

COMPLEXITY, SELECTIVITY AND ASYMMETRY IN THE
CONFORMATION OF THE POWER PHENOMENON. ANALYSIS
OF CHILEAN SOCIETY

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ABSTRACT. In this work we analyzed the relationships between powerful politicians and businessmen of Chile in order to study the phenomenon of social power. We developed our study according to Complex Network Theory but also using traditional sociological theories of Power and Elites. Our analyses suggest that the studied network displays common properties of Complex Networks, such as scaling in connectivity distribution, properties of *small-world* networks, and modular structure, among others. We also observed that social power (a proposed metric is presented in this work) is also distributed inhomogeneously. However, the most interesting observation is that this inhomogeneous power and connectivity distribution, among other observed properties, may be the result of a dynamic and unregulated process of network growth in which powerful people tend to link to similar others. The compatibility between people, increasingly selective as the network grows, could generate the presence of extremely powerful people, but also a constant inequality of power where the difference between the most powerful is the same as among the least powerful. Our results are also in accordance with sociological theories.

1. Introduction. Perhaps nothing in human history has been more seductive than power and its relationships. It seems very likely that its manifestation is parallel to the act of abandon the (primal) isolation and to form a society in order to achieve, in common, its protection and survival. The sociological literature is replete with the power phenomenon, and it has been explained in many ways [38]; these explanations are based not so much on its explicit expression (imposition of will over another, or even against its resistance [64, 30]), but rather on its relational character (*i.e.*, there's always someone who commands and another who obeys)

2010 *Mathematics Subject Classification.* Primary: 05C82, 91D30; Secondary: 90B15.

Key words and phrases. Complex networks, social networks, model, theory of Elites, theory of social power.

The first author is supported by INRIA-Chile.

and very particularly on the factors that make such interaction possible (both for those who rule and those who obey).

The social sciences, and political sociology in particular, have paid attention to the study of power, particularly on “what to do” once achieved, even, subordinating what should be done once it has been achieved. This comes from a long tradition first expressed in the second century B.C. by Polybius [61] who prioritizes a pragmatic sense of politics subordinating moral purpose. Niccolò Machiavelli, republished this position of decoupling politics from ethics thirteen centuries later [61]. Since then, it has been power, and not the common good, which has preferentially concerned the literature of the social sciences. More recently, however, and perhaps in an attempt to explain (and modify) society itself, other frameworks, such as the Theory of Organizations and General Systems Theory [13] have made contributions to the phenomenon from a systemic point of view¹. One example of this kind of approach is the work done by Mark Lombardi, an American artist and historian who studied social power, or more clearly its “uses and abuses” [10]. He will be remembered not only due to his art but for his bravery and for his work’s non-conventional way of looking at the phenomenon. In Lombardi’s view, the power of people cannot be understood by looking at individuals; rather, it is necessary to look at the system. In fact, his work was immortalized in his graph drawings called Narrative Structures, where people and organizations are linked by power relations. Today, this kind of approach is common because social scientists recognize the limitations of reductionism in addressing social problems. Notwithstanding these modern procedures, it was in 18th century that E. Durkheim [52, 19] first opened the door to understanding sociological phenomena from this perspective. He talked about a concept called “dynamic density” in order to explain the transition of an organic society to a mechanical one. This change is produced by a significant increase in the number of actors of the system and simultaneously, the number of interactions between them. Nowadays, this is known as a fundamental characteristic of Complex Systems and the evidence that this kind of social complex structures display collective behaviors that are not described in the actors, makes it necessary its study from an holistic perspective, since it is the web of relationships who “hides” the information about the system’s properties [15, 7, 59]. This coincides with the ideas of Michel Foucault [23] on social power: “Power must be analyzed as something which circulates, or rather as something that operates in chain. It is never localized here or there, it is never in the hands of someone, it is not an attribute such as wealth or goods. The power functions... and is exercised through networks...”.

In 2012 a Chilean website, called Poderopedia, was founded on the same spirit of Lombardi’s work. Supported by a 16-month News Challenge Grant provided by the Knight Foundation², and later with the help of Start-Up Chile³ and new funds provided by the Knight Fellows Program of the International Center for Journalists (ICFJ)⁴, Poderopedia has developed a huge public data base with (public) information about relations between powerful businessmen, politicians and organizations/companies in Chile with the aim of providing public transparency as a

¹These theories have explored the phenomenon of power, giving explanations of the process of the gains or losses thereof and the subsequent effects on the structure and efficiency of the systems.

²<http://www.knightfoundation.org/grants/20110953/>

³<http://www.startupchile.org/congrats-ya?11/>

⁴<http://www.icfj.org/>

project embedded in what appears to be a global need. In fact, Poderopedia's spirit seems to capture a concern of much of the world's population and recently the website is already operating in Colombia and Venezuela. However, the data collected by Poderopedia are also interesting from a scientific point of view, not only because of the amount (and dynamics) of the data, but also due to its richness, which might contains (hide) information about the power phenomenon. Precisely that motivated this work. Using the data from Poderopedia, we studied the social network of Chilean powerful people; this was not with the aim of detecting or reporting the powerful, but rather to map social power in Chile, characterizing it according to the links that define the relation among people, and trying to explain the origin of its structure.

Considering the huge number of people and organizations/companies intricately connected, it was necessary to approach the problem using tools from Complex Systems Theory while also relying on the sociological theory of Power and Elites. This effort was based on the evidence that certain features of complex systems are ideal in understanding and explaining certain social processes more comprehensively. What is surprising is that using a novel approach to the social power phenomenon, we found a principle of causal interpretation derived from Complex Network Theory. This principle was contrasted with the major political underpinnings, discovering, in this kind of "assisted reproduction" among disciplines, surprising consequences. Our work puts in evidence that the power phenomenon differs little from other collective behaviors of completely different nature. In fact, the complexity of the power system seems to converges to a universal architecture that depends on the system interactions rather than psycho-social or even moral factors affecting the political and business world.

The work is structured as follows: in the next section, the methodology used by Poderopedia to complete its relational data is presented and, in the same section, we also show how we process the data provided in order to obtain graphs of entities which map the structures of the social power network of Chile; section 3 introduces the social network model that we propose in order to explain the structure observed in the real network from section 2; in Section 4, we present a sociological interpretation of the results obtained in the previous sections; and, in the last section, we discuss the major implications of the obtained results and present the conclusions of our work.

2. Chilean social power network: Construction and analysis. Poderopedia is a collaborative data journalism platform (www.poderopedia.org) that maps the "who's who in business and politics in Chile". It is developed by journalists, programmers, designers, and independent collaborators who investigate, extract, select, and validate information from public sources, such as media, government databases, business databases, and websites. This information is subjected to careful source verification processes and the most relevant aspects of public interest are stored and published.

Poderopedia was designed to be used as a tool in the day-to-day of journalists, media, general public, professionals, organizations, and companies who need to find information about the relations between powerful people and organizations in Chile. It also seeks to promote citizen participation by giving users the option to register on the website to provide all kinds of data.

The data collected are stored according to the ontology called PoderVocabulary (<https://github.com/poderopedia/podervocabulary>), specially designed

for this purpose. PoderVocabulary is based on OWL (Web Ontology Language), Friend-of-a-friend (FOAF) and BIO, an extension of FOAF, focused on biographical information. Data stored can be accessed by users who want to search for specific entities' properties as well as their relations. Users registered in Poderopedia can also suggest new entity relationships.

Entities in the Poderopedia ontology can be of two types: Persons and Organizations/Companies; each is characterized by a set of attributes that describe their properties. Furthermore, relations between entities are also of different kinds: Person-Person, Person-Organization, and Organization-Organization. A sub set of connection types are defined inside of each link category (Table 1).

TABLE 1. Types of relationships used by Poderopedia to link entities.

Relation category	Relation type
Person-Person	family, friend, close, known, classmate
Person-Organization	position in company, participation in company, position in NGO, participation in NGO, participation in economic group, position in International organism, public office, study, religious group, support groups for political campaign, social movement, private club, political party, think tanks or study center
Organization-Organization	commercial, dependence, donations, property, grants

We worked with data stored in Poderopedia servers between June 2012 and March 11th, 2014. The reason is that day the change of government took place in Chile. Michelle Bachelet began her second period as President and Sebastián Piñera finished his one. Any data collected after that date might have created noise in our analysis due to the entry of many new entities and relationships (associated with the new government) to the system.

Our analysis was initially focused on person to person relations. For this reason, we projected the original network onto a unimodal structure. Since the original network of Poderopedia is not a real bipartite graph⁵, the projection made is not one typically used in the case of bipartite networks; that is, there are links between entities of the same type. Thus, if two persons are connected by an organization/company in the original network, they would be connected in the projected network. However, if two persons are connected by a path composed of two adjacent organizations/companies, they are not connected (through this path) in our projected network.

Figure 1 shows the projected people network. This network is composed of $N=3140$ people and $E=17353$ edges between them. The figure also shows nodes and links colored according to the community partition detected using the algorithm proposed by Blondel *et al.* [14]. Although we treat the networks as undirected, the color of links represents the community color of the source node according to the relational data used.

⁵*theyrule.net* is a website similar to Poderopedia, but offers real bipartite graphs, where people are not linked among themselves but through organizations/companies.

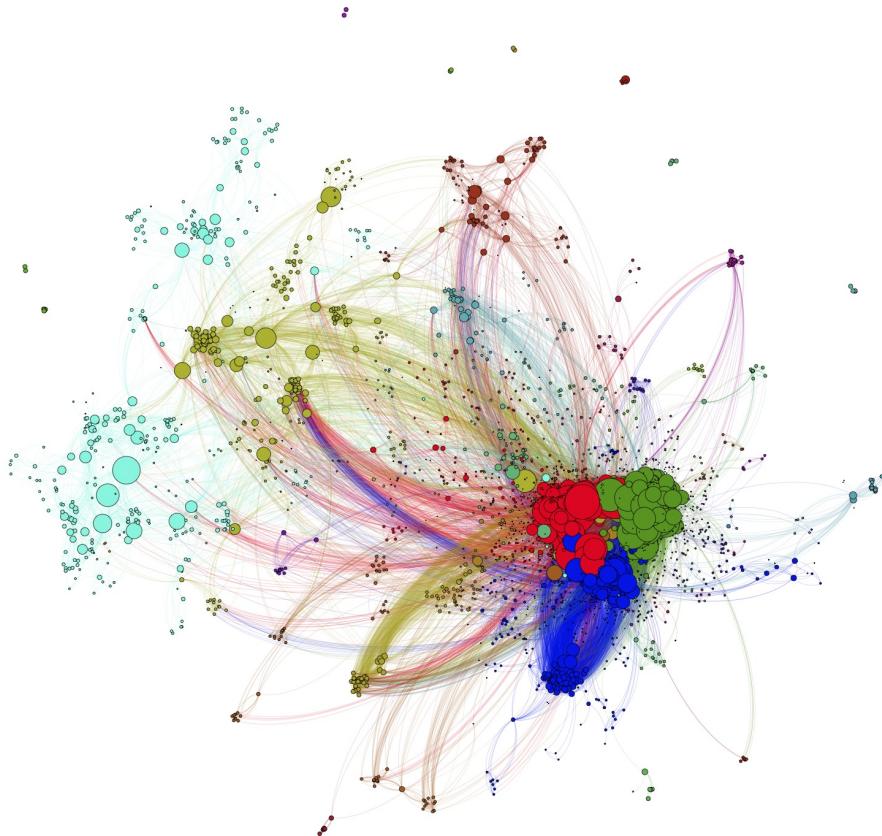


FIGURE 1. Network of Chilean Power. The network represents the projected network of 3140 people and 17353 edges. The layout, obtained using the OpenOrd algorithm (<https://github.com/gephi/gephi-plugins/tree/openord-layout>), shows the powerful people (see definition below) bigger than the rest and colored by community partition using the Blondel *et al.* algorithm [14].

We were interested in the projected people network because we needed to know what was the most powerful people of the network, and then analyzed their relationships as cases of study. Although the social power in this network could be rudimentarily defined as the number of incoming and outgoing links, we wanted to find a more sophisticated metric. For this reason we implemented a metric of social power, P , that considers the quality of links of the person (Page Rank [47]), the cohesiveness of the immediate neighborhood (clustering coefficient, c_i), the capacity of the person to connect people (betweenness coefficient, b_i) and the proportion of person's links that represent family, business, religious or political relations. The sizes of the nodes in the network of Fig. 1 represent corresponding P values.

The community analysis shows that there are three communities bigger than the rest, comprising 51.6% of the nodes and 74.8% of the links (red, blue and green communities in Fig. 1). A detail of the connections within this densely connected structure is shown in Figure 2. These three communities contain the set of people

and relationships used for analysis in the following sections. Before that, however, let us now delve into some topological particularities of this network which are similar to those observed in other complex networks.

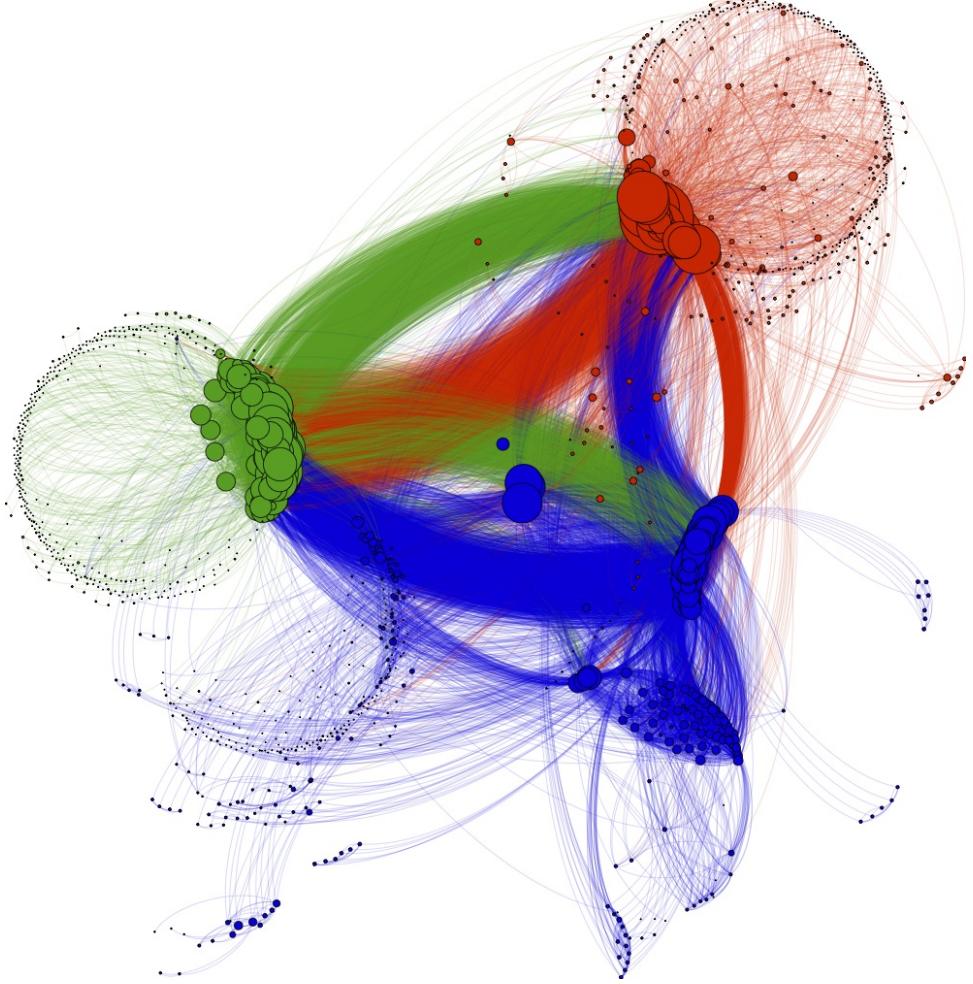


FIGURE 2. The three major communities of the network of Chilean power. Color and node size as in Fig. 1.

A wide range of real complex systems have been studied from the perspective of Complex Network Theory. This theory provides a framework for describing interactions in a system from a purely topological point of view and allows us to abstract away dynamic processes that use such a structure as a substrate [43]. A common and non-trivial topology was observed in most of the systems studied [44, 20]. In particular, the topology found in these complex networks was characterized by the presence of scaling in the node connectivity distribution. This phenomenon denotes high inhomogeneity in connectivity, which is where the term *scale-free* network comes from [8]; this is unlike the connectivity observed in networks where connections are randomly assigned. Such inhomogeneity stems from the non-negligible

presence of densely connected nodes (*hubs*) in these networks. Besides inhomogeneity, complex topologies share characteristic properties of *small-world* networks [63], *i.e.*, they are associated with low distances between randomly chosen pairs of nodes and having a high clustering coefficient. The *scale-free* character and properties of *small-world* networks seem to be a finger print of so-called complex networks [44, 58].

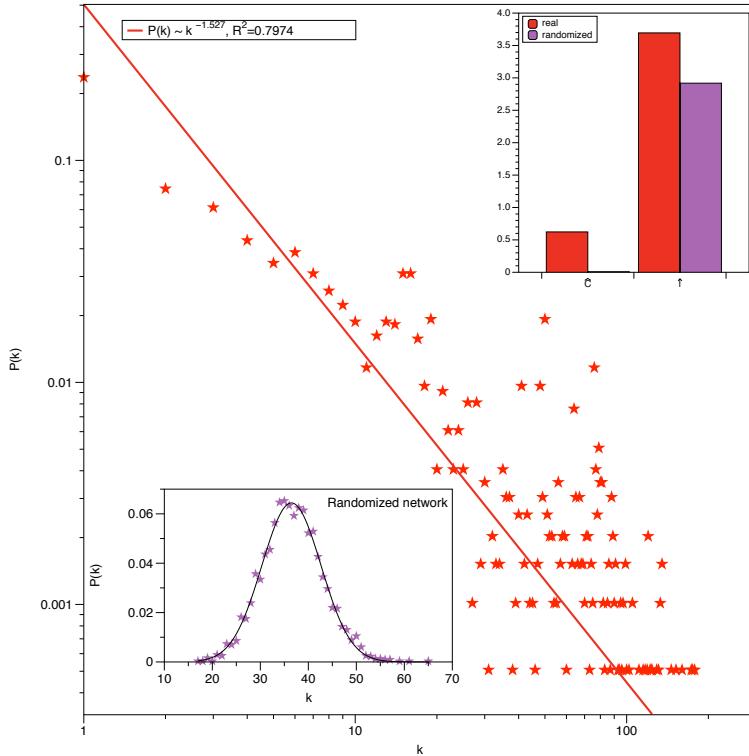


FIGURE 3. Node degree distribution, $P(k)$, for the real network and for its randomized version (bottom inset). Upper inset shows the mean clustering \hat{C} and average path length \hat{l} of the real network (red) and its randomized version (purple).

Using the Python *powerlaw* package [3], we determined the function that best fits the connectivity distribution of our people network. The results show that the power law function is the best candidate, specifically, a truncated power law⁶ in comparison with normal, log-normal or exponential functions. This means that the people network displays the same *scale-free* character that many other complex systems share, wherein the probability of choosing a person with k connections scales (negatively) with the degree k . As can be seen in Fig. 3, close to 50% of

⁶Due to the fact that the system has a finite size and that there is a limit of people to connect to, the powerful cannot become more powerful forever. Thus it is probable that there is a gradual upper bounding effect on the scaling of the power law. An exponentially truncated power law is better suited to reflect this bounding [3]. Moreover, according to [10], this could be a product of “prohibited relationships”, as in the case of mutualistic networks in ecology [11].

the nodes are poorly connected ($k \leq 3$) but a few have many connections. This scenario, for a network of the same size and same number of links but with random connections, is totally different (Fig. 3 (bottom inside plot)). In the “random” scenario (not a real classical random graph [22] because the existing edges were randomly redirected), more than 80% of the people have a connectivity close to the mean, between 30 and 40 links, and connectivities far from this magnitude are practically impossible (the probability decays following an exponential function). This means that the probability of finding a person with a connectivity higher (or less) than the mean decays quickly in comparison with the scaling observed in the original network. In the real scenario the “speed” of probability decrease remain constant, that is, the inequality between densely connected people is comparable to the one observed between the poorly connected people.

Furthermore, we found that a short distance between randomly chosen pairs of persons coexists with a high transitivity of connectivity, as in *small-world* networks [63]. The upper inset of Figure 3 shows how transitivity is lost in a random scenario: the high transitivity of connection in the social network ($\hat{C}=0.62$) practically goes to 0 when links are randomly distributed between people. By contrast, the average path length, \hat{l} , remains practically unaltered, suggesting that the well known *small-world effect*, associated with a short average path length, is not only a property of complex graphs, but also of those with random connections [22].

3. Modeling the social power network. Since the social network of powerful Chileans shows properties reminiscent of complex systems, it follows that one should want to know the reason, or at least the mechanism. In this respect, we compared different dynamic complex networks models that have been proposed in recent years [20]. One of them, the well-known Preferential Attachment model, or Barabási-Albert (BA) model [8], have been the most popular. The model considers a social-like rule, where “the rich get richer”, as the rule that governs the growth of the network. In this model, a new node added to the system is linked preferentially to the most connected nodes. The mechanism appears to apply in the same way for the power network. Indeed, this is intuitively how we as non-powerful people think: power attracts more power.

However, this study has a different hypothesis. According to studies concerning Elites and Power in society, “a man (belonging to the Elite) is shaped by his relations with others like him...” [37], “(Elites) develop a common language and generate meeting spaces” [50] and “not enough that each elite has its own communication mechanisms, but it needed to be building a common image of society” [50]. In summary, it appears that the relationships between powerful people necessarily depends on their sharing certain characteristics. In fact, G. Tarde [46] talks about the *phenomenon of imitation*, common among powerful people. Considering this, the Compatibility Attachment Model (CAM) [16] seems to be a good candidate.

In CAM, a (complex) network arises from *compatibility*, a simple local mechanism so called due to the fact that the relationship of two system entities is a product of the compatibility between their characters. For the purposes of this study, compatibility would be this common language, view of society, etc., common among powerful persons.

In this model the compatibility among nodes depends on the system size according to the compatibility threshold, C_i , given by,

$$C_i = \frac{d}{\tau}, \quad (1)$$

where d is a constant called *compatibility distance* between node characters, which is determined by a certain probability density function; and τ represents the size N of the system at that moment. The dependence of τ makes the probability of linking remains constant over time. This means that, as more nodes appear in the network, the new ones arrived to the system should be more like to the oldest nodes to which the link occurs. This perspective has major implications, which will be seen in the last section of this work.

Figure 4 shows the degree distribution, $P(k)$, observed both in the real power network and in the two models previously described, BA model and CAM. As can be seen, both models generate a network with heterogeneous connectivity, with many poorly-connected nodes and few *hubs*. However, the CAM more accurately reproduces the real connectivity distribution. The BA model gives poorly connected people a higher probability in comparison with the real network; moreover, the scaling exponent is stronger, which denotes less connectivity heterogeneity with respect to the real network. The inset of Figure 4 shows the high correlation of finding people with k connections in the real and CAM networks.

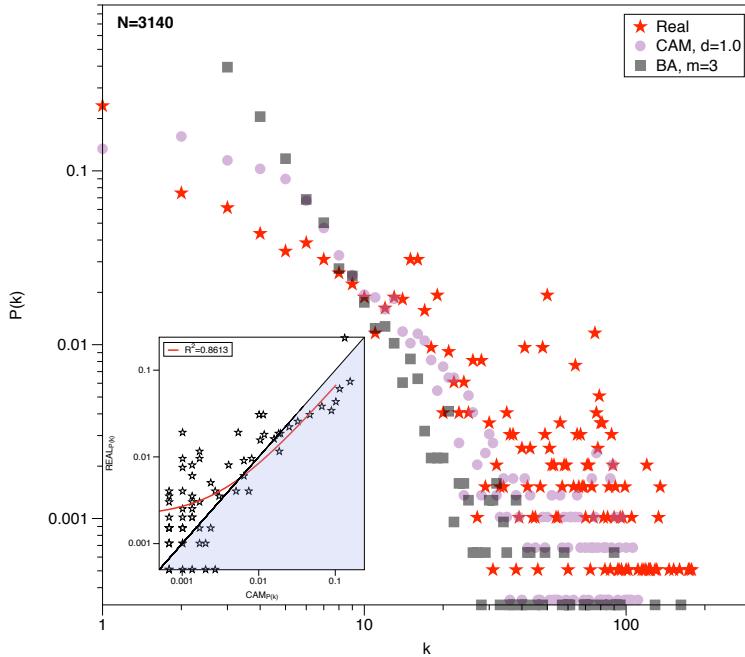


FIGURE 4. Node degree distribution, $P(k)$, for the real network (red stars) and two stochastic models: CAM (purple dots) and BA model (grey squares). Bottom inset shows the correlation between $P(k)$ of real network and those generated by the CAM.

CAM not only closely reproduces the connectivity distribution, it also reproduces the high transitivity of connections \hat{C} and the mean connectivity \hat{k} better than the BA model (Table 2). The BA model does have a fairly faithful reproduction of the average shortest path length \hat{l} , whereas CAM overestimates this metric.

TABLE 2. Models comparison. Number of nodes, links, scaling exponent γ , transitivity of connections \hat{C} , average shortest path length \hat{l} , mean connectivity \hat{k} , percentage of nodes that compose the giant component GC and the degree assortativity r , for the real network and two stochastic models: CAM and BA model.

Network	Links	γ	\hat{C}	\hat{l}	\hat{k}	GC (%)	r
Real	17353	-1.5	0.622	3.69	17.0	60.0	0.38
CAM	13741.4 ± 593	-1.6	0.596 ± 0.005	7.65 ± 0.34	8.8 ± 0.4	60.6 ± 2.4	0.88 ± 0.01
BA	9411.0 ± 0	-2.0	0.013 ± 0.001	3.88 ± 0.007	5.0 ± 0	-	~ 0.0 [45]

Another interesting aspect of the CAM is that it is capable of generating a graph with a giant component, as occurs in the real network where the entire graph is composed by isolated subgraphs and one giant network that groups over 60% of the people. In the BA model the resulting network graph has a unique connected component. Moreover, the CAM can reproduce the assortativity [45] (k -correlation) observed in the real network. The last was expected in the CAM because the compatibility mechanism generates a homophilic network, however, the observed homophily in the real network is not trivial. Highly connected people in the power network are preferably linked together, while those with few connections are linked with others with few connections.

It is interesting to note what happened with the attribute of social power P . Well, the assortativity per person attribute (p_i) is also positive $r_p=0.11$, which means that *powerful people* (according to our definition) tend also to connect to powerful people and people with low power are linked to less powerful people.

Due to the fact that, according to the Poderopedia power connection data, power P seems to be strongly correlated with node degree, it is not surprising that the distribution of P also follows a power law with an exponent similar to the $P(k)$ distribution (Fig. 5). Using the same fit test as of section 2, we can observe that the power P also scales giving to 1% of the population of the network (31 people) 31.7% of the total P power⁷. Approximately 2% of the population has a half of power of the system. Notice that the most powerful quartile is composed of only 2 people, a clear social power concentration.

In order to explore the connections between *powerful people*, and to validate the compatibility attachment model in this context, we use the distribution of power P to establish a “nucleus of power”, defined as the top 20 politicians and businessmen to respective positions in the P rank (40 people = 1.2% of the population). Using the information of each entity stored in Poderopedia data, we selected only people that have an exclusively political or business “career”. However, it is necessary to say that in spite of the result that shows an inhomogeneous distribution of P , the concept of “nucleus of power” it is not totally correct; this is because there are many nuclei at different scales, a *Polyarchy* according to R. Dahl [17]. However, we will use this concept throughout the work to refer to the group of most powerful people.

The same meaning of “nucleus of power” was used by W. Mills [37] to refers to the most powerful people in the United States. Mills understood that it is not merit which determines the possibility of belonging and inclusion, but rather trust, a subjective factor that is related to the attitude of commitment to the defense of

⁷Coincidentally, the percentage of income that the top 1% of Chileans accumulates is 30.5% [31].

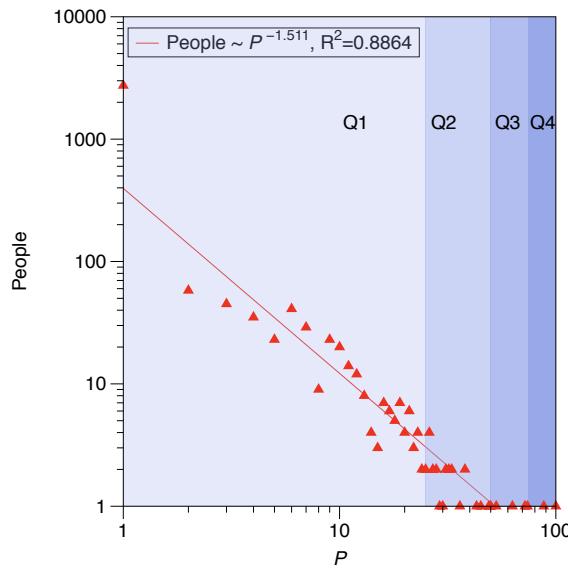


FIGURE 5. Number of people having social power P in the network. The power was normalized and divided in quartiles (Q).

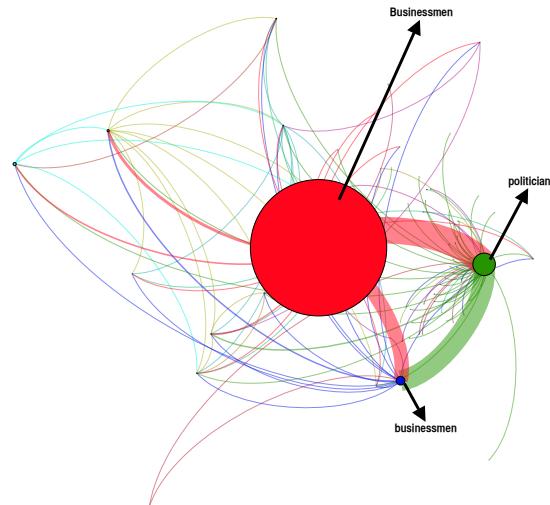


FIGURE 6. Network of Chilean Power. Layout as Fig. 1 with people of the same community “collapsed” into a macro-node labeled according the most representative people group detected. Size of the node represents the amount of social power P contained.

that position of power. It’s what Michels understood as the “iron law of oligarchy” [36]. The nucleus of power, in our view, is pierced by these kinds of attitudes, which represent identity links, commitments supporting domain positioning, and

optimal gratification involving rewards. The remarkable thing about this is that this phenomenon explained by political sociology can be observed in our analysis.

It is not surprising that these forty people are located in the three principal communities. However, their distribution on these modules is different. For example, top businessmen belong to the red and blue communities (50% each one), while 65% of the top politicians belongs to the green community, 25% to the red, and the rest to the blue. Figure 6 show the same representation of the network of Figure 2 but with communities collapsed into macro nodes labeled according to their principal type of top entities. It can be observed that the red community contains not only 50% of the top businessmen and 25% of the top politicians, but also the most powerful people (the size of the (macro) node represents the amount of power P contained in it).

4. An interpretation from sociological theory of power and Elites. Sometimes it seems more interesting to ask *why* a person obeys another, rather than trying to explain *how* someone has power over another. Political sociology assumes this question with the understanding that, in this relationship, the search for “prompt and sincere” obedience seems to be essential [64]. Therein lies legitimacy, a dimension shared by all political action.

Max Weber and his followers (including theorists who studied Elites, such as G. Mosca, W. Pareto, W. Mills and R. Michels) have built a vast analytical interpretation, which we delve into below (for details of source theory, see Table 3). Classification of power and the phenomenological categories explaining it are a powerful analytical tool box that we have applied in an initial attempt to understand exactly what is involved in the interpretation of the connections between powerful people in Chile. These include the *factors of domination* adduced by G. Mosca (*organizational skills* and *capacity to create political formula*); the laws from R. Michels (*specialization law*, *law of psychological metamorphosis of the leader* and *the iron law of oligarchy*), on which positivism is based; the *psychological residues* left by W. Pareto, which defines permanence, combination, and the recurring phenomenon of the *circulation of elites*; and the analysis of the *nucleus of power*, by W. Mills.

TABLE 3. Conceptual categories of Power and Elites used in this work. Principal referent for each category and typologies associated.

Categories	Author	Typologies
Power	M. Weaver [64, 12, 6, 54]	Economic, Coercive, Ideologic
Legitimate Domination	M. Weaver [64, 12, 6, 54]	Charismatic, Traditional, Racional Legal
Nucleus of Power	W. Mills [37]	Economic, Military, Politic
Objects of Situation	T. Parsons [57, 54]	Expected Roles, Internalized values, Recognition of affection
Domination Factors	G. Mosca [39, 40]	Capacity to organize, Capacity to create political formula
Law of Oligarchy	R. Michels [36]	Law of specialization, Law of psychological metamorphosis of the leader, Iron Law of Oligarchy
Psychological residues of Elites	W. Pareto [2, 33, 48]	Persistence residues, Residues of combination
Interests of Domination	R. Dahrendorf [53]	Latent interests, Manifests interest
Pluralistic Society	W. Kornhauser [28]	Accessibility of elites, Availability of non-elites

According to the CAM, the power network of Chile can be interpreted as the result of a dynamic population growth process where relationships between people depend on the compatibility between their personal characteristics. In fact, looking at professional training and age characteristics within the “nucleus of power”, we

observed that a group with homogeneous attributes exists. Figure 7 shows the distribution of professional training in the nucleus, where 70% of the people are lawyers, economists or engineers, with an average age of 60.7 ± 9.6 years. However, as we might intuit, not all 65 year old Chilean lawyers are powerful. Deeper reasons must exist to explain this phenomenon.

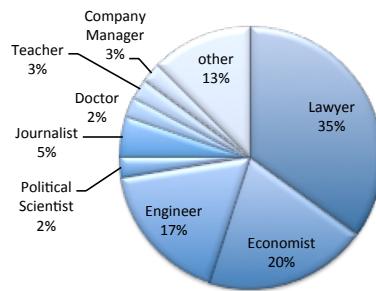


FIGURE 7. Distribution of professional training in the nucleus of power.

Despite professional training and age supporting the proposed compatibility thesis, it was still possible that implicit, underlying causes from Poderopedia's infrastructure could have a measurable effect on relationship analysis (see Table 1). In order to search for these causes, we explored paired connections of nucleus nodes. In this way we were able to circumvent one of the major weakness of modern sociological theory, which does not convincingly marry interactions at the micro level with those of the macro-level [25].

As many possible paths exist between politicians and businessmen nodes in the nucleus, we analyzed the shortest paths, which are more robust for detecting the if a common view of society is held by both entities. The inverse of this reinforces this choice; indeed Harary *et al.* [26] noted that there may be a distance beyond which it is not feasible for a person to communicate with another because of the costs and distortions associated with the act of transmission. It is important to mention that our analysis makes use of the original Poderopedia graph (*i.e.*, before projection) since not only was the detail of personal relationships need, but also the relations between people and organizations.

The (shortest) path that connects two people was characterized by all the relation types and their path frequency. Including all the possible paths computed, we obtained a link type probability vector. Since there were two link types considered [person \leftrightarrow person] and [person \leftrightarrow organization], the vector was divided in both categories. Figure 8 shows both vectors represented as bar charts where the height indicates the link type probability.

As can be seen, 80% of the relations, or social actions, in the nucleus of power are between close friends and family, followed by friends, in [person \leftrightarrow person] relations. No significant difference can be observed with the paths computed for random sampling of those outside the top businessmen and politicians.

On the other hand, considering [person \leftrightarrow organization] actions, over 50% of the relations inside the nucleus of power are between those belonging to the same

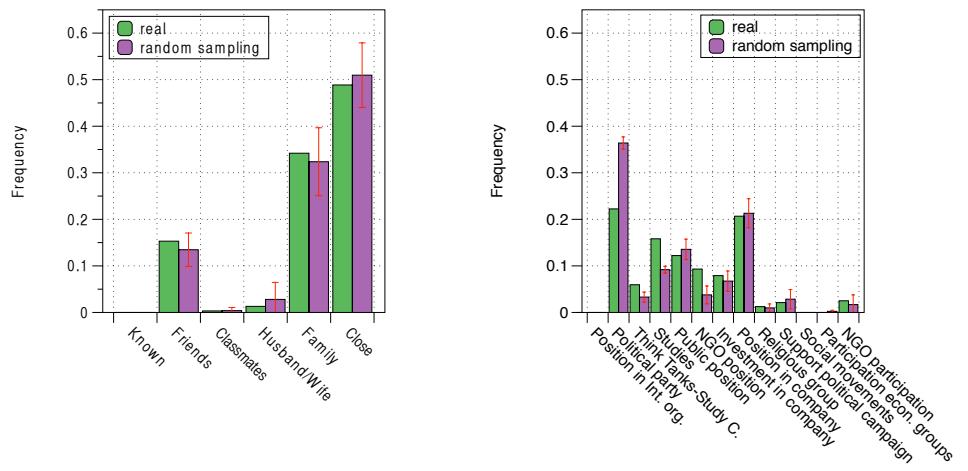


FIGURE 8. Frequency of links types detected in the paths computed for the nucleus of power. Person to Person (left) and Person to Organization/Companies (right).

political party, same place of study, or having a position in the same company. For random paths, the study site loses importance in favor of political party relations.

What we understand as relations or social actions, is entirely related to the motivations that make it possible for someone to be linked to another, and any conditions that favor this link, including the intersubjective and homogeneous construction of “world” that actors perform (shared codes). This is in agreement with *rational motivators*, related both to *interests* and *values*, as well as to *traditions* and *affections*. This traditional classification given by M. Weber [56] was gathered and expanded upon by T. Parsons[49, 54]. In order to give content to what happens along the paths that connect people, we derived *attitudes*, *expectations* and *behaviors* associated with this typology of social action from the computation of paths between powerful people.

Table 4 shows the interpretation that we used for Poderopedia link types as according to theories of Weber and Parsons [49, 54]. The relationships contained in the Poderopedia data set represents the *Situation of action*, according to Parsons, and reflects the scenario faced by an actor. This scenario can be evaluated according to the orientation modes that actors take, which can be cognitive, valorative, or affective, in what Parsons calls “motivational orientation” [57, 54]. For cognitive orientation, we used the *Expected Roles*; in the valorative orientation, the *Internalized Values*; and in the affective orientation, the *Recognition of Affections* as *Objects of Situation*. Thus, our interpretation sees the actors as evaluating their actions according to a rational analysis (cost / benefit); an valorative analysis, in order to estimate the consequences and effects of their action from the perspective of their moral responsibility; and finally, an affective analysis, in order to estimate the emotional satisfaction that the object will produce (desired). Through case studies of the subjects, we emphasize the manifest or latent character of each of these *Objects of Situation*.

In addition, and given the interpretation framework, paths connecting two people contain information about *symbols* and *meanings*. People act on the objects of their

TABLE 4. Motivational Orientation associated to Poderopedia link types. Manifest (M) and Latent (L). [Source: own elaboration].

Situation	Cognitive orientation	Motivational orientation	Affective orientation
		Value orientation	
		Need Dispositions Internalized Values	
[person ↔ person]			
Known	•(L)		•(M)
Friends		•(L)	•(M)
Classmate		•(L)	•(M)
Husband/Wife		•(L)	•(M)
Family		•(L)	•(M)
Close		•(L)	•(M)
[person ↔ organization]			
Position in International organisms	•(M)	•(L)	
Political party	•(L)	•(M)	
Think Tanks and Study Centers	•(L)	•(M)	
Studies		•(M)	•(L)
Public position	•(M)	•(L)	
NGO position	•(M)	•(L)	
Investment in company	•(M)	•(L)	
Position in company	•(M)	•(L)	
Religious group	•(L)	•(M)	
Support groups to political campaigns	•(L)	•(M)	
Social movements	•(M)	•(L)	
Participation in economic groups	•(M)	•(L)	
NGO participation	•(M)	•(L)	

world and interact with others utilizing the subjective meanings that objects and people have, that is, from “symbols”. In turn, “meanings” are the product of social interaction, mainly communication. Communication then becomes essential in the constitution of both the person and in the social production of meaning.

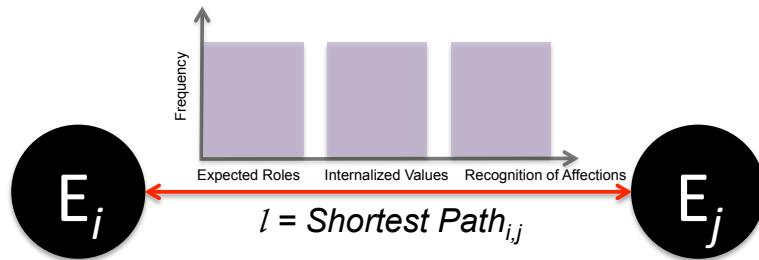


FIGURE 9. Path between entities i and j . Length and amplitude defined.

A relevant point from sociology highlights that interaction (social action) is only possible when actors uniformly understand the senses and meanings, codes and symbols, of either party involved in the relation. This point is also key to understanding the phenomenon that supports the construction of a “nucleus of power”. As discussed throughout, the “powerful” tend to be linked with themselves, which does not solely happen by a factor of domination but rather by one of likeness [37].

Figure 9 shows an example of a proposed method including the interpretation rules discussed above. In this example, entity i and j are separated by l entities denoting the length of the path. Here, we identify another property of the path:

its amplitude. Path amplitude is defined as the frequency of the (for example) the three motivational orientations: Expected Roles, Internalized Values, and Affect Recognition, along the shortest path between two entities according to Table 4.

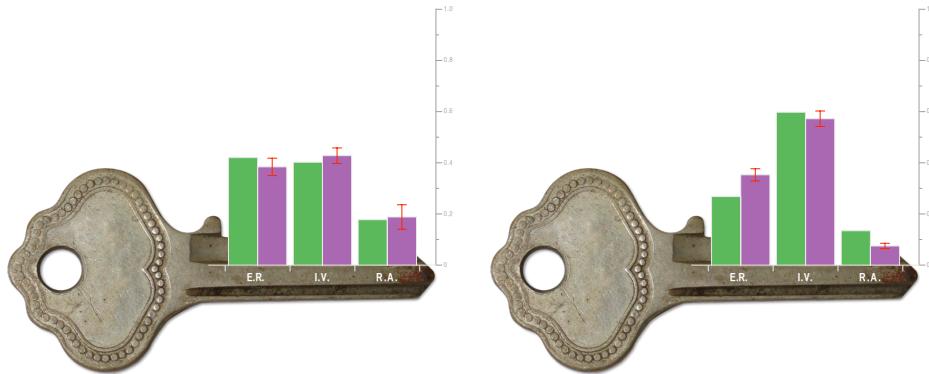


FIGURE 10. Keys of compatibility: Manifest Motivational Orientation (left) and Latent Motivational Orientation (right). According to Table 4. Nucleus of power (green) and 3 random measures (purple). E.R.= Expected Roles, I.V.=Internalized Values, R.A.=Recognition of Affections.

This amplitude can be interpreted as a “key” or “code” that allows two entities to belong to the nucleus, or simply be linked to another. In simple words, the “key of compatibility” is the deeper compatibility between people that we found.

Figure 10 shows the “key of compatibility” for nucleus members. The result suggests that the links between powerful people obey their Expected Roles and Internalized Values to a similar magnitude. Affect Recognition seems to be less important. No difference was observed between nucleus relation and random relations, suggesting a robust result. However, the analysis of latent motivations shows that Internalized Values have a “starring” role followed by Expected Roles. The recognition of affect also seems to be the less important.



FIGURE 11. Keys of compatibility: Optimum of Gratification (left) and Resulting Basic Action Types (right). According to Table 5. Nucleus of power (green) and 3 random measures (purple).

The previous results can be further reinforced by taking the theory of Optimal Gratification into consideration, that is, by adding the analysis of vested interests of actors and behaviors associated with the social action (Table 5). In terms of motivation, the ultimate interest of any actor is to obtain the “Optimum of Gratification” as the best that can be obtained from the conditions given the set of existential needs and the set of possibilities. Thus, in order to designate the interests embodied in the *Objects of Situation*, Parsons [57, 54] used the same as those of *vested interests*. These interests are related to “Power” and “Domination”. Additionally, there are resulting behaviors linked to each one of the *Objects of Situation* of Table 4 (cognitive/Intellectual-Instrumental; Valorative/Responsible; Affective/Expressive). Figure 11 shows others “keys of compatibility” for the nucleus of power.

TABLE 5. Optimum of Gratification and Resulting Basic Action Types associated to Poderopedia link types. [Source: own elaboration].

Situation	Optimus of gratification		Resulting Basic Action Types			
	Vested Interests		Behavior			
	Power	Domination	Intellectual	Expressive	Responsible	Instrumental
Known, Friends, Classmate, Husband/Wife, Family, Close	•			•		
Position in International organisms, Political Party, Think Tanks and Study Centers	•		•			
Studies	•		•			
Public position	•	•			•	
NGO position or participation	•		•			
Investment or position in company, Support groups to political campaigns	•					•
Religious groups	•			•		
Social Movements	•			•	•	
Participation in economic groups	•		•			

As can be seen in the left “key of compatibility” of Figure 11, actions of powerful people are related to expected “Power” and “Domination”, both in a similar magnitude. Among the randomly sampled (less-powerful people) gratification seems to be related to power more than domination. With respect to the behaviors derived from the *Situation of action* (right “key of compatibility”), the results suggest that most of the resulting behaviors are “Expressive” and “Instrumental”, followed by

“Responsible”, and much further along, “Intellectual”. A similar pattern is seen in the random sampling of less-powerful persons.

4.1. Businessmen *vs* politicians. According to [50], power in Chile is concentrated in two areas: business and politics. In contrast, symbolic and social power represent less than 30%. In order to explore the relations inside the two main groups and to search for the same signals of relation detailed in the previous section, we analyzed the shortest paths between businessmen and politicians. Figure 12 shows the vector of probability for link types that describe the relationships between top people in both groups.

As can be observed, for [person \leftrightarrow person] context, the social actions between businessmen are characterized by close and familiar relations. However, for the case of politicians, most of the relations are between close people, while family or friend relations are infrequent. In the random politician paths, interestingly, we observed that family ties seem to play a much more important role, denoting that these kind of links are less frequent between politicians within the nucleus.

The [person \leftrightarrow organization] context yielded somewhat expected results. The most probable relation type for businessmen is their participation in a company, while for politicians, belonging to a political party seems to be the most probable, especially in random paths. However, this context exposes something else, namely, that paths for businessmen are more diverse than politician paths.

All the detected (social) actions give us the “keys of compatibility” associated with Motivational Orientation, Optimum of Gratification and Resulting Basic Action for politicians and businessmen (Fig. 13).

TABLE 6. Conducts and effects of politicians and businessmen associated with their objects of situation (left part of the table). Capacity of politicians and businessmen for organization and to create political formula as Domination Factors. * I=Intellective, R= Responsible, E=Expressive. ** P=Power, D=Domination, R= Responsible. [Source: own elaboration].

ENTITY POLITICIAN/BUSINESSMEN			DOMINATION FACTORS POLITICIAN/BUSINESSMEN	
Need Dispositions	Conduct*	Effect**	Capacity of organization	Capacity to create political formula
Roles expectatives	I / I	P / P	high / high	high / low
Internalized values	R / R	D / R	low / low	high / low
Recognition of affect	E / E	D / D	low / high	high / low

A clear difference between groups can be observed. In businessmen (Fig. 13, top row, left) relations depends on Expected Roles, while those that depend on Internalized Values and Recognition of Affect are less frequent. This result is quite different than the observed behavior between politicians (Fig. 13, top row, right) where Internalized Values seems to dominate the relations inside the group. With respect to the expected gratification return, businessmen and politicians in the nucleus of power seem to act in search of domination and power; however, in the random samples, politicians seem more likely to look for power. Finally, with respect to the types of Resulting Basic Action, the analysis shows that businessmen (bottom row, left) have Instrumental behaviors, followed by Expressive and Intellectual. On the other hand, the behaviors of politicians (bottom row, right) are preferentially

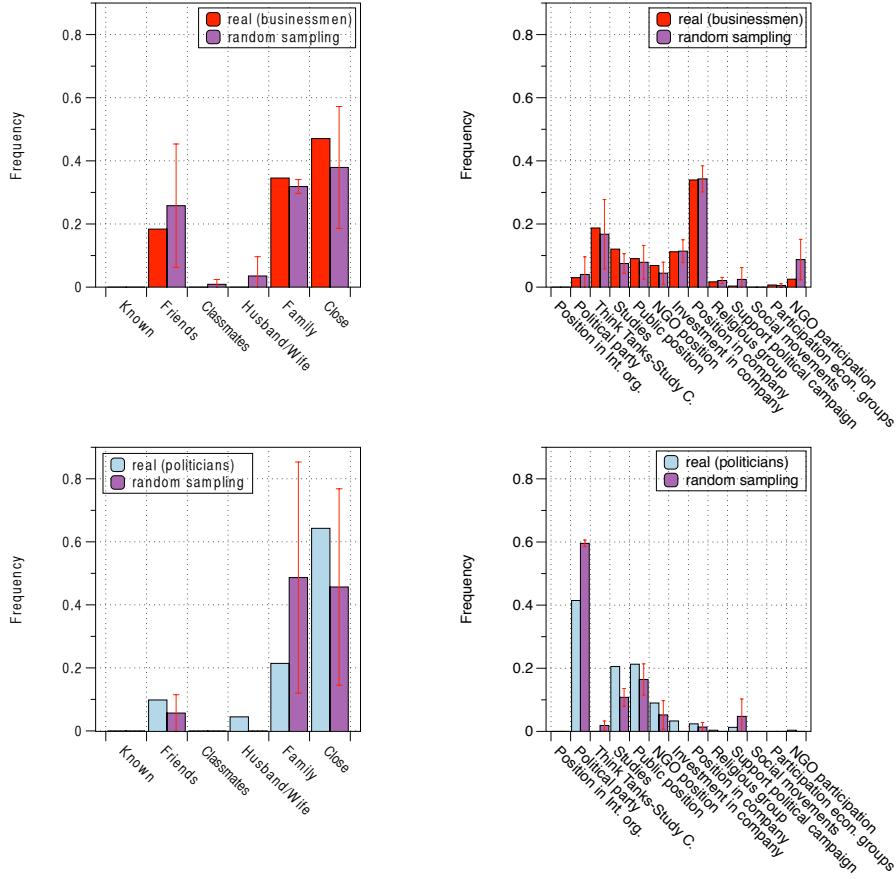


FIGURE 12. Businessmen relations: Person to Person (left top) and Person to Organization (right top). Politicians relations: Person to Person (left bottom) and Person to Organization (right Bottom). Frequency of links detected in the paths computed. Businessmen (red), politicians (cyan) and 3 random sampling (purple).

Expressive or Responsible. In most of the cases, random samples show similar behaviors respective to their corresponding real data, denoting again, robust results.

Although the keys herein presented already provide valuable insight, it is possible to go deeper in these results because, according to sociological theory, there are conducts and effects (results) associated to *Objects of Situation* (Table 6, left column). For the two most representatives motivational orientations of both groups, Expected Roles and Internalized Values (see Fig. 13, top row), there are *Intellective* and *Responsible* conducts associated [57]. *Power* is the effect associated with the *Expected Roles* for both groups, however, a key difference appears in the effect of *Internalized Values*: for politicians, it is the *Domination*, but for businessmen, it is *Responsibility*.

Furthermore, there are *Domination Factors* [39, 40] (Table 6, right column) such as “capacity of organization” and “capacity to create political formula” associated to conducts and object. The theory summarized in the table supposes that the

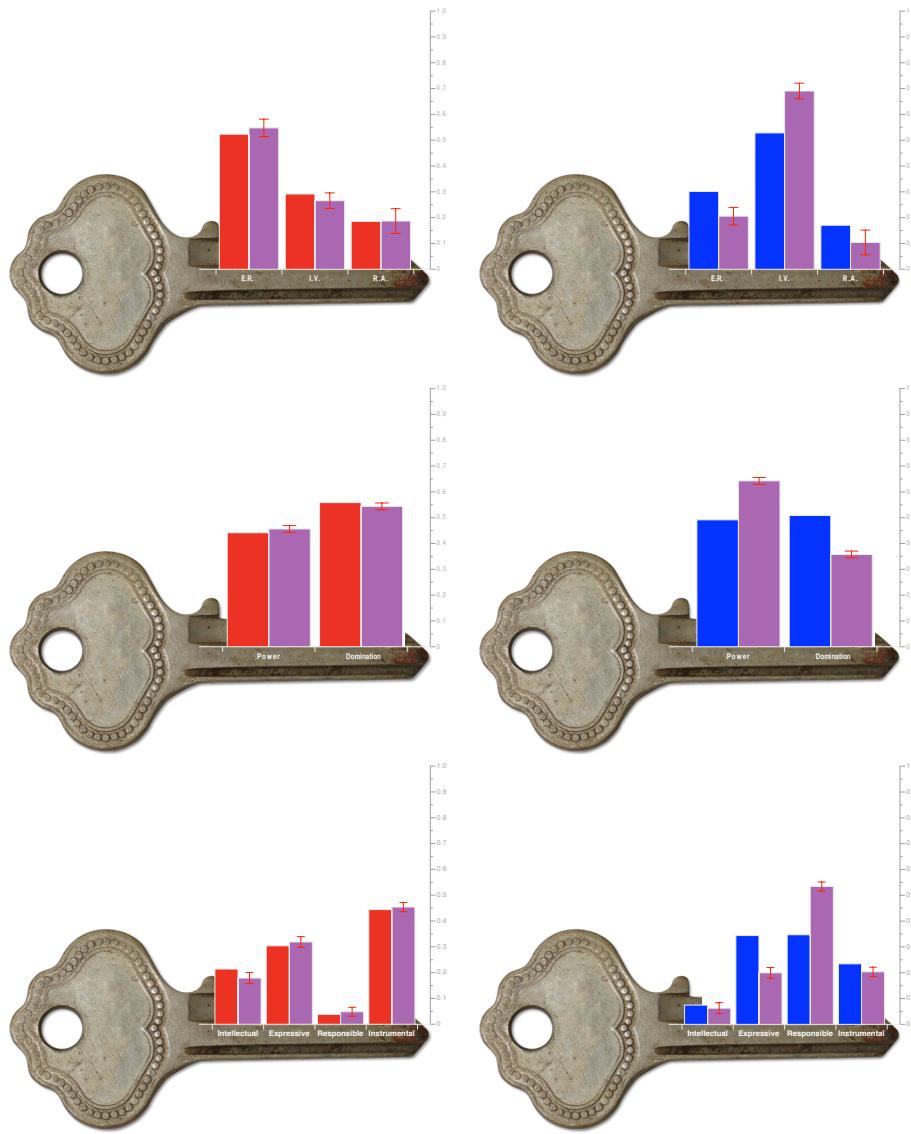


FIGURE 13. Keys of compatibility: Motivational Orientation (Top), Optimum of Gratification (mid) and Resulting Basic Action Types (bottom) for businessmen (left, red) and politicians (right, blue) in comparison with 3 random measures (purple). According to Tables 4 and 5. E.R.=Expected Roles, I.V.=Internalized Values, R.A.=Recognition of Affections.

difference between politicians and businessmen is in their ability to create political formula. In order to test this, we used the generated topological entity information as an approximation of their capacity of organization. Thus, we say that this capacity is related with the “size” of their “world”. If their “world” (nearby people) is small, we say the people have a high capacity of organization. According to this definition we use two classic metrics to gauge this “world size”: the mean

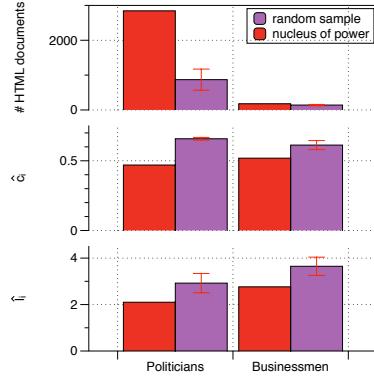


FIGURE 14. Politicians *vs* businessmen. Average shortest path length \hat{l}_i from entity i to the rest (bottom), average clustering coefficient of entity i (mid) and average number of HTML documents of entity i “saying something” (top), in comparison with 3 random samples (purple bars).

cohesiveness of their neighborhood (c_i), and the average length of the shortest connections between them (\hat{l}_i). As the bottom and middle plots in Figure 14 show, both groups have relatively the “same capacity”.

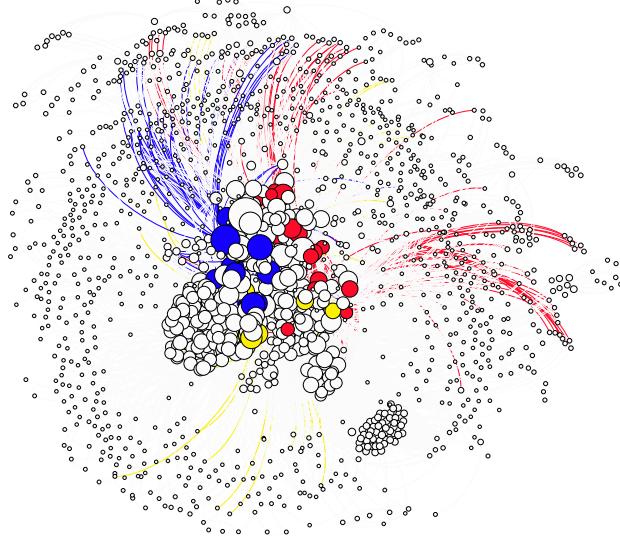


FIGURE 15. Three major communities of Chilean power network. Layout shows the powerful in the center. The nucleus of power (40 people) is colored according the profile of the person: businessmen (red), liberal politician (yellow) and conservative politician (blue).

Since these results were so similar, another approach was needed to observe differences in the capacity to create political formula. In order to measure this difference, the number of HTML documents that contains words such as “say”, “explain”, among others, associated to the person were used as indicator, and as

a primary and very basic attempt to approach the problem. We worked under the assumption that phrases such as “He said...” or “She explained...” denotes construction of language that can lead to “essay building” which may mean to reach a *consensus* [27, 51] in the population or to build legitimacy [64]. As Figure 14 (top plot) shows, politicians are much more prolific than businessmen in this respect.

Finally, we connected the profile of persons with social power P defined in the previous section. In order to obtain clear results, we divided the politician group in two: liberals and conservatives. Figure 15 shows the positions of top businessmen (red) and top politicians (blue=conservatives, yellow=liberals) in the three communities described in Section 2. The layout of the figure shows that the less powerful people “orbit” the core of power. As can be seen, a high proportion of links of conservatives politicians and businessmen go to the periphery, but most of the links of liberals seem to be inside this core.

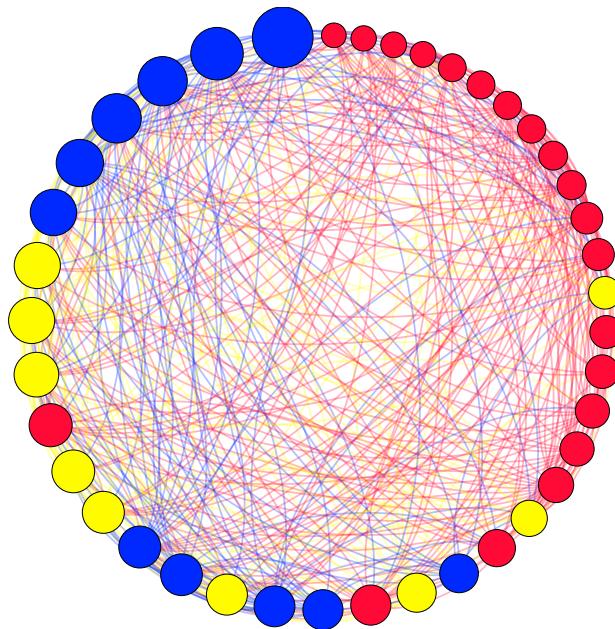


FIGURE 16. Nucleus of power isolated and sorted (in the clockwise direction) according to their P power. Color nodes as in Fig. 15.

Once these people were isolated from the core and sorted, clockwise, according to their P power (Fig. 16), we can observe that Chilean businessmen are clearly less powerful than politicians, especially conservatives.

5. Discussion and conclusions. The results of the previous sections open the discussion about the validity of the original claim of sociology, that of explaining social facts, which assumes a misleading perception that it is possible to differentiate the dimensions of subject and object and thus to accentuate the “objectivity” in the same way as natural sciences do. That’s what Durkheim [21, 32, 5, 42] and other founders of the Social Sciences believed. However, to continue to support this separation is difficult because those things that we objectify (social facts) end

up being social constructs inseparable from their attributed meanings (interpretive values), which in turn allows for (undue) interference stemming from subjectivity (*i.e.*, the subject). The epistemological consequences are varied, and in part, we try to mediate these phenomena in this study. That said, and through this novel epistemological approach to the phenomenon of power, here are some discussions and conclusions about the results.

The social network of powerful Chilean people shows non-trivial and non-intuitive statistical properties, commonly observed in complex systems. The most remarkable of these have to do with the unequal distribution of power and its links in the population, and that these distributions are of *scale-free* character. It is also surprising to see that power in Chile is highly cohesive, as denoted by the high degree of transitivity of connections. On average, more than half of the connections of people in the network are also interconnected. Moreover, the power seems to be “tight-knit”, a real small-world where at most only a few people (~ 4) are intermediaries between any randomly chosen pair of individuals in the network.

The presence of these properties is very similar to those observed in complex systems of different natures. For this reason, their presence can be explained, at least intuitively, as an effect of their growth and adaptation. The time and the mechanisms associated with these processes most likely play an important role in their emergence. The ubiquity (universality) of these complex properties suggests that there may exist universal principles underlying the evolution of systems, irrespective of their origin.

With respect to this underlying principle that may generate this kind of system structure, our results suggest that a simple compatibility mechanism between people in a growing network may engender a social structure such as the one studied, *i.e.*, strongly inhomogeneous in its connectivity and power distribution. According to Taleb [59], this inequality is unexpected for most of us and would be the reason why it seems to be a non-intuitive behavior.

According to the CAM, the compatibility of personal characteristics (see Figs. 10 and 11) seem to be the “key” for people to belong to a elite group. But, this mechanism is not exclusive to the most powerful group; it operates at all scales, as indicated by the observation of scaling in the distribution of power P or connectivity. As a result, there is no single “nucleus of power”; power concentration exists at all levels, and even the inequality between powerful people across their distribution is the same. This coincides with Dahl’s idea of Polyarchy [17], a government of many that is structured around a system of *polar* balance. As societies develop, they become more concrete; this concretion, then, manifests itself politically as an increase in the number of institutions and leaders (the principle of “dynamic density” of Durkheim [54]). This leads to a situation of many overlapping institutions that constantly need to negotiate in order to achieve their purposes. To resolve any issue that arises, powerful institutions with their own interests and different leaders have to be in agreement.

The concentration of social power in a few seems to be an emergent property of a dynamical system. This is not the product of a conspiracy, but the result of unregulated growth in the social system. However, according to the model, the distribution of personal characteristics plays an important role. In fact, as [16] exposes and under assumptions of compatibility, inhomogeneous distributions of personal characteristics could lead to this type of network, while homogeneous distributions oppose concentration. This suggest that more homogeneous populations

could affect, in some way, this risky⁸ concentration of power. This is an important argument in favor of social reforms that ensure equality and social inclusion.

Another interesting aspect of the proposed model is that according to Eq. 1, the compatibility should be more accurate as the population grows. Belonging to the elite in large populations requires sharing more and more things. The research of J. Barbier [9] on Chilean elites between 1755 and 1800 showed that the elite was composed by approximately 347 people, representing 0.04% of the population at that moment. Moreover, the study argues that during the last quarter of the 17th century and the first half of the 18th century, the structure of the Chilean elite was characterized by strong family ties (from marriages among the elite) linked to the possession of titles of nobility. This condition favored the strong link between power and political control and associated business, an issue that would continue in the second half of the 18th century, even though this same elite gave greater importance to matrimonial relationships with those managers and government administrators through whom enough influence was generated to favor power and political control.

Today, with a Chilean population over 16 times greater, belonging to a family of the elite is not enough. Although our results suggest that family relations are important as direct links (see Fig. 8), the results also show that not every person that descended from the elite has secured power, as was most common in the 18th century. There are many examples of people that belong to the elite without an elitist past. Nowadays, belonging to a powerful group means to share common interests (Expected Roles, Positioning, Functions) and values (see Fig. 10). These commonalities may (or may be not⁹) have been inculcated during (similar) formations in their homes or in a few groups of schools and universities (see results of Fig. 8). Therefore, people could be linked in various nuclei of power due to the interpretation of senses and meanings attached to the mutual construction of symbols, which contain different “senses” linked to *objects of gratification* of power and domination, associated with preferably expressive and instrumental conducts (see Fig. 11). The results showing that powerful people link to persons with similar power (see Section 3) dramatically reflect this process, although, as a remarkable outcome of our analysis, this phenomenon was shown to occur between less powerful people as well.

The effects of relation by likeness and similarity, accompanied by the imitation phenomenon [39, 40], are the key to understanding the phenomenon of attraction. Although this was illustrated by W. Mills in his study of “Power Elite” in the United States [37], it had already been presented as a caveat by R. Michels in his “law of

⁸We say that concentration is risky because there are possible scenarios when the action of (or over) extremely powerful people may affect many people (many directed and undirected connections depends on them). However, these scenarios are less probable than the ones where the action of (or over) less-powerful people.

⁹According to W. Pareto [2, 33, 48] (non-rational) psychological residues can be involved in this distinction. Pareto understand that social interaction is directly linked to psychological predispositions. People are linked not by “rational action” or “instinctive actions”, but by “non-rational actions”. The latter are, in his opinion, what normally occurs. Such actions are covered by a veil that gives appearance of logic (which Pareto called “derivation”), but if that veil is removed, only “residues” remain (psychological predispositions). Pareto distinguishes different types of residues that remain in the elite, highlighting “residues of persistence” that causes those who have it to prefer change over tradition. These people also have no religious attachment. On the other hand, people that have “residues of combination”, tend to preserve a certain state of things, to value the traditions and have a certain religious attachment. Using a metaphor of Machiavelli, the first may be identified as “lions” (conservatives), while the latter as “foxes” (liberals).

the psychological metamorphosis of the leader". This law reflects the inevitability that powerful people end up acting and behaving according to the parameters of the elite and, indeed, thinking similarly and exhibiting an attitude of conserving positions of power. This is one possible interpretation from looking at the nucleus (nuclei) of power.

When we study the two groups of powerful people¹⁰, businessmen and politicians, more profoundly, the results show that their "keys of compatibility" are different (see Fig. 13). This is not at all surprising, since power has a different meaning for each group, despite the fact that in both cases we are talking about a power that emerges from relations, a *social capital* [1]. Economic power is projected through trade relations that allow actors access to goods, which has an *instrumental* character to their purposes [41, 55]. On the other hand, political power does not refer to possession of goods or instruments, but the ability to control the system of relations. Political power is the mobilization of all the relational context as a means. Indeed, our results show that powerful businessmen, mostly engineers or economists, seem to be dominated by a compatibility based on Expected Roles (interest), while politicians, mostly lawyers, seem to be moved by compatibility of Internalized Values (see Fig. 13). These results would again be explained by sociological theories of social power. According to M. Weber [64], power is the imposition of one's will over another, even against all resistance, and ultimately rests on the use of force or threat thereof. However, it is much smarter to ensure prompt and sincere obedience, which Weber himself appointed "legitimate domination": The power required to legitimize aims to capture the belief of the people, which is where social legitimacy lies. Hence, politics become a more efficient instrument to build legitimacy, "to convince". In that sense, there is a greater ability of politicians to undertake this task than businessmen (see Fig. 14, upper plot). Unlike the nature of politics, the economy seems to rest on a principle of rationality linked to obtaining optimal profits that guide social actions (supply and demand). In this latter logic, legitimacy building does not seem a requirement *sine qua non*, and thus reduces to some extent efforts to hold onto the "great narratives" that contain principles and rating of "political economy". This difference in constructing legitimacy sheds some light differences observed between politicians and businessmen in our work.

Furthermore, businessmen generally seem to follow a sectoral logic. Their interactions are fundamentally cognitive and are related to expected roles, functions, and positions. In that sense, the search for power seems to be more explicit. Politicians, for their part, seem to generally obey a sectoral logic associated with obtaining control over processes, planning, and distribution within the social system. In their search for social legitimacy, their interactions seem to be related to domination, which is why their behavior seems to follow value orientations of social and moral responsibility. However, in both groups, affect orientations operate transversely and equivalently. Usually, however, actors do not usually make this kind of orientation "expressive". This is one possible explanation of our analysis, in which the affect orientation appears to play a less important role (see Figs. 10 and 13).

In light of the results and discussions above, there are some ideas that want further development. One of these is related to the Kornhauser's categories [28]: "accessibility of elites" (how permeable the elites are to the influence of non-elites) and "availability of non-elites" (how non-elites are mobilized by elites). The role

¹⁰Our suspicion is that, since its inception, the power in Chile has focused in the strong link between politics and business, which has led us to prioritize our research on these two categories.

played by Chilean society (the non-elite) since 2011 [29, 62, 34], seems to be the result of a process that has transformed Chilean society into a more pluralistic one. In such societies, the accessibility of elites tends to be increasingly high (high ability to be permeated by non-elite) and the ability of non-elite to be mobilized (by elites) is increasingly difficult. This makes us notice that linkages of power also tend to become part of this dynamic.

Finally, and maybe the most remarkable underlying conclusion of our work, is that power seems to be in the network, in the connections, in the processes, in the codes, in the communication, in everything; the concentration (at different scales) that we presented is nothing more than the “instrumental” organization of power, its efficient administration with respects to purposes related to control and maintaining the network itself. A view in agreement with the observation made recently by Alvaredo *et al.* [4] respect to the economic elites. This represents a different approach to social power in comparison with the classic view related to obtaining certain power that only a few are privy to (“Theory of Elites”). Power seems to be rather a phenomenon of complex social systems, part of its substantive properties, not just the result of petty intentions of mastery of the “few over the many”, even when these seem to be the “real” expression that we commonly observe and experience. This opens an interesting next research that we want to develop in the future.

Acknowledgments. This work was financed by projects: “Diseño de Redes” from INRIA-Chile and Universidad Técnica Federico Santa María, and CONICYT SOC-1101, “Anillo en Complejidad Social” of Universidad del Desarrollo de Chile. We also want to thank Poderopedia.org for the data provided, and we appreciate the comments and suggestions made by Professor Arturo Fuenzalida, Mason Taylor and Miguel Paz, which contributed significantly to better expose the results of our research.

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Received June 2014; revised November 2014.

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