

Buying Your Own Congressman: Using the Market Basket Analysis To Predict Political Behavior in Brazil

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Abstract

It is widely known that corruption in Brazil is historical and, according to Fleischer (1997), it has two possible dimensions: the manipulation of political decisions and the illegal appropriation of public funds. Predicting the way a Congressman is going to vote may be an important tool in locating bribery cases, once it points to an atypical behavior. The objective here is to predict the expected voting behavior of Brazilian Congressmen in the impeachment poll of the Brazilian President, Dilma Rousseff, by August 2016. Association rules have been used for a long time as predicting tools to better offer products to clients. Therefore, we used the Market Basket Analysis to point abnormalities in expected behavior. The affinity analysis has been used over Brazilian political data, publicly available, aiming to find conduct deviations of politicians. This function employs level-wise search to find frequent items in a basket, using association rules to find the most probable consumers actions (in this case, a "basket of votes"). Data applied to the poll on the process acceptance (occurred in April) and the final voting session of Mrs. Rousseff impeachment process have shown success of the analysis, pointing unexpected actions of politicians.

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1. INTRODUCTION

Since September 17th, 2015, the impeachment proceedings have started in Brazil. In fact, that is the date when the petition to initiate the proceeding has been delivered to the President of the Deputy's Chamber. Other dates that should be mentioned are December 2nd, when the President of the Deputy's Chamber decided to receive the petition and start the proceeding, only after his process in the Ethics Committee had been accepted – he declared this didn't influence his decision at all; and April 17th, 2016, when the report approving the initial petition was voted, what put the President aside while the process is conducted to the final judgment in the Senate. Despite the enormous controversy on the correctness of this attitude, no one can deny the political trait of the whole process. The final voting is marked to the end of August, 2016, and that is why it is so intriguing to realize how the deputies and senators vote: if there is a commitment with the party, with their electors or with any other binder (meaning there may be some not so noble reasons behind their behavior).

Therefore, this paper aims to verify the expected behavior of the Congressmen using the Market Basket Analysis. The theory is frequently used by web marketing agencies while organizing the buying suggestions for consumers. It studies consumer behavior and it will offer someone determined product while he/she is buying something else, based on the behavior of other consumers. This algorithm is classic for data mining and its formal model can be found in Agrawal, Imielinski, and Swami (1993). The original aspect of this work is that we apply this very common tool from the marketing area to the choices politicians make. It means that if they have "bought" certain products, i.e. had certain actions – here, taken certain positions while voting – they will probably choose certain specific other products – or vote in a specific way. The output can show that someone may have changed his/her mind possibly by different reasons than what is expected from truthful Congressmen.

The intriguing posed question is: If there is a high probability of a Congressman voting somehow, why would he/she vote differently? This paper does not intend to have a response for that – neither politicians nor their parties will be identified here. The market basket analysis was originally developed to estimate future behavior and not exactly to find causality, but it has been used for this purpose in primary investigations. Pande and Abdel-Aty (2009), for example, used this algorithm as a support tool to successfully predict causes of car accidents, using a similar style database as the one used here. The authors concluded the *a priori* is an efficient approach to find patterns in past data and suggest the patterns should be used to develop policies in the field of safety science. In this paper, the approach is similar, but investigating political data are used. The paper estimates the future behavior and highlights there might be some unfounded reason for a conduct different from the expected one. These surprising attitudes should be considered to launch investigations.

2. THEORY

2.1. The Congress and Its Voting Process in Brazil

In Brazil, as in many countries, the congress is bicameral, formed by the Deputy's House and the Senate. The population of 204,450,649 persons (according to IBGE, 2015, the Brazilian Institute of Geography and Statistics) is represented by 513 deputies. They are elected every four years by 144,088,912 citizens (TSE, 2016), and voting is mandatory. Each of the 26 states plus the District Capital – Brazil is a Federal Republic – elect three representatives, forming the Upper House with 81 senators. Their mandate is 8-years long and the House is renewed by 1/3 or 2/3 every 4 years.

The senators are elected by the majority system, i. e., the one who gets more votes is elected. On the other hand, the deputies are elected by the proportional system, meaning that the electors vote for the party, which is going to get a certain number of chairs and, within the party, the most voted candidates will be selected. Therefore, parties stimulate very famous persons to become candidates so that they can bring votes to less known persons. The most recent and emblematic case was a clown (Tiririca) who got 1,3 million votes, the most voted candidate in the country in 2010 (the second most voted got 700,000 votes), carrying along with him other 4 persons, that had, each of them, 90,000 votes only. He was reelected in 2014 with another expressive number of votes and helping elect other 4 persons. The present configuration of the deputy's house counts only 34 deputies elected with their own votes. The others are there because of the system. This surely is one of the reasons why the representatives are so disengaged with whom they represent.

In both houses the Congressmen vote for or against law approval and their votes are public. The principle of transparency is very strong and the non-secret votes are available at the website of both houses. Some polls are still secret, according to the internal rules of each chamber, but they are rare.

According to the Brazilian Constitution (articles 59 and the followings), the process of creating a new law happens according to the following steps. Any project of law can be started by a deputy, by a senator, by the President of the Republic and by the people (fulfilled some requisites) or also by the President of the Supreme Court, of the Superior Tribunals and the Head of the Public Ministry in situations concerning the judicial system. The project starts always in the Lower House, except when a senate makes the proposition, when it starts at the Upper House. Once started, it will always follow the same procedure: first a special committee, according to the proposition, analyses its viability (e.g. Education Committee, Environment Committee, Financial Committee); then the Committee for Constitution and Justice analyses the appropriateness with the Constitution; and finally it goes to the plenary to be voted. The approval quorum depends on the type of the law, but most of them are approved with simple majority. We will not get into further details, once it is not the main purpose of this paper. After the approval, the project is sent to the other house and the same process is applied. If there are any amendments, the project returns to the initial House, which is in charge to vote solely their pertinence. Once approved, they are kept in the text; on the contrary, the main text will be sent to the President of the Republic, in charge of sanctioning or vetoing the project. After sanctioned, it becomes a law. This process is completely transparent and can be followed by anyone through the Congress website. This is the process where the votes that compose the data used here were obtained.

2.2. The Impeachment Process

As the main objective here is to predict the vote of the Congressmen in the impeachment proceeding, it may be interesting to examine how it works. The description is according to what is prescribed in the Brazilian Constitution from 1988, in the law 1079/50, that defines the crimes of responsibility and its process, in the internal rules of the Congress Houses and as it is interpreted by jurisprudence. First of all, a petition is needed where it must be clear and

proved the crime imputed to the President (Governors can also be subjected to the same kind of procedure). After this document, the President of the Lower House is going to analyze the plausibility of the accusation and, he/she is the one in charge to decide whether he/she will start the process or not. One interesting remark is that many requests have been made over the last years against all the Presidents, but none was remarkable enough to come out to media or even to be taken seriously by the President of the Deputy's House, except the one object of this paper.

It is tempting to stop with the proceeding for a while to bring some historical information on Brazil's history with impeachment. According to Fleischer (1997) (3), the first time an impeachment took place in Brazil was in 1956, but only for 10 days, while the president Juscelino Kubitschek, who had been elected in October 1955 was waiting for his inauguration on January 31st, 1956 and to guarantee that would happen. After that, the military overtook the government from 1964 to 1985 and the first President democratically elected in 1989 after the then installed dictatorship, Fernando Collor de Mello, was also subject to an impeachment in 1992. This was a very different process from the first one, with massive wave of corruption charges. The then President became ineligible for 8 years but is nowadays back to the political scenario, being currently Senate by the state of Alagoas. The actual proceeding is also very different once besides the gigantic corruption wave, there is not (yet) an evident/proved crime or money deviation committed by President Dilma Rousseff to be judged. We are not inferring any judgment; we only note that the accusations belong to different categories. Mrs. Rousseff (mainly) is accused of reorganizing the budget to favor her accountability, while Mr. Collor had effectively deviated money (Fleischer, 1997).

Back to the procedure, after receiving the accusation, the President of the Deputy's House organizes a Special Committee to analyze the petition. This Committee will search for proves and finally write a report. Once, accepted by the Committee, the report will be voted by the House. This poll means the acceptance of the petition and the Lower House approval to the Upper House conduct the process. The needed quorum is 2/3, i.e. 342 votes are necessary to accept the process. We should ask for another license to bring some information on the present impeachment against Mrs. Dilma Rousseff. This vote was organized to happen on a Sunday so that every Brazilian could watch the session – showed along the day in the main TV channels. The votes were nominal and there was a big discussion on the vote order. It means it is known and accepted already that one could change his/her vote in case the decision had already been taken. At the end of the day, 367 votes to start the impeachment process were collected.

With this approval, the process is sent to the Senate that will establish another special Committee to decide again on its acceptance. Accusation and defendant are heard and another report is voted in the plenary, being approved with simple majority – Dilma Rousseff was removed with 55 votes while only 41 would have been enough. This approval removes the President for 180 days, while the process takes place. Once the process starts, again evidences are collected, accusation and defendant are heard and a final report is produced. After approved inside the Committee, the report is voted in the plenary and is approved, with the impeachment declaration, by 2/3 of the votes. In the case, 54 votes are necessary. The vote that initiated the idea of this paper is supposed to happen in a week or two after this paper is presented.

This entire scenario in Brazil has been designed within a big popular claim against corruption. But corruption isn't a new strategy used in the country's politics, as we will see.

2.3. Corruption

There is no unambiguous definition for the term corruption and that may be one of the main difficulties in combating it. One would assume that as undesirable, but it is possible to find anthropologists who defend it can be "morally acceptable" and "socially cohesive" (Torsello and Venard, 2015): "For example, because a bribe could be part of a gift exchange implying reciprocity, cooperation, and collaboration, ethnographers have stressed that corruption can foster social harmony and cohesiveness. Ethnographic research on corruption has also shown that individuals face conflicting moralities, especially in periods of rapid economic and political

transformation.” We can, then, have a reason why corruption has taken the stage more than ever in Brazil. We have been suffering big economic and political transformation after the redemocratization in 1985. The inflation control during the 90’s and the structuring of the society perpetrated after the new Constitution came into force in 1988 mark this era. The new Constitution reorganized the “Public Ministry” and it is worthwhile to spend some moments here. In the common law system, this institution does not exist as it is here, so explaining its functioning as it is nowadays and as it happened to be may put some light to the discussion.

The “Public Ministry” used to be an institution in charge of protecting the state, but in 1988 its duty has dramatically changed and it is in charge of looking after the welfare of the society, configuring a Brazilian Government Agency for Law Enforcement. It is nowadays citizens’ rights protector, while it used to be state protector until then. After almost 28 years the new Bill of Rights is in force, we still have some persons who mix up what is from the state and what is public and this is the origin of some corruption issues. They are different concepts but straightly connected. This is the agency responsible for looking for corruption problems and chasing them. It is completely independent from government nowadays (different from what it used to be) and from any of the Republic powers, being able to pursuit any public figure involved in corruption issues. The new state apparatus built on behalf of the 88 Constitution is enabling the major control on public agents.

Add to the Constitution, the Fiscal Responsibility Act (Complementary Law 101/2000), that forbids state agents to be irresponsible with the fiscal budget. In force only in 2000, the law could manage the acts practiced after that only. Imagine any irregularity happened by that time: The Public Accounts Committee (also organized after the 1988 Constitution) would have 5 years to judge the accounts; once a fault or a fiscal crime has been realized, the member of the Brazilian Government Agency for Law Enforcement would spend around another 5 years to investigate and denounce the crime; we are now by 2010, when the process may have started, and will have taken around another 3 years (being quick) to have the first condemnation. The public agent can still appeal and may not have had his final condemnation yet. This means it is only by 2015 we have started to experience the consequences of this so important law.

In the 90’s, when Mr. Collor de Mello was impeached, we did not have the same apparatus and structure and laws and mentality we have nowadays, once the institutions were not so solid yet. 28 years after the redemocratization, this feeling of unfamiliarity with the strong public figures condemnation terrifies the politicians who were used to act in the “old way”. We may be living the beginning of a different era, with a new understanding on corruption.

Fish, Michel and Lindberg (2015) have stated: “While scholars have not reached consensus on a definition of corruption, there is general agreement that the misuse of public office for private material gain qualifies corrupt practice.” If there is not common consensus, we can then assume that certain attitudes configure corruption. It unquestionably occurs when any political agent acts in an official capacity for his or her own personal gain. If a Congressman is supposed to vote according to his party’s indicatives or according to what his electors want, he should vote in a regular manner. That is why this study may put some light to corruption hunting. If statistically he/she would vote somehow, based on his previous votes, why then he voted differently to what was expected? The result of our analysis surely does not determines there was a corrupt act, but indicates that maybe the member of the Brazilian Government Agency for Law Enforcement should pay more attention to this person. It can become an important tool to inform corruption investigation.

3. MODEL

Expected voting behavior of Brazilian Congressmen during the impeachment sessions (in both the Lower House and the Senate) was analyzed using the Market Basket Analysis, using the function *a priori* in R environment. This function searches for frequent items by using a level-wise search, locating recurrent items and returning association rules for them (Hahsler et al., 2016). Consider people choosing different products in a market. The items a person buys in

a certain period of time can be considered as part of this person's market basket and information can be mined of it. A collection of transactions in a basket type format can be mined targeting rules between sets of items, with a certain support and confidence (Agrawal, Imielinski, and Swami, 1993), in which support means the proportion of transactions a given item appears and confidence is the share of transactions in which the presence of an item or set of items outcomes in a presence of another item or set of items (conditional probability). In other words, this means that analyzing people's baskets we can predict with certain accuracy what other people who buy similar products might want and offer them.

A "basket of actions" (instead of a basket of products) was considered for this work. The previous votes of each Congressman were considered as the items they have in their collection and, among previous voting behavior, we searched for patterns (rules), which indicate voting "yes" or voting "no" to start the impeachment process. Data of all the previous voting sessions from 2015 (when Mrs. Rousseff and all Brazilian deputies began their mandates for this actual period) to the ones in which Deputy or Senator voted the impeachment of the President were collected from the official Brazilian Congress website (Fleischer, 1997), exported in a .txt format, month per month, until the last voting session before the one in which starting the impeachment process was decided. The files with voting data (part of the documents had other bureaucratic information not related to this paper) were merged in one only document, which include material related to the session, the Deputy/Senator and his/her vote, party, state and personal number. Part of the .txt final file used is shown in Figure I.

CC010005E	006127	ABEL MESQUITA JR.	Não	PDT	Roraima	1
CC010005E	006127	MARIA HELENA	Sim	PSB	Roraima	6
CC010005E	006127	REMÍDIO MONAI	Sim	PR	Roraima	7
CC010005E	006127	SHÉRIDAN	Não	PSDB	Roraima	8
CC010005E	006127	CABUÇU BORGES	Sim	PMDB	Amapá	14
CC010005E	006127	MARCOS REATEGUI	Sim	PSC	Amapá	12
CC010005E	006127	PROFESSORA MARCIVANIA	Não	PT	Amapá	15
CC010005E	006127	ROBERTO GÓES	Não	PDT	Amapá	17
CC010005E	006127	BETO FARO	Sim	PT	Pará	19
CC010005E	006127	BETO SALAME	Sim	PROS	Pará	20
CC010005E	006127	DELEGADO ÉDER MAURO	Sim	PSD	Pará	22
CC010005E	006127	EDMILSON RODRIGUES	Não	PSOL	Pará	27
CC010005E	006127	ELCIONE BARBALHO	Sim	PMDB	Pará	21
CC010005E	006127	FRANCISCO CHAPADINHA	Não	PSD	Pará	28
CC010005E	006127	HÉLIO LEITE	Não	DEM	Pará	32
CC010005E	006127	JOAQUIM PASSARINHO	Não	PSD	Pará	33
CC010005E	006127	JÚLIA MARINHO	Não	PSC	Pará	34
CC010005E	006127	NILSON PINTO	Não	PSDB	Pará	31
CC010005E	006127	SIMONE MORGADO	Não	PMDB	Pará	35
CC010005E	006127	ZÉ GERALDO	Sim	PT	Pará	25
CC010005E	006127	ARTHUR VIRGÍLIO BISNETO	Não	PSDB	Amazonas	37
CC010005E	006127	ÁTILA LINS	Não	PSD	Amazonas	38
CC010005E	006127	CONCEIÇÃO SAMPAIO	Não	PP	Amazonas	41
CC010005E	006127	MARCOS ROTTA	Não	PMDB	Amazonas	43

Figure I. Fragment of the Final Database

Four categories of votes were created: yes ("sim"), no ("não"), absence in the session and other (that includes abstention, obstruction and other not common answers). The amount of votes per politician was from one up to 339 (338 previous votes and impeachment voting session) and the number of each Congressman was between one and 949, including substitutes and blanks. Numbers related to blank spaces were identified as "NotAvailable" and considered in the tables, although with no interference in the results. A table linking the strings representing session and vote to their respective voter number was created (looking at Figure I, that means linking, "006127,Não" to the number 1, "006127,Sim" to the number 6 and so on). Another table linking the politicians' numbers and their actual party was also created. The number was chosen in place of the politicians' names because it's easier to handle and, at the same time, it avoids a fast identification of the person (although it is easy to identify the voter and his/her party by his/her number, in this paper they'll not be explicitly shown).

After these steps, the table with the voting data was transformed in a new table, in a format that can be read by the *apriori* function, to run this association rules algorithm. The search for

rules was done in R environment, using the *apriori* parameters as support=0.2, confidence=0.9 and minlen=6.

This implies that were only considered for this analysis votes that appeared in more than 20% of the baskets per session and the rules had at least 5 different items resulting the “vote for (or against the) impeachment” behavior (i.e. Congressmen voted v1, v2, v3, v4, v5 and v6, being v6 “yes” or “no” at the impeachment session voting). The confidence of 0.9 means that, at least 90% of the Congressmen who voted v1, v2, v3, v4 and v5 also voted v6. The only two targets searched in this work were positive and negative votes to start the process of Mrs. Rousseff’s impeachment.

4. ANALYSIS AND DISCUSSION

Surprisingly, zero association rules implying negative vote were found, while 497 rules for positive votes were discovered with the specified parameters. All of the association rules found had a lift higher than two, what means for all of them was at least two times more probable a person would vote “yes” if he or she had that previous behavior than would vote “no” (voting v1, v2, v3, v4, v5 and v6 is at least two times more probable than voting v1, v2, v3, v4 and v5 and not voting v6). For the next step, we checked how many patterns each politician obeys, by searching how many rules are present in each Congressman history of votes. This number was, then, divided by the total of patterns found (497) and the given density was linked to each voter. Because the objective of this paper is to find incongruences in the voting behavior, a person whose ratio was higher than 50% and whose expected vote was “yes” for starting the impeachment process of Mrs. Rousseff but voted “no” were flagged. Since no association rule was found for voting “no”, it was not necessary to repeat the procedure for this other situation. Finally, the flagged politicians were sorted in order of higher ratio first, and their parties were identified. The results can be seen in Table I:

Table I. Flagged Politicians

<i>Politician</i>	<i>Party</i>	<i>Association Rules</i>	<i>Density</i>
<i>A</i>	<i>P1</i>	493	99.2%
<i>B</i>	<i>P1</i>	478	96.2%
<i>C</i>	<i>P1</i>	470	94.6%
<i>D</i>	<i>P1</i>	460	92.6%
<i>E</i>	<i>P2</i>	410	82.5%
<i>F</i>	<i>P3</i>	361	72.6%
<i>G</i>	<i>P4</i>	339	68.2%
<i>H</i>	<i>P5</i>	264	53.1%
<i>I</i>	<i>P4</i>	261	52.5%

The data clearly suggest these Congressmen have acted in a non-expected way, what could indicate some external influence. Although politicians I, H and G responded to half or even 2/3 of the association rules for voting positively and they ended up voting against the impeachment, this might not necessarily mean a deviation of expected behavior (people may change their political positions in time, still have doubts about the situation voted etc.). On the other side, the situation changes for higher ratios, i.e. deputies A, B, C, D, E and F. Somebody who has the same behavior as a significant part of his/her peers concerning most part of the topics voted would rarely have a different opinion in a main topic (impeachment) that would only allow or not someone to be put in a trial. We must specify that the analyzed voting session

was not the voting of a certainty (“the President is innocent” or “the President is guilty”), but the voting of a doubt (“the President may not be innocent”) that allows (or not) starting the investigation on the public agent. It is also remarkable that deputies A, B, C and D belong to the same party.

Considering that an action different than the expected one could be motivated by a party strategy, the votes of Congressmen A, B, C, D, E and F were compared to their parties’ votes. The Table II shows the behavior of the parties 1, 2 and 3 in the impeachment voting sessions (Lower House and Senate).

Table II. Parties’ Voting Behavior

Party	Yes	No	Other	Total
P1	30 (68.2%)	10 (22.7%)	4 (9.1%)	44 (100%)
P2	44 (86.3%)	4 (7.8%)	3 (5.9%)	51 (100%)
P3	72 (84.7%)	9 (10.6%)	4 (4.7%)	85 (100%)

Data show that these parties vote “yes” in majority, meaning they would be favorable to starting the impeachment procedure, while the analyzed politicians voted “no”, meaning their action was probably not based in any strategy defined or influenced by the party. Data show they voted against their party’s main position. In fact, the votes of these parties’ politicians are not homogenous, showing they haven’t acted as a group. [This is another issue that could be studied after applying the present model to the voting sessions: The link of the elected deputy and the ideals his/her party conceives. We happen to know this link is not so strong, but further studies could possibly prove this inferring]. Then: If their rule of behavior strongly points at a specific type of vote (“yes”); If their vote didn’t obey the expected rule (they voted “no”); If it is demonstrated they didn’t follow any party instruction; Then, an intriguing question lingers: What could possibly have made them change their minds?

5. FINAL REMARKS

Applying the Market Basket Analysis with the function *apriori* in R environment to the voting sessions in Brazil has raised some very strong indicatives of non-expected behavior that could be investigated by the members of the Government Agency for Law Enforcement. We are definitely not allowed to conclude there were frauds during the voting session to install the impeachment procedure of the Brazilian President; however, we can question the good faith of these Congressmen. This tool has shown to be an efficient way to indicate where an investigation could start.

A limitation of this study is the proximity in time, so that we still don’t have the outcome of any investigation. If their mind changing had affected the result, then we could see any investigation. But the result was not influenced and, from what we can predict based on the theory, the impeachment is inevitable, what puts an investigation even farther. One positive outcome is that the same tool used here could be used, as indicated before, in other similar situations, like the linkage of the politicians to their party’s proposals. The *apriori* algorithm is easy to handle and with access-free data many new applications could be thought like applying in other countries or for different situations.

Positive outcomes are the *apriori* algorithm is easy to handle and the data is access-free, letting this work simply to reproduce (and even identify politicians and parties) and the same

process used here could be used, as indicated before, in other similar situations or in other countries, if available the data.

Though we can never assure frauds have happened, there are strong indicators, according to the findings, to the non-correct attitude of the indicated Congressmen in the studied situation.

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POST-SCRIPTUM

Within the presentation of the paper and its publication, the impeachment session happened (on August 31st, 2016) and it is desirable to inform the readers that, as expected, the President was impeached. It was the second impeachment in Brazil after redemocratization. From the 81 Senators, 78 were present and 55 voted for the impeachment (54 were needed). An unexpected outcome had to do with the possibility of the impeached president occupy any other public spot. Surprisingly, only 42 of the same voters chose to withdraw her political rights, i.e., she was impeached, but didn't lose her political rights for 8 years, as expected. This has been matter for lots of different comments maybe to be explored in any other paper.

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