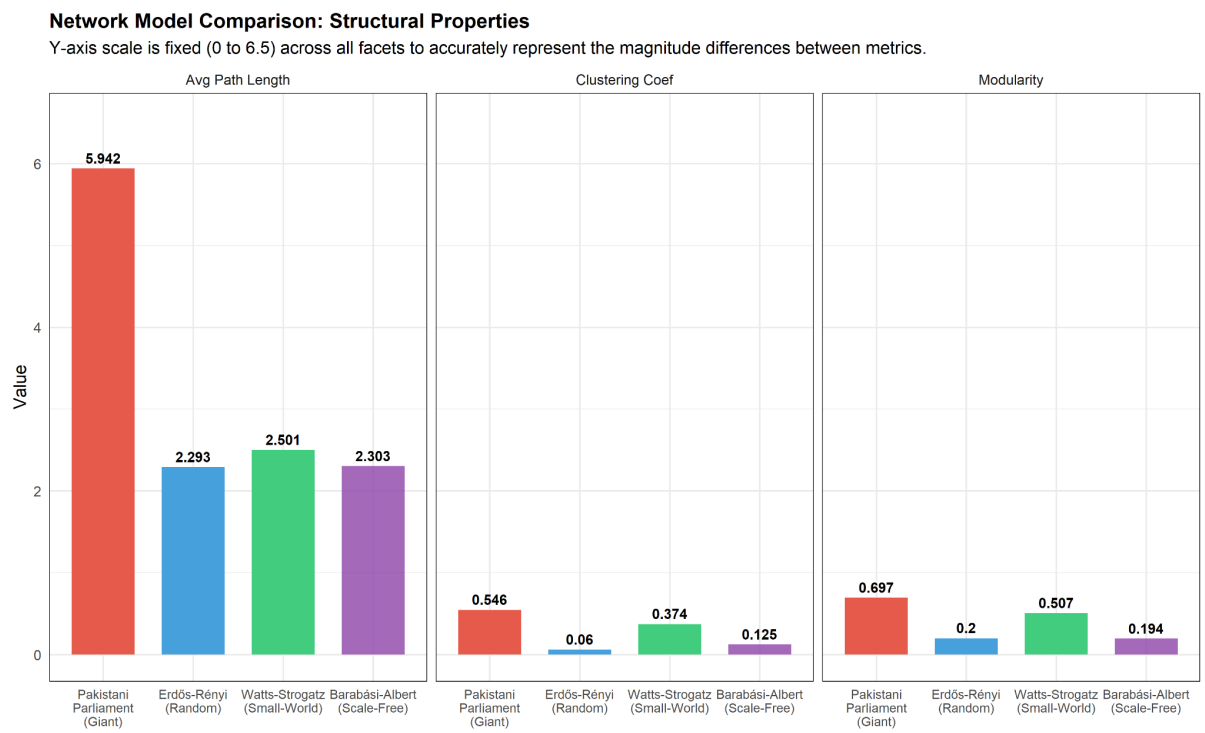


Figure 2: Network Model Comparison Bar chart

As shown in **Figure 2**, our network aligns closely with the *Watts-Strogatz Small-World model*, but it deviates in one significant way: **Modularity**. The parliament’s modularity score is **0.697** and average path length is **5.942** (Table 1), which is significantly higher than any standard theoretical model predicts.

This high modularity and average path length changes the story. It suggests that the "efficiency" we observed is not necessarily the result of a happy, cooperative legislature as a whole. Instead, the parliament is composed of relatively isolated silos, parties most likely, that rarely interact. The information flows quickly within these silos, but it faces massive friction when trying to cross from one party to another. The "Small World" of the Pakistani Parliament is not a relatively global village. Instead, it is a series of walled spaces connected by only a few narrow bridges.

Table 1: Network Model Comparison Table

282 Nodes				
Metric	Pakistani Parliament (Giant Component)	Erdős.Rényi	Watts.Strogatz	Barabási.Albert
Number of Edges	2350	2350	2538	2220
Average Degree	16.667	16.667	18	15.745
Average Path Length	5.942	2.293	2.501	2.303
Clustering Coefficient	0.5461	0.0604	0.3741	0.1249
Diameter	67	3	4	4
Number of Communities (Fast Greedy)	14	6	4	6
Modularity	0.6968	0.1999	0.5069	0.194

5.2 A System of "Haves" and "Have-Nots"

Underpinning this fractured structure is a clear reality of inequality. One might expect a democratic assembly to feature widespread participation, where every elected official contributes to the legislative process. However, our analysis proves otherwise. The network forms a distinct **Core-Periphery structure**, creating a legislative environment of "Haves" (the active elite) and "Have-Nots" (the silent majority).

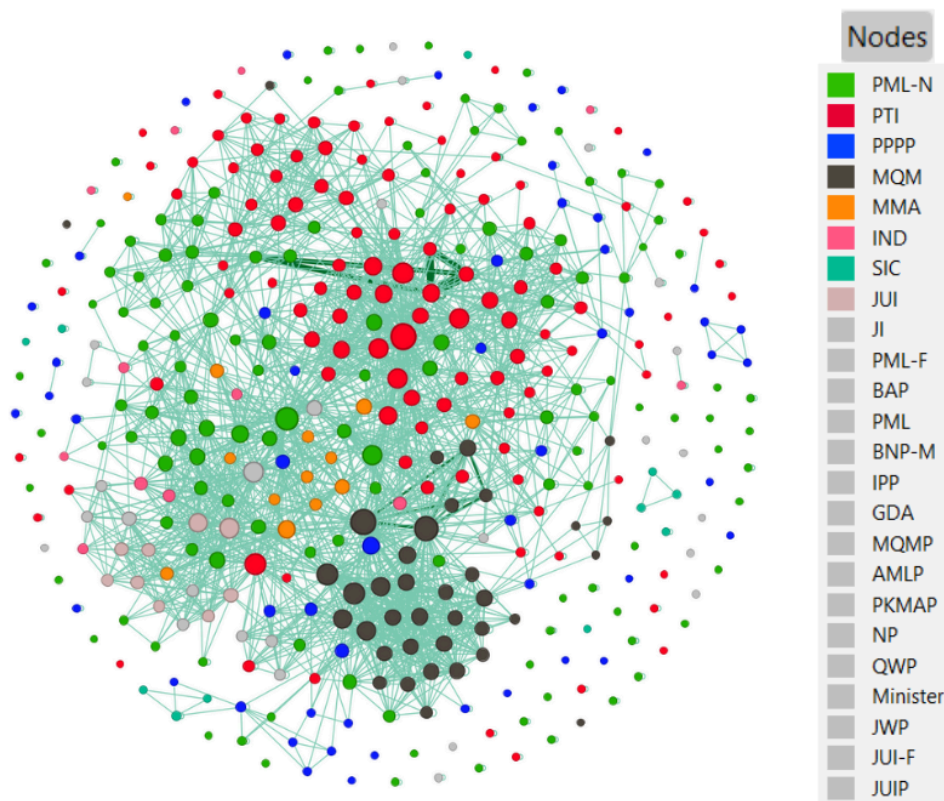


Figure 3: Pakistani Parliament Co-authorship Network

Visually, **Figure 3** displays this dynamic clearly. We see a dense, tangled "hairball" of activity in the center, representing the active core, surrounded by a ring of floating, disconnected nodes. The statistics support this visual separation. The overall network density is only **3%** (without zero nodes is 4%). This means that out of all the possible collaborative relationships that could exist between all legislators of the assembly, 97% of them simply do not happen. Collaboration is the exception, not the rule.

Perhaps most concerning is the level of complete disengagement. We found that approximately **14.6% of legislators** are "isolates" (Zero Degree nodes). These are elected officials who, during the observed period, did not co-sponsor a single bill. They are effectively invisible in the collaborative network.

This creates a "rich-get-richer" dynamic known as preferential attachment. A small elite of roughly 20 to 30 legislators attracts the vast majority of connections, acting as the

gravitational center of the parliament. Meanwhile, a significant portion of the assembly remains on the sidelines, disengaged from the formal process of drafting and co-sponsoring laws. This concentration of activity suggests that legislative power in Pakistan is far more centralized than the democratic structure implies.

Table 2: Global Network Metrics

Metric	Value	Interpretation
Density	0.042	Low overall connectivity, collaboration is selective,
Giant component Density	0.059	It is relatively more connected but still collaboration is selective.
Average path length	5.94	It takes ~6 steps to connect any two random legislators.
Clustering coefficient	0.55	High tendency for legislators to form tight-knit cliques/clusters.
Diameter	67	The network is elongated, with few distant peripheral actors.

5.3 The Division of Labor — "Creators" vs. "Connectors"

If the parliament is a system of silos, who runs them? By distinguishing between two different types of power, **Degree Centrality** (Volume) and **Betweenness Centrality** (Brokerage), we uncovered an interesting division of labor between the major political parties. It appears that PTI and MQM are the "engines" of the parliament, while PML-N acts as the "glue."

The Creators: PTI and MQM

When we look strictly at who produces the most bills (Degree Centrality), the **PTI** and **MQM** parties are dominant. Legislators like **Nafeesa Inayatullah Khan Khattak (PTI)** and **Iqbal Muhammad Ali Khan (MQM)** appear at the very top of the list (Table 3). These members are the "Creators" or main collaborators. They generate the sheer volume of legislative drafts, motions, and proposals. Their high degree scores indicate they are working with many people, likely within their own parties, to churn out legislation. If one were to judge influence solely by the number of bills signed, these two parties would appear to have total control.

The Connectors: PML-N

However, generating bills is not the same as building consensus. When we shift our focus to "Betweenness Centrality", the metric that measures how often a person acts as a bridge between two other groups, the leaderboard changes dramatically. The top ranks are suddenly populated by **PML-N** members (Table 3).

Table 3: Top 20 Centrality Metrics (Legislator List)

	<i>Top 20 Betweenness Centrality</i>					<i>Top 20 Degree centrality</i>		
No#	Legislator	Party	Degree	Betweenness		Legislator	Party	Degree
1	Seema Mohiuddin Jameeli	PML-N	54	0.095		Nafeesa Inayatullah Khan Khattak	PTI	64
2	Sher Akbar Khan	JI	45	0.078		Iqbal Muhammad Ali Khan	MQM	63
3	Isphanyar M. Bhandara	PML-N	23	0.077		Kishwer Zehra	MQM	58
4	Dr. Ramesh Kumar Vankwani	PTI	47	0.068		Seema Mohiuddin Jameeli	PML-N	54
5	Syed Naveed Qamar	PPPP	15	0.063		Dr. Nikhat Shakeel Khan	MQM	49

6	Qaisar Ahmad Sheikh	PML-N	25	0.055	Shaikh Salahuddin	MQM	48
7	Muhammad Ibrahim Khan	PTI	42	0.054	Dr. Ramesh Kumar Vankwani	PTI	47
8	Ramesh Lal	PPPP	21	0.052	Imran Khattak	PTI	46
9	Ijaz Ahmad Shah	PTI	11	0.046	Sher Akbar Khan	JI	45
10	Imran Khattak	PTI	46	0.045	Shahida Akhtar Ali	JUI	43
11	Mian Najibuddin Awaisi	PML-N	16	0.043	Uzma Riaz	PTI	42
12	Sardar Ayaz Sadiq	PML-N	22	0.040	Tahira Aurangzeb	PML-N	42
13	Sardar Muhammad Irfan Dogar	PML-N	20	0.037	Asma Hadeed	PTI	42
14	Nafeesa Inayatullah Khan Khattak	PTI	64	0.037	Muhammad Ibrahim Khan	PTI	42
15	Naveed Aamir	PPPP	12	0.033	S. A. Iqbal Qadri	MQM	39
16	Romina Khurshid Alam	PML-N	34	0.032	Abdul Waseem	MQM	39
17	Ali Nawaz Awan	PTI	36	0.031	Sanjay Perwani	MQM	39
18	Mrs. Aliya Kamran	MMA	35	0.031	Naeema Kishwar Khan	JUI	38
19	Muhammad Azam Khan Swati	PTI	9	0.030	Ali Nawaz Awan	PTI	36
20	Rana Sana Ullah Khan	PML-N	19	0.028	Ali Khan Jadoon	PTI	36

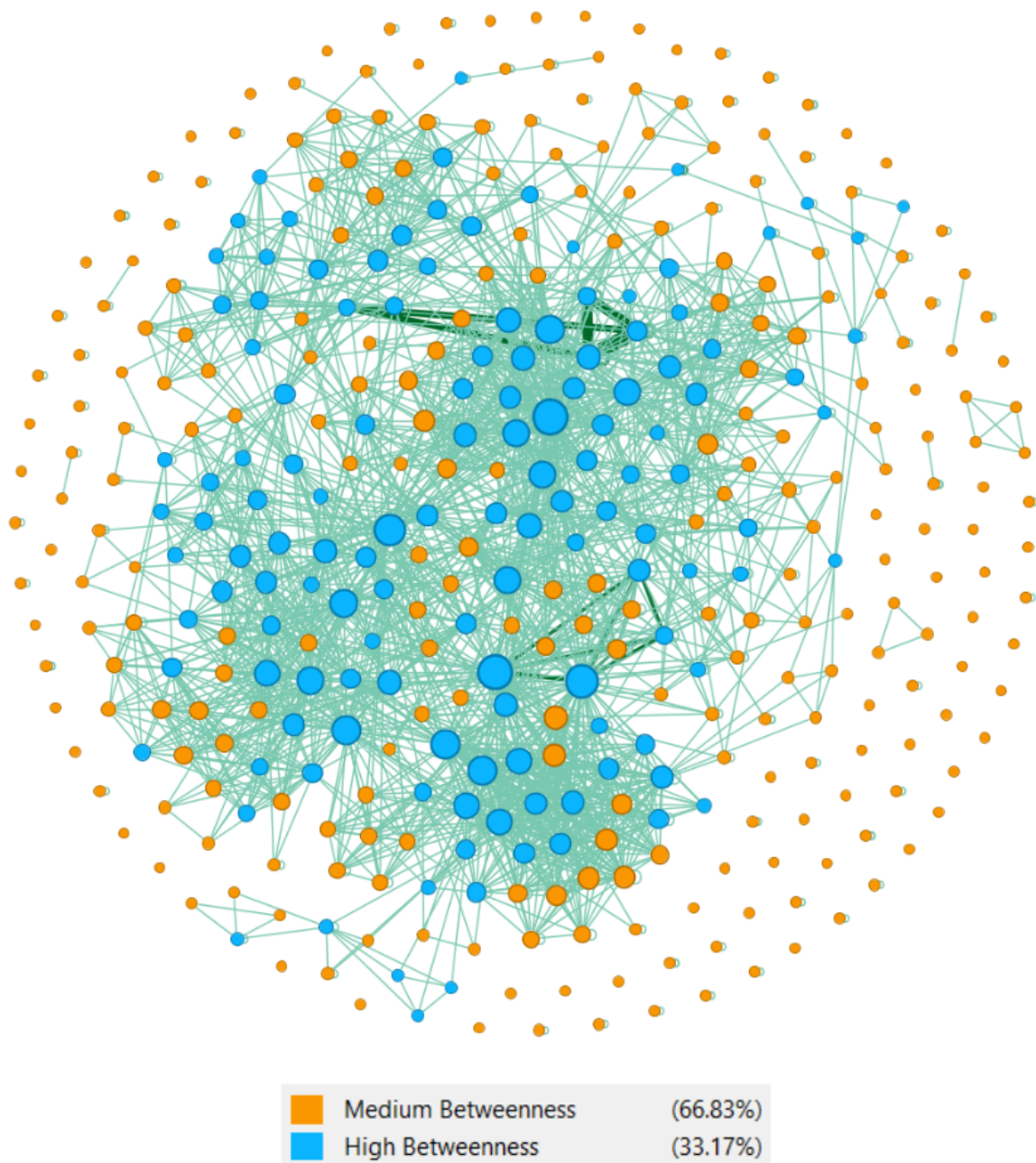


Figure 4: Network Visualisation of Betweenness Centrality

As shown in Figure 4 and Table 3, the nodes with high brokerage power (colored green) are predominantly PML-N legislators, such as **Seema Mohiuddin Jameeli**. These individuals may not always produce the highest volume of paper, but they are structurally indispensable. They sit at the crossroads of the network. A bill drafted by a smaller party or a religious faction often needs to pass through these "Connectors" to reach the wider assembly parties.

This division of labor highlights a major systemic risk. The system relies on a very small number of people to keep the conversation going across party lines. Our analysis identified only 16 "**Articulation Points**", who are specific legislators whose removal would cause the main network component to physically snap into disconnected pieces. The fact that the

entire legislative ecosystem relies on such a small handful of brokers to maintain its structural integrity makes the parliament highly vulnerable to political boycotts or the disqualification of key individuals.

5.4 The "Big Tent" vs. The "Silo"

To better understand how these parties organize themselves, we used the Fast-Greedy algorithm to detect "communities", which are groups of legislators who cluster together based on actual behavior rather than just their official party tickets. This analysis reinforced the unique roles of the three major parties.

Table 4: Top 7 prominent communities in the Giant component by size

Rank	Community_ID	Size	Dominant_Party	Party_Diversity	Top_Parties
1	9	64	PML-N	10	PML-N, MMA, JUI
2	3	62	PTI	5	PTI, PML-N, PPPP
3	11	33	MQM	3	MQM, PML-N, PTI
4	4	29	PTI	2	PTI, PML-N, NA
5	10	25	PTI	7	PTI, MQM, PML-N
6	1	21	PML-N	3	PML-N, PTI, PPPP
7	5	18	PPPP	3	PPPP, PML-N, MQM

The community detection revealed three distinct organizational styles:

The largest community in the parliament (Community 9) is dominated by PML-N. However, it is not *only* PML-N. This community is the most diverse, including members from religious parties like the MMA and JUI. This confirms our earlier finding that PML-N functions as a coalition builder, absorbing smaller factions into its legislative orbit.

On the other end of the spectrum is MQM (Community 11). This cluster is highly homogenous, with very low party diversity. MQM members co-sponsor almost exclusively with other MQM members, forming a tight, impenetrable clique that interacts minimally with the rest of the network.

Interestingly, PTI does not form a single, unified block. Its members are split across three different communities (C3, C4, C10). This implies that PTI acts less like a single entity and more like a federation of different working groups, which may operate independently of one another.

5.5 Homophily and the Limits of Cooperation

While the previous section highlighted volume and brokerage, we also needed to measure the preference for collaboration. Do parties actively seek each other out, or do they stick to their own kind? To test this, we generated a **Homophily Graph**, which measures the ratio of "Observed" to "Expected" ties. This metric works like a lottery check: if we randomly assigned co-sponsors, we would get an "Expected" number of cross-party links. A ratio of 1.0 means parties collaborate exactly as predicted by chance. A ratio greater than 1.0 indicates "Homophily" (active preference), while a ratio less than 1.0 indicates "Avoidance."

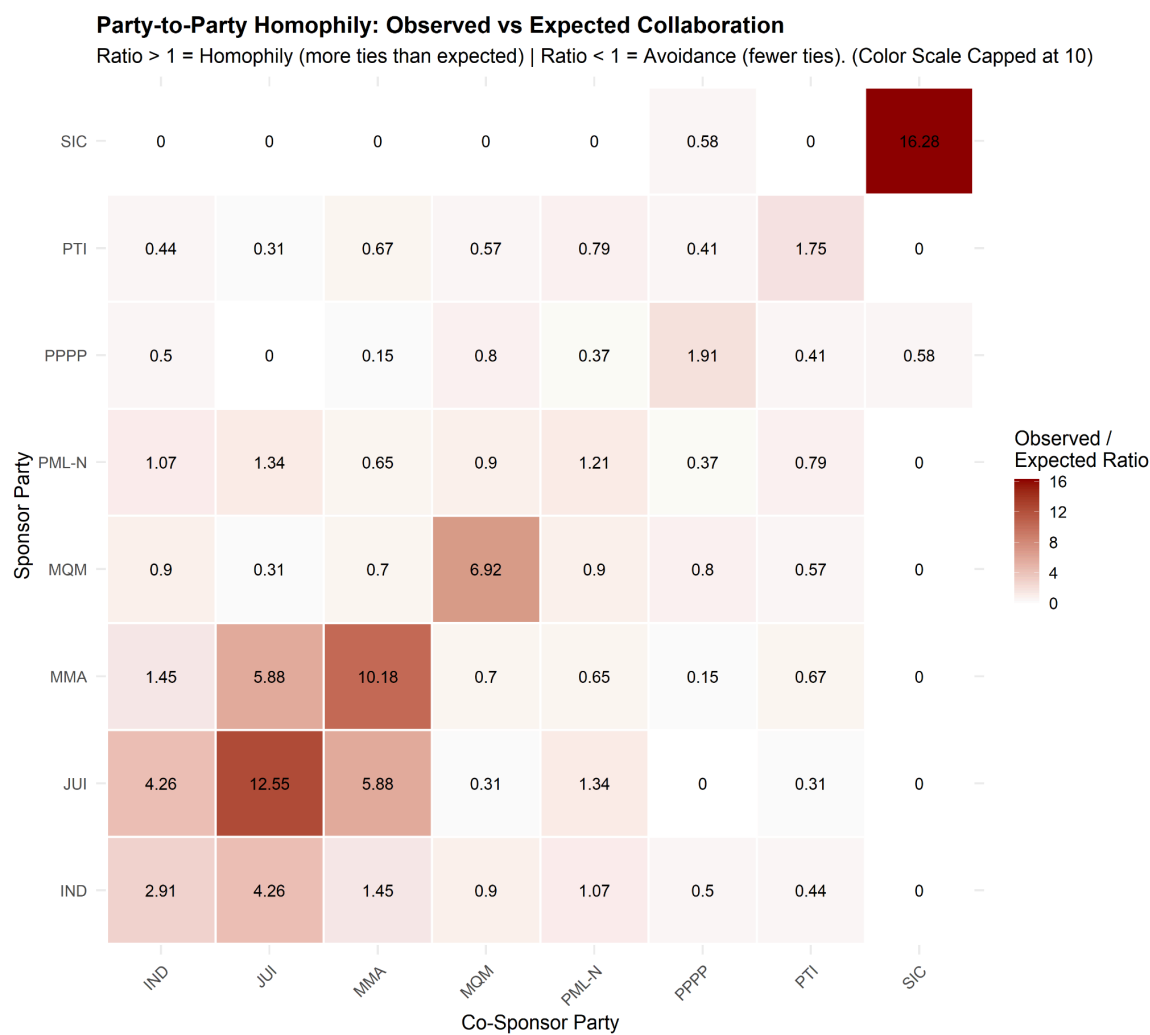


Figure 5: Party-to-Party Homophily: Observed vs Expected Collaboration

The results in **Figure 5** present a clear picture of ideological tribalism, particularly among the smaller parties. We observed massive "echo chambers" in the periphery. Parties like **JUI** (12.55), **MMA** (10.18), and **MQM** (6.92) have incredibly high self-collaboration scores. This means legislators from these groups almost exclusively co-sponsor bills with their own colleagues, while rarely collaborating outside their ideological borders. Interestingly, the only strong cross-party preference in the entire network exists between the religious parties, JUI and MMA, who share a high mutual ratio (5.88). This indicates a genuine, strategic alliance where they actively support each other's bills far beyond what would happen by accident.

The most critical finding, however, concerns the "cold coexistence" of the two major forces, **PTI** and **PML-N**. While raw data suggests they share many bills, the homophily graph reveals this is merely a function of their size, not intent. The cross-party ratio between them is **0.79**, which is less than 1.0, indicating active avoidance. Despite being the largest parties, they collaborate slightly less than they would if they were assigning co-sponsors by rolling dice. This dynamic further highlights PML-N's specific role as a broker. Unlike PTI, whose external ratios are consistently low, PML-N shows a positive preference for working with JUI (1.34) and Independents (1.07). This suggests that while the "Big Two" avoid each other, PML-N actively cultivates relationships with smaller blocs to build majorities, whereas PTI remains more isolated.

6. Discussion

The most significant finding of this study is the paradox of the parliament's structure. It is simultaneously efficient yet fragile. The "small-world" topology suggests that the assembly is optimized for rapid communication within partisan cliques. However, this efficiency relies heavily on a specific set of "bridge" legislators. Our centrality analysis reveals a distinct division of labor where PTI and MQM legislators generate the sheer volume of bills (high Degree Centrality), while PML-N legislators act as the primary connectors (high Betweenness Centrality).

This concentration of brokerage roles within a single party (PML-N) creates a systemic risk. As identified in our articulation point analysis, the network depends on a small number of key individuals to maintain global connectivity. If these specific brokers were to be removed, due to political boycotts, disqualifications, or electoral defeats, the legislative network would likely fragment into disconnected silos. This implies that the parliament's ability to function as a unified lawmaking body is structurally precarious and highly sensitive to the presence of these specific "gatekeepers."

Elite Dominance and the Exclusion of the Periphery

The network also exhibits a high degree of inequality, consistent with the "rich-get-richer" phenomenon often observed in social networks. A small elite of approximately 20 legislators controls a disproportionate share of both activity and influence, while nearly 15% of the assembly remains completely isolated. This core-periphery structure suggests that legislative power in Pakistan is not evenly distributed but is instead consolidated among a few influential "hubs."

Polarization vs. Pragmatism

Finally, our analysis challenges the conventional narrative of absolute polarization in Pakistani politics. While intra-party collaboration is indeed the dominant mode of interaction (accounting for over 60% of ties), the strong cross-party link between PML-N and PTI legislators suggests a layer of pragmatic cooperation exists beneath the surface of public rivalry. This functional cooperation is essential for the passage of non-controversial legislation and indicates that despite rigid party lines, the legislative machinery possesses functional channels for consensus, given the key brokers remain active.

7. Conclusion

This study utilized Social Network Analysis to move beyond traditional voting records and uncover the hidden structure of legislative cooperation in the Pakistani Parliament. By mapping co-sponsorship ties from 2013 to 2024, we demonstrated that the parliament operates as a "Small-World" network, a system characterized by high local efficiency and rapid information flow, but one that is structurally prone to fragmentation.

Our findings highlight a distinct and critical division of labor within the legislative ecosystem. While the volume of legislative activity is driven by a concentrated core of legislators from PTI and MQM, the essential structural role of "brokerage", connecting disparate factions, is largely performed by members of PML-N. This centralization of connectivity creates a fragile system, in which the network relies on a small number of "articulation points" to maintain its cohesion. The removal or disengagement of these specific brokers could effectively isolate entire political blocs, stalling the legislative process.

Ultimately, this research illustrates that while the Pakistani Parliament is highly polarized, it is not completely fractured. Functional cross-party channels exist, primarily sustained by a pragmatic elite. To enhance legislative resilience and inclusivity, future interventions should focus on integrating the 14.6% of isolated legislators into the core network. Future research could further expand on this work by analyzing how these network structures shift during specific regime changes or political crises, offering deeper insights into the resilience of Pakistan's democratic institutions.

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