

# The Potosí principle: religious prosociality fosters self- organization of larger communities under extreme natural and economic conditions

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## Abstract

We show how in colonial Potosí (present-day Bolivia) social and political stability was achieved through the self-organization of society through the repetition of religious rituals. Our analysis shows that the population of Potosí develops over the time a series of cycles of rituals and miracles as a response to social upheaval and natural disasters and that these cycles of religious performance become crucial mechanisms of cooperation among different ethnic and religious groups. Our methodology starts with a close reading and annotation of the *Historia de Potosí* by Bartolomé Arzans. Then, we model the religious cycles of miracles and rituals and store all social and cultural information about the cycles in a multirelational graph database. Finally, we perform graph analysis through traversals queries in order to establish facts concerning social networks, historical evolution of behaviors, types of participation of miraculous characters according to dates, parts of the city, ethnic groups, etc. It is also important to note that the religious activity at the group level gave native communities a way to participate in the social life. It also guaranteed that the city performed its role as producer of silver in the global economic structure of the Spanish empire. This case proves the importance of religion as a mechanism of stability and self-organization in periods of social or political turbulence. The multidisciplinary methodology combining traditional humanistic techniques with graph analysis shows a great potential for other sociological, historical, and literary problems.

# 1 Background

It is normally assumed that there is a contradiction between religiously oriented communities and the ability of these societies to self-organize beyond hierarchical structures imposed and maintained by religious and political elites. On the contrary, certain forms of religiosity contribute to the stability of larger groups made up of socially and ethnically diverse communities.<sup>1</sup> It is a mistake to think that it is possible to acquire this stability only through top-down mechanisms imposed from the highest level of the social, religious, and political institutions in place. The conclusions of this line of thought usually imply that a predominantly religious society is always synonymous with a fundamentalist one in which clerics and officers control all forms of power, and that religion does not allow for the emergence of self-organization from the bottom-up.<sup>2</sup>

The case we study here proves the opposite. In colonial Potosí (present-day Bolivia), an overwhelmingly religious society is able to self-organize under adverse natural conditions and maximum economic stress in order to foster a much-needed intergroup stability and guarantee the survival of the larger community.

Henrich *et al.* (2010) have shown that the existence of norms to maintain fairness among strangers is linked with the dissemination of institutions such as market integration and participation in world religions. Our case confirms the hypothesis that modern world religions may have contributed to the sustainability of large societies and of large-scale interactions and that they still have to be taken into account when explaining present-day political and economic dynamics.

Wright (2009) has demonstrated that there is a connection between the forming of multinational empires such as the Hispanic Monarchy (Elliott, 1963; Elliott, 2006; Kamen, 2003) that have to accommodate within them different ethnic and religious groups, the survival of which depends on the perception of their relationships in terms of a nonzero sum, and the ability of the Abrahamic god to grow beyond the initial political community. Immediately after the discovery of silver by the Spanish in 1545, Potosí (present-day Bolivia)

became a crucial place for Spain's economic interests in America (Bakewell, 1975; Flynn and Giráldez, 2002; Hamilton, 1934) and a testing laboratory for Wright's hypothesis. First, the growth of the population was uncontrolled from the outset, resulting in chaos with regard to urban planning and health (Arzáns de Orsúa y Vela, 1965), with its cyclic corrective elements in natural disasters. Second, Potosí became a key node in the economic structure not only of the Spanish Crown but also of the first global trade network (Bakewell, 1975; Elliott, 1963; Flynn and Giráldez, 2002). Third, in social terms, the number of different groups multiplied very quickly, resulting in a Potosí that never was locally self-sufficient and that turned increasingly complex and interdependent (McNeill and McNeill, 2003), with constant conflicts and high levels of violence between groups, including among Spanish groups from different peninsular origin (Diamond, 2005), and in particular over the native populations working in the mines (Bakewell, 1984; Cole, 1985; Helmer, 1960). All of these factors had an immense impact on the religious behavior of the people of Potosí, who constantly turned to the supernatural to alleviate natural disasters, the abuses of the *mita* system of mining on the indigenous population, and the human disorders resulting from what were perceived to be 'moral errors' of the inhabitants.

Religious prosociality is the idea that religions facilitate certain acts that benefit others even when there is a personal cost to the actor (Tandeter, 1993). The '*Potosí principle*' refers to the radical case that colonial Potosí presents in terms of the survival of a community constantly under threat from natural causes and human violence, but whose position in the imperial and global economic network does not allow it to disappear. The '*Potosí principle*' proves the importance of a sustained activity of religious rituals for the spread of successful behavioral strategies at the group level in a context of conquest and assimilation (Norenzayan and Shariff, 2008).

A sustained ritualistic activity in Potosí guaranteed communication with the supernatural and miraculous participation of the divinity in the survival of the community, while at the same time

allowed for the coming together of the different social and ethnic groups (Boyd and Richerson, 2002). In colonial Potosí, a growth of the Abrahamic god (Wright, 2009) coincided with the reinforcement of religious prosociality (McNeill and McNeill, 2003); the role played by the Catholic religion and its moralizing god (Heinrich et al., 2006) in maintaining a political community of planetary dimensions; as well as its role as a facilitator of social cohesion and in-group solidarity (Roes and Raymond, 2003). This is an extreme case of religious prosociality because rituals and miracles act as a constant cultural response to natural disasters, physical violence, and economic instability over the colonial history of the city on the part of the people of Potosí.

## 2 Methodology

As the main source of our data, we have used the *History of Potosí* (HP) (Arzáns de Orsúa y Vela, 1965), a text written by Bartolomé de Arzáns (1676–1736), who compiles in 1343 pages the history of the famous city from 1545 to 1736. We have carried out a manual annotation of the text in order to select all the parts related to the cycle of miracles and rituals that we described below.

Our model is defined over a multirelational graph database (Chartrand and Lesniak, 1986; Rodriguez and Shinavier, 2009), following the schema graph represented by Fig. 1 and allowing for the detailed inclusion of the objects in question as well as their semantic relations. These objects relate to a repeated cultural phenomenon in the history of Potosí by which a chaotic situation provoked by natural disasters, moral deviations, or social unrest is followed by a ritual to engage the divinity, then the performance of a miracle that restore order, and a final thanksgiving ritual.

This has enabled us to define a homogeneous structure to represent all of the contextual sequences and relations expressed in the text by making use of the following elements: *Miracle of the Chronicle*, *Chaotic Situation*, *Ritual of Request*, *Miraculous Character*, *Miracle*, *Ritual of Thanks*, *Characters*, *Place*, *Date*, and *Location in the Chronicle*. From

each of the 107 miracles—manually annotated—in the chronicle, we obtain a graph that represents the objects and specific relations occurring in the description formed in the HP of each of the miracles. The combination of all of these small graphs, making use of the same semantic context, provides us with a large network of interconnections to show the projection of the socio-religious network that Arzáns describes in his history (Fig. 2).

Since, our model is not defined over a standard relational schema, but over a multirelational graph database (a graph with a classification on the edges and nodes, following the scheme represented by Fig. 1) (Chartrand and Lesniak, 1986; Mendelzon and Wood, 1989), we apply a special query system. As in the case of the query system based on relational algebra in Relational Databases (Rodriguez and Neubauer, 2010a) (resulting on the SQL language) (Rodriguez and Shinavier, 2009), in the case of graph databases an algebra is being developed in order to make queries and graph transformations. Traversals are the most common and useful operations on these query systems for graph databases (Mendelzon and Wood, 1989; Rodriguez and Geldart, 2009; Rodriguez and Neubauer, 2010a, b). They are just as important for graph databases as joins in the SQL queries are for relational ones.

A traversal in a graph database is uniquely described by two data items: a start node and a specification for the schema of the path that will be used for the traversal. And the result always leads to a set of nodes. Depending on the structure of the graph being traversed, and the traversal you are interested in, that set may contain many, one or zero nodes or may even contain repeated nodes, indicating that more than one path, which meets the definition of the traversal, connecting the two nodes have been found. For example, if in the previous scheme, we traverse from a node representing a miraculous character to the nodes representing the required rituals performed with them, we will find that for some specific Miraculous Characters there are no required rituals while others obtain a set of repeated ones.

For example, the following traversal (we do not explicit the types of the edges, since in our case they

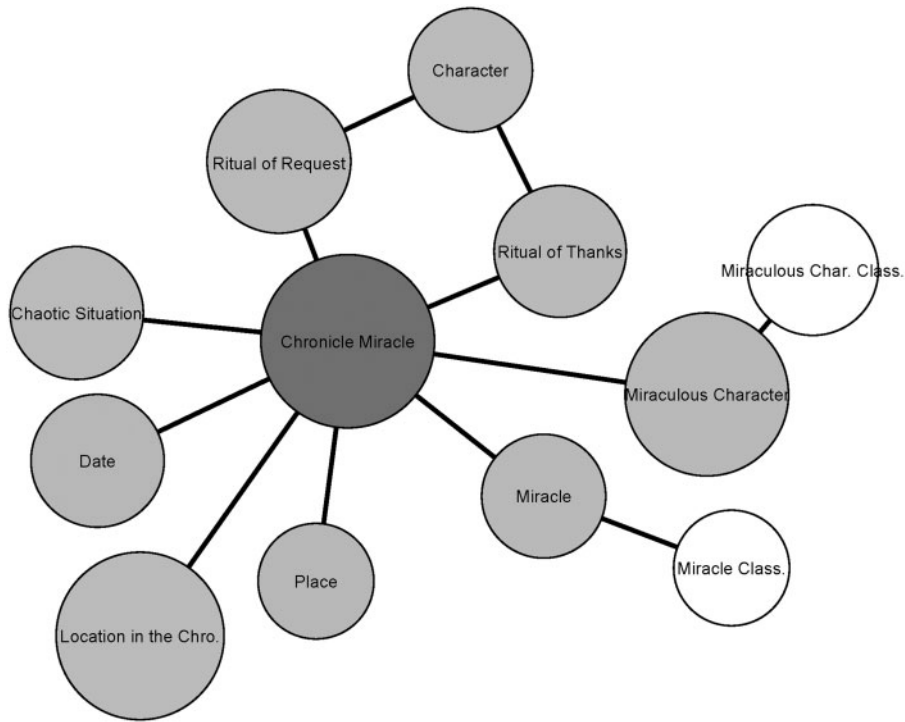


Fig. 1 Schema Graph supporting the data extracted from the History of Potosí.

are determined by the types of the pairs of nodes they connect):

<“*Miraculous Character Clas.*”,  $e_1$ , “*Miraculous Character*”,  $e_2$ , “*Chronicle Miracle*”,  $e_3$ , “*Miracle*”,  $e_4$ , “*Miracle Clas.*”>

When applied to the node ‘*Virgin*’, this produces the following multiset (a set with repeated elements) of *Miracle Classification* nodes:

{*Apparition: 16, Healing:16, Salvation: 34, Nature: 7, Resurrection: 7*}

By applying the previous traversal to the complete graph (from the complete set of nodes of type ‘*Miraculous Character Clas.*’, to the set of nodes of type ‘*Miracle Clas.*’), we obtain the weighted graph in Fig. 3. It shows the different types of miracles that the types of miraculous characters have performed.

In Fig. 4a–d, we show some more simple queries, we can make following the same methodology (a frequency filter has been applied to show only

the more relevant items in the resulting graphs, where size of the node represents the total frequency of the node in the database, and thickness of edges show the weight of it).

From the information obtained from the query, we can also obtain standard chart representations of the same data. Figures 5a and b show the relations between rituals and the main groups of characters participating in them.

Other samples of data analysis with this methodology are represented in Figs 6–8d; Fig 9a and b.

### 3 Discussion

According to the HP, 107 miracles occurred in Potosí between 1545 and 1730. Each of these is associated with at least one ritual of request that individuals or groups use to request the intervention of the divinity and afterwards, it is associated with at least one ritual of thanksgiving. The inhabitants of

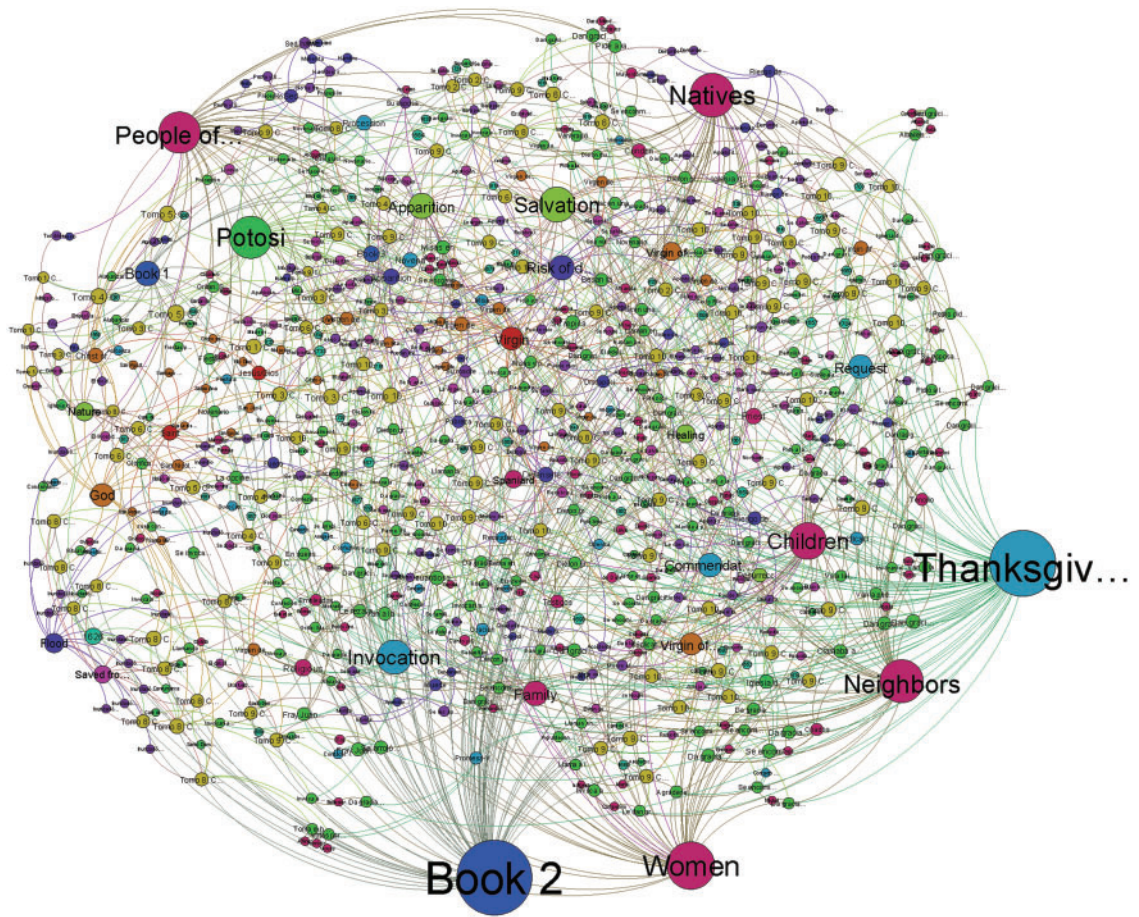


Fig. 2 Network showing the socio-religious network that Arzáns describes in his history.

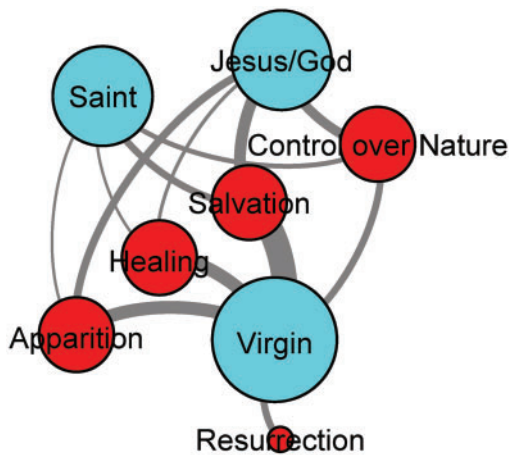
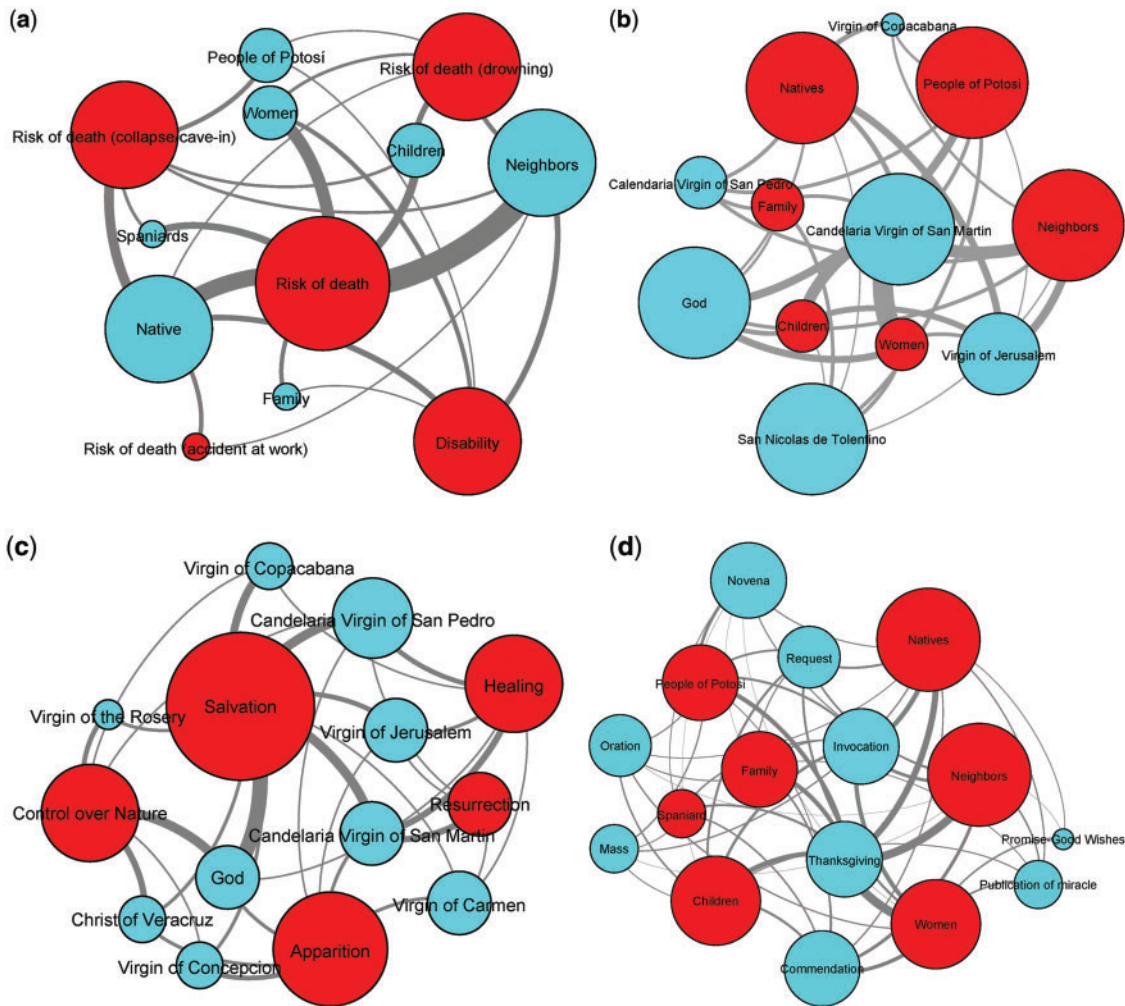


Fig. 3 Result of applying the simple path query from 'Miraculous Char. Class' to 'Miracle Class'.

Potosí relate to the Catholic divinity through a diversity of forms such as God, Jesus, Saints, and various denominations of Virgin Mary. Different individuals and social groups turn to different dedications and forms of saints and virgins in order to communicate with the divinity. This is consistent with Atran and Norenzayan's (Atran and Norenzayan, 2004; Shariff and Norenzayan, 2007) assertions about the role of religion as a cultural innovation that aided by ritual makes possible the existence of large and cooperative moral communities of genetically unrelated individuals.

By scanning the network of miracles and miraculous characters intervening on each occasion, together with the parallel network of social groups



**Fig. 4** The traversals used for these queries are simple paths connecting the nodes: (a) Chaotic Situation–Character; (b) Miraculous Character–Character; (c) Miracle Class–Miraculous Character; (d) Rituals–Character.

participating in rituals (Norenzayan, 2010) and benefiting from the miracles, we are provided with an overall view of the religious network of colonial Potosí as well as its chronological evolution. The analysis of the resulting graph shows that in all cases, the trigger is an episode of chaos in which nature or human violence leads people to immediately turn to the divinity and to perform collective ritualistic acts in order to restore social and natural balance in the city. An example of a natural chaotic situation is the overflowing of

the Kari Kari lagoon that in 1626 resulted in the flooding of Potosí and a huge loss of life and property. According to the chronicle of Arzáns, eleven miracles occurred in the city throughout that year. However, accidents relating to working in the mine placed many inhabitants of Potosí in life-threatening situations are numerous throughout the history of the city.

The miraculous characters who intervened the most in the life of the city are the Candelaria Virgin (under several of her names) and God.

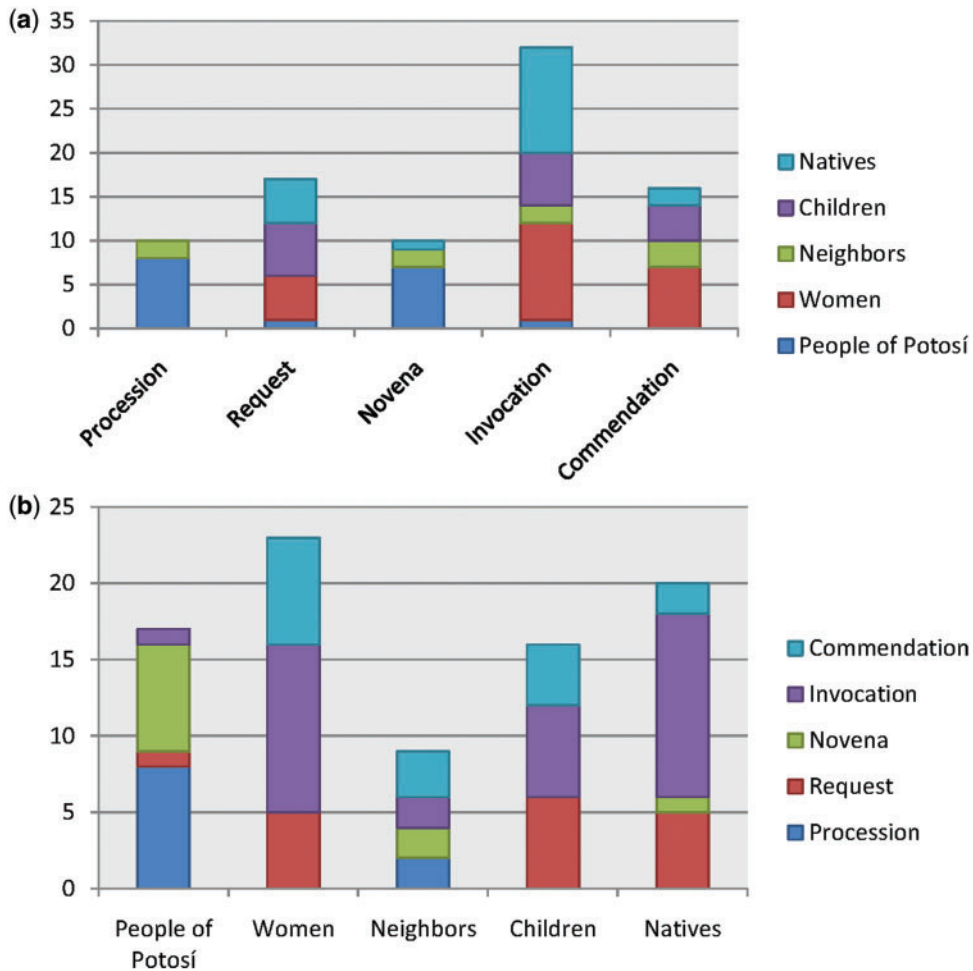


Fig. 5 (a and b) Relations between rituals and main groups of characters.

With regard to the characters in the social network, the groups of neighbors,<sup>3</sup> the people of Potosí, women, children, and the indigenous people are those with the greatest preponderance in the socio-religious life of Potosí. In Fig. 10, we can see how the miraculous characters are connected with the different social groups that participate in the rituals relating to the miracles resulting from them. In this figure, we can appreciate that the group of women has a special bond with the Candelaria Virgin of San Martín, one of the parish churches of Potosí belonging to an area of indigenous people. When there are various ethnic and

social groups participating in the ritual—what we have called the ‘people of Potosí’—then God the Father is the character who intervenes most in a miraculous event. Another important character with a variety of connections and her strong link with the neighbors is the Candelaria Virgin of another one of the parish churches of the Indians, that of San Pedro.

If we turn our attention to the use of different types of rituals, we shall see that the ritual of thanksgiving is very often used by the neighbors, women, indigenous people, and the people of Potosí, whereas the Spanish and Creoles never appear as separate

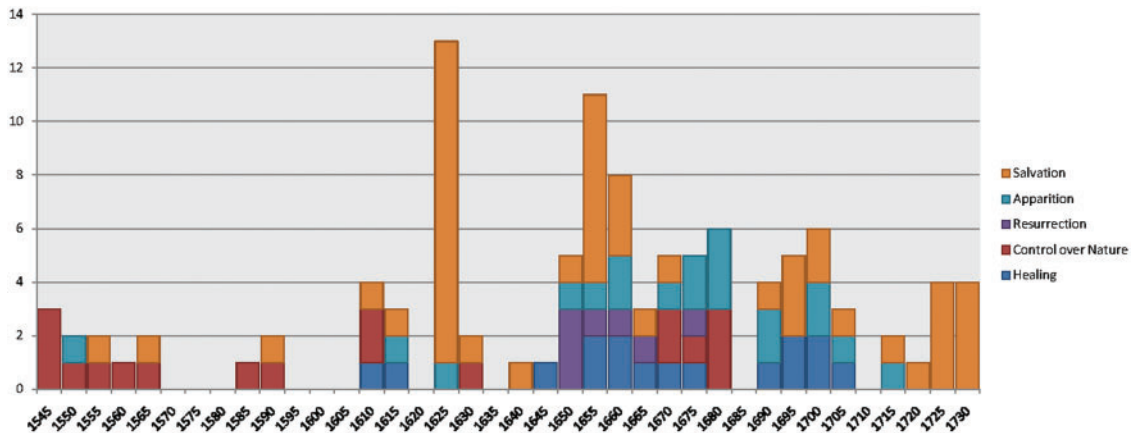


Fig. 6 Temporal distribution of miracles grouped by 'Miracle Class'.

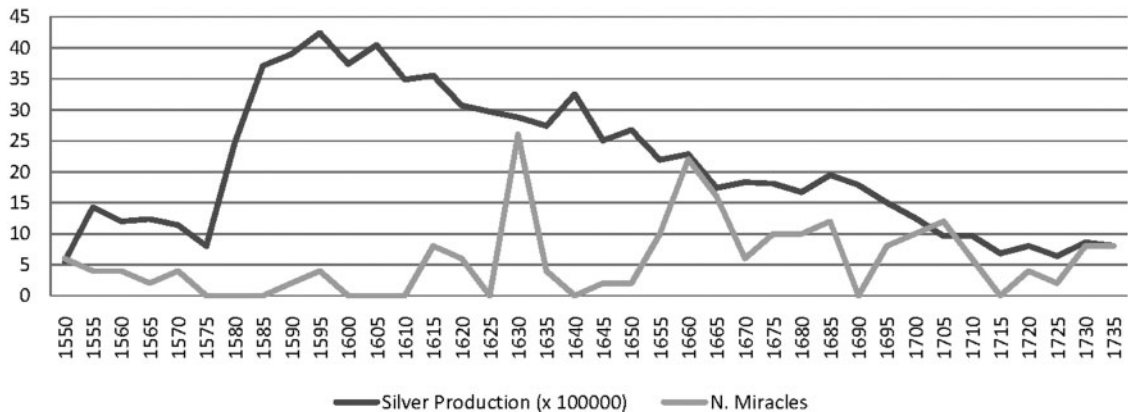


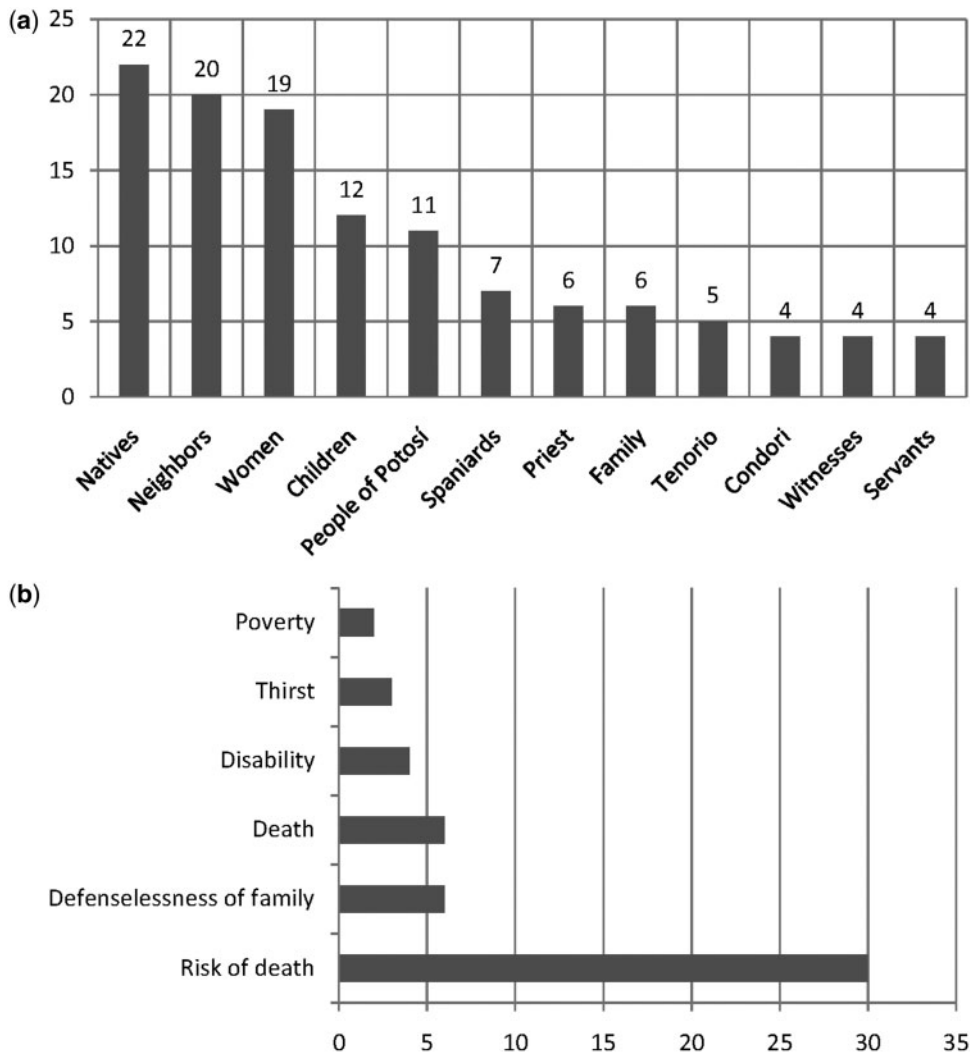
Fig. 7 Chart comparing the chronological distribution of miracles and the silver production in Potosí (silver production according to Bakewell, 1975).

groups, although they do appear on certain occasions as part of the 'people of Potosí' group.

The case of Potosí highlights the decisive role played by religious group behaviors and rituals in maintaining inter-group cohesion and confirms how religious rituals, while costly for the members of the group, serve to reinforce the cooperative norms, ascertain the intentions of other individuals and subgroups in relation to the group's activities and to facilitate the existence and stability of larger groups (Norenzayan and Shariff, 2008).

First, a religious prosociality from the bottom-up emerges from Potosí's history as different ethnic and social groups start the rituals in each particular case reinforcing inter and intra-groups solidarity and cooperation (Sossis and Alcorta, 2003; Sossis and Bressler, 2003) under difficult natural and social conditions. In other words, every group that initiates the religious relationship with the intention of solving a specific problem turns to one or more particular miraculous characters, but they are all part of the many Catholic Christianities of the Atlantic (Fernández-Armesto, 2007; Mills, 2007).





**Fig. 8** (a) Participation of Characters in rituals related to the Candelaria Virgin, considering all the different denominations; (b) Main chaotic situations related to miracles by the Candelaria Virgin; (c) Participation of Characters in rituals related to the Candelaria Virgin, grouped by denominations; (d) Main chaotic situations and related miracles by the Candelaria Virgin grouped by denominations.

Second, religious behavior allows for a better understanding of the mechanisms that explain self-organization and stability under ethnic and cultural variety in Potosí (Klein, 1992).

Third, the case of the Virgin of the Candelaria shows a figure who has undergone a process of hybridization and presents both European and pre-Hispanic features. This helped indigenous peoples within the Spanish empire to domesticate the invaders' beliefs

and maintain a certain degree of continuity with their own past (Fernández-Armesto, 2007).

History teaches that there are different ways in which social and political action, and economic and religion dynamics may relate to one another. One of those cases is that of present-day political movements in favor of democracy in North African and Middle-East countries in which collective rituals organized around religion help to galvanize

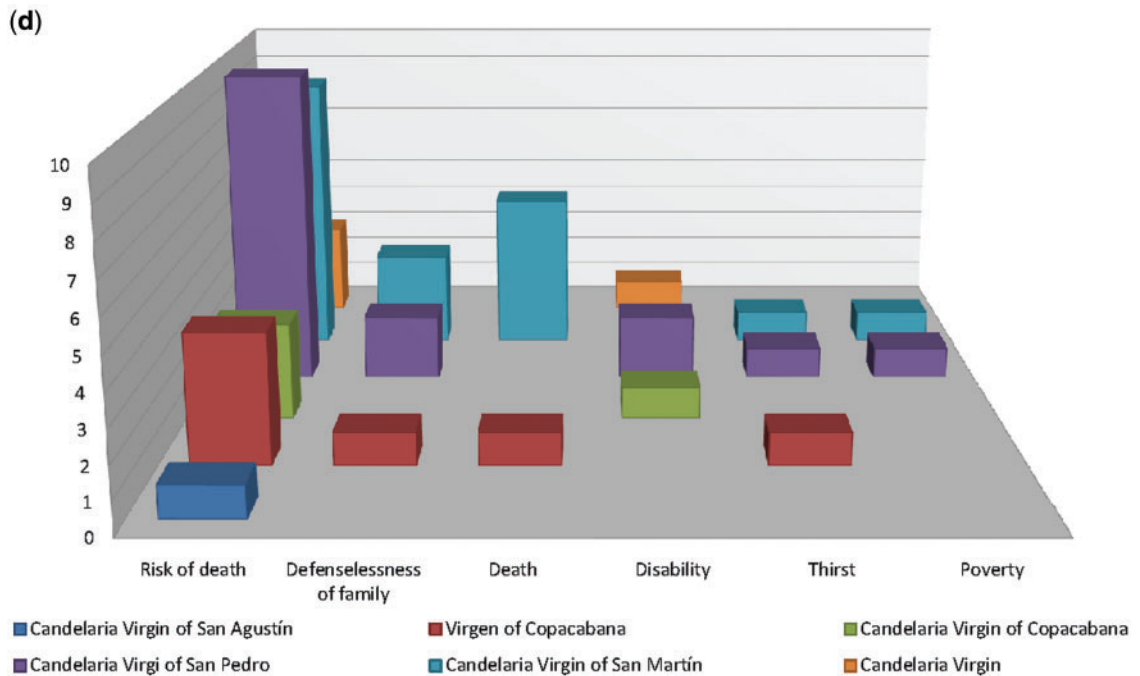
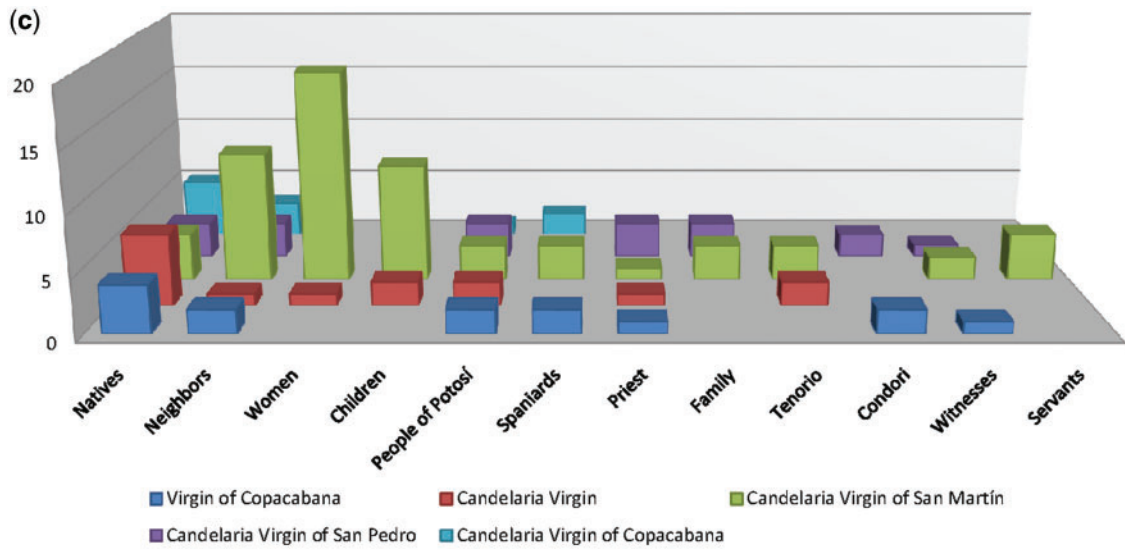
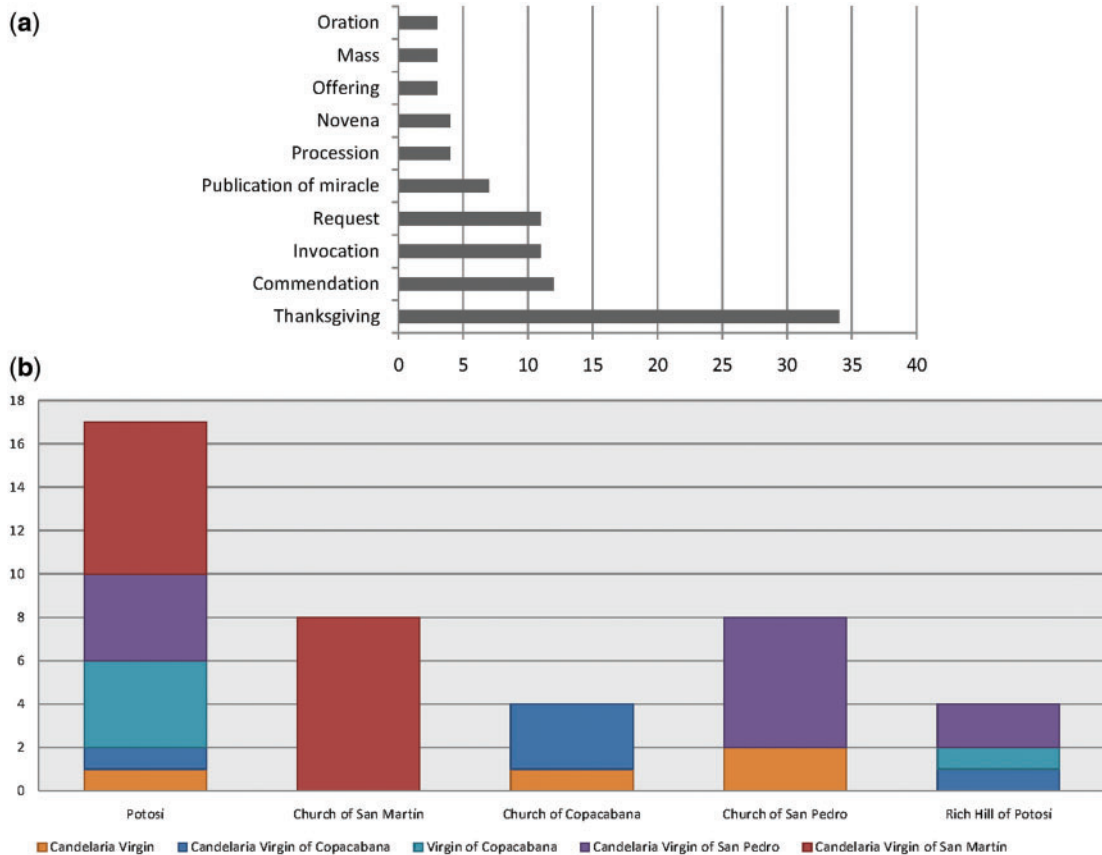


Fig. 8 Continued.

societal action against oppression and provide a high level of stability for the larger community. While preventing religious fundamentalism would make sense, ignoring the role that religious prosociality plays in fostering self-organization and naturalizing foreign ideas would be a mistake.

Finally, this article also shows how fruitful the collaboration across disciplines can be for humanists, social scientists and scientists and how much knowledge about bug problems can be gained from the combined action of large data sets analysis and humanistic interpretation.



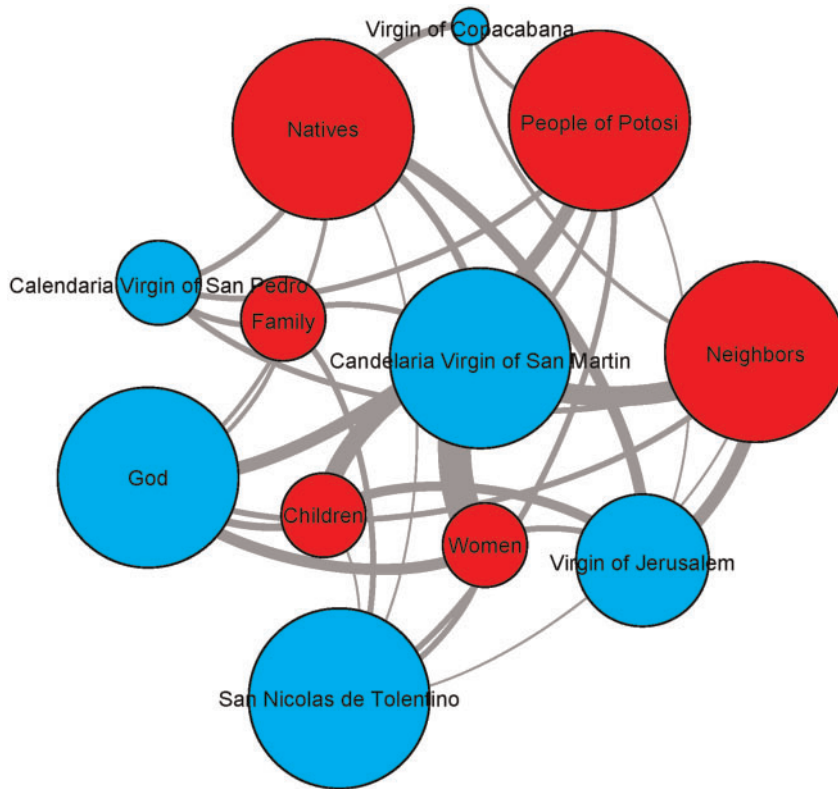
**Fig. 9** (a) Frequency of rituals in miracles related to the Candelaria Virgin in all her denominations; and (b) Places connected with the Candelaria Virgin in her main denominations.

## 4 A special virgin

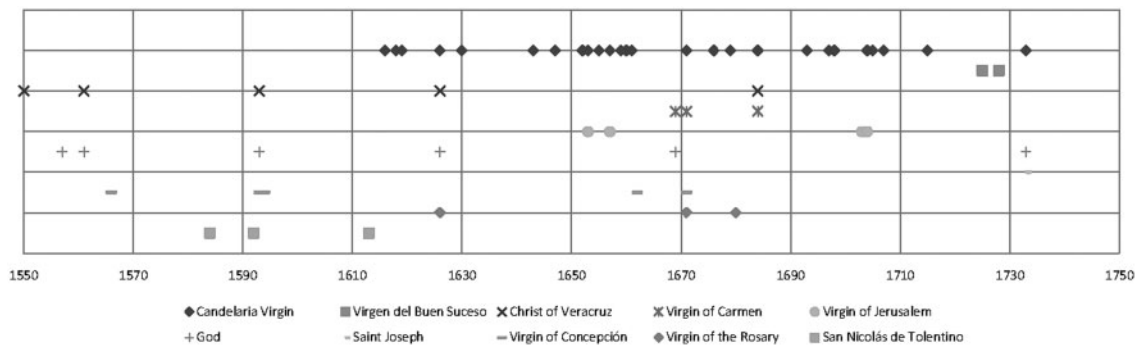
The Candelaria Virgin plays a decisive role in forming this religious network and in the stability of the process of pro-sociality described in the chronicle. If we group together the different names under which she is presented, we can see that she is responsible for approximately 40% of all miracles and that her activity is frequent from the 1650s until around 1710 (Fig. 11). The connections of this virgin with the different groups show that the indigenous people, neighbors, women, children and the ‘people of Potosí’ are those who repeatedly turn to her. If we take into account the different representations or names of this virgin, we can see that indigenous people, neighbors and the people of

Potosí have an even distribution between all of the different names of this virgin, whereas the groups of women and children have a participation tending more towards the Candelaria Virgin of San Martín.

The Candelaria Virgins intervene in almost all types of dangerous situations. However, those related to the risks of death and defenselessness of the family (normally resulting from an accident at work) are the ones with the highest number of interventions. This is related to the types of social groups who turn to her and the fact that they are mainly involved in the dangerous work in the mine. Almost in parallel to this, their activity is concentrated on miracles of salvation, healing and apparition.



**Fig. 10** Connection between miraculous characters and the different social groups that participate in the rituals relating to the miracles resulting from them (only showing the main nodes of the graph).



**Fig. 11** Chronological distribution of miracles for the main Miraculous Characters.

In terms of the geographical distribution of the intervention of these virgins, Potosí as a collective entity and the churches of San Martín and San Pedro were the places in which their activity was

concentrated. The Candelaria Virgin, whose origin is European (Espinosa, 1980), is adopted by the inhabitants of Potosí to the extent that she has become the patron saint of Bolivia today and takes

some of her features from the local pre-Hispanic god Copacabana (Sordo, 2006; Ramos Gavilán, 1867; Salles-Reese, 1997). Furthermore, her manifestations are fragmented according to the districts to which the groups requiring her intervention belong, so that some invoke the Virgin of Copacabana (a type of Candelaria), but in many other cases the dedications of the Candelaria specific to the churches of San Martín and San Pedro are those who intervene in the salvation of their faithful. These faithful are, generally speaking, indigenous people or their women, which is in line with the fact that historically these two churches were founded as parish churches for the Indians and their districts were used to accommodate the indigenous people who came to Potosí to work in the mine. These conclusions also confirm the role played by women in the social and religious life of Potosí (Boyle, 2010; Herman, 1999). This shows how local the relationship between the population of Potosí and their divinity became and how inclusive this divinity could become thanks to her general denomination of Candelaria Virgin, so that the public group rituals of different ethnic, social and district origins could unite.

## Acknowledgement

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## Notes

- 1 In *The Evolution of God*, Robert Wright has explained the evolutionary role of religion as stabilizer of social and political systems in different moments and for different religions.
- 2 Scott Atran (*Talking to the Enemy: Faith, Brotherhood, and the (Un)Making of Terrorists*.) has shown how this is a wide spread perception in Western countries about non-Christian religions, in spite the studies proving the existence of moral universals in all cultures. See also Olivier Roy's *La sainte ignorance. Le temps de la religion sans culture*.
- 3 In many occasions the author refers to the 'neighbors' as a separate group.